Student Achievement Committee Meeting

Wednesday, September 16, 2026 7:00 PM
BOE Auditorium and via Zoom Meeting Platform, 129 Church Street, Bristol, CT 06010

1.	**Call to Order/ Pledge of Allegiance**	
2.	**Decision: Approval of Minutes**	
3.	**Public Comment**	
4.	**Information: Nesolagus Collaboration with BPS**	**Presenter:** Aaron Lyles & Carly Fortin
5.	**Discussion: School Calendar**	**Presenter:** Joseph Grabowski & Carly Fortin
6.	**Decision: Graduation Date, Class of 2027**	**Presenter:** Joseph Grabowski & Carly Fortin
7.	**Information:PSAT/SAT Outcomes**	**Presenter:** Carly Fortin
8.	**Information: Attendance & Discipline Outcomes**	**Presenter:** Erika Treanni
9.	**Information: Pilot of Curriculum Sprints**	**Presenter:** Carly Fortin
10.	**Decision: Latin Historical Prose, New Course**	**Presenter:** Leszek Ward
11.	**Decision: Algebra 2 Revision**	**Presenter:** Laura Lanza
12.	**Decision: Grade 6-8 Science Revision**	**Presenter:** Laura Lanza
13.	**Adjournment**	

PROCEDURES FOR REMOTE PUBLIC COMMENT

Members of the public are invited to comment to the Board on any topic related to school business.

Items requiring consideration by the Board must be approved as an agenda item by a 2/3ds vote of the Board members present. Such items may be referred for further study and not necessarily acted upon at this meeting.

Anyone wishing to address the Board should adhere to the following procedures:

PUBLIC COMMENT

Before a Remote Meeting

1. Send your comments to: KatlyneLaprise@bristolk12.org
2. Be sure to put **PUBLIC COMMENT-SAC** in the subject line.
3. Include your name and address.
4. Direct your comments to the Board Chair.
5. Your comments will be read at the meeting by the Board Chair.
6. All comments should be written in an appropriate manner, particularly if concerning a personnel matter.
7. Any comments not adhering to the guidelines will not be read at the meeting.

During a Remote Meeting

1. Everyone is requested to address the Chair for recognition.
2. Each speaker must state his/her name and address.
3. All speakers must observe rules of common etiquette. Personalities are not to be injected. Anyone violating this rule will be denied the floor. Unless waived by the Chairperson or a majority of the Board,
4. Each speaker shall limit his/her remarks to three (3) minutes.
5. A speaker will not be recognized for a second time on the same topic.
6. Each speaker must concern himself/herself with the topic under discussion. Anyone digressing from the topic will be ruled out of order.
7. Written statements and materials may be made available, in advance of comments, for distribution to Board members.
8. Speakers shall state their positions on the subject being discussed.
9. Board members will not respond directly to comments during the Board meeting. The Superintendent will direct the question to the appropriate staff member for follow-up.

Bristol Public Schools

Bristol, Connecticut

Bristol Public Schools

25-26 Chronic Absenteeism

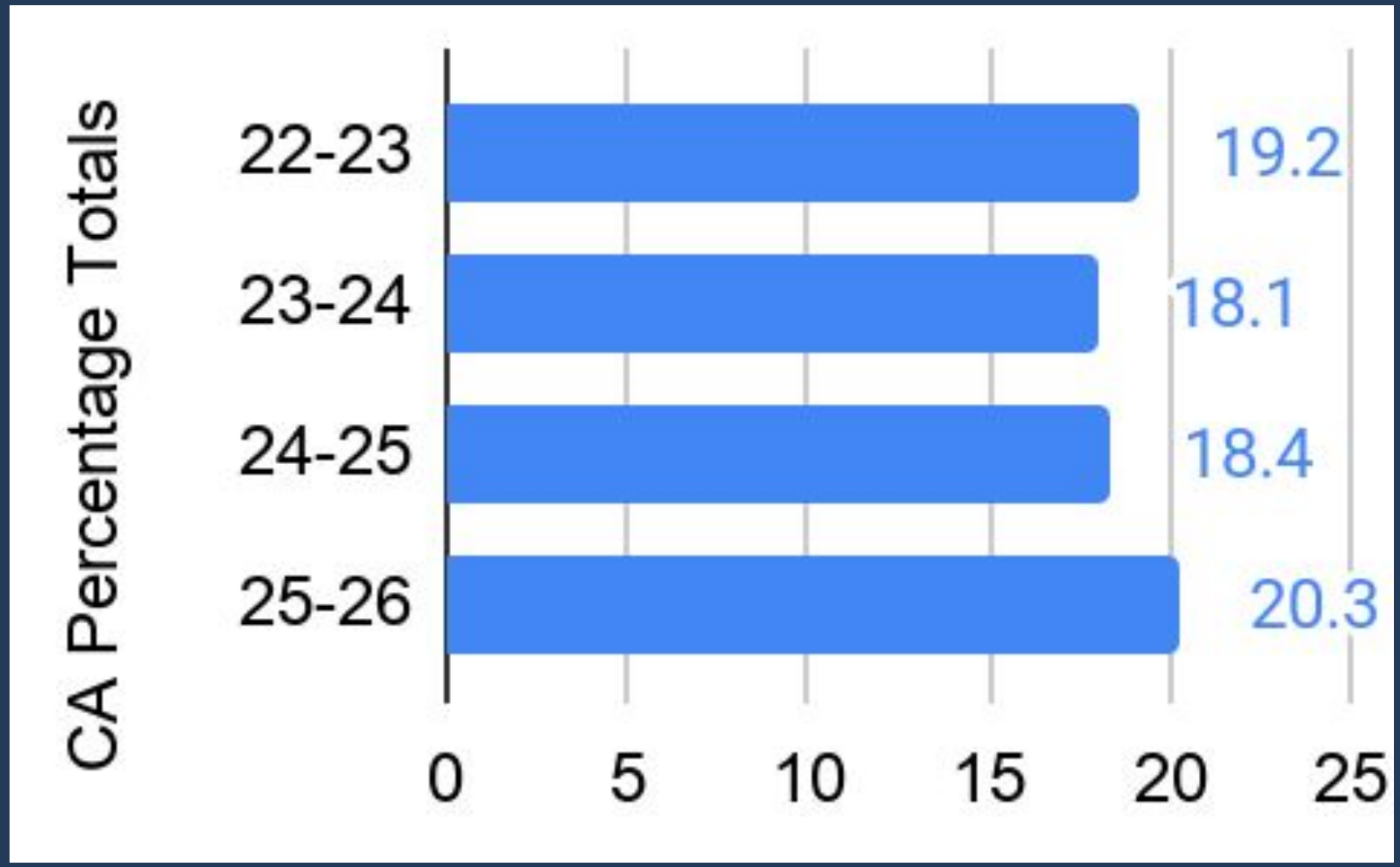
Student Achievement Committee

Growth

- Multiple schools reduced chronic absenteeism year over year
- Several schools achieved rates in the single digits or low teens
- Strong elementary-level gains are evident in several schools
- Our high schools were an area for celebration
- Successful attendance practices are emerging across the district
- BPS has been invited to share our attendance work and successful systems at multiple state conferences.

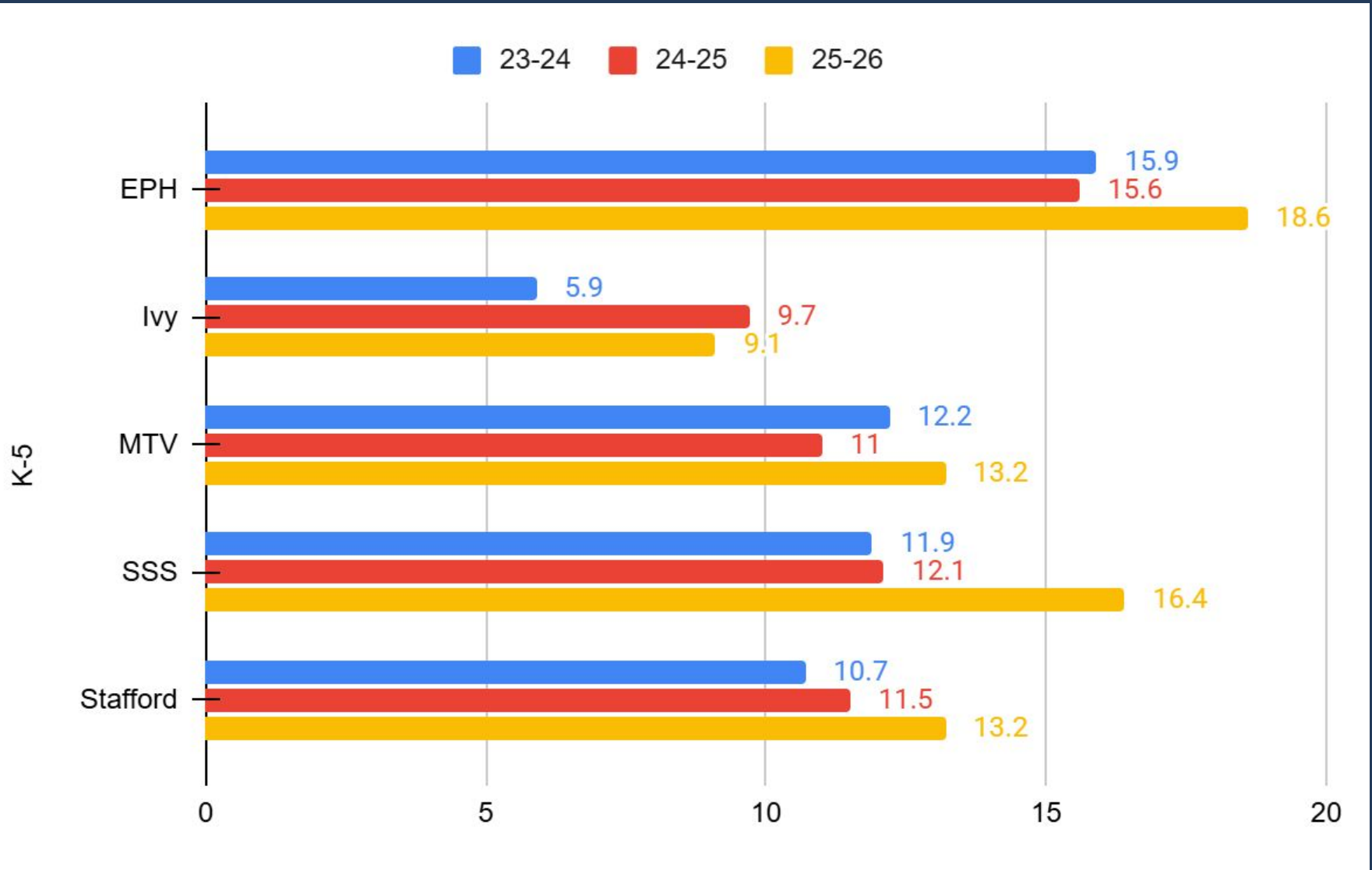
Bristol Public Schools

District Totals:



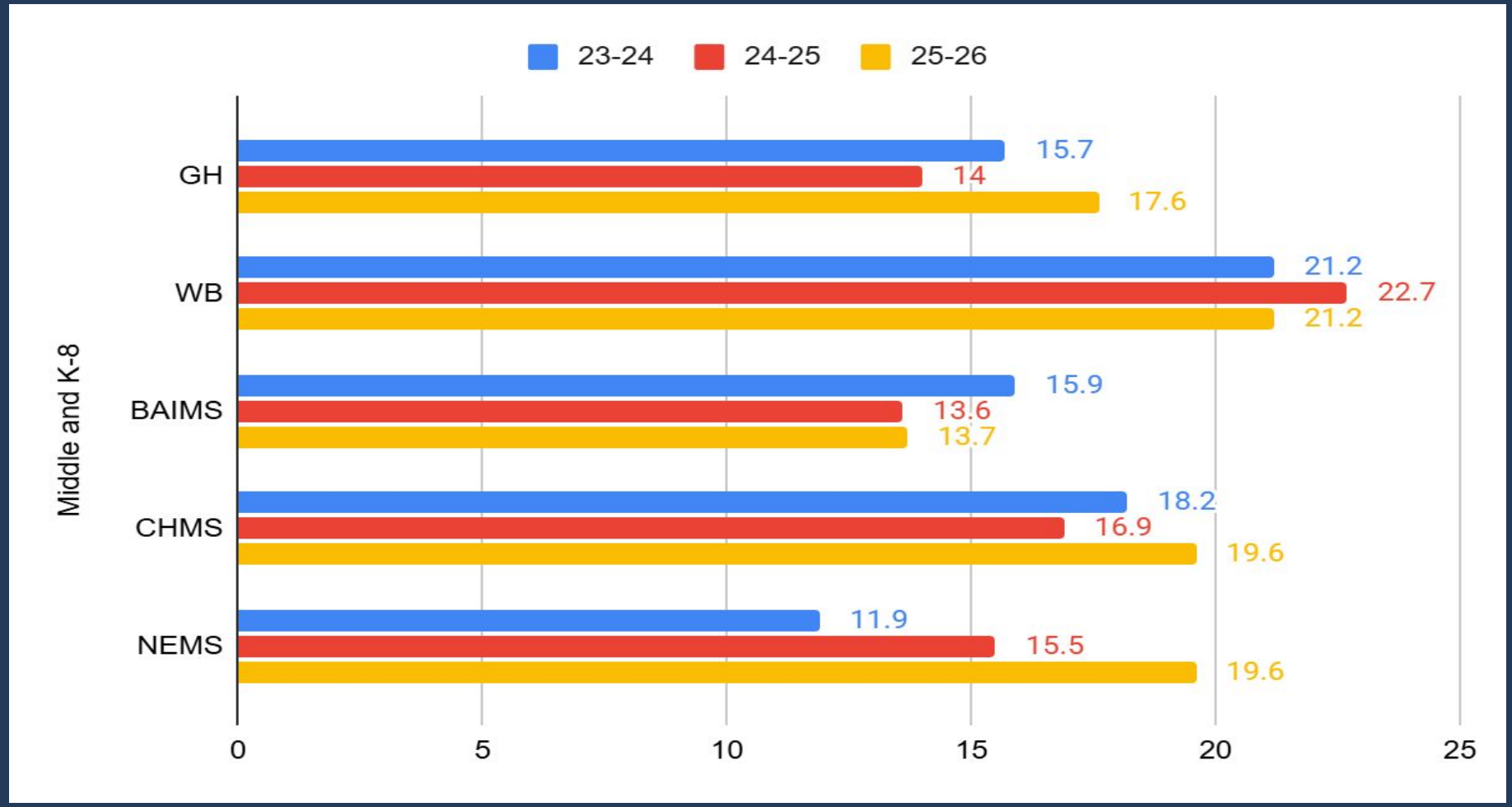
Bristol Public Schools

K-5



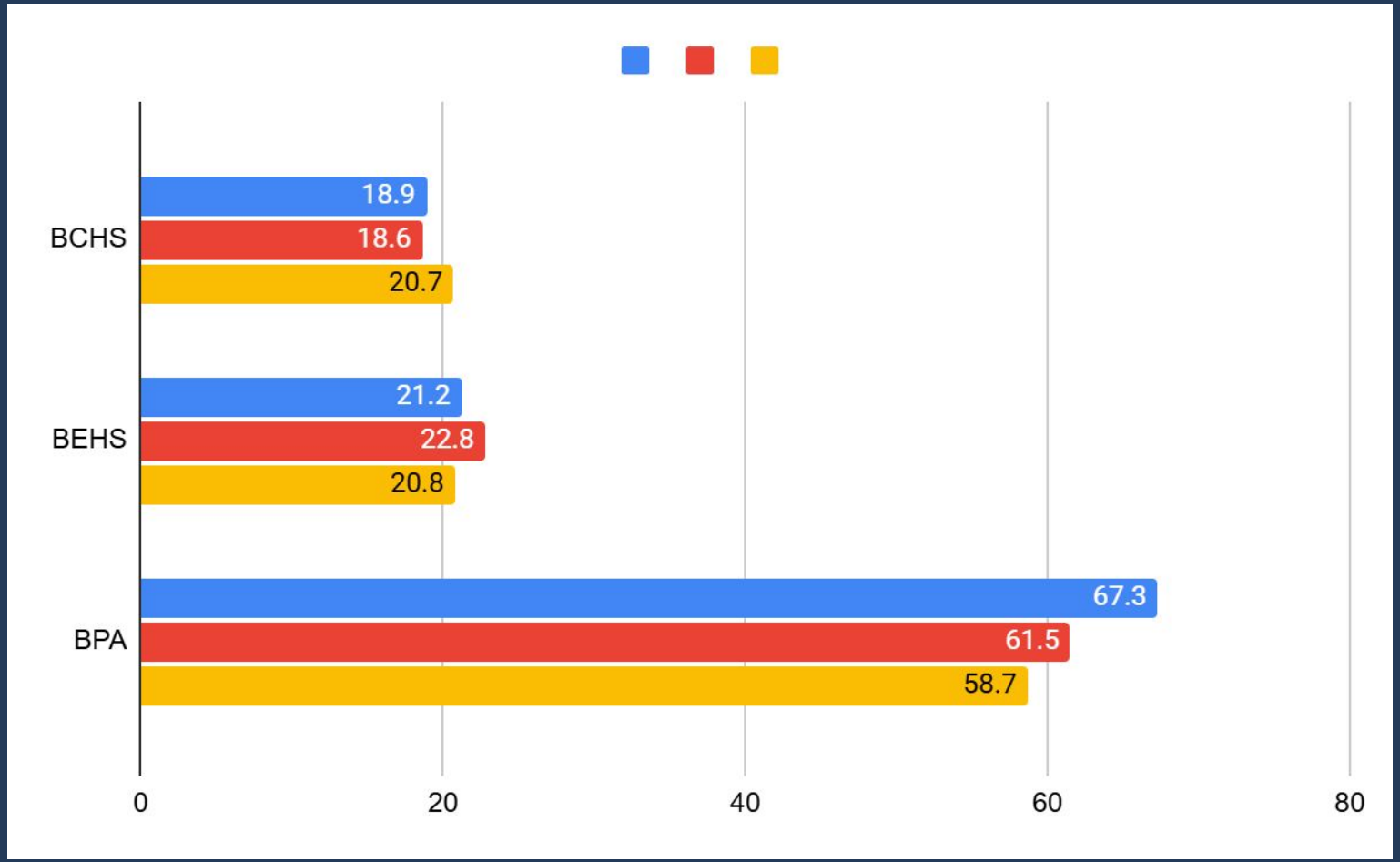
Bristol Public Schools

K8 and MS



Bristol Public Schools

High Schools



Bristol Public Schools

	September			October			November			December			January			February			March			April			May			June		
	Sept % Missing 10%			Oct % Missing 10%			Nov % Missing 10%			Dec % Missing 10%			Jan % Missing 10%			Feb % Missing 10%			March % Missing 10%			April % Missing 10%			May % Missing 10%			June % Missing 10%		
	23-24	24-25	25-26	23-24	24-25	25-26	23-24	24-25	25-26	23-24	24-25	25-26	23-24	24-25	25-26	23-24	24-25	25-26	23-24	24-25	25-26	23-24	24-25	25-26	23-24	24-25	25-26	23-24	24-25	25-26
S	19.90%	10.11%	8.33%	10.70%	11.99%	10.61%	16.48%	14.98%	12.88%	13.60%	15.36%	11.74%	14.65%	17.51%	12.12%	16.79%	20.90%	13.64%	17.15%	18.28%	14.02%	15.69%	16.79%	10.61%	15.33%	16.42%	10.61%	16.79%	15.85%	14.39%
	25.50%	17.98%	17.28%	16.20%	21.49%	19.49%	21.52%	24.44%	24.32%	20.76%	23.72%	23.32%	21.29%	23.51%	24.18%	23.62%	26.18%	26.99%	23.19%	25.89%	27.42%	22.13%	24.96%	25.75%	23.61%	24.43%	26.21%	22.90%	25.00%	26.94%
	25.60%	15.89%	16.39%	17.60%	21.79%	18.48%	24.43%	26.83%	22.49%	21.98%	26.80%	23.08%	22.32%	26.79%	21.83%	25.72%	29.47%	24.19%	25.63%	28.54%	24.79%	24.91%	27.84%	23.03%	25.40%	27.98%	24.05%	25.04%	25.69%	25.76%
	65.20%	48.00%	40.48%	54.10%	58.82%	44.19%	72.34%	64.71%	51.16%	69.57%	72.55%	52.17%	70.69%	70.69%	58.49%	71.67%	75.86%	66.67%	70.00%	70.69%	61.11%	69.49%	68.97%	64.81%	71.19%	68.97%	61.11%	71.19%	67.24%	63.64%
	22.90%	14.04%	13.85%	16.60%	15.32%	14.31%	22.37%	18.20%	18.14%	22.03%	17.74%	19.97%	22.33%	18.98%	21.46%	24.88%	23.39%	22.20%	23.44%	20.85%	22.27%	21.89%	19.74%	20.21%	21.83%	20.39%	19.24%	22.45%	19.83%	22.60%
-8	20.80%	11.15%	12.93%	16.10%	12.27%	12.23%	22.53%	14.69%	16.06%	19.45%	15.20%	14.93%	21.44%	17.10%	15.93%	20.68%	19.22%	17.10%	20.45%	17.65%	18.39%	20.65%	16.87%	16.51%	19.08%	16.67%	17.18%	18.88%	16.17%	20.17%
X-8	23.90%	13.73%	11.94%	17.10%	16.76%	14.58%	23.01%	21.65%	18.69%	23.19%	21.40%	19.02%	26.28%	23.99%	21.71%	24.80%	29.32%	22.25%	25.53%	27.81%	21.37%	26.00%	25.19%	20.45%	24.94%	25.03%	21.08%	23.39%	24.29%	23.68%
	20.80%	14.20%	11.18%	9.20%	14.45%	12.57%	14.13%	18.53%	16.62%	14.09%	17.30%	16.57%	16.08%	19.01%	16.23%	17.62%	22.03%	18.50%	17.12%	21.39%	18.86%	15.68%	19.60%	19.09%	14.48%	17.82%	21.31%	13.93%	17.92%	22.51%
	28.50%	12.94%	14.99%	15.30%	15.86%	14.40%	21.98%	19.15%	18.16%	20.38%	19.21%	20.92%	22.67%	20.68%	21.14%	22.55%	25.92%	23.14%	22.45%	27.75%	22.83%	21.93%	24.74%	21.88%	20.88%	21.88%	19.27%	19.49%	22.36%	23.18%
	12.90%	9.51%	9.90%	5.80%	8.98%	6.88%	8.09%	12.29%	10.29%	9.38%	10.61%	10.24%	8.83%	13.70%	10.02%	10.36%	17.70%	10.27%	8.55%	14.25%	9.29%	6.96%	14.45%	8.25%	6.70%	13.00%	8.50%	6.70%	11.37%	9.95%
	22.10%	11.53%	10.54%	11.20%	12.77%	10.92%	18.62%	15.51%	15.41%	16.57%	15.16%	14.25%	18.03%	15.61%	13.37%	17.50%	16.67%	14.44%	15.89%	16.89%	15.51%	15.93%	15.79%	13.89%	15.89%	14.21%	14.64%	13.97%	12.77%	16.02%
	18.70%	8.53%	10.47%	12.20%	9.37%	11.02%	21.12%	12.10%	14.40%	18.76%	16.70%	16.40%	17.18%	19.67%	16.10%	17.18%	23.49%	17.03%	14.74%	19.27%	16.33%	15.54%	17.30%	14.51%	14.95%	15.97%	14.43%	13.27%	14.55%	17.59%
	20.70%	11.57%	8.97%	13.40%	11.93%	8.65%	17.37%	14.47%	11.81%	16.10%	13.49%	15.04%	18.04%	19.24%	14.96%	15.46%	20.35%	15.17%	15.13%	18.91%	16.38%	15.27%	15.38%	15.89%	15.05%	13.86%	14.18%	13.74%	14.15%	15.65%
ations	71.05%	44.12%	38.71%	67.50%	66.67%	44.12%	62.79%	62.86%	54.05%	62.79%	58.33%	56.76%	64.44%	57.89%	63.00%	62.79%	53.84%	59.52%	63.64%	58.97%	62.79%	63.64%	61.54%	64.58%	63.64%	61.53%	59.18%	63.64%	66.67%	61.54%
ct	22.80%	13.84%	13.52%	15.25%	16.25%	14.47%	21.51%	19.73%	18.47%	20.23%	19.81%	19.02%	21.26%	21.39%	19.68%	22.14%	24.55%	21.18%	21.62%	23.17%	21.42%	21.12%	21.80%	20.01%	20.96%	21.17%	20.16%	20.20%	21.16%	22.36%

Bristol Public Schools

Areas for growth and Improvement:

- Increase targeted support for students with persistent attendance concerns
  Move beyond general attendance messaging and ensure students with repeated absences are receiving individualized outreach and intervention.

- Continue examining disparities among student groups and schools to ensure supports are reaching students who need them most.

- Climate and Culture: Monitor discipline trends and how it impacts attendance rates.

- Continue examining disparities among student groups and schools to ensure supports are reaching students who need them most.

Bristol Public Schools

Course Title:	Content Area:	Grade Level:	Credit (if applicable)
Latin Historical Prose	**World Language**	**11th-12th**	**.5**

Course Description:

This semester-long course will explore topics in Roman history, especially the founding stories of the Monarchy and the early Republic, through actual texts written by ancient Roman authors, including Livy, Cornelius Nepos, and Eutropius. Students demonstrate familiarity with Rome's politics, history, and topography, as well as the passive voice and subjunctive mood in a variety of clausal constructions.

Aligned Core Resources:	Connection to the ***BPS Vision of the Graduate***
• *Dickinson Classics Commentaries:* Latin Texts • The Pericles Group: Tiered Readings Collection • The Latin Library	GLOBAL AWARENESS • Learn from and work collaboratively with individuals representing diverse cultures, religions and lifestyles in a spirit of mutual respect and open dialogue in personal, work and community contexts. • Understand other nations and cultures, including the use of non-English language
Knowledge/Skill Dependent courses/Prerequisites:	**Link to *Completed Equity Audit***
• Latin 2	• Latin Historical Prose 2026 - Curriculum Equity Audit

Unit Links

Standard Matrix
Unit 1: Origins: the Monarchy (Livy)
Unit 2: Honorable Enemy: the Republic (Cornelius Nepos)
Unit 3: Conspiracy: the Republic (Sallust

Standard Matrix	Unit 1	Unit 2	Unit 3
1.1 Interpersonal Communication: Learners interact and negotiate meaning in spoken, signed, or written conversations to share information, reactions, feelings, and opinions.			
1.2 Interpretive Communication: Learners understand, interpret, and analyze what is heard, read, or viewed on a variety of topics.	x	x	x
1.3 Presentational Communication: Learners present spoken, written, or signed information, concepts, and ideas to inform, explain, persuade, and narrate on a variety of topics using appropriate media and adapting to various audiences of listeners, readers, or viewers.	x	x	x
2.1 Relating Cultural Practices to Perspectives: Learners use the language to investigate, explain, and reflect on the relationship between the practices and perspectives of the cultures studied.	x	x	x
2.2 Relating Cultural Products to Perspectives: Learners use the language to investigate, explain, and reflect on the relationship between the products and perspectives of the cultures studied.	x	x	x
3.1 Making Connections: Learners build, reinforce, and expand their knowledge of other disciplines while using the language to develop critical thinking and to solve problems creatively.	x	x	x
3.2 Acquiring Information and Diverse Perspectives: Learners access and evaluate information and diverse perspectives that are available through the language and its cultures.	x	x	x
4.1 Language Comparisons: Learners use the language to investigate, reflect on, and explain the nature of language through comparisons of the language studied and their own.	x	x	x
4.2 Cultural Comparisons: Learners use the language to investigate, explain, and reflect on the concept of culture through comparisons of the cultures studied and their own.	x	x	x
5.1 School and Global Communities: Learners use the language both within and beyond the classroom to interact and collaborate in their community and the globalized world.			

Unit 1: Origins: the Monarchy (Livy)

Overview:

Relevant Standards: Bold indicates priority

- 1.2 Interpretive Communication: Learners understand, interpret, and analyze what is heard, read, or viewed on a variety of topics.2.1 Relating Cultural Practices to Perspectives: Learners use the language to investigate, explain, and reflect on the relationship between the practices and perspectives of the cultures studied.
- 2.1 Relating Cultural Practices to Perspectives: Learners use the language to investigate, explain, and reflect on the relationship between the practices and perspectives of the cultures studied.
- 2.2 Relating Cultural Products to Perspectives: Learners use the language to investigate, explain, and reflect on the relationship between the products and perspectives of the cultures studied.
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- 4.1 Language Comparisons: Learners use the language to investigate, reflect on, and explain the nature of language through comparisons of the language studied and their own.
- 4.2 Cultural Comparisons: Learners use the language to investigate, explain, and reflect on the concept of culture through comparisons of the cultures studied and their own.

Overview

In this unit, students explore the line between myth and history by reading the foundational stories of early Rome. Students follow key narratives, from the origin story of Aeneas to the founding legend of Romulus and Remus to see how Rome defined itself. By reading Livy, students examine how storytellers used these legends to bring stability to a society recovering from civil war. Students analyze Livy's complex role as a writer who doubted stories of divine intervention, yet still retold them because they showcased core Roman values: military courage, fate, and devotion to the gods. Ultimately, students investigate how ancient writers used the past not just to report facts, but to shape public identity and justify power.

Essential Question(s):

1. What does history mean to different audiences and authors?
2. What does Livy's treatment of Roman early history reveal about the ancient world?

Enduring Understanding(s):	
1. At a time of political instability and transition, ancient authors like Livy turn to foundational myths to define what is meant to be Roman. While the line between mythology, history and propaganda in the ancient world is often blurred, preserving narratives of martial valor (virtus), religious duty (pietas), and fate (fatum) was essential to forging collective identity and making sense of contemporary events, even when historians felt ambivalent about their factual accuracy.	
Demonstration of Learning:	**Unit Specific Vocabulary**

• Exam
  ○ Students will translate equivalent sight passages with the assistance of vocabulary and notes.
  ○ Students will use Latin passages to reflect on themes discussed.
  ○ Students will identify prepositional phrases and noun cases in familiar Latin passages.
• Project on Artifact, Image, or Map
  ○ Part 1: Research/Presentation explaining basic contextual information, source, material, current location, etc
  ○ Part 2: Museum Label using evidence from the text to support visual analysis, roman virtues, contextual significance, historical accuracy.
	Vocab Lists
	• Vocabulary from passages, prioritized by Latin Core Vocabulary
	Key Verbs / Phrases
	• *Fatum*
	• *Virtus*
	• *Pietas*
	Grammatical Concepts
	• prepositional phrases
	• variety of uses of different noun cases
	• ablative absolutes

Connections to Prior Units:	**Connections to Future Units:**
• None	• Students will be prepared to analyze how ancient authors define Roman identity externally through foreign adversaries like Hannibal, expanding on the internal foundation myths studied in this unit. • Students will return to the core Roman values (virtus, pietas, fatum) established in foundational myths when they evaluate how these virtues are applied to, subverted by, or recognized in Hannibal in Unit 2. • Studying Livy's ideal depiction of early Roman civic unity will prepare them to see a contrast to Sallust's portrait of systemic greed, debt, and factionalism during the late Republic.
Family Overview (link below)	**Pacing for Unit**
•	• 15 lessons, 6 weeks

Integration of Technology:	**Aligned Unit Materials, Resources, and Technology:**
• Use of google docs is recommended throughout the writing process to facilitate drafting, feedback, collaboration, and revision. • Digital resources will be used to review and explore vocabulary.	•
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions:**
• ELA: Push students to compare Livy's direct editorializing in historical prose to Jon Krakauer's authorial interventions in Into the Wild (11th grade) in order to help them recognize how even non-fiction authors insert their own perspectives/biases into factual accounts.	• Students may assume that ancient historical writing operated like modern non-fiction or objective news reporting, failing to recognize that ancient history was primarily a narrative art designed to deliver moral lessons and shape civic identity. • Students may assume there is a single, objective, and authoritative account of history, failing to recognize how ancient historians like Livy selectively synthesized conflicting oral traditions, regional variants, and political myths into a narrative shaped by their own political contexts and social aims. • Students may dismiss ancient mythology as simple, purely fictional fairy tales, failing to see how Romans used mythic origin stories as powerful cultural symbols carrying profound political authority and shared identity. • Students may view religion and history as completely separate domains, failing to recognize that divine will, omens, and religious devotion (pietas) were considered integral forces driving Roman historical outcomes.
Differentiation through *Universal Design for Learning*	
UDL Indicator • Consideration 3.1: Connect prior knowledge to new learning	**Teacher Actions:** • Introduce students to tiered translations of Livy's text, allowing students to isolate the primary historical action simpler translations before re-assembling more complex structures and original text. • Bridge the transition from adapted Latin 2 narrative prose to Livy's complex periodic style by using sentence organizers that map familiar main clause structures (Subject–Object–Verb) before unpacking subordinate ablative absolutes and indirect discourse. • Reactivate core Roman values (virtus, pietas, fides) established in earlier Latin stages, prompting students to trace how early Romans defined civic duty before seeing those virtues subverted in later units.

Unit 1: Rome's Origins according to Livy

Lesson Map

Lesson	Learning Target	Success Criteria	Resources
1 -	• I can summarize Livy's self proclaimed writing goals. • I can describe the historical context in which Livy was writing	• By comparing a personal definition for historical writing with a definition based on Livy's prologue • By identifying members of the imperial family on the Ara Pacis	Livy's Preface: English translation Online museum | Museo dell'Ara Pacis
2-3	• I can explain why Aeneas came to Italy • I can distinguish competing traditions about his arrival	• By analyzing prepositional phrases to distinguish directionality • By identifying genitive nouns to determine relationships • By tracking the names of peoples, places and their connections to each other	Selections from Book 1, Section 1 (Aeneas's arrival at Latium) Maps
4-6	• I can explain why Romulus and Remus's birth was mysterious • I can identify how Livy undermines the traditional story	• By analyzing prepositional phrases to track the twins' origins and movement • By comparing expectations regarding the Vestals and Rhea Silvia's experience • By identifying phrases that suggest doubt	Selections from Book 1, Section 4 (Birth of Romulus and Remus) Who were the Vestal Virgins, and what was their job? - Peta Greenfield Capitoline She-wolf | Musei Capitolini
7-8	• I can explain how the concept of fate was used to lend legitimacy to the new state • I can summarize and compare the conflicting accounts of Remus's death.	• By comparing the locations, timing, and observations of the twins • By identifying phrases that suggest doubt	Selections from Book 1, Section 7, (Founding of Rome, Death of Remus)) Mapping the Sky: Roman Augury in the Classroom
9-10	• I can explain how Hercules is connected to the site of Rome • I can analyze how Livy presents violence as a necessary foundation to national stability.	• By analyzing prepositional phrases the connect Hercules to Rome in conjunction with a map • Buy comparing Hercules and Romulus's use of omens	Selections from Book 1, Section 7, (Death of Remus) The Mystery of the Building of the Temple of Hercules Victor - IMR Blog

			Importing
11-12	• I can compare Livy's two explanations for the disappearance of Romulus. • I can contextualize this story in contemporary events	• By identifying prepositional phrases to track events. • By identifying genitive nouns to track preferences and alliances • By identifying key events in both accounts	Selections from Book 1, Section, 15 -16 (Death of Romulus)
13 Review	• I can compare Eutropius and Livy's accounts of the founding of Rome • I can compare how the contexts for the two historians differ	• By identifying genitive nouns and prepositional phrases • By analyzing a short biography of Eutropius	Eutropius: 1.1 | Dickinson College Commentaries Eutropius Wikipedia entry (Latin for 4s, English for 3s)
14	FLEX	•	
15	ASSESSMENT	•	

Unit 2: Hannibal of Carthage (Nepos)

Overview:

Relevant Standards: Bold indicates priority

- 1.2 Interpretive Communication: Learners understand, interpret, and analyze what is heard, read, or viewed on a variety of topics.2.1 Relating Cultural Practices to Perspectives: Learners use the language to investigate, explain, and reflect on the relationship between the practices and perspectives of the cultures studied.
- 2.1 Relating Cultural Practices to Perspectives: Learners use the language to investigate, explain, and reflect on the relationship between the practices and perspectives of the cultures studied.
- 2.2 Relating Cultural Products to Perspectives: Learners use the language to investigate, explain, and reflect on the relationship between the products and perspectives of the cultures studied.
- 3.2 Acquiring Information and Diverse Perspectives: Learners access and evaluate information and diverse perspectives that are available through the language and its cultures.
- 4.1 Language Comparisons: Learners use the language to investigate, reflect on, and explain the nature of language through comparisons of the language studied and their own.
- 4.2 Cultural Comparisons: Learners use the language to investigate, explain, and reflect on the concept of culture through comparisons of the cultures studied and their own.

Overview

In this unit, students read Cornelius Nepos' Life of Hannibal to explore how ancient biography served as a tool for moral evaluation and political critique during the collapse of the Roman Republic. Students follow Hannibal's life from his childhood oath to his Italian campaign, his political leadership in Carthage, his Mediterranean exile, and ultimate death. Through close reading, students analyze how Nepos presents Rome's arch-nemesis as a model of leadership possessing key virtues like strategy (prudentia), cleverness (calliditas), and duty (pietas). By contrasting Hannibal's brilliance with the envy (invidia) of the Carthaginian senate and relentless Roman interference, students evaluate how Roman writers used portraits of foreign rivals to hold up a mirror to the political decay of their own society.

Essential Question(s):

1. Is Hannibal a dangerous threat, a tragic figure, or an embodiment of Roman virtue?
2. Why would a Roman historian write a biography about his national greatest enemy?

Enduring Understanding(s):

1. Rather than reducing an adversary to a simple villainous threat, Nepos uses carefully chosen anecdotes to present Hannibal as a complex, tragic figure who paradoxically embodies core Roman virtues prudentia (strategy), calliditas (cleverness), and pietas (piety), demonstrating how Romans used "the other" to conceptualize their own cultural ideals.
2. Writing the biography of a foreign enemy allowed ancient authors to hold up a moral mirror to their own society; by celebrating an adversary's individual virtues and attributing his defeat to internal political corruption (invidia) rather than Roman military superiority, authors like Nepos could subtly critique the factionalism and moral decay threatening the late Roman Republic.

Demonstration of Learning:

- Exam
  - Students will translate equivalent sight passages with the assistance of vocabulary and notes.
  - Students will use Latin passages to reflect on themes discussed during the unit.
  - Students will identify prepositional phrases and noun cases in familiar Latin passages.
- Project on Artifact, Image, or Map
  - Part 1: Research/Presentation explaining basic contextual information, source, material, current location, etc
  - Part 2: Museum Label using evidence from the text to support visual analysis, roman virtues, contextual significance, historical accuracy.

Unit Specific Vocabulary

Vocab Lists

- Vocabulary from passages, prioritized by Latin Core Vocabulary

Key Verbs / Phrases

- *mors voluntaria?*
- *Dignitas*
- Prudentia
- Calliditas
- Pietas

Grammatical Concepts

- connective relative and demonstrative clauses
- ablative absolutes
- featured prepositions and conjunctions
- syncopated perfect tense verbs

Connections to Prior Units:

- Students will be able to draw on their understanding of internal origin myths from Unit 1 as they analyze how Roman identity is framed in contrast to—and through the reflection of—a formidable foreign rival.
- Students will have established a foundational understanding of core cultural values (virtus, pietas, fatum) in Unit 1, allowing them to evaluate how Nepos attributes these traditional "Roman" virtues to a Carthaginian enemy.
- Students will have examined how Livy wrote about the past to address his own contemporary context, enabling them to recognize how Nepos similarly uses Hannibal's story as a moral mirror to warn late Republican Romans of internal decay

Connections to Future Units:

- Students will compare these same qualities in analyzing Catiline and his internal challenge to the state.
- Students will examine traditional Roman values (for men and women) as demonstrated by near contemporary Romans in Bellum Catilinae.
- Students will explore how historiography practices may change when addressing more contemporary events.
- Students once again examine how authors build complex moral portraits in Unit 3, moving from Nepos's biographical presentation of a foreign enemy to Cicero and Sallust's rhetorical construction of a domestic traitor.

Family Overview (link below)	Pacing for Unit
•	• 16 lessons, 6 weeks
Integration of Technology:	**Aligned Unit Materials, Resources, and Technology:**
• Use of google docs is recommended throughout the writing process to facilitate drafting, feedback, collaboration, and revision. • Text and notes from Dickinson Classics Commentaries will be used extensively.	•
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions:**
• Grade 11 ELA - As with Unit 1, students can compare Nepo's treatment of Hannibal to Krakauer's portrayal of Chris McCandles, both to evaluate his objectivity, but also to determine whether this real life protagonist is characterized positively or negatively. • Grade 9 ELA - Students might compare Hannibal's decision to commit suicide to Juliet's suicide in Romeo and Juliet, using the Roman concept of a noble dealth to compare characters actions in the face of hostile, corrupt, or inescapable external forces.	• Students may assume that ancient national literature always vilifies wartime enemies, failing to recognize how Roman writers like Nepos used respect for a foreign rival's character as both an ideal to emulate and a moral mirror to critique his own society. • Students are likely to view suicide through a modern cultural lens as an act of defeat or weakness, failing to understand that in the ancient Greco-Roman world, choosing death to escape humiliation and preserve personal honor was often regarded as an act of political agency and noble bravery. • Students may assume that ancient military leadership were defined by immediate battlefield aggression and brute force, failing to see how strategic delay, cleverness and calculated restraint were celebrated as vital components of effective command.
Differentiation through *Universal Design for Learning*	
UDL Indicator • Consideration 7.4: Address biases, threats, and distractions	**Teacher Actions:** • Provide pre-reading ethical frameworks when encountering Hannibal's death, explicitly distinguishing modern psychological perspectives on suicide from ancient Greco-Roman concepts of political agency, dignity, and escaping public humiliation. • Proactively notify school support staff and families prior to reading about Hannibal's death, providing historical context and establishing clear check-in protocols for students.

UDL Indicator	Teacher Actions:
• Consideration 3.2: Highlight patterns, critical features, big ideas, and relationships	• Provide a "Virtue Matrix" graphic organizer that lists key Roman virtues introduced in Unit 1 (virtus, pietas, fides) and guides students to collect Latin evidence where Nepos attributes these exact traits to Hannibal, helping them trace how an ancient author projects traditional Roman ideals onto a foreign adversary.

Unit 2:			
Lesson Map			
Lesson	**Learning Target**	**Success Criteria**	**Resources**
1	• I can summarize Nepos's self proclaimed writing goals. • I can describe the historical context in which Nepos was writing	• By situating Nepos and Hannibal chronologically with Romulus, Livy, and Julius Caesar • By contrasting the purposes of biography with that of history	Prologus (in translation) Prologus: Essay | Dickinson College Commentaries
2	• I can identify some of Nepos' biases as an author. • I can describe Hannibal's judgement of the Romans.	• By recognizing ablatives of specification and degree of difference • By comparing descriptions of the Roman People and Hannibal	Chapter 1: Introduction to Hannibal
3	• I can explain why Hannibal tells the story of his oath. • I can describe what made the oath powerful	• By recognizing an ablative absolute • By identifying Hannibal's audience and the timing of the story • By detailing the steps of making the oath	Chapter 2: Hannibal recounts his oath against Rome.
4	• I can explain how Hannibal rose to leadership. • I can describe why crossing the Alps was a remarkable strategy.	• By utilizing connective relative and demonstrative clauses • By completing graphic organizers (a family tree, a chronology of action, a map of the region) • By explaining the relevance of Hercules	Chapter 3: Hannibal crosses the Alps & invades Italy
5	• I can identify and enumerate Hannibal's victories. • I can explain what battles reveal about Hannibal's character.	• By identifying Ablative Absolutes • By naming the Romans Hannibal defeated in each battle • By describing Hannibal's own injuries	Chapter 4: Battles at Trebia, Lake Trasimene, & Cannae
6	• I can explain why Nepos describes Hannibal as 'callidus' (clever).	• By identifying Ablative Absolutes • By mapping Hannibal's victories • By identifying Hannibal's specific strategies	Chapter 5: Escaping Fabius Maximus
7	• I can explain the significance of Zama.	• By utilizing connective relative and	Chapter 6: Recalled to Carthage

	• I can describe how Hannibal's position was undermined by the Carthaginians. • I can explain how Roman interference in Carthaginian politics impacted Hannibal	demonstrative clauses • By identifying the participants and activities at Zama • By contrasting Hannibal's accomplishments as king with his punishment by the Carthaginians	
8	• I can explain how Hannibal became king. • I can explain why and how the Carthaginians turned on Hannibal.	• By recognizing a demonstrative pronoun used in an Ablative Absolute • By identifying Hannibal's accomplishments as king • By identifying how the Carthaginians punished Hannibal in absentia	Chapter 7: King or Outlaw?
9	• I can contrast Hannibal's leadership with that of Antiochus. • I can describe how Mago presages what might happen to Hannibal	• By identifying syncopated perfect tense verbs • By comparing two possible causes of death for Mago • By identifying Hannibal's use of prudentia	Chapter 8: Working with Antiochus, Mago's Fate
10	• I can explain how Hannibal protects his assets while traveling.	• By identifying Ablative Absolutes • By identifying vocabulary describing wealth and where it is placed	Chapter 9: Asylum in Crete
11	• I can explain how and why Hannibal formed alliances. • I can describe how Hannibal prepared for biological warfare.	• By utilizing connective relative and demonstrative clauses • By tracking the names of rulers, their allies, and their enemies • By identifying Hannibal's weapons and how they were utilized	Chapter 10: Fighting Eumenes
12	• I can explain how Hannibal used strategy to overcome superior numbers. • I can describe the outcome of the battle	• By utilizing connective relative and demonstrative clauses • By focusing on objects that crossed the battle lines and their reception	Chapter 11: Fighting Eumenes
13	• I can describe how the rules of xenia (hospitality) protected Hannibal. • I can explain how Hannibal protected his legacy.	• By utilizing connective relative and demonstrative clauses • By describing Prusias's dilemna • By identifying how Hannibal died	Chapter 12: Arrival of the Romans

14	• I can respond to Nepos's assessment of Hannibal.	• By identifying adjectives Nepos uses to describe Hannibal	Chapter 13: Sources (translation)
15	FLEX	•	
16	ASSESSMENT	•	

Unit 3: Catiline the Rebel (Sallust)

Overview:

Relevant Standards: Bold indicates priority

- 1.2 Interpretive Communication: Learners understand, interpret, and analyze what is heard, read, or viewed on a variety of topics.2.1 Relating Cultural Practices to Perspectives: Learners use the language to investigate, explain, and reflect on the relationship between the practices and perspectives of the cultures studied.
- 2.1 Relating Cultural Practices to Perspectives: Learners use the language to investigate, explain, and reflect on the relationship between the practices and perspectives of the cultures studied.
- 2.2 Relating Cultural Products to Perspectives: Learners use the language to investigate, explain, and reflect on the relationship between the products and perspectives of the cultures studied.
- 3.2 Acquiring Information and Diverse Perspectives: Learners access and evaluate information and diverse perspectives that are available through the language and its cultures.
- 4.1 Language Comparisons: Learners use the language to investigate, reflect on, and explain the nature of language through comparisons of the language studied and their own.
- 4.2 Cultural Comparisons: Learners use the language to investigate, explain, and reflect on the concept of culture through comparisons of the cultures studied and their own.

Overview

In this unit, students learn about Catiline, a charismatic yet bankrupt aristocrat who inspired disaffected youth and indebted citizens to participate in a plot to assassinate the consul, cancel debts, and seize power. Through close reading, students analyze speeches against Catiline alongside Sallust's dramatized debate between Julius Caesar and Cato the Younger regarding the execution of the conspirators. By evaluating Catiline's complex characterization as both a villain and an undeniably charming leader, students continue their semester-long study of Roman virtues, while also uncovering the underlying socioeconomic tensions of late Republican Rome . In doing so, students investigate how ancient writers used domestic crises to diagnose and speak to failures of their own political system.

Essential Question(s):

1. Was Cateline a dangerous villain, a tragic reformer, or a symptom of a corrupt society?
2. Why study "invented" historical speeches when we know they aren't entirely accurate?

Enduring Understanding(s):	
1. Hannibal and Catalinae share a number of qualities, but Hannibal was fighting for country and honor, while cataline was fighting more for personal gain. Sallust presents Catiline as the antithesis of Roman values and a man whose own faults are representative of systemic Roman corruption and potential precursors to political revolution. 2. Whether edited after delivery in Cicero's case, or imagined reconstructions in the case of Sallust, such speeches were rarely verbatim transcripts. Politicians like Cicero and historians like Sallust crafted speeches not to record literal facts, but to reveal deep political motives, expose economic tensions, and diagnose why a state was failing. By studying these speeches today, we gain insight into how Romans understood authority, ethics, and power of the late Republic	
Demonstration of Learning:	**Unit Specific Vocabulary**

• Exam
  ○ Students will translate equivalent sight passages with the assistance of vocabulary and notes.
  ○ Students will use Latin passages to reflect on themes discussed.
  ○ Students will identify prepositional phrases and noun cases in familiar Latin passages.
• Project on Artifact, Image, or Map
  ○ Part 1: Research/Presentation explaining basic contextual information, source, material, current location, etc
  ○ Part 2: Museum Label using evidence from the text to support visual analysis, roman virtues, contextual significance, historical accuracy.
	Vocab Lists
	• Vocabulary from passages, prioritized by Latin Core Vocabulary
	Key Verbs / Phrases
	• *Amicitia (friendship)*
	• *Vis (force/strength)*
	• *Populares (people/confederates)*
	Grammatical Concepts
	• asyndeton
	• historical infinitives
	• descriptions expressed as nouns

Connections to Prior Units:	**Connections to Future Units:**
• Students will be able to draw on the civic virtues (virtus, pietas) established in Unit 1 to evaluate how Catiline and his co-conspirators represent the total subversion of Rome's founding values. • Students will have analyzed Hannibal's external war against Rome in Unit 2, enabling them to contrast a foreign rival driven by duty to his homeland with a domestic agitator driven by debt, status loss, and self-interest. • Students will be able to draw on their earlier work with historical narrative (Livy) and biography (Nepos) to critically analyze how authors use edited and invented speeches to diagnose social crises rather than record literal history.	• None

Family Overview (link below)	Pacing for Unit
•	• 10 lessons, 4 weeks
Integration of Technology:	**Aligned Unit Materials, Resources, and Technology:**
• Use of google docs is recommended throughout the writing process to facilitate drafting, feedback, collaboration, and revision.	•
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions:**
•	• Students are likely to assume that speeches in ancient historical texts or Cicero's published orations are verbatim, literal transcripts, forgetting (or failing to recognize) that speeches were heavily edited, embellished, or completely reconstructed by authors to advance political commentary and shape narrative bias. • Students may assume Cicero's speeches represent a neutral, objective record of the conspiracy, failing to see how senatorial rhetoric often served both political and personal aims. • Students may overemphasize Catiline's personal qualities, viewing his wickedness, charisma, or individual flaws as the sole cause of the uprising, and fail to recognize the widespread socioeconomic crises that fueled the conspiracy he led.
Differentiation through *Universal Design for Learning*	
UDL Indicator • Consideration 9.3: Promote individual and collective reflection	**Teacher Actions:** • Have students maintain individual reflection logs tracking how their personal perception of Catiline evolves—from an irredeemable villain in Cicero's rhetoric to a symptom of systemic economic inequality in Sallust's critique. • Host structured Socratic reflections where the class evaluates the ethical and historiographical utility of "invented" or edited speeches, reflecting collectively on how notions of truth and objectivity have developed over all three units. • Guide students in using tiered readings as a metacognitive self-checking tool to pinpoint exactly where their syntactic decoding breaks down and track their growing independence in handling unadapted prose over time.

Unit 3:			
Lesson Map			
Lesson	**Learning Target**	**Success Criteria**	**Resources**
1	• I can explain Sallust's purpose and limitations when writing history. • I can compare Sallust's approach and reasoning with Livy's.	• By situating Catiline and Sallust chronologically with Livy, Nepos, and Julius Caesar. • By contrasting the challenges and advantages of writing about recent events	Introduction: Why History? 1-4 translation
2	• I can compare Catiline's positive and negative traits.	• By recognizing descriptions using genitives of quality and partitive genitives. • By comparing the connotation and denotation of words	Portrait of Catiline 4-5 Latin (selections)
3	• I can compare the story of Aeneas to Romulus to Sallust's Rome. • I can enumerate Catiline's motivations for participating in a conspiracy.	• By identifying verbs that express that motivation • By comparing adjectives that express decline	History of Rome 6-9 translation The Conspiracy 14-15 in translation 16 in Latin
4	• I can compare the use of speeches in Roman history to modern sound bits. • I can analyze how Catiline describes his supporters.	• By examining Catiline's definition of amicitia (friendship) • By comparing the use of positive and negative adjectives (litotes)	Catiline's Speech 20 excerpts
6	• I can compare the depictions of the key women referenced in the text. • I can analyze how women are presented as following or disrupting Roman mores.	• By comparing the connotation and denotation of words • By analyzing descriptions to distinguish factual information and Sallust's personal opinions	Fulvia 23 in Latin 25 in translation
7	• I can compare Caesar & Cato's plans for responding to the crisis. • I can explain how their speeches reflect their different political and personal philosophies.	• By analyzing descriptions of the crime • By choosing a position and summarizing its arguments	Caesar & Cato 51-52 mixture of Latin and translation

8	• I can analyze Catiline's truth and debate its sincerity. • I can explain how Catiline's death corresponds to or challenges Sallust's description in Chapter 5.	• By focusing on the second person verbs and associated descriptions • By comparing not only adjectives and descriptions but actions	Catiline's Battle Speech 58 in Latin 59 in translation Catline's Death 60-61 excerpts in Latin
9	REVIEW		
10	FLEX		

Course Title:	Content Area:	Grade Level:	Credit (if applicable)
Algebra 2 ACA/ACC	Math	Gr. 10/11	1.0

Course Description:

Algebra 2 extends students' understanding of functions, equations, and mathematical modeling through an in-depth exploration of polynomial, rational, exponential, and trigonometric functions while developing sophisticated problem-solving skills for real-world applications. Students progress through eight units covering sequences and functions, polynomial analysis with factors and zeros, rational functions and optimization, complex numbers and rational exponents, exponential and logarithmic relationships, function transformations, trigonometric modeling, and statistical inference. The course emphasizes multiple representations of mathematical relationships, logical reasoning, and mathematical communication while integrating technology for exploration and problem-solving. Students develop both procedural fluency and conceptual understanding through formative assessments, performance tasks, and mathematical discourse, with real-world connections spanning STEM applications, financial literacy, and data-driven decision making. By course completion, students demonstrate mastery of advanced algebraic concepts, confidence in tackling unfamiliar mathematical problems, and understanding of mathematics as an essential tool for understanding and improving the world around them.

Aligned Core Resources:

Teacher Materials
https://accessim.org

- Key Structures in this Course
  - Developing a Math Community
  - Student Journal Prompts
  - Mathematical Modeling Prompts
  - Are You Ready For More?
  - Principles of IM Curriculum Design
- Algebra 2 Scope and Sequence
  - Narrative
  - Unit 1: Sequences and Functions
  - Unit 2: Polynomial Functions
  - Unit 3: Rational Functions and Equations
  - Unit 4: Complex Numbers and Rational Exponents
  - Unit 5: Exponential Functions and Equations
  - Unit 6: Transformations of Functions
  - Unit 7: Trigonometric Functions
  - Unit 8: Statistical Inferences
  - Pacing Guide
  - Dependency Diagram

CT Core Standards

Imagine Learning iM Resources (BPS teacher login through ClassLink)

Connection to the *BPS Vision of the Graduate*

Common Core State Standards: Math Practice (MP) Standards
MP 1: Make sense of problems and persevere in solving them.
MP 2: Reason abstractly and quantitatively.
MP 3: Construct viable arguments and critique the reasoning of others.
MP 4: Model with mathematics.
MP 5: Use appropriate tools strategically.
MP 6: Attend to precision.
MP 7: Look for and make use of structure.
MP 8: Look for and express regularity in repeated reasoning.

Lessons that Showcase Math Practice Standards

	Unit 1 iM Alg 2 Unit 1	Unit 2 iM Alg 1 Unit 7	Unit 3 iM Alg 1 Unit 8	Unit 4 iM Alg 2 Unit 2	Unit 5 iM Alg 2 Unit 3	Unit 6 iM Alg 2 Unit 4
MP 1	5, 7, 10, 11	4, 14, 17	1-3, 9, 10, 21, 22, 24	14, 15	1, 6, 9–11	7, 8, 10, 15
MP 2	9, 10	1, 3, 6, 7, 12, 14	1, 2, 17, 21	1	3–6	8
MP 3	6	2, 3, 12, 15-17	5, 6, 13, 18, 19, 21	4, 5, 7, 9, 13	2	1, 6
MP 4	8, 9	7, 17	1			3, 8, 10, 15
MP 5	4–6, 8, 10	1, 4, 6, 12	3, 5, 17, 21	3, 9	2, 4–6, 11	6, 15
MP 6	1–3, 7, 8	7, 9, 11, 14, 15	9, 10, 13, 15, 22	1, 3, 6, 8, 9, 14	7	1, 2, 5, 7, 9, 11, 14
MP 7	1, 9, 11	1-5, 8-13, 15-17	3-13, 16, 19, 21, 23	2, 3, 5, 7, 9–11, 13	2, 3, 5, 7, 8, 10	4-7, 12-14
MP 8	1, 2, 5, 8	2, 5-7, 9-13, 15	4, 7, 8, 11, 14, 20, 21	8, 12, 15	1, 4, 8	2, 4, 10-12

Bristol Public Schools Vision of the Graduate

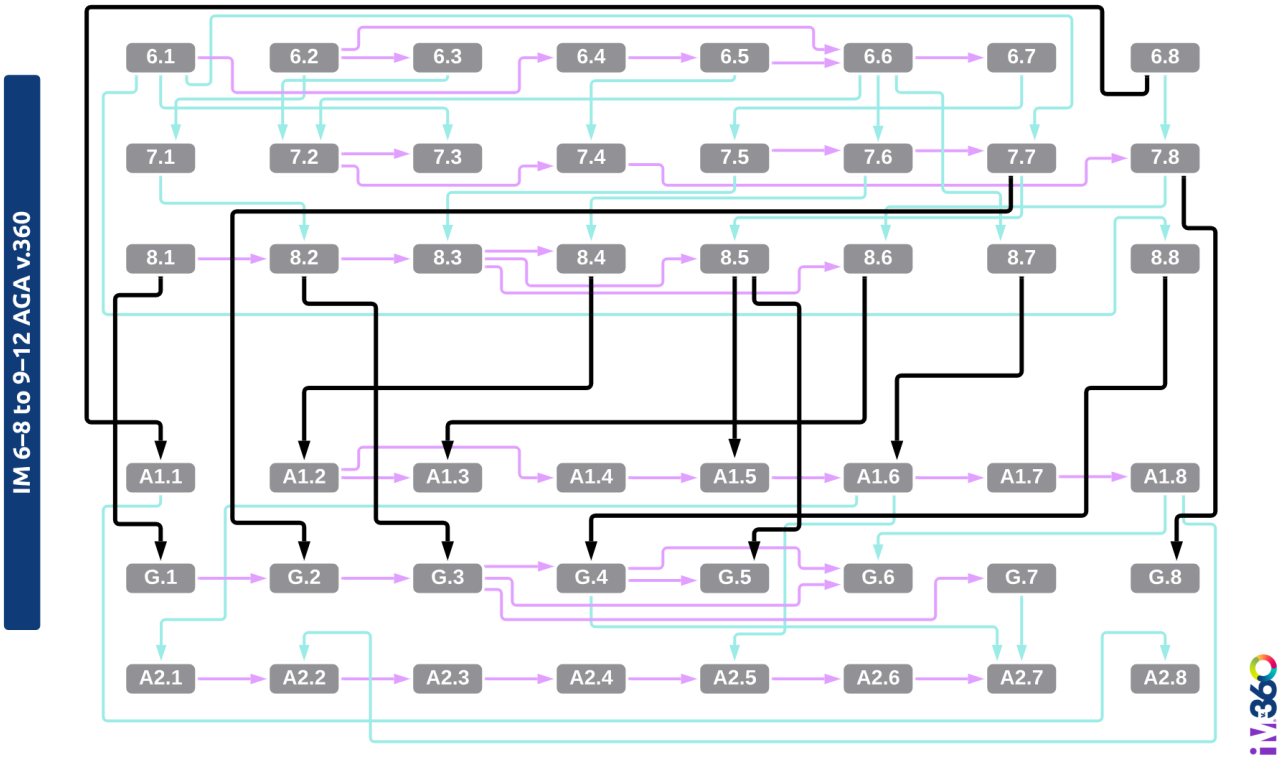
Problem Solving
- iM's focus on real-world modeling and problem-solving strategies
- Multiple solution pathways are encouraged and explored
- Students develop perseverance through challenging tasks

Critical Thinking
- Students analyze mathematical relationships and justify their reasoning
- Regular opportunities to critique others' reasoning
- Emphasis on understanding "why" not just "how"

Communication and Collaboration
- Structured mathematical discourse is built into lessons
- Students explain their thinking both verbally and in writing
- Many activities involve partner and group work

Link to *Completed Equity Audit*: Equity Curriculum Review Audit: 6-12 Illustrative Math (2026)

Additional Course Information: *Knowledge/Skill Dependent courses/prerequisites*



Standard Matrix

Standard	Unit 1 iM Alg 2 Unit 1	Unit 2 iM Alg 1 Unit 7	Unit 3 iM Alg 1 Unit 8	Unit 4 iM Alg 2 Unit 2	Unit 5 iM Alg 2 Unit 3	Unit 6 iM Alg 2 Unit 4
HSS-ID.A	X					
HSS-ID.A.1	X					
HSS-ID.A.2	X					
HSS-ID.A.3	X					
HSA-CED.A.2		X		X		
HSA-REI.D.10		X	X	X		X
HSA-SSE.A		X	X			
HSA-SSE.A.1		X	X	X		
HSA-SSE.B.3		X	X			
HSF-BF.A.1		X				
HSF.BF.A.1.a		X				
HSF-BF.B.3		X				
HSF-IF.A.2		X	X			
HSF-IF.B.4		X	X			
HSF-IF.B.6		X				
HSF-IF.C		X	X			
HSF-IF.C.7		X	X			
HSF-IF.C.7.a		X	X			
HSF-IF.C.8		X				

HSF-IF.C.8.a		X	X			
HSF-IF.C.9		X	X			
HSF-LE.A		X				
HSF-LE.A.1		X				
HSF-LE.A.2		X	X			
HSA-CED.A.1			X			X
HSA-CED.A.3			X	X		X
HSA-REI.A			X	X		
HSA-REI.A.1			X	X		
HSA-REI.B.3			X	X		X
HSA-REI.B.4			X			
HSA-REI.B.4.a			X			
HSA-REI.B.4.b			X			
HSA-REI.C.7			X			
HSA-REI.D			X			
HSA-SSE.A.2			X			
HSA-SSE.B.3.a			X			
HSA-SSE.B.3.b			X			
HSF-IF.A.1			X			
HSF-IF.B.5			X			
HSN-RN.B			X			
HSN-RN.B.3			X			
HSA-CED.A.4				X		
HSA-REI.C				X		
HSA-REI.C.5				X		
HSF-BF.A.1.b				X		
HSN-Q.A.3					X	
HSS-ID.B.5					X	
HSS-ID.B.6					X	
HSS-ID.B.6.a					X	
HSS-ID.B.6.b					X	
HSS-ID.B.6.c					X	
HSS-ID.C.7					X	
HSS-ID.C.8					X	
HSS-ID.C.9					X	
HSA-REI.D.12						X

Unit Links
Algebra 2 ACA/ACC Unit 1 (iM A2 U1): Sequences and Functions Unit 2 (iM A1 U7): Introduction to Quadratic Functions Unit 3 (iM A1 U8): Quadratic Equations Unit 4 (iM A2 U2): Polynomials Unit 5 (iM A2 U3): Rational Functions and Equations Unit 6 (iM A2 U4): Complex Numbers and Rational Exponents

Unit Title

Unit 1 (iM A2 U1): Sequences and Functions

Relevant Standards

Lesson	Standards	Lesson	Standards	Lesson	Standards
Lesson 1		Lesson 5	HSF-BF.A.1.a HSF-BF.A.2 HSF-IF.A.3 HSF-LE.A.2	Lesson 9	HSF-BF.A.2 HSF-IF.A.3 HSF-IF.B.5 HSF-LE.A.2
Lesson 2	HSF-BF.A.1.a	Lesson 6	HSF-BF.A.2 HSF-IF.C HSF-LE.A.2	Lesson 10	HSF-BF.A.2 HSF-LE.A.2
Lesson 3	HSF-IF.C	Lesson 7	HSF-BF.A.2 HSF-IF.A.3 HSF-LE.A.2	Lesson 11	HSF-BF.A.1.a HSF-BF.A.2
Lesson 4	HSF-IF.C	Lesson 8	HSF-BF.A.2 HSF-LE.A.2		

Essential Question(s)

- How do different representations (tables, graphs, recursive formulas, nth term formulas) help us understand sequences?
- What are the advantages of recursive versus nth term definitions?
- How can we move between different representations of the same sequence?
- How can we determine if a sequence is arithmetic, geometric, or neither?
- What real-world situations are best modeled by sequences rather than continuous functions?

Enduring Understanding(s)

- Sequences follow predictable patterns that can be identified, extended, and represented mathematically.
- The growth characteristics of sequences can be quantified and used to make predictions.
- Mathematical representations of sequences are interconnected and serve different purposes for analysis and communication.
- Real-world contexts impose meaningful constraints on mathematical models.
- Sequences provide powerful tools for modeling growth, decay, and change in authentic situations.

Demonstration of Learning

CFA 1: Checkpoint A (after lesson 4)
CFA 2: Checkpoint B (after lesson 7)
Checkpoint C (after lesson 11) use as opportunity for feedback
EoU: Assessment (after lesson 11)

Pacing for Unit

16 Days (8 class periods)
Lesson Modifications: (from adaptation pack)

- Remove 1.4 - An optional lesson on spreadsheets
- Remove 1.7 - info gap on reinforcing parts of the recursive function

Family Overview (link below)

https://accessim.org/9-12-aga/algebra-2/unit-1?a=family

Integration of Technology:

- Desmos Online Graphing Calculator

Unit-specific Vocabulary

sequence, term (of a sequence), geometric sequence, arithmetic sequence

Aligned Unit Materials, Resources, and Technology (beyond core resources)

- Desmos Online Graphing Calculator
- Pear Assessment (Edulastic)
- IL Classroom Adapted Resources
- Interactive Tower of Hanoi puzzle
- Paper cutting activity to visualize a sequence (paper and scissors)

Opportunities for Interdisciplinary Connections:

Science

- Population growth models (geometric sequences for bacterial growth, predator-prey relationships): Cell division patterns and exponential reproduction, Fibonacci sequences in nature (plant growth patterns, shell spirals, flower petals), Ecosystem modeling with discrete time intervals
- Population dynamics in ecological systems: Carbon

Anticipated misconceptions

- Thinking sequences can have any real number input rather than just integers
- Mixing up the term value with its position in the sequence
- Looking at differences without checking if they're constant (arithmetic) or assuming any growing pattern is geometric

footprint reduction scenarios, Resource consumption modeling, Climate data analysis with discrete measurements Economics & Business • Compound interest calculations and investment growth: Depreciation models for assets, Market analysis using geometric and arithmetic progressions, Revenue and profit projections over time periods Art & Design • Fractal patterns and geometric art (Koch Snowflake connections): Architectural proportions and scaling, Visual pattern recognition and creation, Digital art algorithms and iterations	• Adding when they should multiply (geometric) or multiplying when they should add (arithmetic) • Expecting all sequences to be either arithmetic or geometric when many are neither • Writing f(n−1) incorrectly or confusing it with f(n)+1 • Initial term confusion: Not clearly stating the starting value (e.g., f(1)=3) • Not being clear whether n starts at 0 or 1, leading to different but equivalent formulas • Not recognizing arithmetic sequences as linear functions with restricted domain • Not connecting geometric sequences to exponential functions • Difficulty understanding sequences that decrease (growth factor < 1) • Thinking a sequence is geometric when it involves both addition and multiplication • Difficulty moving from specific steps to general nth term formulas • Using inappropriate domains for real-world contexts • Mixing up terms like "growth factor," "common ratio," and "rate of change" See teacher's guide for specific misconceptions aligned to each lesson
Connections to Prior Units	**Connections to Future Units**
Relevant Unit(s) to review: Algebra 1: Units 5 and 6 • Alg 1 Unit 5 Lesson 2 Activity 1 • Alg 1 Unit 5 Lesson 4 • Alg 1 Unit 6 Lesson 3 Warm-up (pay particular attention to the review in the launch) Essential prior concepts to engage with this unit • Function notation. • Translating among table, graph, function, and description for both linear and exponential situations.	Connection to Unit 4 (iM A2 U2): Polynomial Functions • Building explicit formulas • Function representation skills • Domain understanding:
Differentiation through *Universal Design for Learning*	
Engagement • Connect sequences to real-world contexts and familiar patterns students encounter daily • Offer multiple entry points and representations to accommodate different learning preferences • Scaffold learning progression systematically from concrete examples to abstract notation • Build on prior knowledge of linear and exponential functions while celebrating incremental progress • Make learning goals transparent and provide opportunities for reflection on different representations Encourage metacognitive strategies and mathematical discourse about sequence patterns and formulas. **Representation** • Present sequences through multiple sensory modalities (visual graphs, numerical tables, written patterns) • Use clear visual design in coordinate plane representations and ensure accessibility of mathematical notation • Support vocabulary development for key terms (sequence, term, recursive, explicit, arithmetic, geometric) • Provide multiple representations of mathematical notation and connect symbolic expressions to verbal descriptions • Activate prior knowledge by explicitly connecting sequences to familiar linear and exponential functions • Guide pattern recognition through scaffolded examples and highlight critical features that distinguish arithmetic from geometric sequences **Action & Expression** • Provide multiple ways for students to demonstrate understanding (verbal explanations, written formulas, graphical representations, or digital tools) • Support planning and strategy development by teaching systematic approaches to identify sequence types and choose appropriate representations • Offer various tools and assistive technologies for mathematical expression including graphing calculators, spreadsheets, and function notation templates	

- Scaffold executive functions by providing organizational frameworks for moving between recursive and explicit formulas
- Create opportunities for students to express mathematical thinking through multiple modalities and support fluency development in function notation
- Guide students in monitoring their progress as they transition from informal pattern description to formal mathematical modeling

Supporting Multilingual/English Learners

The Illustrative Mathematics curriculum incorporates eight Mathematical Language Routines (MLRs) that support English Language Learners:

MLR1: *Stronger and Clearer Each Time* - Students revise and refine their mathematical language through multiple drafts
MLR2: *Collect and Displa*y - Students capture and organize language in visual displays
MLR3: *Clarify, Critique, Correct* - Students analyze mathematical writing/talk
MLR4: *Information Gap* - Students share information to solve problem
MLR5: *Co-Craft Questions* - Students create and improve questions
MLR6: *Three Reads* - Students analyze complex mathematical text
MLR7: *Compare and Connect* - Students connect different mathematical representations
MLR8: *Discussion Supports* - Students participate in mathematical discussions

MLR1: Stronger and Clearer Each Time
Used in Lesson 1 (Tower of Hanoi) where students refine their mathematical language through multiple drafts when describing sequences

MLR2: Collect and Display
Used in Lesson 3 (Three Sequences) to capture and organize student language about different types of sequences

MLR5: Co-Craft Questions
Used in Lesson 2 (Paper Slicing) where students generate mathematical questions about geometric sequences

MLR6: Three Reads
Used in Lesson 8 (Sierpinski Triangle) to help students analyze complex mathematical text about sequence definitions

MLR7: Compare and Connect
Used in Lesson 5 (Let's Define Some Sequences) where students compare different recursive definitions and representations

MLR8: Discussion Supports
Used in multiple lessons (Lessons 6, 11) to support rich mathematical discussions about sequences and their representations

Sentence Frames and Stems

Section A
- The next term(s) in the sequence _____ (list the given terms) is/are _____ because ...
- I know the sequence _____ (list the given terms) is arithmetic/geometric because ...
- The pattern is growing by _____ which represents a/an _____ sequence because ...
- The rate of change in the arithmetic sequence is _____ because ...
- The growth factor in the geometric sequence is _____ because ...

Section B
- The recursive definition f(1) = _____, f(n) = _____ ["f of 1" is _____, "f of n" is _____] describes this sequence because ...
- To create a graph of the sequence _____ (list the given terms), first I _____, then I ...
- The table shows the _____ terms which are _____ by _____. This means the sequence is _____ because ...
- Given the recursive definition f(1) _____, f(n) _____ ["f of 1" is _____, "f of n" is _____], the first _____ terms of the _____ sequence are ...

Section C
- The formula _____ defines the sequence _____ (list the given terms) because ...
- The function _____ can be used to find the nth term in the sequence _____ (list the given terms) because ...
- The function _____ can be used to represent this situation because ...
- A reasonable domain for this situation is _____ because ...

Related *CELP standards* and Learning Targets:

	Emerging	Expanding	Bridging
LT1	Find the next two terms by counting or simple addition/multiplication, using short phrases, single words, or drawings to communicate the rule and answer. Focus is on sequences with small whole numbers.	Find a missing term in the middle of a sequence, calculating with integers and simple decimals. Uses short, simple sentences with general academic terms (e.g., "I added the number four").	Find any missing term (nth term) using the explicit formula. Articulates and justifies the process using complex sentences and content-specific language (e.g., "I used the explicit formula $a_n=a_1+(n-1)d$").
LT2	Identify the growth factor/rate when given adjacent terms that are small whole numbers. Verbalizes or writes the answer as a number or simple	Calculate the rate of change (d) or growth factor (r) given a table or two terms, including sequences with negative numbers. Explains the	Derive and justify the rate of change or growth factor from non-adjacent terms or a complex verbal situation. Uses precise technical vocabulary ("common

	phrase (e.g., "plus 5" or "times 2").	calculation using connected, but simple, sentences.	difference," "common ratio") and defends the solution in a coherent paragraph.
LT3	Complete a pre-made table or graph by filling in a few steps of a sequence given the initial term and the rule, using a template or heavy scaffolding.	Create a complete table and accurately sketch a graph OR write a basic recursive rule for a sequence, using short sentences to explain the pattern.	Independently create an accurate table, graph, AND a recursive rule for a sequence based on a complex context, using well-structured language to define the relationship between consecutive terms.
LT4	Insert numerical values into a provided explicit equation template or sentence frame to represent a simple situation. Focus on correct substitution (e.g., f(n)=[start]+n · [rate]).	Write the explicit equation for an arithmetic or geometric sequence from a given table or scenario, using appropriate function notation.	Develop and write both the explicit and recursive equations for a sequence representing a complex real-world situation, and clearly articulate in writing the meaning of each variable and why the equation is appropriate.
LT5	State the starting point (n=1 or n=0) and correctly identify that the domain uses whole numbers, possibly by pointing or circling options.	Explain, using simple sentences, why the domain must be integers (i.e., discrete data) based on the context (e.g., "Because you only have whole stairs, not half a stair").	Analyze a complex scenario to determine, state, and mathematically justify the full domain and range restrictions (start, end, and integer-only) using precise set notation.

Unit Description

This unit provides students an opportunity to revisit functions by way of sequences. Through many concrete examples, students will see arithmetic and geometric sequences as linear and exponential functions restricted to a domain that is a subset of the integers. This unit reinforces understanding of functions by using multiple representations (including graphs, tables, and expressions).

Students begin with an invitation to describe sequences with informal language and learn to identify if a sequence is geometric, arithmetic, or neither. Students write out the terms of sequences arising from mathematical situations, in addition to interpreting and creating tables and graphs about the given relationship.

Students learn that sequences are a type of function in which the input variable is the position and the output variable is the term at that position. They learn to interpret sequences and then use function notation to write their own recursive definitions of the sequences. Students make connections between the sequences and different representations of functions.

Students then build on their prior knowledge of linear and exponential functions to develop explicit formulas for arithmetic and geometric sequences and to model several situations represented in different ways.

In the last section of the unit, students use sequences to model several situations represented in different ways. This work is meant to touch on some practices that must be attended to while modeling, such as choosing a good model and identifying an appropriate domain. Students also recognize that a sequence is an appropriate type of function to use as a model for these situations since the domain of each situation is a subset of the integers. Finally, students encounter some situations in which it makes sense to compute the sum of a finite sequence. This thinking connects to later work in which students will determine the formula for the sum of the first terms of a geometric sequence.

Lesson Sequence	Learning Target	Success Criteria/Assessment
Section A Sequences (Lessons 1-4)	**Learning Target 1** Determine missing terms in arithmetic and geometric sequences. **Learning Target 2** Determine the growth factor of a geometric sequence and the rate of change of an arithmetic sequence.	**Lesson 1 A Towering Sequence** • I can give an example of a sequence. **Lesson 2 Introducing Geometric Sequences** • I can find missing terms in a geometric sequence. **Lesson 3 Different Types of Sequences** • I can explain what it means for a sequence to be arithmetic or geometric. Checkpoint A Problems 1 and 2 **ACC Lesson 4 Using Technology to Work with Sequences**

		• I can use a spreadsheet to create many terms of a sequence. • I can use technology to graph a sequence.
Checkpoint A	*Responding to Student Thinking* **Problem 1 & 2** (remove 1c) More Chances - Students will have more opportunities to develop this understanding in later lessons. There is no need to slow down or add additional work to review this concept at this time.	
Section B Representing Sequences (Lessons 5-7)	**Learning Target 3** Create a table, graph, or recursive definition of a sequence from given information.	**Lesson 5 Sequences Are Functions** • I can use function notation to define arithmetic and geometric sequences recursively. Checkpoint B Problem 1 End of Unit Problems 1 and 4 **Lesson 6 Representing Sequences** • I can represent a sequence in different ways. **ACC Lesson 7 Representing More Sequences** • I can ask questions to get the information needed to represent a sequence in different ways.
Checkpoint B	*Responding to Student Thinking* Points to Emphasize - If most students struggle to write a recursive definition, spend more time asking students to share their strategies for writing a recursive definition in the Activity Synthesis of the activity referred to here.	
Section C What's the Equation? (Lessons 8-11)	**Learning Target 4** Create equations for sequences representing situations. **Learning Target 5** Identify restrictions on the domain of a sequence based on the context.	**Lesson 8 The nth Term** • I can explain why different equations can represent the same sequence. End of Unit Problems 2, 3, 6 and 7 **Lesson 9 What's the Equation?** • I can represent situations with sequences. Checkpoint B Problem 1 (feedback opportunity) End of Unit Problem 5 **Lesson 10 Situations and Sequences Types** • I can define a sequence using an equation. **Lesson 11 Adding Up** • I can determine the sum of a sequence representing a situation.
Checkpoint C	*Responding to Student Thinking* Press Pause - By this point in the unit, there should be some student mastery of writing equations for sequences representing situations. If most students struggle, make time to revisit related work in the section referred to here. See the Course Guide for ideas to help students re-engage with earlier work. For example, consider having students create their own patterns with black and white squares, similar to those in the activity referred to here, and exchange with a partner to write equations for the patterns.	

END OF UNIT ASSESSMENT

General End of Unit Assessment Notes:

- Modify select all questions to mimic SAT-style "I-II-III Questions"
- #1 - Press enter after each part of the formula
- #2 - Make them all (n-1) and switch the start at and rate of change in B and D
- #3 - make some n and some n-1, but make the rate of change and start at correct on all, remove E and F, make SAT-like but only 1 correct answer
- #4 - do not include domain restrictions/index, tell them it's arithmetic, put blank in the table between 1 and 3 (optional)
- #5 - A strip that is ⅓ the orignal area is cut off, and the remaining area is recorded. Part c) Reword: What is a reasonable domain for this situation? Justify why you included some values of n and not others in your domain.
- #6 - Add a fill in the blank for rate of change before each definition (0.5 pt), definition as (1.5 pts)
- #7 - Rephrase and b: Use words to describe how to get from one term to the next, make everything with Sequence A together and B together. Add back in/keep Which is greater A(9) or B(9)

Unit Title:

Unit 2 (iM A1 U7): Introduction to Quadratic Functions

Also see Algebra 1 ACA Unit 6/Alg+ Unit 8 (Algebra 1 is aiming to cover through Lesson 11)

Relevant Standards

Lesson	Standards	Lesson	Standards	Lesson	Standards
Lesson 1	HSF-BF.A.1.a	Lesson 7	HSF-BF.A.1.a HSF-IF.B.5 HSF-IF.C.7.a	Lesson 13	HSA-SSE.B.3 HSF-BF.B.3 HSF-IF.C.7 HSF-IF.C.7.a
Lesson 2	HSA-SSE.A.1 HSA-SSE.B.3 HSF-BF.A.1.a HSF-IF.A.3	Lesson 8	HSA-APR.A HSA-SSE.A HSA-SSE.A.2 HSA-SSE.B.3	Lesson 14	HSF-IF.A.2 HSF-IF.B.4 HSF-IF.C.7.a HSF-IF.C.8 HSF-IF.C.9
Lesson 3	HSA-SSE.A.1 HSF-BF.A.1.a HSF-IF.A.2	Lesson 9	HSA-APR.A HSA-SSE.A.2 HSA-SSE.B.3	Lesson 15	HSF-BF.B.3 HSF-IF.C HSF-IF.C.7.a
Lesson 4	HSF-BF.A.1.a HSF-IF.C HSF-LE.A.3	Lesson 10	HSA-SSE.B.3	Lesson 16	HSF-IF.C HSF-IF.C.7.a
Lesson 5	HSF-BF.A.1.a HSF-IF.A.2	Lesson 11	HSA-SSE.A HSF-IF.C.7.a	Lesson 17	HSF-BF.B.3 HSF-IF.C HSF-IF.C.7.a
Lesson 6	HSF-BF.A.1 HSF-BF.A.1.a HSF-IF.B.5 HSF-IF.C HSF-IF.C.7.a	Lesson 12	HSF-BF.B.3 HSF-IF.CHSF-IF.C.7 HSF-LE.A.2		

Essential Question(s):

- How do different forms of a function's equation help us understand its key features and behavior?
- What do the key features of a function—such as intercepts, maximums, minimums, and end behavior—reveal about its graph and real-world meaning?
- How do transformations, such as shifts, reflections, and stretches, affect the graph and equation of a function?
- How do we determine whether a function best models a real-world situation as linear, quadratic, or exponential?
- What are the different kinds of growth and how do they compare?
- How can we analyze and compare functions that are represented in different ways, such as equations, graphs, tables, and verbal descriptions?
- How can expressing the same equation in different forms reveal different properties of a quadratic function?

Enduring Understanding(s):

- Functions can be represented in multiple ways and each representation provides different insights into the function's behavior.
- Rewriting expressions through factoring, expanding, and completing the square reveals important characteristics of functions, such as zeros, intercepts, and vertex points.
- Transformations, including shifts, reflections, stretches, and compressions, help us understand how function graphs change and how different functions relate to one another.
- The structure of an algebraic expression can be analyzed and rewritten to make solving equations easier and to reveal key features of the function it represents.
- Exponential, linear, and quadratic functions model different types of real-world relationships, and understanding their differences allows us to choose the best function for a given situation.
- Comparing functions in different forms—such as equations, tables, graphs, and descriptions—helps us analyze relationships and make predictions.
- Projectile motion can be represented using a quadratic function.

Demonstration of Learning:

Section A Checkpoint

Pacing for Unit

21 Days (11 class periods)

Section B Checkpoint Section C Checkpoint Mid-Unit Assessment Section D Checkpoint End-of-Unit Assessment	Lesson Modifications: (from adaptation pack) No lessons are recommended to remove or modify for additional lessons. If time is an issue, these modifications could be made to move students more quickly into working with quadratic equations in the next unit: • Combine Lessons 1 and 2. Emphasize Activities 2.2 and 2.3. • Combine Lessons 3 and 4. Emphasize Activity 4.2 and the idea that exponential functions always eventually grow more quickly than quadratic functions. • Remove Lesson 7. This focuses on quadratic functions in the context of price versus revenue. • Remove Lesson 13. This focuses on the effect of the linear term in quadratic functions and is beyond the scope of Algebra 1 standards. • Remove Lessons 15–17. These lessons introduce vertex form. While vertex form is important, the lessons in the first sections of Unit 7 are of higher priority for Algebra 1 students.
Family Overview (link below)	**Integration of Technology:**
https://accessim.org/9-12-aga/algebra-1/unit-7?a=family	• Desmos Online Graphing Calculator
Unit-specific Vocabulary:	**Aligned Unit Materials, Resources, and Technology (beyond core resources):**
Quadratic expression, quadratic function, vertex, zero, factored form, standard form, vertex form	• Desmos Online Graphing Calculator • Pear Assessment (Edulastic) • IL Classroom Adapted Resources
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions:**
Science • Quadratic functions describe projectile motion and acceleration in physics, helping students understand real-world applications of parabolic paths. • Transformations of functions relate to wave motion, sound frequencies, and light reflection in physics. Economics & Business • Linear and quadratic models help analyze profit, revenue, and cost trends in business scenarios. • Understanding function transformations allows for predicting market growth and stock trends over time. Computer Science & Engineering • Quadratic and exponential functions play a role in algorithm efficiency and machine learning models in computer science. • Graph transformations and function comparisons help analyze digital image processing, scaling, and animation effects in game development.	• Many students misunderstand that transformations (shifts, reflections, stretches) apply to all points on a function, not just specific ones like the vertex. • Some students assume that exponential and quadratic functions both grow at a constant rate instead of recognizing that exponentials grow by multiplication while quadratics do not. • Students may incorrectly believe that the x-intercepts (solutions) are always the maximum or minimum of the function, rather than understanding how the vertex relates to symmetry and extrema. • Some students struggle to compare functions across different representations (graph, table, equation, verbal) and focus only on algebraic form. See teacher's guide for specific misconceptions aligned to each lesson
Connections to Prior Units:	**Connections to Future Units:**
Prior to this unit, students have studied what it means for a relationship to be a function, used function notation, and investigated linear and exponential functions. In this unit, they look at some patterns that grow quadratically and contrast this growth with linear and exponential growth. Essential prior concepts to engage with this unit: Write equivalent expressions by combining like terms and applying the distributive property. • If students need additional support with combining like terms or applying the distributive property, Grade 7 Unit 6 Lessons 18–22 address these topics.	Connections to Units in Future Courses Transformations of Functions • Understanding shifts, reflections, stretches, and compressions of functions lays the foundation for geometric transformations in Geometry and function transformations in Algebra 2. Circles, Higher-Degree Polynomials, and Rational Expressions • Skills like factoring and completing the square extend to deriving the equation of a circle and factoring and solving higher-degree polynomials in Algebra 2.

• The Algebra 1 Extra Supports materials, particularly Lessons 1 and 3, provide additional material for students who may need resources to support their understanding of area and perimeter.	

Differentiation through *Universal Design for Learning*

Engagement

- Connect rational exponents to familiar geometric contexts like area and volume calculations to make abstract concepts concrete
- Build on familiar integer exponent rules to justify and extend understanding to fractional exponents
- Address the conceptual challenge of imaginary numbers by introducing them as solutions to previously unsolvable equations
- Scaffold learning progression from square and cube roots to rational exponents to complex number operations
- Make learning goals transparent about extending the number system and solving all quadratic equations
- Encourage mathematical discourse about why extraneous solutions arise when squaring both sides of equations

Representation

- Present complex numbers through multiple sensory modalities using the imaginary axis, coordinate plane representations, and algebraic notation
- Ensure clear visual design for representing square roots, cube roots, and rational exponent notation
- Support vocabulary development for terminology (rational exponent, imaginary number, complex number, extraneous solution, principal root)
- Connect symbolic radical expressions to verbal descriptions and geometric interpretations of roots
- Activate prior knowledge by explicitly connecting rational exponents to familiar exponent rules and root operations
- Guide pattern recognition in complex number operations and highlight critical features like $i^2 = -1$

Action & Expression

- Provide multiple ways for students to demonstrate understanding through radical equations, complex arithmetic, or geometric applications
- Support planning strategies for choosing appropriate methods to solve quadratic equations including those with complex solutions
- Offer various tools including graphing technology, exponent rule organizers, and complex number operation templates
- Scaffold executive functions by providing organizational frameworks for connecting rational exponents to radical notation
- Create opportunities for students to express mathematical thinking about extending the number system beyond real numbers

Supporting Multilingual/English Learners

The Illustrative Mathematics curriculum incorporates eight Mathematical Language Routines (MLRs) that support English Language Learners:

MLR1: *Stronger and Clearer Each Time* - Students revise and refine their mathematical language through multiple drafts
MLR2: *Collect and Displa*y - Students capture and organize language in visual displays
MLR3: *Clarify, Critique, Correct* - Students analyze mathematical writing/talk
MLR4: *Information Gap* - Students share information to solve problems
MLR5: *Co-Craft Questions* - Students create and improve questions
MLR6: *Three Reads* - Students analyze complex mathematical text
MLR7: *Compare and Connect* - Students connect different mathematical representations
MLR8: *Discussion Supports* - Students participate in mathematical discussions

MLR1: Stronger and Clearer Each Time

Used in Lesson 9 (Standard Form and Factored Form) where students refine their explanations of different forms, and Lesson 16 (Graphing from the Vertex Form) where students improve their descriptions of graphing strategies

MLR2: Collect and Display

Used in Lesson 3 (Expanding Squares) to capture student language about quadratic patterns, Lesson 5 (Galileo and Gravity) for language about falling objects, and Lesson 11 (What Do We Need to Sketch a Graph?) to organize terminology about graph features

MLR5: Co-Craft Questions

Used in Lesson 5 (Falling from the Sky) where students generate mathematical questions about free-falling objects and quadratic motion

MLR6: Three Reads

Used in Lesson 17 (A Peanut Jumping over a Wall) to help students analyze complex contextual problems involving quadratic functions

MLR7: Compare and Connect

Used in Lesson 8 (Using Diagrams to Find Equivalent Quadratic Expressions) where students compare different strategies for expanding expressions and connect area diagrams to algebraic methods

MLR8: Discussion Supports

Used extensively throughout multiple lessons (Lessons 1, 2, 9, 15, 16) to support rich mathematical discussions about quadratic

patterns, different forms of expressions, and graph transformations

Sentence Frames and Stems

Section A

- This pattern represents a _____ relationship because ...
- Using the _____ I see that the pattern is growing by ...
- The expression _____ represents this situation because ...

Section B

- The expression _____ represents this situation because ...
- When the input is _____, the output for the function _____ is greater/less than the output for the function _____ because ...
- The height of the _____ after _____ is _____ because ...
- The function _____ represents this situation because ...

Section C

- If the factored form of a quadratic expression is _____, then the standard form is _____ because ...
- In this situation, the _____ (feature of the graph) represent(s) _____ because ...
- The equation _____ defines the function of the graph shown because ...

Section D

- When the equation is written in _____ form, I can easily identify the _____ (feature of the graph) which is _____ because ...
- In the equation _____, if the value _____ is changed to _____, the graph changes by ...
- To graph the function _____, first I _____, then I ...
- In this situation, the _____ (feature of the graph) represent(s) _____ because ...
- An EL can . . . construct grade appropriate oral and written claims and support them with reasoning and evidence.

Related *CELP standards* and Learning Targets:

	Emerging	Expanding	Bridging
LT1	I can identify quadratic expressions by looking for an x^2 term using a visual checklist and word bank.	I can explain that a relationship is quadratic when it contains a squared term (such as x^2) using sentence frames.	I can define and explain how a squared term (x^2) creates a non-linear quadratic relationship in equations, tables, and graphs.
LT2	I can sort visual patterns into linear, exponential, or quadratic groups using pattern cards and graphic organizers.	I can explain whether a visual pattern is linear, exponential, or quadratic by describing how it grows using sentence starters.	I can analyze visual patterns and construct a mathematical argument proving whether the growth rate is linear, exponential, or quadratic.
LT3	I can match points on a projectile graph (starting height, peak, landing point) to picture cards or simple labels.	I can describe what key parts of a quadratic graph mean in real-world contexts (e.g., maximum height, time in air) using sentence frames.	I can analyze quadratic expressions and graphs modeling physical phenomena to interpret key features (vertex, intercepts, domain) in context.
LT4	I can compare tables or graphs to point out where an exponential line passes above a quadratic curve using visual guides.	I can use tables, graphs, and calculations to show how an exponential function eventually becomes larger than a quadratic function using sentence starters.	I can demonstrate and justify numerically and graphically why exponential growth will always eventually exceed quadratic growth.
LT5	I can match the numbers in a factored form equation, like $(x - a)(x - b)$, to the x-intercepts on a graph using color-coding.	I can explain how to find the x-intercepts of a parabola from its factored form equation using step-by-step guides and sentence frames.	I can connect the zero product property to factored form quadratic equations to determine and explain the x-intercepts of a graph.
LT6	I can use an area model (box method) to multiply two binomials and write an equivalent expression with visual templates.	I can use the distributive property or area model to convert factored form into standard form ($ax^2 + bx + c$) using guided prompts.	I can algebraically convert quadratic expressions from factored form into standard form using the distributive property and prove their equivalence.
LT7	I can match parameter changes in an equation to visual movement of a parabola (shifts up, down, flips) using visual cards.	I can describe how changing numbers in standard, factored, or vertex form changes a graph's shape or position using sentence starters.	I can explain in detail how changing parameters a, b, c, h, k, and roots affects the graph's orientation, width, vertex, and intercepts across forms.
LT8	I can circle the vertex point (h, k) in an equation like $f(x) = a(x - h)^2 + k$ and point to the high or low point on a graph.	I can identify the maximum or minimum value of a quadratic function from its vertex form equation using structured sentence frames.	I can analyze a quadratic equation in vertex form $f(x) = a(x - h)^2 + k$ to determine its vertex, identify if it is a maximum or minimum, and justify why using the sign of a.

Unit Description

Prior to this unit, students have studied what it means for a relationship to be a function, used function notation, and investigated linear and exponential functions. In this unit, they look at some patterns that grow quadratically and contrast this growth with linear and exponential growth. They further observe that eventually these quadratic patterns grow more quickly than do linear patterns but more slowly than exponential patterns grow.

Students examine the important example of free-falling objects whose height over time can be modeled with quadratic functions. They use tables, graphs, and equations to describe the movement of these objects, eventually looking at the situation in which a projectile is launched upward. They interpret the meaning of each term in this context and work toward understanding how the coefficients influence the shape of the graph. Additional situations, such as revenue and area, are also introduced.

Next, students examine standard, factored, and vertex forms of quadratic functions. They recognize what information about the graph is easily obtained from each form and how the different values in each form influence the graph. In particular, they begin to generalize ideas of how horizontal and vertical translation, as well as vertical and horizontal stretching of graphs, relate to modifying the equation of a function.

Note on materials: Access to graphing technology is necessary for many activities. Examples of graphing technology are: a handheld graphing calculator, a computer with a graphing calculator application installed, and an internet-enabled device with access to a site like desmos.com/calculator or geogebra.org/graphing. For students using the digital version of these materials, a separate graphing calculator tool isn't necessary. Interactive applets are embedded throughout, and a graphing calculator tool is accessible in the student math tools.

Lesson Sequence	Learning Target	Success Criteria/Assessment
Section A: A Different Kind of Change Lessons 1-2	**Learning Target 1** I can comprehend that a "quadratic relationship" can be expressed with a squared term. **Learning Target 2** I can determine and explain whether a visual pattern represents a linear, exponential, or quadratic relationship.	**Lesson 1 A Different Kind of Change** • I can create drawings, tables, and graphs that represent the area of a garden. • I can recognize a situation represented by a graph that increases and then decreases. **Lesson 2 How Does it Change?** • I can describe how a pattern is growing. Checkpoint B Problem 1 Middle of Unit Problem 1 • I can tell whether a pattern is growing linearly, exponentially, or quadratically. Checkpoint A Middle of Unit Problem 1 • I know a quadratic expression has a squared term. Checkpoint A
Checkpoint A	*Responding to Student Thinking* **Problem 1:** More Chances: Students will have more opportunities to develop this understanding in later sections. There is no need to slow down or add additional work to review this concept at this time.	
Section B Quadratic Functions Lessons 3-7	**Learning Target 3** I can interpret quadratic functions that represent a physical phenomenon, given expressions and graphs. **Learning Target 4** I can use graphs, tables, and calculations to show that exponential functions eventually overtake quadratic functions.	**Lesson 3 Building Quadratic Functions from Geometric Patterns** • I can explain using graphs, tables, or calculations that exponential functions eventually grow faster than quadratic functions. Middle of Unit Problem 5 • I can recognize quadratic functions written in different ways. • I can use information from a pattern of shapes to write a quadratic function. Middle of Unit Problem 1

		Lesson 4 Comparing Quadratic and Exponential Functions • I can explain using graphs, tables, or calculations that exponential functions eventually grow faster than quadratic functions. Middle of Unit Problem 5 **Lesson 5 Quadratic Functions to Describe Situations (Part 1)** • I can explain the meaning of the terms in a quadratic expression that represents the height of a falling object. Checkpoint B Problem 2 Middle of Unit Problem 2 • I can use tables, graphs, and equations to represent the height of a falling object. **Lesson 6 Building Quadratic Functions to Describe Situations (Part 2)** • I can create quadratic functions and graphs that represent a situation. • I can relate the vertex of a graph and the zeros of a function to a situation. • I know that the domain of a function can depend on the situation it represents. Middle of Unit Problem 2 **ACC Lesson 7 Building Quadratic Functions to Describe Situations (Part 3)** • I can choose a domain that makes sense in a revenue situation. Middle of Unit Problem 7 • I can model revenue with quadratic functions and graphs. Middle of Unit Problem 4 *NOTE: Middle of Unit Problem 4* *Test question context is area but the Lesson is based on revenue, may want to preview revenue.* Middle of Unit Problem 7 • I can relate the vertex of a graph and the zeros of a function to a revenue situation.
Checkpoint B	*Responding to Student Thinking* **Problem 1:** Points to Emphasize: If students struggle to describe why exponential growth is eventually faster than quadratic growth, plan to revisit the idea throughout the rest of the unit. For example, as students explore graphs of quadratic functions in the lesson referred to here, use different functions of the form $y = ab^x$ to show that the exponential functions eventually grow faster. **Problem 2:** More Chances: Students will have more opportunities to develop this understanding in later sections. There is no need to slow down or add additional work to review this concept at this time.	
Section C Working with Quadratic Expressions Lessons 8-10	**Learning Target 5** I can coordinate a quadratic expression given in factored form and the intercepts of its graph. **Learning Target 6** I can use the distributive property to write equivalent quadratic expressions from factored into standard form.	**Lesson 8 Equivalent Quadratic Expressions** • I can rewrite quadratic expressions in different forms by using an area diagram or the distributive property. Checkpoint C Middle of Unit Problem 3 Middle of Unit Problem 6 **Lesson 9 Standard Form and Factored Form** • I can rewrite quadratic expressions given in factored form, in standard form, using either the distributive property or a diagram. Middle of Unit Problem 3

		Middle of Unit Problem 6 • I know the difference between "factored form" and "standard form." Checkpoint C **Lesson 10 Graphs of Functions in Standard and Factored Forms** • I can explain the meaning of the intercepts on a graph of a quadratic function in terms of the situation it represents. Middle of Unit Problem 7 End of Unit Problem 5 *NOTE: End of Unit Problem 5 Clare's function in factored form should be looked at. Question b. Give a different time value so that someone's height is higher and they are NOT the same. Difficult to understand why a student made an error.* End of Unit Problem 7 • I know how the numbers in the factored form of a quadratic expression relate to the intercepts of its graph. Middle of Unit Problem 7 End of Unit Problem 5 End of Unit Problem 7
Checkpoint C	*Responding to Student Thinking* **Problem 1:** More Chances: Students will have more opportunities to develop this understanding in later sections. There is no need to slow down or add additional work to review this concept at this time.	
Section D Features of Graphs of Quadratic Functions Lessons 11-17	**Learning Target 7** I can explain how a graph is affected by changing parameters in quadratic expressions written in standard, factored, and vertex forms. **Learning Target 8** I can use an equation in vertex form to identify the maximum or minimum of a quadratic function.	**Lesson 11 Graphing from the Factored Form** • I can graph a quadratic function given in factored form. End of Unit Problem 4 • I know how to find the vertex and y-intercept of the graph of a quadratic function in factored form without graphing it first. End of Unit Problem 4 End of Unit Problem 5 **Lesson 12 Graphing the Standard Form (Part 1)** • I can explain how the a and c in $y = ax^2 + bx + c$ affect the graph of the equation. Checkpoint D Problem 1 End of Unit Problem 3 • I understand how graphs, tables, and equations that represent the same quadratic function are related. **ACC Lesson 13 Graphing the Standard Form (Part 2)** • I can explain how the b in $y = ax^2 + bx + c$ affects the graph of the equation. • I can match equations given in standard and factored form with their graph. End of Unit Problem 1 End of Unit Problem 2 **Lesson 14 Graphs That Represent Situations** I can explain how a quadratic equation and its graph relate to a situation. End of Unit Problem 5 **ACC Lesson 15 Vertex Form**

		• I can recognize the "vertex form" of a quadratic equation. • I can relate the numbers in the vertex form of a quadratic equation to its graph. End of Unit Problem 2 End of Unit Problem 6 **ACC Lesson 16 Graphing from the Vertex Form** • I can graph a quadratic function given in vertex form, showing a maximum or minimum and the y-intercept. • I know how to find a maximum or a minimum of a quadratic function given in vertex form without first graphing it. Checkpoint D Problem 2 End of Unit Problem 6 **ACC Lesson 17 Changing the Vertex** • I can describe how changing a number in the vertex form of a quadratic function affects its graph. End of Unit Problem 6 Note: May condense Lessons 15-16 for ACA
Checkpoint D	*Responding to Student Thinking* **Problem 1:** Press Pause: If students struggle to describe how graphs of quadratic functions differ based on the functions, make time to explore the idea further. For example, revisit the digital form of the activity referred to here to explore how changing the parameters influence the graph. **Problem 2:** Press Pause: If students struggle to identify the maximum or minimum of a quadratic function in vertex form, plan to make time to revisit the idea. For example, use the optional lesson referred to here to practice connecting the equation of the quadratic function with the graph that represents it.	
END OF UNIT ASSESSMENT		

Unit Title

Unit 3 (iM A1 U8): Quadratic Equations

Relevant Standards

Lesson	Standards	Lesson	Standards	Lesson	Standards
Lesson 1	HSA-CED.A.1	Lesson 9	HSA-REI.B.4.b HSA-SSE.B.3.a HSF-IF.C.8.a	Lesson 17	HSA-CED.A.1 HSA-REI.A HSA-REI.B.4.b HSF-IF.B.5
Lesson 2	HSA-REI.B.4 HSA-REI.B.4.b	Lesson 10	HSA-REI.B.4.b HSA-REI.D HSA-SSE.A HSA-SSE.A.2 HSF-IF.B.4 HSF-IF.C.8.a	Lesson 18	HSA-CED.A.1 HSA-REI.B.4.b HSF-IF.A.2
Lesson 3	HSA-REI.A.1 HSA-REI.B.4.b	Lesson 11	HSA-REI.B.4.b HSA-SSE.A.2	Lesson 19	HSA-REI.B.4.a HSA-SSE.A.2
Lesson 4	HSA-REI.B.4	Lesson 12	HSA-REI.B.4.a HSA-REI.B.4.b HSA-SSE.A HSA-SSE.A.2	Lesson 20	HSA-REI.B.4.b HSF-IF.C.7.a HSN-RN.B.3
Lesson 5	HSA-REI.A.1 HSA-REI.B.4 HSA-REI.B.4.b HSA-REI.D HSA-REI.D.10	Lesson 13	HSA-REI.A HSA-REI.B.4.b	Lesson 21	HSA-REI.B.4.b HSN-RN.B HSN-RN.B.3
Lesson 6	HSA-SSE.A.2	Lesson 14	HSA-REI.B.4.a HSA-REI.B.4.b HSA-SSE.A.2	Lesson 22	HSA-SSE.A.2 HSA-SSE.B.3 HSA-SSE.B.3.b HSF-IF.C
Lesson 7	HSA-SSE.A.2	Lesson 15	HSA-REI.B.4.a HSA-REI.B.4.b HSA-REI.D	Lesson 23	HSA-SSE.B.3.b HSF-IF.C HSF-IF.C.9
Lesson 8	HSA-SSE.A.2	Lesson 16	HSA-REI.B.4.b HSA-SSE.A	Lesson 24	HSA-REI.B.4.b HSA-REI.C.7 HSF-IF.C.8.a

Essential Question(s):	Enduring Understanding(s):
• Why do we need different methods to solve quadratic equations? • How can the same quadratic equation have 0, 1, or 2 solutions, and what does this tell us about real-world situations? What mathematical structures and patterns help us transform quadratic expressions to reveal important information? • How do we determine when solutions to equations are rational versus irrational, and why does this matter? • When is it worth completing the square instead of using other solving methods? • How does the quadratic formula connect to and generalize other solving methods we've learned? • What makes a quadratic model appropriate for a real-world situation, and how do we interpret solutions in context? • How do different representations of the same quadratic relationship highlight different aspects of	• Multiple solution methods exist for quadratic equations, and strategic method selection depends on the form of the equation and the desired information. • The structure of quadratic expressions determines their solvability and the nature of their solutions. • Completing the square is both a solving technique and a method for transforming quadratic expressions to reveal maximum/minimum values. • The quadratic formula represents a generalized method derived from the completing the square process and works for any quadratic equation. • Quadratic equations can have 0, 1, or 2 real solutions, and this number connects to graphical features and real-world constraints. • Different forms of quadratic expressions reveal different information: standard form shows y-intercept, factored form shows zeros, and vertex form shows maximum/minimum. • Solutions to quadratic equations can be rational or irrational, and understanding the nature of these

a problem?	solutions helps in determining appropriate representations and approximations. • Quadratic models effectively represent many real-world phenomena involving optimization, projectile motion, and area problems, but solutions must be interpreted within contextual constraints.
Demonstration of Learning:	**Pacing for Unit**
Section A Checkpoint Section B Checkpoint Mid-Unit Assessment Section C Checkpoint Section D Checkpoint Section E Checkpoint End-of-Unit Assessment	30 days (15 class periods) Lesson Modifications: (from adaptation pack) • Combine Lessons 1 and 2 (particularly if Unit 7 Lesson 8 was skipped). Focus on Lesson 2 Activity 1. • Remove Lesson 10. This focuses on factoring when the coefficient of the squared term is greater than 1. • Remove or condense Lessons 11–15 on completing the square, depending on the emphasis in your standards on completing the square. • Remove Lessons 19–21.
Family Overview (link below)	**Integration of Technology:**
https://accessim.org/9-12-aga/algebra-1/unit-8?a=family	• Desmos Online Graphing Calculator
Unit-specific Vocabulary:	**Aligned Unit Materials, Resources, and Technology (beyond core resources):**
Factored form (of a quadratic expression), quadratic equation, standard form (of a quadratic expression), zero (of a function), zero product property, linear term, perfect square, completing the square, quadratic formula	• Desmos Online Graphing Calculator • Pear Assessment (Edulastic) • IL Classroom Adapted Resources
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions**
Science & Engineering • Projectile Motion: The flying potato activity (Lesson 1) models object trajectories using $h(t) = -16t^2 + 80t + 64$ • Maximum Height Problems: Using vertex form to find optimal launch conditions in physics • Arch Design: Parabolic shapes in bridge and building construction • Population Growth: Quadratic models for limited growth scenarios in biology • Antenna Design: Parabolic reflectors for communication systems Business & Economics • Ticket Sales Revenue: Lesson 2's concert revenue model R=(8−2x)(x+5) • Maximum Profit: Using vertex form to determine optimal production levels • Break-even Analysis: Finding when profit equals zero using quadratic equations • Price-Demand Relationships: Quadratic revenue functions showing optimal pricing • Manufacturing Costs: Quadratic cost functions with economies of scale Arts & Recreation • Frame Design: The framing problem (Lesson 1) connects to mat cutting and display optimization • Basketball Trajectories: Parabolic paths of shot attempts in sports analysis • Diving Trajectories: Height vs. time relationships (Lesson 24's diving context) • Garden Planning: Maximum area problems for	• Missing both solutions when solving quadratic equations • Errors in quadratic formula application (sign errors, arithmetic mistakes) • Confusion about number of solutions (thinking all quadratics have 2 solutions) • Factoring errors when rewriting expressions • Completing the square mistakes • Misunderstanding rational vs. irrational solutions See teacher's guide for specific misconceptions aligned to each lesson

landscape design
- Parabolic Art: Mathematical curves in sculpture and graphic design

Connections to Prior Units	Connections to Future Units
Relevant Unit(s) to review: • Grade 7, Unit 6: Expressions, Equations, and Inequalities Essential prior concepts to engage with this unit: • Write equivalent expressions by combining like terms and applying the distributive property.	Unit 4 (iM A2 U2): Polynomial Functions • Introduces complex solutions (a ± bi) that become central in this unit and and factoring techniques extend to polynomial functions Mathematical Modeling Foundations • Emphasizes setting up equations from real contexts and interpreting solutions within constraints, preparing students for the increased applications focus throughout Algebra 2 Unit 5 (iM A2 U3): Rational Functions and Equations • Students develop flexibility in choosing solving methods (factoring vs. quadratic formula vs. completing the square) that transfers to solving rational equations

Differentiation through *Universal Design for Learning*

Engagement
- Connect quadratic patterns to engaging real-world contexts like projectile motion, ball tosses, and revenue optimization
- Compare quadratic growth to familiar linear and exponential patterns to build understanding and maintain interest
- Scaffold learning progression from concrete visual patterns to abstract function forms and equations
- Build on prior knowledge of linear and exponential functions while highlighting unique characteristics of quadratic growth
- Make learning goals transparent about understanding different forms of quadratic expressions and their graphical meaning
- Encourage mathematical discourse about how coefficients affect parabola shape and position

Representation
- Present quadratic functions through multiple sensory modalities using tables, graphs, equations, and physical motion contexts
- Ensure graphing technology accessibility and provide clear visual design for parabola key features
- Support vocabulary development for quadratic terminology (vertex, axis of symmetry, standard/factored/vertex form)
- Connect symbolic expressions to verbal descriptions and graphical representations of parabola transformations
- Activate prior knowledge by explicitly connecting quadratics to familiar function types and growth patterns
- Guide pattern recognition in quadratic sequences and highlight critical features that distinguish parabola characteristics

Action & Expression
- Provide multiple ways for students to demonstrate understanding through graphing technology, algebraic manipulation, or contextual interpretation
- Support planning strategies for choosing appropriate quadratic forms to reveal specific function properties
- Offer various tools including graphing calculators, interactive applets, and function transformation templates
- Scaffold executive functions by providing organizational frameworks for moving between standard, factored, and vertex forms
- Create opportunities for students to express mathematical thinking about parabola transformations and real-world modeling
- Guide students in monitoring progress as they interpret coefficients' effects on graph shape and position

Supporting Multilingual/English Learners

The Illustrative Mathematics curriculum incorporates eight Mathematical Language Routines (MLRs) that support English Language Learners:

MLR1: *Stronger and Clearer Each Time* - Students revise and refine their mathematical language through multiple drafts
MLR2: *Collect and Displa*y - Students capture and organize language in visual displays
MLR3: *Clarify, Critique, Correct* - Students analyze mathematical writing/talk
MLR4: *Information Gap* - Students share information to solve problems
MLR5: *Co-Craft Questions* - Students create and improve questions
MLR6: *Three Reads* - Students analyze complex mathematical text
MLR7: *Compare and Connect* - Students connect different mathematical representations
MLR8: *Discussion Supports* - Students participate in mathematical discussions

MLR2: Collect and Display
Used in Lesson 12 (Building Perfect Squares) to capture and organize student language about completing the square

MLR5: Co-Craft Questions
Used in Lesson 2 (Revenue from Ticket Sales) where students generate mathematical questions about quadratic situations

MLR6: Three Reads

Used in Lesson 23 (All the World's a Stage) to help students analyze complex mathematical text about quadratic applications

MLR7: Compare and Connect

Used in Lesson 1 (Representing the Framing Problem) where students compare different approaches to writing quadratic equations and connect mathematical representations

MLR8: Discussion Supports

Used extensively throughout multiple lessons (Lessons 2, 4, 6, 9, 12, 16, 23) to support rich mathematical discussions about quadratic equations, factoring, completing the square, and the quadratic formula

Sentence Frames and Stems

Section A

- The equation _____ represents this situation because ...
- The solution(s) to the equation is/are ____. The solution(s) represent(s) ...

Section B

- To factor the expression _____ given in standard form, first I _____, then I ...
- I know the equation _____ has _____ solution(s) because ...
- To find the solution(s) to the equation _____, first I _____, then I ...
- The solution(s) to the equation _____ is/are _____.

Section C

- The equation _____ can be more easily solved by completing the square because ...
- The solution(s) to the equation _____ is/are _____.
- I know _____ is a perfect square because ...
- To solve the equation _____ by completing the square, first I _____, then I ...

Section D

- The product/sum of the values _____ is rational/irrational because ...
- The equation _____ can be more easily solved by using the quadratic formula because ...
- The solution(s) to the equation _____ is/are _____.
- The solution(s) represent(s) _____ in this situation.

Section E

- To convert the equation _____ to vertex form, first I _____, then I ...
- Using the equation _____ in vertex form, I recognize the _____ (feature of the graph) is _____ which represents _____.
- The solution(s) to the equation _____ is/are _____.

Section F

- I chose to write the quadratic equation in _____ form because ...
- Using the graph, the _____ (feature of the graph) is _____ and represents _____.
- Without graphing, I can tell _____ about a situation when the equation is in _____ form because ...

Related *CELP standards* and Learning Targets:

	Emerging	Expanding	Bridging
LT 1	Identify the key quantities and match a given quadratic equation to its described real-world situation. Use a word bank to label the meaning of the solutions.	Describe in short, connected sentences how the solutions (roots) of a given equation relate to the starting, ending, and maximum/minimum points of a simple context (e.g., a ball's flight).	Write a quadratic equation to model a described complex situation and justify the meaning of the solutions (real or non-real) in the context of the problem, using academic vocabulary.
LT 2	Use provided graphic organizers or manipulatives (e.g., algebra tiles) to factor the standard form of a quadratic expression, identifying the correct factors.	Explain the steps used to factor a quadratic expression and correctly create the equivalent expression in factored form with minor support.	Analyze a given quadratic expression and systematically generate the equivalent factored form, justifying the choice of factoring method used.
LT 3	Select the correct solutions (roots) from a multiple-choice list when given a quadratic equation already in factored form. Complete a sentence frame to state the zero-product property.	Explain in simple, ordered steps how to use the zero-product property to find the solutions to a factored quadratic equation.	Apply the zero-product property to solve a multi-step quadratic equation, explaining the logical connection between the equation's factors and the resulting solutions.
LT 4	Match the +/- symbol to the concept of "two solutions" and the square root symbol to the concept of "only one positive solution."	Compare and contrast the meaning and necessary use of the +/-symbol versus the square root symbol in mathematical contexts, using short comparative sentences.	Justify the mathematical reasoning for why the +/- symbol is required when solving by taking the square root, but not when interpreting the radical symbol, using precise mathematical language.

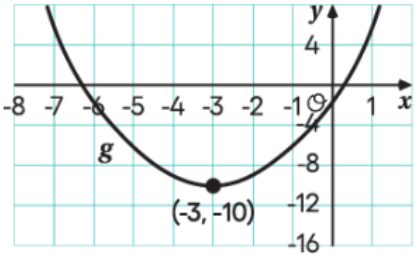
LT5	Follow a provided step-by-step example, labeling each step and identifying the missing number to create a perfect square trinomial (when b is even).	Describe and execute the steps for solving a quadratic equation by completing the square, using mathematical action verbs.	Evaluate and solve any quadratic equation by completing the square, explaining the transformation of the equation and the rationale for rearranging terms.
LT6	Classify given numbers as rational or irrational using a checklist. Use a provided rule (e.g., Rational + Irrational = Irrational) to state the result of a single operation.	Describe, using simple language and one numerical example for each, the general rules for the sum and product of a rational number and an irrational number.	Justify with clear mathematical evidence whether a given statement about the closure properties of rational and irrational numbers under addition and multiplication is true or false.
LT7	Identify and label the values of a, b, and c in a quadratic equation. Match the labeled values to the correct placement within the structure of the quadratic formula template.	Describe the purpose of the quadratic formula and demonstrate its use to solve a given quadratic equation, clearly showing the substitution and calculation steps.	Analyze the structure of the quadratic formula and use it to solve an equation, interpreting the discriminant to predict the number and type of solutions before fully solving.
LT8	Identify the vertex coordinates (h, k) from an equation written in vertex form $y=a(x-h)^2+k$. Select whether the vertex is a maximum or minimum from two choices.	Describe the process for finding the vertex of a quadratic function (using -b/2a or completing the square) and explain how the vertex relates to the function's maximum or minimum value.	Rewrite a quadratic expression from standard form to vertex form (by completing the square) and use the vertex form to mathematically justify the maximum or minimum value in a practical context.

Unit Description

In this unit, students interpret, write, and solve equations algebraically.

Previously, students represented quadratic functions using expressions, tables, and descriptions. They connected important features of graphs to standard, factored, and vertex forms and expanded expressions into standard form.

Students begin with solving quadratic equations through reasoning without much algebraic manipulation. Then, they examine solving using the zero product property for quadratic equations that can be written in factored form. They notice patterns that help them rewrite quadratic expressions in factored form and recognize that not all of them are easily factorable.



This motivates finding another process of solving quadratic equations. Students recognize the benefits of equations of the form and develop the method of completing the square. Then, they generalize this process to the quadratic formula.

Throughout the unit, students analyze quadratic equations to recognize that there can be 0, 1, or 2 solutions. Solutions can be rational, irrational, or combinations of these. Students interpret the solutions that arise in different contexts.

The unit concludes with rewriting quadratic expressions from standard form into vertex form to find maximum and minimum values, then apply all of their understanding to applied problems.

Lesson Sequence	Learning Target	Success Criteria/ Assessment
Section A Finding Unknown Inputs Lessons 1-2	**Learning Target #1** Write quadratic equations, and reason about their solutions in terms of a situation.	**Lesson 1 Finding Unknown Inputs** I can explain the meaning of a solution to an equation in terms of a situation. • I can write a quadratic equation that represents a situation. Checkpoint A Problem 1 **Lesson 2 When and Why Do We Write Quadratic Equations?** • I can recognize the factored form of a quadratic expression and know when it can be useful for solving problems.

		• I can use a graph to find the solutions to a quadratic equation but also know its limitations.
Checkpoint A	*Responding to Student Thinking* **Problem 1:** Points to Emphasize - If students struggle to determine reasonable solutions from a situation, revisit the idea throughout the unit. For example, in the activity referred to here, when students find a solution, ask them about its meaning in the situation and whether it is reasonable.	
Section B Solving Quadratic Equations Lessons 3-10	**Learning Target #2** Given a quadratic expression of the form $ax^2 + bx + c$, create an equivalent expression in factored form. **Learning Target #3** Use factored form and the zero-product property to solve quadratic equations.	**Lesson 3 Solving Quadratic Equations by Reasoning** • I can find solutions to quadratic equations by reasoning about the values that make the equation true. • I know that quadratic equations may have two solutions. Mid-Unit Assessment Problem 1 **Lesson 4 Solving Quadratics Equations with the Zero-Product Property** • I can explain the meaning of the "zero product property." • I can find solutions to quadratic equations when one side is a product of factors and the other side is zero. Checkpoint B Problem 1 **Lesson 5 How Many Solutions?** • I can explain why dividing by a variable to solve a quadratic equation is not a good strategy. • I know that quadratic equations can have no solutions and can explain why when there are none. Mid-Unit Assessment Problem 2- 7c **Lesson 6 Rewriting Quadratic Expressions in Factored Form (Part 1)** • I can explain how the numbers in a quadratic expression in factored form relate to the numbers in an equivalent expression in standard form. • When given quadratic expressions in factored form, I can rewrite them in standard form. • When given quadratic expressions in the form of • $x^2 + bx + c$, I can rewrite them in factored form. Checkpoint B Problem 2 **Lesson 7 Rewriting Quadratic Expressions in Factored Form (Part 2)** • I can explain how the numbers and signs in a quadratic expression in factored form relate to the numbers and signs in an equivalent expression in standard form. • When given a quadratic expression given in standard form with a negative constant term, I can write an equivalent expression in factored form. Mid-Unit Assessment Problems 3-4 **Lesson 8 Rewriting Quadratic Expressions in Factored Form (Part 3)** • I can explain why multiplying a sum and a difference, $(x + m)(x - m)$, results in a quadratic expression with no linear term. • When given quadratic expressions in the form of $x^2 + bx + c$, I can rewrite them in factored form.

		Lesson 9 Solving Quadratic Equations by Using Factored Form • I can rearrange a quadratic equation to be written as an expression in factored form equal to zero and find the solutions. • I can recognize the number of solutions for a quadratic equation from the factored form. Mid-Unit Assessment Problem 6-7a,b **ACC Lesson 10 Rewriting Quadratic Expressions in Factored Form (Part 4)** • I can use the factored form of a quadratic expression or a graph of a quadratic function to answer questions about a situation. • When given quadratic expressions of the form • $ax^2 + bx + c$, where a is not 1, I can write equivalent expressions in factored form. Mid-Unit Assessment Problem 5
Checkpoint B	*Responding to Student Thinking* **Problem 1:** More Chances - Students will have more opportunities to develop this understanding in later sections. There is no need to slow down or add additional work to review this concept at this time. **Problem 2:** Points to Emphasize - If students struggle to factor quadratic expressions in standard form, provide additional practice throughout the rest of the unit. For example, the practice problems referred to here can help draw the connection between factored forms and standard forms. Algebra 1, Unit 8, Lesson 13, Practice Problem 5 Algebra 1, Unit 8, Lesson 15, Practice Problem 5	
Mid-Unit Assessment		
Section C Completing the Square Lessons 11-15	**Learning Target #4** Comprehend that the plus-minus symbol is used to represent both square roots of a number and that the square root notation expresses only the positive square root. **Learning Target #5** Solve quadratic equations of the form $x^2 + bx + c = 0$ by rearranging terms and completing the square.	**Lesson 11 What are Perfect Squares?** • I can recognize perfect-square expressions written in different forms. • I can recognize quadratic equations that have a perfect-square expression and solve the equations. End-of-Unit Assessment Problem 1 **Lesson 12 Completing the Square (Part 1)** • I can explain what it means to "complete the square" and describe how to do it. • I can solve quadratic equations by completing the square and finding square roots. Checkpoint C Problem 1 **Lesson 13 Completing the Square (Part 2)** • When given a quadratic equation in which the coefficient of the squared term is 1, I can solve it by completing the square. End-of-Unit Assessment Problem 4a **Lesson 14 Completing the Square (Part 3)** • I can complete the square for quadratic expressions of the form $ax^2 + bx + c$, where a is not 1, and explain the process. • I can solve quadratic equations in which the squared term coefficient is not 1 by completing the square. End of Unit Problem 4b **Lesson 15 Quadratic Equations with Irrational Solutions** • I can use the radical and "plus-minus" symbols to represent solutions to quadratic equations. • I know why the plus-minus symbol is used when

		solving quadratic equations by finding square roots. Checkpoint C Problem 2
Checkpoint C	*Responding to Student Thinking* **Problem 1:** Points to Emphasize - If students struggle to complete the square to solve quadratic equations, emphasize the idea throughout the next section. For example, return to the idea of completing the square whenever the quadratic formula is used to remind students of the connection. The lesson referred to here shows a connection. Algebra 1, Unit 8, Lesson 19 Deriving the Quadratic Formula **Problem 2:** Points to Emphasize: If students struggle to understand ± notation, emphasize its meaning throughout the next section. For example, in the lesson referred to here, write the quadratic formula three times: once using the plus-minus sign, then again, splitting it into the two forms, one with only a plus sign and one with only a minus sign. Algebra 1, Unit 8, Lesson 16 The Quadratic Formula	
Section D The Quadratic Formula Lessons 16-21	**Learning Target #6** Explain whether the products or sums of combinations of rational and irrational numbers are rational or irrational. **Learning Target #7** Use the quadratic formula to solve quadratic equations of the form $ax^2 + bx + c = 0$.	**Lesson 16 The Quadratic Formula** • I can use the quadratic formula to solve quadratic equations. • I know some methods for solving quadratic equations can be more convenient than others. Checkpoint D Problem 1 **Lesson 17 Applying the Quadratic Formula (Part 1)** • I can use the quadratic formula to solve an equation and interpret the solutions in terms of a situation. **Lesson 18 Applying the Quadratic Formula (Part 2)** • I can identify common errors when using the quadratic formula. • I know some ways to tell if a number is a solution to a quadratic equation. **ACC Lesson 19 Deriving the Quadratic Formula** • I can explain the steps and complete some missing steps for deriving the quadratic formula. • I know how the quadratic formula is related to the process of completing the square for a quadratic equation $ax^2 + bx + c = 0$. End-of-Unit Assessment Problem 5 **ACC Lesson 20 Rational and Irrational Solutions** • I can explain why adding a rational number and an irrational number produces an irrational number. • I can explain why multiplying a rational number (except 0) and an irrational number produces an irrational number. • I can explain why the sum or product of two rational numbers is rational. Checkpoint D Problem 2 **ACC Lesson 21 Sums and Products of Rational and Irrational Numbers** • I can explain why adding a rational number and an irrational number produces an irrational number. • I can explain why multiplying a rational number (except 0) and an irrational number produces an irrational number. • I can explain why the sum or product of two rational numbers is rational. End-of-Unit Assessment Problem 6
Checkpoint D	*Responding to Student Thinking*	

	Problem 1: Points to Emphasize - If students struggle to use the quadratic formula to solve equations, make time to provide additional practice throughout the rest of the unit. For example, revisit the practice problems referred to here to provide additional chances to use the formula. Algebra 1, Unit 8, Lesson 19, Practice Problems 1 and 5 **Problem 2:** Points to Emphasize - If students struggle to classify values as rational or irrational, make time to revisit the idea. For example, after the Warm-up referred to here, revisit this problem, and use the Lesson Summary from the lesson also referred to here to match the values given in this checkpoint question to the bulleted statements about sums and products. Algebra 1, Unit 8, Lesson 22, Activity 1 Three Expressions, One Function Algebra 1, Unit 8, Lesson 21 Sums and Products of Rational and Irrational Numbers	
Section E Vertex Form Revisited Lessons 22-23	**Learning Target #8** Rewrite a quadratic expression in vertex form to identify the maximum or minimum value of the function that the expression defines.	**Lesson 22 Rewriting Quadratic Expressions in Vertex Form** • I can identify the vertex of the graph of a quadratic function when the expression that defines it is written in vertex form. • I know the meaning of the term "vertex form" and can recognize examples of quadratic expressions written in this form. • When given a quadratic expression in standard form, I can rewrite it in vertex form. Checkpoint E Problem 1 **Lesson 23 Using Quadratic Expressions in Vertex Form to Solve Problems** • I can find the maximum or minimum of a function by writing, in vertex form, the quadratic expression that defines it. • When given a quadratic function in vertex form, I can explain why the vertex is a maximum or minimum. Checkpoint E Problem 1 End of Unit Problem 3
Checkpoint E	*Responding to Student Thinking* **Problem 1:** Points to Emphasize - If students struggle to find the vertex of the quadratic functions, plan to emphasize the idea during the lesson referred to here. For example, spend additional time discussing methods for finding the vertex, including completing the square to rewrite the equations in vertex form as well as using symmetry arguments. Algebra 1, Unit 8, Lesson 24, Activity 2 The Dive	
Section F Let's Put It To Work Lesson 24	*There are no new goals for this section.*	**ACC Lesson 24 Using Quadratic Equations to Model Situations and Solve Problems** • I can interpret information about a quadratic function given its equation or a graph. • I can rewrite quadratic functions in different but equivalent forms of my choosing and use that form to solve problems. • In situations modeled by quadratic functions, I can decide which form to use depending on the questions being asked. End-of-Unit Assessment Problem 7
End of Unit Assessment		

Unit Title

Unit 4 (iM A2 U2): Polynomials

Relevant Standards: Bold indicates priority

Lesson	Standards	Lesson	Standards	Lesson	Standards
Lesson 1	HSA-CED.A.2 HSA-SSE.A.1.a HSF-IF.A.2 HSF-IF.B.4 HSF-IF.B.5	Lesson 6	HSA-APR.A HSA-APR.A.1 HSA-APR.B HSA_SSE.B.3 HSF-IF.A.2	Lesson 11	HSA-REI.C.7 HSA-REI.D.11
Lesson 2	HSA-APR.A.1 HSA-CED.A.2 HSA-REI.D.11 HSA-SSE.A.1 HSF-IF.A.2	Lesson 7	HSA-APR.B HSA-SSE.A.1.a	Lesson 12	HSA-APR.A HSA-APR.B.3 HSF-IF.C.7.c
Lesson 3	HSA-SSE.A HSF-IF.C.7 HSF-IF.C.9	Lesson 8	HSA-SSE.A	Lesson 13	HSA-APR.A
Lesson 4	HSA-APR.A.1	Lesson 9	HSA-SSE.A HSF-IF.C	Lesson 14	HSA-APR.A HSA-APR.B HSA-APR.B.3 HSF-IF.C.7.c
Lesson 5	HSA-APR.B HSA-APR.B.3 HSF-IF.C.9	Lesson 10	HA-APR.B.3 HSF-IF.C.7.c	Lesson 15	HSA-APR.B.2

Essential Question(s)	Enduring Understanding(s)
• Why is it useful to write polynomials in factored form versus standard form? • What can we learn from a polynomial's factors that we can't see from its expanded form? • When is each form most advantageous for solving problems? • How are polynomial operations similar to operations with whole numbers? • Why do the same rules for multiplication and division apply to both polynomials and integers? • How can we predict the x-intercepts of a polynomial from its factored form? • What does it mean when a zero has "multiplicity," and how does this affect the graph? • Why does (x−a) being a factor guarantee that a is a zero? • What determines the end behavior of a polynomial function? • How can we sketch a polynomial's graph without plotting many points? • What role do degree and leading coefficient play in a polynomial's behavior? • What types of situations can be modeled by polynomials of different degrees? • How do we determine a reasonable domain for polynomial models? • What are the limitations of polynomial models? • What does the Remainder Theorem tell us about factors and zeros?	Polynomial functions can be represented in multiple equivalent forms (standard form, factored form), and each form reveals different structural information that helps us understand the function's behavior, including its zeros, intercepts, end behavior, and overall shape.

• How is polynomial division similar to and different from numerical division? • When is it useful to divide polynomials in problem-solving contexts?	
Demonstration of Learning	**Pacing for Unit**
CFA 1 Checkpoint A (Lessons 1-4) CFA 2 Checkpoint B (Lessons 5-7) CFA 3 Checkpoint C (Lessons 8-11) NOTES • Question 1 replace written end behavior with notation instead of words "as x->infinity... • Remove question 3 CFA 4 Checkpoint D (Lessons 12-15) End of Unit Assessment NOTES • Problem 1: change to drop down menus for different parts (degree - odd/even)(constant - positive/negative)(end behavior - written using notation instead of words "as x->infinity, etc...) • Problem 2: remove answer choice E - change to SAT style question • Problem 3: remove this question (not a key concept for this unit) - Change to "rewrite the following polynomial in standard form: y = (x + 2)(x - 9)(x + 6)" • Problem 5: Change the equation to say " + d" instead of " - d" Also change the equation to have d come out to a whole number • Problem 6: For academic only, change the given factor of (x-3) to (2x+1) • Problem 7: Change equation so that the (3x+4) changes to (2x +5), then reorder the question: start with part b (change to x- and y- intercepts), then part c (give drop down box for end behavior), then part a (graph)	20 days (10 class periods) Lesson Modifications: (from adaptation pack) • No lessons to remove or merge
Family Overview (link below)	**Integration of Technology:**
https://accessim.org/9-12-aga/algebra-2/unit-2?a=family	• Desmos Online Graphing Calculator
Unit-specific Vocabulary	**Aligned Unit Materials, Resources, and Technology (beyond core resources)**
polynomial, degree, relative maximum, relative minimum, end behavior, multiplicity	• Desmos Online Graphing Calculator • Pear Assessment (Edulastic) • IL Classroom Adapted Resources • Blank paper • Chart paper • Desmos graphing calculator • Math Community Chart • Rulers • Scientific calculators • Scissors • Slips of paper • Tape
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions**
CTE • Investment growth modeling • Profit maximization • Market analysis • Break-even analysis • Package design optimization Science (Physics, Environmental) • Projectile motion	• Degree confusion: Saying $5x^2+3x^4-2$ has degree 2 instead of degree 4 • Zeros from factors: Not connecting (x-3) as a factor to x = 3 as a zero • Sign errors: Thinking (x + 4) gives a zero at x = 4 instead of x = -4 • Multiplicity confusion: Not recognizing $(x-2)^3$ creates

• Wave behavior • Optics • Population dynamics	different graph behavior than (x- 2) • End behavior patterns: Thinking all polynomial graphs "go up" on both ends. • Not connecting odd degree → opposite ends, even degree → same ends • Leading coefficient impact: Ignoring how negative leading coefficients affect end behavior • Intercept vs. zeros: Confusing x-intercepts (points) with zeros (values) See teacher's guide for specific misconceptions aligned to each lesson
Connections to Prior Units	**Connections to Future Units**
Relevant Unit(s) to review: • Algebra 1, Unit 2 and Unit 6 • Algebra 1, Unit 7, Lesson 8 Essential prior concepts to engage with this unit • Multiplying binomials. • Solving systems of linear equations by substitution.	Unit 5 (iM A2 U3): Rational Functions and Equations • End behavior analysis from polynomial functions directly applies to understanding asymptotic behavior in rational functions • Factoring polynomial expressions is essential for simplifying rational expressions and finding vertical asymptotes • Polynomial division (Remainder Theorem) connects to analyzing rational function behavior and finding holes vs. asymptotes Unit 6 (iM A2 U4): Complex Numbers and Rational Exponents • Polynomial zeros and factors extend to finding complex zeros using the Fundamental Theorem of Algebra • Factoring techniques learned with real polynomials apply to factoring over the complex numbers • Polynomial degree and multiplicity concepts transfer to understanding complex solutions

Differentiation through *Universal Design for Learning*

Engagement

- Connect polynomial patterns to familiar contexts and extend understanding from linear and quadratic functions
- Compare polynomial growth rates to previously learned function types to maintain interest and build understanding
- Scaffold learning progression from concrete graphical features to abstract algebraic operations and polynomial division
- Build on prior knowledge of factoring and multiplication while highlighting connections to zeros and factors
- Make learning goals transparent about understanding polynomial forms and their relationship to graphical features
- Encourage mathematical discourse about end behavior, multiplicity effects, and the Remainder Theorem

Representation

- Present polynomials through multiple sensory modalities using graphs, factored forms, standard forms, and division algorithms
- Ensure graphing technology accessibility and provide clear visual design for polynomial key features like zeros and end behavior
- Support vocabulary development for polynomial terminology (degree, leading coefficient, multiplicity, end behavior, Remainder Theorem)
- Connect symbolic polynomial expressions to verbal descriptions and graphical representations of function behavior
- Activate prior knowledge by explicitly connecting polynomial operations to familiar number operations and distributive property
- Guide pattern recognition in polynomial graphs and highlight critical features that distinguish degree and multiplicity effects

Action & Expression

- Provide multiple ways for students to demonstrate understanding through factoring, graphing, division algorithms, or contextual interpretation
- Support planning strategies for choosing appropriate polynomial forms to reveal specific function properties like zeros or end behavior
- Offer various tools including graphing technology, polynomial division templates, and factoring organizers
- Scaffold executive functions by providing organizational frameworks for moving between standard and factored forms
- Create opportunities for students to express mathematical thinking about factor-zero relationships and polynomial behavior
- Guide students in monitoring progress as they connect algebraic operations to graphical features and apply the Remainder Theorem

Supporting Multilingual/English Learners

The Illustrative Mathematics curriculum incorporates eight Mathematical Language Routines (MLRs) that support English Language Learners:

MLR1: *Stronger and Clearer Each Time* - Students revise and refine their mathematical language through multiple drafts
MLR2: *Collect and Displa*y - Students capture and organize language in visual displays
MLR3: *Clarify, Critique, Correct* - Students analyze mathematical writing/talk
MLR4: *Information Gap* - Students share information to solve problems
MLR5: *Co-Craft Questions* - Students create and improve questions
MLR6: *Three Reads* - Students analyze complex mathematical text
MLR7: *Compare and Connect* - Students connect different mathematical representations
MLR8: *Discussion Supports* - Students participate in mathematical discussions

MLR1: Stronger and Clearer Each Time

Used in Lesson 10 (Sketching Polynomials) where students refine their explanations of how to sketch polynomial graphs from factored form

MLR2: Collect and Display

Used extensively in multiple lessons

Sentence Frames and Stems

Section A

- The degree of the polynomial _____ is _____ because ...
- The constant term of the polynomial _____ is _____.
- The point _____ is the relative minimum/maximum on the graph because ...
- A reasonable domain for the polynomial function _____ is _____ because ...
- The function _____ represents this situation because ...
- When the polynomial _____ is combined with the polynomial _____ using _____ (operation), the result is/is not a polynomial because ...

Section B

- The expression _____ represents the polynomial _____ with zeros at ...
- The zeros of the polynomial _____ are _____ because ...
- The degree of the polynomial _____ is _____ because ...
- The constant term of the polynomial _____ is _____.
- The polynomial _____ in standard/factored form is _____ in factored/standard form.

Section C

- To sketch the graph of the polynomial _____, first I _____, then I ...
- To find the point(s) of intersection for the polynomials, first I _____, then I ...
- The system of equations has _____ solution(s). I know this because ...
- The solution to the system of equations is _____ because ...
- _____ is a possible equation for a polynomial with the following properties: ...
- As _____ gets _____ in the _____ direction, _____ gets _____ in the _____ direction.

Section D

- The polynomial _____ with a known factor of _____, can be written as a product of the linear factors _____ (a set of 2 or factors)because ...
- To divide the polynomial _____ by the factor _____, first I _____, then I ...
- I chose to use _____ (method) to write the polynomial _____ in factored form because ...

Supporting Multilingual/English Learners (*CELP standards*)

	Emerging	Expanding	Bridging
LT1	I can identify the dimensions (length, width, height) of a box and recognize that volume = length x width x height with visual support and sentence frames like "The volume is _____ times _____ times _____."	I can write volume expressions like V=x(x-2)(x+3) and explain what each factor represents using mathematical language with some support: "The factor (x-2) represents the width because..."	I can independently create volume expressions, interpret what restrictions on xxx make sense in context, and explain why certain values are reasonable: "Since x represents length, x>2 because width must be positive."
LT2	I can match polynomial expressions to real-world contexts (area, volume, profit) using visual aids and choose from given options like "This polynomial could represent: A) area B) number of people C) temperature"	I can explain connections between polynomial features and context with sentence frames: "The degree tells us..." "The coefficient means..." and identify which situations polynomials can and cannot model.	I can analyze polynomial models critically, compare different polynomial models for the same situation, and justify why polynomial models are appropriate or inappropriate for specific contexts.
LT3	I can locate and name basic features (x-intercepts, y-intercepts, maximum/minimum points) using vocabulary cards and sentence frames	I can describe relationships between algebraic and graphical features using mathematical language: "The factor (x-3) creates an x-intercept at..." "The	I can analyze and compare multiple representations fluently, explaining connections: "The multiplicity of the zero affects the graph's behavior

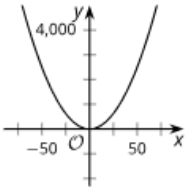
	like "The x-intercept is at x=" "The graph increases/decreases."	leading coefficient affects..."	because..." and make predictions about unseen features.
LT4	I can perform polynomial operations with step-by-step guidance and recognize the result is still a polynomial using sentence frames: "When I add these polynomials, I get..." "The result is still a polynomial because..."	I can explain why polynomial operations result in polynomials using mathematical language: "The degree of the sum is..." "Polynomial closure means..." and connect this to the definition of polynomials.	I can generalize the closure property, explain exceptions (like division), and apply this understanding to determine if expressions are polynomials: "This expression is/isn't a polynomial because of the closure property..."
LT5	I can identify zeros by setting each factor equal to zero using sentence frames: "If (x-3) is a factor, then x = ___" and visual supports showing the connection between factors and x-intercepts.	I can find zeros from factored form and explain the process using mathematical language: "The zeros are found by..." and connect zeros to x-intercepts on graphs with guided support.	I can find zeros from complex factored forms, explain the relationship between factors and zeros, and analyze how multiplicity affects the graph at each zero.
LT6	I can identify basic features (degree, leading coefficient, x-intercepts) from standard and factored forms using vocabulary cards and sentence frames: "The degree is ___" "The leading coefficient is ___"	I can compare how standard and factored forms reveal different information using mathematical language: "Standard form shows..." "Factored form reveals..." and explain advantages of each form.	I can analyze polynomial features across multiple representations, strategically choosing forms based on needed information, and explaining complex relationships between algebraic and graphical features.
LT7	I can write simple polynomial expressions with given x-intercepts using patterns: "If zeros are 2 and -1, then factors are (x-2) and (x+1)" with step-by-step guidance and visual supports.	I can construct polynomial functions with specified intercepts and explain my reasoning: "To have zeros at x = 3 and x = -2, I need factors..." using mathematical language with some support.	I can create polynomial functions with complex intercept conditions (including multiplicity), justify my methods, and explain how different constructions affect the graph's behavior.
LT8	I can identify the leading term and describe basic end behavior using sentence frames: "As x gets very large, y..." "As x gets very negative, y..." with visual graphs showing patterns.	I can explain why the leading term determines end behavior using mathematical language: "The leading term dominates because..." and predict end behavior from equations with guided support.	I can analyze end behavior in complex situations, explain the mathematical reasoning behind leading term dominance, and compare end behavior across different polynomial types.
LT9	I can plot zeros on a graph and identify whether the graph crosses or touches the x-axis using visual patterns and sentence frames: "At x = 2, the graph crosses/touches because the multiplicity is ___"	I can sketch polynomial graphs using zeros and multiplicities, explaining the relationship: "When multiplicity is even, the graph touches..." "When multiplicity is odd, the graph crosses..." with mathematical language.	I can create accurate polynomial graphs considering zeros, multiplicities, and end behavior, explaining complex behaviors and making connections between algebraic features and graphical characteristics.
LT10	I can find where two simple polynomial functions intersect by setting them equal and solving with step-by-step support, using sentence frames: "To find intersections, I set ___ equal to ___"	I can solve intersection problems for polynomial functions and explain my method: "The functions intersect when..." using mathematical language and connecting algebraic solutions to graphical intersections.	I can find intersections of complex polynomial functions, analyze the meaning of solutions in context, and explain why intersection points represent equation solutions.
LT11	I can perform basic polynomial division with step-by-step guides and identify quotient and remainder using vocabulary supports and sentence frames: "When I divide ___ by ___, I get quotient ___ and remainder ___"	I can divide polynomials using long division and explain the process using mathematical language: "First, I divide the leading terms..." connecting division to multiplication relationships.	I can perform complex polynomial division, apply the division algorithm strategically, and explain how division relates to factoring and the Remainder Theorem.
LT12	I can use a known factor to find other factors through division with guided support, using sentence frames: "If (x-2) is a factor, then dividing gives me..." and visual step-by-step processes.	I can apply polynomial division to completely factor polynomials starting from one known factor, explaining the process: "After dividing by the known factor, I can factor the quotient..."	I can strategically use division and known factors to completely analyze polynomial functions, sketch graphs from factored forms, and explain the complete factorization process.
LT13	I can apply the Remainder Theorem using substitution with step-by-step guidance: "To find the remainder when dividing by (x-a), I substitute x = a" using sentence frames and examples.	I can explain the Remainder Theorem and why it works using mathematical language: "The remainder equals f(a) because..." and apply it to solve problems with guided support.	I can prove why the Remainder Theorem is true, apply it in complex situations, and connect it to broader concepts of polynomial division and function evaluation.

Unit Description

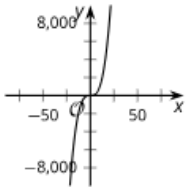
This unit extends students' previous work with linear and quadratic functions as they investigate polynomials of higher degree. Students rewrite polynomials in different forms, recognizing the benefits of the various forms for their ability to reveal the structure of key features of their graphs.

The unit begins with an introduction to two situations that can be modeled by a polynomial function. Students build their understanding of what polynomials are and what their graphs can look like. Certain aspects, such as end behavior, will be important in a later unit when students explore the end behavior of rational functions.

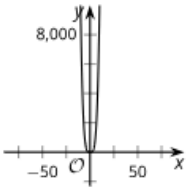
$y = x^2$



$y = x^3$



$y = x^4$



Focusing on functions expressed in factored form and their graphs, students connect that a factor of $(x - a)$ means a is a zero of the function and $(a, 0)$ is a horizontal intercept. The effect of the degree and leading coefficient on end behavior is established along with the effect of multiplicity on the shape of the graph near zeros of the function. Taking in all of these features, students learn to sketch polynomial functions expressed as a product of linear factors.

In a previous course, students used the distributive property to multiply factors, and also factored quadratics. Opportunities to review these skills and apply them to polynomials of higher degree are embedded throughout the unit and in practice problems. This prepares students for the final section where students divide a polynomial written in standard form by a suspected factor. From there, the connection between division and multiplication equations is used to establish the Remainder Theorem. This allows the conclusion that if a polynomial has a zero at $x = a$, then it must also have $(x - a)$ as a factor.

Lesson Sequence	Learning Target	Success Criteria/ Assessment	Resources
Section A What Is a Polynomial? Lessons 1-4	**Learning Target 1** Generalize that when polynomials are combined by addition, subtraction, or multiplication, the result is a polynomial. **Learning Target 2** Identify and interpret relative minimums, relative maximums, the degree, and the constant term of polynomials and their graphs.	**Lesson 1 Let's Make a Box** • I can create and interpret an expression that models the volume of a box. **Lesson 2 Funding the Future** • I can use polynomials to understand different kinds of situations. **Lesson 3 Introducing Polynomials** • I can identify important characteristics of polynomial graphs and expressions. Checkpoint A Problem 1 End of Unit Problem 1 **Lesson 4 Combining Polynomials** • I understand that if you add, subtract, or multiply polynomials, you get another polynomial. Checkpoint A Problem 2 End of Unit Problem	
Checkpoint A	*Responding to Student Thinking:* **Problem 1**: More Chances: Students will have more opportunities to develop this understanding in later lessons. There is no need to slow down or add additional work to review this concept at this time. **Problem 2:** Points to Emphasize: If most students struggle with the definition of a polynomial, focus on this as opportunities arise in the next several lessons. For example, in the Synthesis of the activity referred to here, ask students whether these are polynomial functions and to explain how they know.		
Section B Working with Polynomials	**Learning Target 3**	**Lesson 5 Connecting Factors and Zeros** • I can find the zeros of a function from its factored form.	

Lessons 5-7	Determine properties of polynomials by representing them in standard or factored form. **Learning Target 4** Generate a possible expression for a polynomial function given the horizontal intercepts of the function. **Learning Target 5** Identify zeros of polynomial functions written in factored form.	Checkpoint B Problem 1 **Lesson 6 Different Forms** • I can identify features of polynomials and their graphs using their standard and factored forms. End of Unit Problems 1 and 2 **Lesson 7 Using Factors and Zeros** • I can write an expression for a function that has specific horizontal intercepts. End of Unit Problems 2
Checkpoint B	*Responding to Student Thinking* **Problem 1:** Points to Emphasize: If most students struggle with finding the zeros of a polynomial from its factors, focus on this as opportunities arise over the next several lessons. For example, in the Activity Synthesis of this activity, spend time discussing how the factored form of the polynomials can be used to find where the value of y is 0. **Problem 2:** Press Pause: By this point in the unit, there should be some student mastery of identifying the degree and constant term of a polynomial from its factored form. If most students struggle with these, make time to revisit related work in the practice problems referred to here. See the Course Guide for ideas to help students re-engage with earlier work.	
Section C Graphs of Polynomials Lessons 8-11	**Learning Target 6** Calculate the solution to a system of polynomial equations. **Learning Target 7** Create equations for polynomial functions with specific end behavior. **Learning Target 8** Use zeros and multiplicities to sketch a graph of a polynomial function given in factored form.	**Lesson 8 End Behavior (Part 1)** • I understand why a function's end behavior is determined by its leading term. End of Unit Problem 1 and 7 **Lesson 9 End Behavior (Part 2)** • I can identify the end behavior of a polynomial function from its equation. End of Unit Problem 1 and 7 **Lesson 10 Multiplicity** • I can use zeros and multiplicities to sketch a graph of a polynomial. End of Unit Problem 7 **Lesson 11 Finding Intersections** • I can find where two polynomial functions intersect. End of Unit Problem 4
Checkpoint C	*Responding to Student Thinking* *More Chances: Students will have more opportunities to develop this understanding in later lessons. There is no need to slow down or add additional work to review this concept at this time.*	
Section D: Polynomial Division Lessons 12-15	**Learning Target 9** Generalize that for a polynomial p(x) and a number a, the remainder on division by (x-a) is p(a). **Learning Target 10** Rewrite a polynomial as the product of linear factors.	**Lesson 12 Polynomial Division (Part 1)** • I can divide one polynomial by another. End of Unit Problem 5 and 6 **Lesson 13 Polynomial Division (Part 2)** • I can use long division to divide polynomials. End of Unit Problem 5 and 6 **Lesson 14 What Do You Know about Polynomials?** • I can use division to rewrite a polynomial in factored form starting from a known factor and then sketch what it looks like. End of Unit Problem 6 **Lesson 15 The Remainder Theorem** • I understand the Remainder Theorem and why it's true. End of Unit Problem 5

Checkpoint D	*Responding to Student Thinking* Press Pause: By this point in the unit, there should be some student mastery of using polynomial division. If most students struggle with this, make time to revisit related work in the practice problems referred to here. See the Course Guide for ideas to help students re-engage with earlier work.
End of Unit Assessment	

Unit Title

Unit 5 (iM A2 U3): Rational Functions and Equations

Relevant Standards: Bold indicates priority

Lesson	Standards	Lesson	Standards	Lesson	Standards
Lesson 1	HSA-CED.A HSA-CED.A.2 HSA-CED.A.4	Lesson 5	HSA-CED.A.1 HSA-REI.A HSA-CED.A.2 HSA-REI.A.1	Lesson 9	HSA-APR.D MP1
Lesson 2	HSA-CED.A.2 HSF-IF.A.2 HSF-IF.C HSF-IF.C.7 HSA-CED.A.4 HSF-BF.B.3 HSF-IF.B.4	Lesson 6	HSA-CED.A.1 HSA-REI.A.1 HSA-REI.D.11 MP1 MP2 MP5	Lesson 10	HSA-APR.C HSA-SSE.A.2 HSA-SSE.B.4 MP1 MP7
Lesson 3	HSA-APR.D.6 HSA-SSE.A.1 HSF-IF.C	Lesson 7	HSA-REI.A.2 MP6 MP7	Lesson 11	HSA-SSE.A.1 HSA-SSE.B.4 MP1 MP5
Lesson 4	HSF-IF.C.7 HSA-APR.D.6 HSA-SSE.A.1 HSA-SSE.A.1.c	Lesson 8	HSA-APR.C.4 HSA-SSE.A.2 HSA-SSE.B.4 MP7 MP8		

Essential Question(s):

- How do rational functions help us model and understand real-world optimization problems?
- What stories do the asymptotes of rational functions tell about real-world situations?
- When does an algebraic solution fail to solve the real-world problem it represents?
- How can we distinguish between equations that are sometimes true and mathematical truths that are always true?

Enduring Understanding(s):

- The algebraic form of rational functions (degree relationships, factorization, restrictions) directly determines their graphical features like asymptotes and discontinuities
- Rational functions naturally model inverse relationships and trade-offs in real-world optimization problems (cost per unit, surface area vs. volume)
- Values that make rational expressions undefined represent physical impossibilities, economic constraints, or logical boundaries in context
- Solving rational equations can produce extraneous solutions that satisfy manipulated equations but not the original problem
- Algebraic, graphical, and contextual views each reveal different aspects requiring flexible movement between them

Demonstration of Learning:

CFA 1: Checkpoint A (Lessons 1-4)
CFA 2: Checkpoint B (Lessons 5-7)

NOTES
- For academic: Change equation to 1/(x-5)=x/(x-5)
- Keep as is for accelerated

CFA 3: (accelerated only) Checkpoint C (Lessons 8-11)
Checkpoint C is for feedback only (for academic)
End of Unit Assessment

NOTES
- Problem 1: Change the denominator to x + 3, then change the answers based on the new equation
- Problem 2: remove for academic, keep for accelerated
- Add additional solving rational equations to test for accelerated only (rational + rational = rational) or (find common factors then solve) - can be done on teacher

Pacing for Unit

20 days (10 class periods)
Lesson Modifications: (from adaptation pack)
- ACA Can remove/skip Lessons 8-11
- Optional Lesson 2 may be safely skipped if the Check Your Readiness assessment indicates that students are familiar enough with the concepts to engage with the other lessons.

level • Problem 5: remove for academic, keep for accelerated: add part b “show that the expressions are equivalent” • Problem 6: split part b into parts b and c - part b “at what value of w does the graph have a vertical asymptote? Explain how you know.” part c “What does the vertical asymptote mean in the situation” • For academic: Add a question where students identify the equations of the vertical and horizontal asymptotes from a graph	
Family Overview (link below)	**Integration of Technology:**
https://accessim.org/9-12-aga/algebra-2/unit-3?a=family	• Desmos Online Graphing Calculator
Unit-specific Vocabulary:	**Aligned Unit Materials, Resources, and Technology (beyond core resources):**
Rational function, Rational expression, Rational equation, Vertical asymptote, Horizontal asymptote, End behavior, Equivalent forms, Extraneous solution, Domain restriction, Discontinuity, Hole (removable discontinuity)	• Desmos Online Graphing Calculator • Pear Assessment (Edulastic) • IL Classroom Adapted Resources
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions**
Business & Economics • Average cost functions for manufacturing, break-even analysis, geometric series for loan payments, and supply/demand optimization Health & Medicine • Drug concentration and elimination rates, dosage optimization, epidemiological modeling, and medical imaging mathematics Environmental Science • Population dynamics and carrying capacity models, resource sustainability analysis, carbon footprint optimization, and climate modeling	• Domain and Asymptote Confusion • Invalid Algebraic Manipulation • Extraneous Solutions Ignored • Identity vs. Equation Confusion • Modeling Reality Disconnect - Students assume mathematical solutions always make contextual sense See teacher’s guide for specific misconceptions aligned to each lesson
Connections to Prior Units	**Connections to Future Units**
Relevant Unit(s) to review: • Algebra 1 Unit 6: Introduction to Exponential Functions Essential prior concepts to engage with this unit • Exponential functions • Rational exponents The optional lesson and previous units of this course should provide enough support for students to engage in the material for this unit. If the formative assessments provided in this unit indicate that additional resources are needed, consider using Algebra 1 Unit 6 for additional resources.	Unit 6 (iM A2 U4): Complex Numbers and Rational Exponents • Extraneous solutions analysis from rational equations extends to radical equations, where extraneous solutions are even more common • Equation-solving strategies developed in Unit 3 apply to equations with rational exponents • Domain restrictions understanding helps with radical function domains and complex number contexts
Differentiation through *Universal Design for Learning*	
Engagement • Connect rational functions to engaging real-world contexts like average costs, surface area minimization, and travel time calculations • Build on familiar polynomial functions by introducing rational functions as fractions with polynomials in numerator and denominator • Scaffold learning progression from concrete asymptotic behavior observations to abstract polynomial division techniques • Address misconceptions about extraneous solutions by connecting algebraic manipulation to graphical intersections • Make learning goals transparent about understanding asymptotes, end behavior, and the relationship between rational equations and their solutions • Encourage mathematical discourse about polynomial identities and their applications to geometric series formulas	

Representation

- Present rational functions through multiple sensory modalities using graphs showing asymptotes, tables, equations, and real-world contexts
- Ensure graphing technology accessibility and provide clear visual design for asymptotic behavior and discontinuities Support vocabulary development for rational function terminology (asymptote, discontinuity, end behavior, extraneous solution, polynomial identity)
- Connect symbolic rational expressions to verbal descriptions and graphical representations of function behavior and restrictions
- Activate prior knowledge by explicitly connecting polynomial division to familiar long division algorithms with numbers Guide pattern recognition in rational function graphs and highlight critical features like vertical and horizontal asymptotes

Action & Expression

- Provide multiple ways for students to demonstrate understanding through polynomial division, graphing, equation solving, or contextual modeling
- Support planning strategies for choosing appropriate methods to solve rational equations and identify potential extraneous solutions
- Offer various tools including graphing technology, polynomial division organizers, and step-by-step equation solving templates
- Scaffold executive functions by providing organizational frameworks for connecting algebraic manipulation to graphical verification
- Create opportunities for students to express mathematical thinking about asymptotic behavior and prove polynomial identities
- Guide students in monitoring progress as they apply geometric series formulas and verify solutions to rational equations

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MLR5: *Co-Craft Questions* - Students create and improve questions
MLR6: *Three Reads* - Students analyze complex mathematical text
MLR7: *Compare and Connect* - Students connect different mathematical representations
MLR8: *Discussion Supports* - Students participate in mathematical discussions

MLR1: Stronger and Clearer Each Time

Used in Lesson 3 (Horizontal Asymptotes) where students refine their explanations of matching graphs to equations, Lesson 6 (Rational Resistance) where students improve descriptions of graphing strategies, and Lesson 7 (Rational Solving) where students refine explanations about extraneous solutions

MLR2: Collect and Display

Used in Lesson 2 (Biking 10 Miles Part 2) to capture and organize student language about rational functions and vertical asymptotes, and Lesson 3 (Publishing a Paperback) to collect language about horizontal asymptotes and end behavior

MLR5: Co-Craft Questions

Used in multiple lessons:

- Lesson 4 (Combined Fuel Economy) where students generate mathematical questions about rational functions in context
- Lesson 5 (Batting Averages) where students create questions about rational equations
- Lesson 6 (Two Directions) where students generate questions about boat travel contexts

MLR6: Three Reads

Used in Lesson 10 (Breakthrough Artist?) to help students analyze complex contextual problems involving geometric sequences and sums

MLR7: Compare and Connect

Used in Lesson 9 (Theorems and Identities) where students compare different strategies for proving polynomial identities, and Lesson 11 (Some Interesting Sums) where students compare different approaches to finding geometric sums

MLR8: Discussion Supports

Used extensively throughout multiple lessons (Lessons 1, 2, 4, 6, 7, 8, 9, 11) to support rich mathematical discussions about rational functions, asymptotes, rational equations, extraneous solutions, and polynomial identities

Sentence Frames and Stems

Section A

- The rational function _____ is helpful in this situation because ...
- The function _____ has/does not have a horizontal asymptote because ...
- The equation _____ represents the horizontal asymptote for the function _____.
- The asymptote _____ represents _____ in this situation because ...

- The end behavior of the function _____ can be written as _____.

Section B

- _____ is/are the solution(s) to the equation _____ because ...
- To solve the rational equation _____, first I _____, then I ...
- The expression _____ represents this situation because ...
- The equation _____ represents this situation because ...
- The equation _____ is equivalent to the equation _____ because ...

Section C

- The equation _____ is/is not an identity because ...
- The sum of the terms in the geometric sequence _____ (list terms) is _____.
- The situation can be modeled using a geometric sequence because ...
- I used the formula _____ to find that the total number of _____ after _____ was/is _____.

Related *CELP standards* and Learning Targets:

	Emerging	Expanding	Bridging
LT 1	I can identify the parts of rational functions that model cylinder properties using visual supports and sentence frames: "The numerator represents ___" "The denominator represents ___" with guided examples.	I can create rational functions to model cylinder situations and explain what each part means: "This function models surface area because..." using mathematical language with some support.	I can develop and analyze complex rational function models for cylinders, justify my modeling choices, and explain limitations and assumptions in real-world contexts.
LT 2	I can locate vertical asymptotes on graphs and find them in equations by setting the denominator equal to zero using sentence frames: "The vertical asymptote is at x = ___" "The denominator equals zero when ___"	I can identify vertical asymptotes from graphs and equations and explain why they occur: "Vertical asymptotes happen when the denominator is zero because..." using mathematical language.	I can analyze vertical asymptotes in complex rational functions, distinguish between asymptotes and holes, and explain the mathematical reasoning behind asymptotic behavior.
LT 3	I can find horizontal asymptotes by comparing degrees of numerator and denominator using visual patterns and sentence frames: "When the degrees are equal, the horizontal asymptote is y = ___"	I can determine horizontal asymptotes and explain the degree comparison rules: "The horizontal asymptote depends on the degrees because..." connecting to end behavior concepts.	I can analyze horizontal asymptotes in complex situations, explain why degree relationships determine asymptotes, and connect to limit behavior of rational functions.
LT 4	I can rewrite simple rational functions in the form f(x) = q(x) + r(x)/b(x) with step-by-step guidance and identify the end behavior using sentence frames: "As x gets large, f(x) approaches ___"	I can perform polynomial division to rewrite rational functions and explain how this reveals end behavior: "The quotient tells us..." "The remainder term approaches zero because..."	I can strategically rewrite complex rational functions to analyze end behavior, explain the mathematical reasoning behind the approach, and connect to asymptotic analysis.
LT5	I can write simple rational expressions for averages using templates and sentence frames: "The average is total divided by number, so the expression is ___" with visual supports showing the relationship.	I can create rational expressions representing averages in various contexts and explain my reasoning: "This expression represents the average because..." using mathematical language.	I can develop and analyze complex average rate models using rational expressions, interpret results in context, and explain how changing conditions affect the average.
LT6	I can solve simple rational equations by finding common denominators with step-by-step guidance using sentence frames: "First, I multiply both sides by ___" "Then I solve ___"	I can solve rational equations and explain my solution method: "I multiply by the LCD because..." "This step eliminates fractions because..." using mathematical language with support.	I can solve complex rational equations using strategic methods, explain why different approaches work, and connect solution processes to function properties.
LT7	I can check solutions by substituting back into the original equation and identify when answers don't work using sentence frames: "When I substitute x = ___, I get ___" "This is extraneous because ___"	I can explain why extraneous solutions occur in rational equations: "Extraneous solutions happen when..." and systematically check all solutions using mathematical language.	I can predict when extraneous solutions might occur, explain the mathematical reasoning behind their existence, and analyze why certain algebraic operations can introduce invalid solutions.
LT8	I can recognize that identities are equations that are always true and identify simple examples using sentence frames: "An identity means ___" "This equation is true for all values because ___"	I can explain what mathematical identities are and distinguish them from conditional equations: "Identities are different from regular equations because..." using mathematical language.	I can analyze complex mathematical identities, explain their significance, and distinguish between identities, conditional equations, and contradictions in various mathematical contexts.

LT9	I can verify simple identities by substituting values or using basic algebraic steps with guided support using sentence frames: "I can show this is true by ___" "Both sides equal ___ when ___"	I can prove identities using algebraic manipulation and explain my reasoning: "I can rewrite the left side as..." "This proves the identity because..." using mathematical language.	I can construct rigorous proofs of complex identities, explain multiple proof strategies, and connect identity verification to broader algebraic reasoning principles.

Unit Description

Building on the "Polynomial Functions" unit, in this unit, students transition to working with rational functions, rational equations, and identities.

The unit begins with an introduction to rational functions as students consider situations they can model, such as when minimizing surface area or determining average costs. Students examine the asymptotic behavior of their graphs, which relates to the structure of the equations. Students continue to build on structure as they use polynomial division to rewrite rational expressions for the purpose of identifying the end behavior of the function. Students then focus on solving rational equations and making sense of how some methods can lead to possible solutions that are in fact not solutions (so-called "extraneous solutions").

In the final section, students study identities. Students sharpen their skills manipulating expressions while proving, or disproving, that two expressions are equivalent. The unit concludes with a return to geometric sequences first examined in the previous unit and, using a polynomial identity proved at the start of the section, students derive the formula for the sum of a finite geometric series before using the formula to solve problems.

Lesson Sequence	Learning Target	Success Criteria/ Assessment
Section A Rational Functions Lessons 1-4	**Learning Target 1** I can create and interpret rational functions that model real-world situations (such as surface area of cylinders with known volume) and explain what the function represents in context. **Learning Target 2** I can identify and interpret key features of rational functions from graphs and equations, including vertical asymptotes, horizontal asymptotes, and end behavior. **Learning Target 3** I can determine horizontal asymptotes and end behavior by analyzing the degrees of numerator and denominator, and by rewriting rational functions in the form f(x) = q(x) + r(x)/b(x). **Learning Target 4** I can interpret graphs of rational functions in context, explaining the meaning of asymptotes and other features in real-world situations, both orally and in writing.	**Lesson 1 Minimizing Surface Area** • I can write a rational function to model different properties of cylinders. End of Unit Problem 7 **Lesson 2 Graphs of Rational Functions (Part 1)** • I can identify a vertical asymptote from a graph or an equation of a rational function. End of Unit Problem 3 Check Point A Problem 1 **Lesson 3 Graphs of Rational Functions (Part 1)** • I can identify a horizontal asymptote from a graph or an equation of a rational function. End of Unit Problem 3 Check Point A Problem 2 **Lesson 4 End Behavior of Rational Functions** • I can find the end behavior of a rational function by rewriting it as f(x) = q(x) + r(x)/b(x) End of Unit Problem 3
Checkpoint A	*Responding to Student Thinking* **Problem 1:** Points to Emphasize - If students struggle to determine reasonable solutions from a situation, revisit the idea throughout the unit. For example, in the activity referred to here, when students find a solution, ask them about its meaning in the situation and whether it is reasonable.	
Section B Rational Equations	**Learning Target 5** I can solve equations involving rational expressions using strategic multiplication and other algebraic methods, and	**Lesson 5 Rational Equations (Part 1)** • I can write rational expressions that represent averages to answer questions about the situation.

Lessons 5-7	determine whether solutions are valid or extraneous.. **Learning Target 6** I can create and solve rational equations to model real-world situations and use these models to answer questions about the context. **Learning Target 7** I can identify when extraneous solutions occur in rational equations and explain why they arise, both orally and in writing.	Check Point B Problem 1 **Lesson 6 Rational Equations (Part 2)** • I can write and solve equations with simple rational expressions on each side. Check Point B Question 1 **Lesson 7 Solving Rational Equations** • I know how to check for extraneous solutions to rational equations. End of Unit Problem 4 Check Point B Question 1
Checkpoint B	*Responding to Student Thinking* **Problem 1:** Press Pause: By this point in the unit, there should be some student mastery of solving rational equations. If most students struggle, make time to revisit related work in the practice problems referred to here. See the Course Guide for ideas to help students re-engage with earlier work. **Problem 2:** Press Pause: By this point in the unit, there should be some student mastery of creating rational expressions and equations. If most students struggle, make time to revisit related work in the practice problems referred to here. See the Course Guide for ideas to help students re-engage with earlier work.	
ACC Section C: Polynomial Identities Lessons 8-11	**Learning Target 6** Calculate the solution to a system of polynomial equations. **Learning Target 7** I can understand, prove, and create polynomial identities to represent mathematical situations and justify general relationships in writing. **Learning Target 8** I can derive and apply the formula for the sum of the first n terms in a finite geometric sequence to solve problems. **Learning Target 9** I can interpret and explain results involving geometric sums in real-world contexts, both orally and in writing.	**ACC Lesson 8 Polynomial Identities (Part 1)** • I understand what an identity is in mathematics. End of Unit Problem 5 Check Point C Question 1 **ACC Lesson 9 Polynomial Identities (Part 2)** • I can justify why identities are true. End of Unit Problem 5 Check Point C Question 1 **ACC Lesson 10 Summing Up** • I understand why the geometric sum formula is true. End of Unit Problem 2 **ACC Lesson 11 Using the Sum** • I can use the geometric sum formula to solve problems. End of Unit Problem 2 Check Point C Question 2
Checkpoint C	*Responding to Student Thinking* **Problem 1:** Press Pause: By this point in the unit, there should be some student mastery of expanding polynomials to prove identities. If most students struggle, make time to revisit related work in the practice problems referred to here. See the Course Guide for ideas to help students re-engage with earlier work. **Problem 2:** Press Pause: By this point in the unit, there should be some student mastery of finding the sum of a finite number of terms of a geometric sequence. If most students struggle, make time to revisit related work in the practice problems referred to here. See the Course Guide for ideas to help students re-engage with earlier work.	
End of Unit Assessment		

Unit Title

Unit 6 (iM A2 U4): Complex Numbers and Rational Exponents

Relevant Standards: Bold indicates priority

Lesson	Standards	Lesson	Standards	Lesson	Standards
Lesson 1	HSA-CED.A.1	Lesson 8	HSA-REI.A.2 HSA-REI.D.11	Lesson 15	HSN-CN.A.2
Lesson 2	HSA-REI.B.4 HSA-REI.B.4.b	Lesson 9	HSA-REI.A.2 HSG-GMD.A.3	Lesson 16	HSA-REI.B.4.a HSA-REI.B.4.b
Lesson 3	HSF-IF.C.7.e HSN-RN.A.1 HSN-RN.A.2	Lesson 10	HSN-CN.A.1	Lesson 17	HSA-REI.B.4.b HSA-REI.D.11 HSN-CN.C.7
Lesson 4	HSF-IF.C.7.e HSN-RN.A.1 HSN-RN.A.2	Lesson 11	HSN-CN.A.1	Lesson 18	HSA-REI.B.4 HSN-CN.C.7
Lesson 5	HSN-RN.A.1 HSN-RN.A.2	Lesson 12	HSN-CN.A.1 HSN-CN.A.2	Lesson 19	HSA-REI.B.4.b HSN-CN.C.7
Lesson 6	HSA-REI.A.2 HSF-IF.C.7.b	Lesson 13	HSN-CN.A.1 HSN-CN.A.2	Lesson 20	HSA-CED.A.4 HSA-REI.B.4 HSF-BF.A
Lesson 7	HSA-REI.A.1 HSA-REI.A.2 HSA-REI.B.4.b	Lesson 14	HSN-CN.A.1 HSN-CN.A.2		

Essential Question(s)

- How do we extend mathematical systems to solve problems that previously had no solutions?
- How do we perform arithmetic operations with complex numbers that don't exist on the traditional number line while maintaining consistent mathematical rules?
- When do algebraic operations create extraneous solutions, and how do we determine when our mathematical solutions are valid in both algebraic and real-world contexts?

Enduring Understanding(s)

- When existing number systems prove insufficient, mathematicians create new number types while preserving familiar arithmetic properties and logical consistency
- Fractional exponents provide algebraic notation for roots that maintains exponent rule consistency while connecting area, volume, and other geometric measurements to symbolic expressions
- The introduction of *i* ensures that every quadratic equation has solutions, creating a mathematically complete system where polynomial equations always have the expected number of roots
- Operations like squaring both sides of equations can generate extraneous solutions that satisfy the manipulated equation but not the original problem, requiring systematic verification of all solutions
- Geometric interpretations (area/volume), algebraic notation (rational exponents), and visual models (complex plane) each provide unique insights into the same mathematical relationships
- New numbers and operations must follow the same arithmetic properties (commutative, associative, distributive) as familiar numbers to maintain mathematical coherence and usefulness
- Understanding where functions and operations are defined or undefined reveals both mathematical structure and real-world constraints in problem contexts

Demonstration of Learning

CFA 1: Checkpoint A (Lessons 1-5)
CFA 2: Checkpoint B (Lessons 6-9)
CFA 3: Checkpoint C (Lessons 10-15)
CFA 4: Checkpoint D (Lessons 16-19)

Pacing for Unit

28 days (14 class periods)
Lessons to Modify (from adaptation pack)

- Optional Lessons: 1, 2, 9, 14, 16, 19, 20
- Any of the 7 optional lessons may be safely skipped if

End of Unit Assessment NOTES • Problem 1: for academic: Change to multiple choice keeping choices A, B and E and change C to 4^2 • Problem 5: change directions to "solve for all values of x" • Problem 6: Remove part a, change parts b and c to "solve for all values of x"	the Check Your Readiness assessment indicates that students are familiar enough with the concepts to engage with the other lessons.
Family Overview (link below)	**Integration of Technology:**
https://accessim.org/9-12-aga/algebra-2/unit-4?a=family	• Desmos Online Graphing Calculator
Unit-specific Vocabulary	**Aligned Unit Materials, Resources, and Technology (beyond core resources)**
Rational exponent, Square root, Cube root, nth root, Radicand, Radical expression, Radical equation, extraneous solution, Imaginary number, Imaginary unit (i), Complex number, Complex conjugate, Completing the square, Quadratic formula, Complex solutions, Real solutions, Non-real solutions, Discriminant, Multiple solutions, Simplest radical form, Rationalize, Perfect square, Perfect cube, Irrational number, Number system extension, Closure property	• Desmos Online Graphing Calculator • Pear Assessment (Edulastic) • IL Classroom Adapted Resources • Compasses • Internet-enabled devices • Rulers • Scientific calculators
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions**
Computer Science & Technology • Complex numbers for 2D graphics rotations and transformations, digital signal processing for audio/image applications, and Fast Fourier Transform algorithms for data compression Music & Audio Production • Complex numbers for sound wave analysis and digital effects processing, rational exponents for musical frequency ratios and harmonic relationships, and synthesizer programming with complex oscillators Finance & Data Science • Compound interest calculations with rational exponents for different compounding periods, complex statistical models for risk analysis and market prediction, and normal distribution mathematics requiring square root operations	• Students think rational functions are just fractions with variables, incorrectly cancel non-factored terms, and forget domain restrictions that exclude values making denominators zero • Students believe graphs can never cross any asymptotes, don't understand the real-world meaning of asymptotic behavior, and confuse holes with vertical asymptotes • Extraneous Solutions Ignored • Students incorrectly apply distributive property to denominators See teacher's guide for specific misconceptions aligned to each lesson
Connections to Prior Units	**Connections to Future Units**
Relevant Unit(s) to review: • Grade 8 Unit 7: Exponents and Scientific Notation • Algebra 1 Unit 7: Introduction to Quadratic Functions • Algebra 1 Unit 8: Quadratic Equations Essential prior concepts to engage with this unit • Properties of Exponents • Square and Cube Roots • Solving quadratics by completing the square • Solving quadratics using the quadratic formula	The entirety of this course prepares students for success on the College Board SAT exam as well as success in Precalculus.
Differentiation through *Universal Design for Learning*	
Engagement • Connect rational exponents to familiar geometric contexts like area and volume calculations to make abstract concepts concrete • Build on familiar integer exponent rules to justify and extend understanding to fractional exponents • Address the conceptual challenge of imaginary numbers by introducing them as solutions to previously unsolvable equations • Scaffold learning progression from square and cube roots to rational exponents to complex number operations • Make learning goals transparent about extending the number system and solving all quadratic equations • Encourage mathematical discourse about why extraneous solutions arise when squaring both sides of equations	

Representation

- Present complex numbers through multiple sensory modalities using the imaginary axis, coordinate plane representations, and algebraic notation
- Ensure clear visual design for representing square roots, cube roots, and rational exponent notation
- Support vocabulary development for terminology (rational exponent, imaginary number, complex number, extraneous solution, principal root)
- Connect symbolic radical expressions to verbal descriptions and geometric interpretations of roots
- Activate prior knowledge by explicitly connecting rational exponents to familiar exponent rules and root operations
- Guide pattern recognition in complex number operations and highlight critical features like $i^2 = -1$

Action & Expression

- Provide multiple ways for students to demonstrate understanding through radical equations, complex arithmetic, or geometric applications
- Support planning strategies for choosing appropriate methods to solve quadratic equations including those with complex solutions
- Offer various tools including graphing technology, exponent rule organizers, and complex number operation templates
- Scaffold executive functions by providing organizational frameworks for connecting rational exponents to radical notation
- Create opportunities for students to express mathematical thinking about extending the number system beyond real numbers
- Guide students in monitoring progress as they verify solutions and identify extraneous solutions in radical equations

Supporting Multilingual/English Learners

The Illustrative Mathematics curriculum incorporates eight Mathematical Language Routines (MLRs) that support English Language Learners:

MLR1: *Stronger and Clearer Each Time* - Students revise and refine their mathematical language through multiple drafts
MLR2: *Collect and Displa*y - Students capture and organize language in visual displays
MLR3: *Clarify, Critique, Correct* - Students analyze mathematical writing/talk
MLR4: *Information Gap* - Students share information to solve problems
MLR5: *Co-Craft Questions* - Students create and improve questions
MLR6: *Three Reads* - Students analyze complex mathematical text
MLR7: *Compare and Connect* - Students connect different mathematical representations
MLR8: *Discussion Supports* - Students participate in mathematical discussions

MLR4: Information Gap

Used in Lesson 15 (Info Gap: What Was Multiplied?) where students must ask precise questions to determine what complex numbers were multiplied together

MLR5: Co-Craft Questions

Used in Lesson 12 (What Does This Path Mean?) where students generate mathematical questions about complex number representations on the complex plane

MLR7: Compare and Connect

Used in Lesson 18 (Solving All Kinds of Quadratics) where students compare different methods for solving quadratic equations with complex solutions

MLR8: Discussion Supports

Used extensively throughout multiple lessons (Lessons 1, 2, 3, 4, 6, 9, 11, 12, 13, 17, 18) to support rich mathematical discussions about exponents, radicals, complex numbers, and quadratic solving methods

Sentence Frames and Stems

Section A

- In this situation, the input of the function _____ represents _____. When the input is _____, the output is _____ and represents _____.
- The growth factor in this situation is _____ because ...
- Between _____ and _____, the _____ increased/decreased by _____.
- The function _____ represents this situation because ...

Section B

- The expression _____ in exponential/logarithmic form is equivalent to the expression _____ in logarithmic/exponential form because ...
- The exact solution to the equation _____ is _____.
- To solve the equation _____, first I _____, then I ...
- The logarithmic expression _____ represents this situation because ...

Section C

- I noticed that for the function _____, the value of "f" increases/decreases when "x' increases/decreases.
- To solve the logarithmic equation _____, first I _____, then I ...
- The solution to the equation _____ is _____ because ...
- The constant e is/is not similar to pi because...

Section D

- Using the graph of the situation represented by the equation _____, I know ... because ...
- On the graph of the function _____, the point _____ represents ...
- The _____-intercept of the graph is _____ and represents ...
- The exact solution to the equation _____ is _____.
- The intersection of the two graphs represents ...

Section E

- Logarithms help reason about the acidity in different liquids because ...
- _____ has _____ moles per liter of hydrogen ion concentration, which is _____ times greater/less than _____ because ...
- The logarithmic scale is used to measure _____ (example: earthquake intensity) because ...

Supporting Multilingual/English Learners (*CELP standards*)

	Emerging	Expanding	Bridging
LT1	I can evaluate simple expressions with integer exponents using patterns and sentence frames: "2^3 means ___" "5^{-2} means ___" with visual supports showing repeated multiplication and division.	I can evaluate expressions with integer exponents and explain the rules: "Negative exponents mean..." "When I multiply powers with the same base..." using mathematical language.	I can evaluate complex expressions with integer exponents, apply exponent rules strategically, and explain why the rules work using mathematical reasoning.
LT2	I can calculate basic square and cube roots using perfect squares and cubes with visual supports: "$\sqrt{9}$ = 3 because 3 x 3 = 9" using sentence frames and number patterns.	I can calculate square and cube roots and explain my reasoning: "I know $\sqrt{25} = 5$ because..." and estimate non-perfect roots using mathematical language with support.	I can calculate various roots efficiently, estimate irrational roots, and explain different methods for finding radical values including approximation techniques.
LT3	I can write simple radicals as fractional exponents using patterns: "$\sqrt{x} = x^{\frac{1}{2}}$" "$\sqrt[3]{x} = x^{\frac{1}{3}}$" with guided examples and sentence frames: "The square root of x is the same as ___"	I can convert between radical and exponential notation and explain the equivalence: "$\sqrt[3]{x^2} = x^{\frac{2}{3}}$ because..." using mathematical language to connect the representations.	I can fluently convert between radical and exponential forms, explain why the equivalence holds, and apply this understanding to simplify complex expressions.
LT4	I can interpret simple fractional exponents with guidance: "$x^{\frac{1}{2}}$ means ___" "$x^{\frac{2}{3}}$ means ___" using visual models and sentence frames connecting to radicals.	I can interpret fractional exponents and explain their meaning: "The denominator tells us..." "The numerator tells us..." connecting to radical notation with mathematical language.	I can interpret complex fractional exponents, explain the general pattern $x^{\frac{m}{n}}$, and apply this understanding to evaluate and simplify expressions.__
LT5	I can interpret negative fractional exponents with step-by-step support: "$x^{\frac{-1}{2}}$ means ___" using sentence frames and connecting to positive fractional exponents and reciprocals.	I can interpret negative fractional exponents and explain the reasoning: "Negative means reciprocal, so $x^{\frac{-2}{3}}$ = ..." using mathematical language to connect multiple concepts.	I can work fluently with negative fractional exponents, explain why the rules work, and apply them to solve complex problems involving rational exponents.
LT6	I can identify that âˆšx means only the positive square root using sentence frames: "$\sqrt{16}$ = 4, not -4, because _" with visual supports showing the distinction	I can explain why the square root symbol represents only positive values: "The radical symbol means the principal root because..." and distinguish this from equation solutions.	I can explain the mathematical reasoning behind the principal root convention, distinguish between $\sqrt{x}$ and solutions to $x^2 = a$, and apply this understanding consistently.
LT7	I can solve simple equations by squaring or taking square roots with guided steps: "If $x^2 = 9$, then x = ___" using sentence frames and checking solutions with support.	I can solve equations involving squares and square roots and explain my method: "I square both sides because..." "I need to check for extraneous solutions because..."	I can solve complex equations involving squares and square roots, explain when different methods are appropriate, and analyze why extraneous solutions occur.
LT8	I can solve basic equations with cubes and cube roots using patterns: "If x^3 = 8, then x = ___" with sentence frames and visual supports showing the relationship.	I can solve equations with cubes and cube roots and explain the process: "Cube roots are different from square roots because..." using mathematical language.	I can solve complex equations involving cubes and cube roots, compare solution processes with square root equations, and explain why cube root equations behave differently.
LT9	I can solve simple radical equations by isolating the radical and squaring with step-by-step guidance using sentence	I can solve radical equations and explain my solution process: "I isolate the radical because..." "I must check my	I can solve complex radical equations using strategic methods, explain why checking is essential, and predict when

	frames: "First, I isolate ___" "Then I square both sides to get ___"	answer because..." using mathematical language with support__	extraneous solutions might occur.
LT10	I can identify that $\sqrt{-1}$ = i and work with simple multiples like 2*i*, 3*i* using sentence frames: "$\sqrt{-4}$ = 2*i* because ___" with visual supports on the imaginary number line.	I can represent $\sqrt{-1}$ and its multiples using *i* notation and explain why this is necessary: "We need *i* because..." connecting to the impossibility of real square roots of negatives.	I can work fluently with $\sqrt{-1}$ and complex radicals, explain the historical development of imaginary numbers, and connect to the complex number system.
LT11	I can use i to solve simple equations like $x^2 = -4$ with guided support using sentence frames: "Since $x^2 = -4$, then x = ___" with step-by-step examples.	I can solve equations that require imaginary solutions and explain when to use *i*: "This equation needs *i* because..." using mathematical language to justify the approach.	I can solve complex equations requiring imaginary numbers, explain why complex solutions are necessary, and connect to the fundamental theorem of algebra.
LT12	I can add complex numbers and calculate simple powers of i using patterns and sentence frames: "(3 + 2i) + (1 + 4i) = ___" "i^2 = ___" with visual aids.	I can perform operations with complex numbers and explain the processes: "To add complex numbers, I..." "Powers of i follow the pattern..." using mathematical language.	I can perform all operations with complex numbers fluently, explain the underlying mathematical principles, and recognize patterns in complex number arithmetic.
LT13	I can multiply simple complex numbers using the distributive property with guided steps: "(2 + i)(3 + i) = ___" using sentence frames and step-by-step support.	I can multiply complex numbers and explain my method: "I use FOIL and remember that i^2 = -1..." connecting to polynomial multiplication with mathematical language.	I can multiply complex expressions efficiently, explain different multiplication strategies, and connect complex multiplication to polynomial operations.
LT14	I can perform basic arithmetic operations on complex numbers with step-by-step guidance using sentence frames for each operation type with visual supports and pattern recognition.	I can perform all arithmetic operations on complex numbers and explain when each is used: "Division requires..." "Multiplication involves..." using mathematical language consistently.	I can perform complex arithmetic fluently, choose efficient methods strategically, and explain the mathematical principles underlying complex number operations.
LT15	I can identify real and imaginary parts when given simple information with guided examples using sentence frames: "If z_1z_2 = 12 + 5i, then the real part is ___"	I can determine real and imaginary parts from given information about complex numbers and their relationships using mathematical reasoning: "Since the product is..., then..."	I can solve complex problems involving unknown complex numbers, use algebraic reasoning to find parts, and explain sophisticated relationships between complex numbers.
LT16	I can solve quadratic equations using completing the square and the quadratic formula with step-by-step guidance using sentence frames for each method and visual supports.	I can solve quadratic equations using multiple methods and explain when to use each: "I use the quadratic formula when..." "Completing the square is helpful when..."	I can solve quadratic equations strategically, choose efficient methods, and explain the advantages and connections between different solution techniques.
LT17	I can find complex solutions by completing the square with guided steps using sentence frames: "When I get $x^2 = -4$, then x = ___" connecting to previous learning about i.	I can complete the square to find complex solutions and explain the process: "When the constant is negative after completing the square..." using mathematical language.	I can complete the square to find complex solutions in various forms, explain when this method is most useful, and connect to graphical interpretations.
LT18	I can use the quadratic formula to find complex solutions when the discriminant is negative with step-by-step support using sentence frames about each part of the formula.	I can apply the quadratic formula for complex solutions and explain when this occurs: "Complex solutions happen when the discriminant..." using mathematical language.	I can use the quadratic formula for complex solutions efficiently, predict solution types from the discriminant, and explain the mathematical significance of complex solutions.
LT19	I can identify when quadratic equations have complex solutions and find them using either method with guided support and sentence frames connecting discriminant to solution type.	I can find complex solutions to quadratics using appropriate methods and explain my choice: "I chose this method because..." connecting discriminant analysis to solution strategies.	I can find complex solutions efficiently using strategic methods, analyze the nature of solutions before solving, and explain the complete solution process including verification.

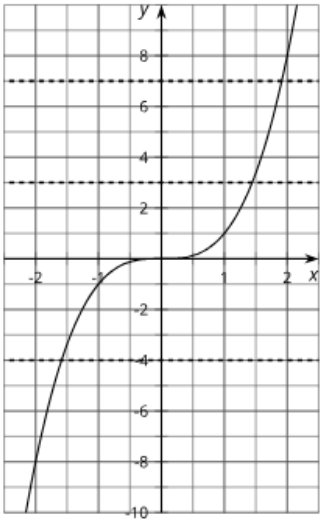
Unit Description

In this unit, students use what they know about exponents and radicals to extend exponent rules to include rational exponents, solve equations involving squares and square roots, develop an understanding of complex numbers, and solve quadratic equations that include complex roots.

The unit opens with an optional review of exponent rules before using those rules to justify why $x^{\frac{a}{b}} = \sqrt[b]{x^a}$ when a and b are integers and x is positive. The new rule leads to an exploration of square and cube roots as solutions to equations of the form $x^2 = c$ or $x^3 = c$. In particular, students learn that positive numbers have two square roots and that $\sqrt{c}$ represents only the positive root.

Students explore equations involving square and cube roots to recognize that squaring each side of an equation can introduce solutions that are not solutions to the original equation.

Note that there are claims in the unit like, "When a square is equal to a negative number, there are no solutions," which would be more precisely stated as "When a square is equal to a negative number, there are no real number solutions." However, until students learn about imaginary numbers in the next section, it doesn't make sense to make this distinction.



The third section introduces imaginary and complex numbers by proposing i as a solution to the equation $x^2 = -1$. Students explore the implications of this new type of number by representing it on an imaginary axis off of the real number line. This exploration includes adding imaginary and real numbers together to get complex numbers, and then adding and multiplying complex numbers.

Next, students use their new understanding of complex numbers to solve more quadratic equations. Finally, there is an optional exploration of data representation on a map using circles with area proportional to the data, in which students must use their understanding of square roots to find the radii of the appropriate circles.

Lesson Sequence	Learning Target	Success Criteria/ Assessment	Resources
Section A Exponent Properties Lessons 1-5	**Learning Target 1** I can understand and justify why exponent properties hold for positive integers and use repeated reasoning to extend these properties to all integers and rational exponents. **Learning Target 2** I can comprehend the meaning of radicals (square roots, cube roots) and justify the equivalence between radical notation and rational exponents $(b^{\frac{1}{n}} = \sqrt[n]{b}$ and $b^{\frac{m}{n}} = \sqrt[n]{b^m})$ **Learning Target 3** I can determine exact side lengths using radicals, use graphs to estimate values of expressions with rational exponents, and represent numbers using both radical and exponential notation.	**Lesson 1 Properties of Exponents** • I can evaluate expressions with integer exponents. Check Point A Question 1 End of Unit Question 1 **Lesson 2 Square Roots and Cube Roots** • I can calculate square and cube roots. End of Unit Question 1 **Lesson 3 Exponents That Are Unit Fractions** • I can write square and cube roots as exponents. Check Point A Question 1 **Lesson 4 Positive Rational Exponents** • I can interpret exponents that are fractions. Check Point A Question 1 End of Unit Question 1 **Lesson 5 Negative Rational Exponents** • I can interpret exponents that are negative fractions.	
Checkpoint A	*Responding to Student Thinking* **Problem 1:** Press Pause: By this point in the unit, there should be some student mastery of writing expressions using rational exponents and radicals. If most students struggle, make time to revisit related work in the practice problems referred to here. See the Course Guide for ideas to help students re-engage with earlier work.		

<table>
<tr><td>Section B
Solving Equations with Square and Cube Roots

Lessons 6-9</td><td>Learning Target 4
I can explain the difference between square roots (which denote only positive values) and cube roots (which exist for all real numbers), and justify why equations involving these have different numbers of solutions.

Learning Target 5
I can solve equations involving square roots, cube roots, and other radicals, explaining my solution methods and using graphs to represent solutions.

Learning Target 6
I can explain why squaring or taking roots of equations may change the solution set, create radical equations with specified numbers of solutions, and identify extraneous solutions.</td><td>Lesson 6 Squares and Square Roots
• I understand that the square root symbol means the positive square root.
Lesson 7 Inequivalent Equations?
• I can solve equations by squaring or finding square roots.
Checkpoint B Question 1
End of Unit Question 3
Lesson 8 Cubes and Cube Roots
• I can solve equations by cubing or finding cube roots.
Checkpoint B Question 1
End of Unit Question 6
ACC Lesson 9 Solving Radical Equations
• I can solve equations with radicals in them.
Checkpoint B Questions 1 and 2
End of Unit Question 5</td></tr>
<tr><td>Checkpoint B</td><td colspan="2">Responding to Student Thinking
Problem 1: Press Pause: By this point in the unit, there should be some student mastery of finding the number of solutions for an equation. If most students struggle, make time to revisit related work in the practice problems referred to here. See the Course Guide for ideas to help students re-engage with earlier work.
Problem 2: Press Pause: By this point in the unit, there should be some student mastery of solving radical equations. If most students struggle, make time to revisit related work in the practice problems referred to here. See the Course Guide for ideas to help students re-engage with earlier work.</td></tr>
<tr><td>Section C
A New Kind of Number

Lessons 10-15</td><td>Learning Target 7
I can justify why $x^2 = -1$ has no real solutions using graphs, understand that i represents $\sqrt{(-1)}$, and comprehend that complex numbers have the form a + bi where a and b are real numbers.

Learning Target 8
I can add, subtract, and multiply complex numbers, represent results in the form a + bi, and justify equivalence of complex expressions using the fact that $i^2 = -1$.

Learning Target 9
I can represent complex numbers and their operations on the complex plane, determine powers of i using patterns, and analyze what information is needed to find factors of complex number products.</td><td>Lesson 10 A New Kind of Number
• I can represent $\sqrt{-1}$ and multiples of it.
Lesson 11 Introducing the Number i
• I can use i to solve equations.
End of Unit Question 3 and 7
Lesson 12 Arithmetic with Complex Numbers
• I can add complex numbers and calculate powers of imaginary numbers.
Checkpoint C Question 1
End of Unit Question 4
Lesson 13 Multiplying Complex Numbers
• I can multiply complex numbers.

Checkpoint C Question 1
End of Unit Question 4
ACC Lesson 14 More Arithmetic with Complex Numbers
• I can do arithmetic with complex numbers.
Checkpoint C Question 1
End of Unit Question 4
Lesson 15 Working Backward
• I can find real and imaginary parts of complex numbers if I know enough about the numbers and their product.
Checkpoint C Question 1</td></tr>
<tr><td>Checkpoint C</td><td colspan="2">Responding to Student Thinking
Problem 1: Press Pause: By this point in the unit, there should be some student mastery of complex number arithmetic. If most students struggle, make time to revisit related work in the practice problems referred to here. See the Course Guide for ideas to help students re-engage with earlier work.</td></tr>
<tr><td>Section D</td><td>Learning Target 10</td><td>Lesson 16 Solving Quadratics</td></tr>
</table>

Solving Quadratics with Complex Numbers Lessons 16-19	I can solve quadratic equations using completing the square and the quadratic formula, and explain my reasoning in writing for both real and complex solutions. **Learning Target 11** I can calculate complex solutions to quadratic equations, represent them in the form c ± di, and explain when and why solutions are non-real using both algebraic and graphical reasoning. **Lesson Target 12** I can create quadratic equations with specified solution types (real or non-real), critique solution methods used by others, and justify whether radical expressions are equivalent.	• I can solve quadratic equations by completing the square or by using the quadratic formula. Checkpoint D Question 1 End of Unit Question 3 and 7 **Lesson 17 Completing the Square and Complex Solutions** • I can find complex solutions to quadratic equations by completing the square. End of Unit Question 7 **Lesson 18 The Quadratic Formula and Complex Solutions** • I can find complex solutions to quadratic equations by using the quadratic formula. Checkpoint D Question 1 End of Unit Question 7 **Lesson 19 Real and Non-Real Solutions** • I can find complex solutions to quadratic equations CheckPoint D Question 1 End of Unit Questions 3 and 7
Checkpoint D	*Responding to Student Thinking* **Problem 1:** Press Pause: By this point in the unit, there should be some student mastery of solving quadratic equations. If most students struggle, make time to revisit related work in the practice problems referred to here. See the Course Guide for ideas to help students re-engage with earlier work. **Problem 2:** Press Pause: By this point in the unit, there should be some student mastery of the number and type of solutions for quadratic equations. If most students struggle, make time to revisit related work in the practice problems referred to here. See the Course Guide for ideas to help students re-engage with earlier work.	
Section E Let's Put It to Work Lesson 20		**ACC Lesson 20 Map Data** • I can represent data on a map using appropriate sized circles.
End of Unit Assessment		

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Course Title:	Content Area:	Grade Level:	Credit (if applicable)
Grade 6 Science	Science	6	N/A (Middle School Course)

Course Description:

This course utilizes an inquiry-based framework grounded in national standards to foster advanced analytical and scientific literacy skills. Throughout the academic year, students engage in evidence-based scientific and engineering practices (including modeling phenomena, interpreting data, and constructing arguments) across four comprehensive disciplines of study.

This Grade 6 Science curriculum provides an integrated exploration of life, earth, and physical science through three comprehensive units: Ecosystems, Destructive Weather, and Waves (Sound, Light, and Technology). Students engage in inquiry-based learning, utilizing hands-on laboratory experiments, interactive simulations, and scientific modeling to investigate complex natural systems—ranging from the intricate energy flow within bio-bottles and symbiotic relationships to the mechanics of severe weather patterns and the fundamental properties of wave energy. By analyzing real-world case studies and leveraging data-driven investigations, students develop the skills to explain cause-and-effect relationships, interpret geographic and climate data, and understand the practical technological applications of wave physics in fields like communication and radio astronomy

Aligned Core Resources:	Connection to the ***BPS Vision of the Graduate***
Grade 6 - MS Science Instructional Guide Next Generation Science Standards (NGSS) Cluster/Item Specifications Specifications for Middle School • MS-LS2: Ecosystems: Interactions, Energy, and Dynamics • MS-ESS2: Earth's Systems • MS-PS4: Waves and their Applications in Technologies for Information Transfer	**Meaningfully Contribute to a Global Society** Collaboration during labs and inquiry related activities, social and cross-cultural skills during small and large group discussions and activities **Effectively Communicate in a Global Society** Media literacy through lab activities, investigations and projects, communication, information literacy **Demonstrate Academic Knowledge and Skills** Checking content mastery through labs and assessments, opportunities for critical thinking and problem solving during independent and group analysis
Additional Course Information: ***Knowledge/Skill Dependent courses/prerequisites***	**Link to *Completed Equity Audit***
N/A	Equity Curriculum Review Audit (Gr. 6-8 Science)

Standard Matrix

Standard		Unit 1	Unit 2	Unit 3
MS-LS2-1	Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.	✔		
MS-LS2-2	Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.	✔		
MS-LS2-3	Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.	✔		
MS-LS2-4	Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.	✔		
MS-LS1-6	Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.	✔		
MS-ESS2-4	Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.		✔	
MS-ESS2-5	Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.		✔	
MS-ESS2-6	Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.		✔	
MS-ESS3-3	Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.		✔	

MS-PS4-1	Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.			✔
MS-PS4-2	Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.			✔
MS-PS4-3	Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.			✔

Unit Links

Grade 6 Science
- Unit 1: Ecosystems
- Unit 2: Destructive Weather
- Unit 3: Sound, Light & Technology Waves

Use of Instructional Time (181 School Days)
- ➔ Maximum of 172 Content and Assessment Days
- ➔ 15 Flex Days
- ➔ 2 Culture and Climate Days at the start of the year
- ➔ 2 half-days before long school breaks
- ➔ 5 SBA/NGSS testing days

Unit Title
Unit 1: Ecosystems

Relevant Standards

MS-LS1-6: Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.
MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
MS-LS2-2: Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
MS-LS2-3: Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Essential Question(s)	Enduring Understanding(s)
• If nature is a competition for resources, how can so many different species live in the same space? • How does the sun's energy eventually end up inside a decomposer underground? • Is a 'healthy' ecosystem one that never changes, or one that knows how to break?	• The growth and survival of organisms are dependent on the availability of living and non-living resources; when these resources are limited, it dictates the "carrying capacity" of the entire environment • Matter cycles and energy flows through an ecosystem; while energy is eventually lost as heat, the atoms that make up organisms are recycled infinitely through the food web. • Ecosystems are dynamic and constantly shifting; their ability to maintain balance (homeostasis) depends on their biodiversity and their capacity to recover from disturbances.
Demonstration of Learning	**Pacing for Unit**

• MS-LS2-1: Pear Assessment CFA
• Formative: Creation and predictions of bio bottle
• MS-LS2-6: Pear Assessment CFA
• MS-LS2-2: Pear Assessment CFA
• MS-LS2-3: Pear Assessment CFA
• MS-LS2-4: Claim - Evidence - Reasoning response (CER)
• SBA Interim Assessment (IAB): Choose 1
  ○ IAB: Japanese Beetles
  ○ IAB: Hippopotamus/Oxpecker
  ○ IAB: Osprey and Trout
• End of Unit Summative Assessment
	Trimester 1

Family Overview (link below)	**Integration of Technology:**
Grade 6 Science - Family Overview	OpenSci Ed Virtual Labs Gizmos Demonstration PhEt Simulators
Unit-specific Vocabulary	**Aligned Unit Materials, Resources, and Technology (beyond core resources)**
NGSS Required - Algae, aquatic, atom, biodiversity, carbon, carbon dioxide, carnivore, chemical process, chemical reaction, competition, conservation, consumer, consumers, convert, decomposer, decomposers, disperse, ecological role, ecosystem, evolve, food chain/web, fungi, genetic, glucose, herbivore, host, hydrogen, infection, interdependent, microbe, microorganism, moisture, molecule, mutualism, mutually beneficial, mutually beneficial	See Instructional Guide - Grade 6 - MS Science Instructional Guide (rev. 2026)

interactions, nitrogen, nutrient, omnivore, organic, organic matter, organic waste, oxygen, parasite, photosynthesis, phytoplankton, predator, prey, producer, producers, product, reactant, reaction, relative, resource, stimulus, structure, sugar, tissue, transformation

BPS Additional - Biotic factor, Abiotic factor, Chlorophyll, Chloroplast, Phloem tubes, Xylem tubes, Transpiration, Stomata, Water Cycle, Scientific Drawing, Model, Primary Consumer (1st), Secondary Consumer (2nd), Tertiary Consumer (3rd)

Opportunities for Interdisciplinary Connections:

Common Core Standards Connections

ELA/Literacy

RST.6-8.1: Cite specific textual evidence to support analysis of science and technical texts.

WHST.6-8.1: Write arguments to support claims with clear reasons and relevant evidence.

Mathematics

MP.4: Model with mathematics.

6.RP.A.3: Use ratio and rate reasoning to solve real-world and mathematical problems.

Connections to Prior Units

Elementary School science bundles

Anticipated misconceptions

- Things that are dead are abiotic factors
- Predation is an example of a parasitic relationships
- Only plants rely on solar energy
- Plants need oxygen
- Food Chain arrows point to consumption

Connections to Future Units

- Cycling of Matter appears again in Unit 2 when the Water Cycle is discussed.
- Conservation appears again in Unit 2 when climate change and water consumption is discussed.
- Photosynthesis appears again when global temperature rises are discussed in unit 2.
- Carbon Dioxide appears when climate change is discussed in unit 2

Differentiation through *Universal Design for Learning*

	Engagement	Representation	Action & Expression
LT1	"Bio-Bottle Launch" building mini sealed bottle ecosystems and predicting how long plants can survive inside without opening them.	Closed-system diagram mapping how soil, water, air, and plant life interact within a sealed bottle environment.	Write a system breakdown or record a video explaining how the sealed bio-bottle provides all essential conditions for plant survival.
LT2	"Schoolyard Safari" exploring outdoor school habitats to spot, list, and categorize items into living and nonliving components.	T-chart and photo matrix comparing biotic factors (plants, animals, fungi, bacteria) vs. abiotic factors (sunlight, water, soil, air, temperature).	Sort physical or digital card sets into biotic/abiotic categories and write brief explanations defending tricky items (e.g., dead leaves, wood).
LT3	"Oh Deer!" ecosystem simulation game playing as animals competing for limited food, water, and shelter resources.	Population vs. Resource line graph illustrating how carrying capacity changes as resource availability fluctuates over time.	Analyze simulation data and write a Claim-Evidence-Reasoning (CER) statement detailing how resource availability limits animal population sizes.
LT4	Plant dissection lab taking apart real flowers and plants to examine roots, stems, leaves, and reproductive structures up close.	Labeled plant anatomy diagram detailing the specific photosynthesis role of each part (e.g., roots absorb water, leaves catch light/gas).	Draw and label a plant diagram or present a physical plant model explaining how each macroscopic structure supports photosynthesis.
LT 5	"Sunlight Solar Bank" demonstration placing plants in sunlight vs. dark closets to observe energy absorption and plant growth differences.	Energy flow diagram showing sunlight entering producer leaves, driving chemical energy creation, and passing to consumers.	Create an energy chain poster or explain in a short presentation why solar energy is the foundational power source for ecosystems
LT 6	Microscope lab creating leaf peels and celery cross-sections to directly observe stomata guard cells and vascular bundles (xylem/phloem).	Magnified cell diagrams showing stomata gas exchange (CO_2/O_2) alongside xylem (water transport) and phloem (sugar transport) pathways.	Sketch labeled microscope views of stomata and vascular tissue and write a short walkthrough of how these microscopic structures move materials.
LT 7	"Inside the Bottle" tracking gas and condensation cycles in a bio-bottle	Chemical equation diagram (Water + Carbon Dioxide + Light -> Sugar +	Build a visual bio-bottle photosynthesis model labeling input/output pathways

	under daylight and night conditions.	Oxygen) mapped directly onto the physical bio-bottle setup.	(light, H2O, CO2, O2, glucose) across the bottle system.
LT 8	Interactive food web and matter cycle simulation linking decomposers, producers, consumers, and abiotic nutrient pools.	Dual-model diagram showing one-way energy flow (sun to top predator) alongside circular matter cycling (carbon, water, nutrients).	Construct a comprehensive ecosystem web model (digital drawing, physical poster, or yarn-map) highlighting energy flow and matter cycling.
LT9	Ecosystem Collapse Mystery" analyzing real-world environmental change case studies (e.g., invasive species introduction, drought, deforestation).	Cause-and-effect flow chart detailing how a physical change (drought) or biological change (new predator) cascades through food webs.	Write a formal CER essay or record an argumentative presentation citing real data to show how a specific ecosystem disruption impacts populations.

Supporting Multilingual/English Learners (*CELP standards*)

	Emerging	**Expanding**	**Bridging**
LT1	I can label and match the living and non-living parts of a bio-bottle using picture cards and a word bank.	I can describe how soil, water, and air work together in a bio-bottle to help plants grow using sentence frames.	I can explain in detail how living and non-living elements in a closed bio-bottle interact and recycle resources to support plant life.
LT2	I can sort items into living (biotic) and non-living (abiotic) groups using pictures and word cards.	I can classify items as abiotic or biotic and explain my choices using sentence starters.	I can differentiate between abiotic and biotic factors across different ecosystems and justify tricky examples using scientific reasoning.
LT3	I can match resource pictures to animal needs and show if a population goes up or down using arrows or icons.	I can describe how changes in food, water, or shelter affect animal population sizes using cause-and-effect sentence frames.	I can analyze data and explain how limited resources control animal population growth and competition in an ecosystem.
LT4	I can label the main plant parts (roots, stem, leaves, flower) and match them to picture cards showing their jobs.	I can describe the job of each plant part during photosynthesis using sentence frames and labeled diagrams.	I can explain in detail how roots, stems, leaves, and flowers work together as a system to collect materials and make food through photosynthesis.
LT 5	I can order picture cards to show energy moving from the sun to plants and animals.	I can explain how energy from the sun moves through plants to animals using sentence starters and food chain templates.	I can explain in detail how producers capture sun energy and pass chemical energy to consumers in a food web.
LT 6	I can point to and label microscopic plant parts (stomata, xylem, phloem) on microscope images using a word bank.	I can describe the jobs of stomata, xylem, and phloem during plant growth using microscope notes and sentence frames.	I can explain using direct observations how stomata, xylem, and phloem work together at the microscopic level to move water, food, and gases for photosynthesis.
LT 7	I can place pre-made input and output cards on a bio-bottle picture to show photosynthesis.	I can draw and label a diagram showing how photosynthesis inputs and outputs move inside a bio-bottle using a guide.	I can create and explain a detailed model showing how energy and matter transform during photosynthesis inside a bio-bottle.
LT 8	I can trace energy flow and matter cycling on an ecosystem diagram using color-coded arrows and picture cards.	I can complete a model showing how energy flows and matter cycles through living and nonliving things using graphic organizers.	I can develop and defend a complex model comparing how energy flows in one direction while matter continuously cycles through an ecosystem.
LT9	I can select picture cards and simple claims to show if an ecosystem change helps or hurts an animal population.	I can write a simple CER (Claim, Evidence, Reasoning) argument using sentence frames to show how a physical or biological change affects a population.	I can construct a complete written argument supported by data and scientific evidence to prove how ecosystem changes impact populations over time.

Lesson Sequence	**Learning Target**	**Success Criteria**	**Resources/Assessments/ Assured Learning Experiences** See: Grade 6 - MS Science Instructional Guide
Learning Sequence 1: 10 Days			
1-4	**Learning Target 1**		**Phenomena Launch** • I can ask questions to better understand how the bio-bottle

	I can explain how the elements of a bio bottle create an ecosystem that supports plant life.	works • I can create a visual bio-bottle model including: how the plant will get food to grow, get water, and how other organisms contribute to the bottle's success. • I can construct a bio-bottle based on my predictions for how it works • I can make predictions for how the plant will change in the bio-bottle
5	**Learning Target 2** I can differentiate between Abiotic & Biotic Factors	• I can categorize things as being Living or Nonliving • I can dissect the words abiotic and biotic to further my understanding
6-7	**Learning Target 3** I can explain the relationship between the number of resources and living animals in an ecosystem	• I can make a prediction about the relationship between resources and animals • I can simulate the effects that resources have on population • I can analyze data to determine the relationship between the number of resources and the number of deer.
8	**Flex Day**	
9	**Assessment of MS-LS2-1**	
Learning Sequence 2: 16 Days		
11	**Learning Target 4** I can identify and describe the main parts of a plant (roots, stems, leaves, flowers) and explain how each part contributes to the process of photosynthesis.	• I can use text to create a systemic order for the events of photosynthesis • I can model the inputs and outputs of photosynthesis • I can model how the ingredients of photosynthesis travel into the leaf • I can create a model of photosynthesis within a bio-bottle • I can explain how the carbon cycle works within a biobottle, describing how plants, animals, decomposers, and the air interact to recycle carbon and maintain balance in a closed ecosystem. • I can design a successful bio-bottle
12	**Learning Target 5** I can explain the role of sunlight as an initial source of energy for most living things	• I can define what is means to be a primary source • I can explain how photosynthesis plays an energy role in an ecosystem
13-14	**Learning Target 6** I can identify and describe the microscopic parts of a plant (stomata, xylem, phloem) and explain their roles in the plant's growth and photosynthesis, using both direct observation and magnified views.	• Identify the microscopic plant parts through direct observation or with the aid of a microscope. • Explain the function of each plant part in relation to photosynthesis and overall plant growth.
15	**Flex Day**	
16	**Assessment of MS-LS1-6**	
Learning Sequence 3: 9 Days		
17-23	**Learning Target 7** I can create a model of photosynthesis within a bio-bottle	• I can compare how David Latimer's bio bottle and Jadav Payeng's forest support living things and stay balanced over time • I can differentiate between the 3 types of symbiotic relationships • I can collaboratively discover which plants and animals have symbiotic relationships and how this impacts each organism. • I can demonstrate my knowledge by completing symbiosis task cards

24	**Flex Day**	
25	**Assessment of MS-LS2-2**	
Learning Sequence 4: 11 Days		
25-33	**Learning Target 8** I can develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem	• I can dissect text to differentiate between the main roles of organism in an ecosystem • I can develop a model to show the movement of an energy in an ecosystem • I can create accurate food chains by analyzing relationships within a food web • I can develop a food web model for a Barn Owl's Menu
34	**Flex Day**	
35	**Assessment of MS-LS2-3**	
Learning Sequence 5: 5 Days		
36-39	**Learning Target 9** I can construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.	• I can analyze data to draw conclusions about whether or not humans should intervene with Isle Royale • I can construct an explanation using data to support or not support the intervention of humans at Isle Royale
40-41	**Flex Days**	
42	**Assessment of MS-LS2-4**	
43	**Flex Day**	
44	**EOU Assessment**	
45	**IAB Practice**	

NOTE: *IAB can be given at a different point in the unit and all flex days can be used strategically throughout the unit if needed.*

Unit Title
Unit 2: Destructive Weather

Relevant Standards

MS-ESS2-4: Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.
MS-ESS2-5: Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.
MS-ESS2-6: Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.
MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Essential Question(s)	Enduring Understanding(s)
• How do solar energy and gravity drive the continuous movement of water through Earth's atmosphere and surface systems? • How do the collisions and complex interactions of different air masses cause sudden changes in local weather conditions? • How do the Earth's rotation and unequal heating by the sun create global atmospheric and oceanic patterns that dictate regional climates?	• Targets the water cycle as the baseline engine for weather, focusing on phase changes (evaporation, condensation, precipitation) powered by the sun and pulled by gravity. • Explores how variables like air pressure, temperature, and humidity change over time, and why weather can only be predicted within probabilistic ranges. • Connects individual weather events to broader climate scales, highlighting the Coriolis effect, convection cycles, and the ocean's role in redistributing solar energy across latitudes.
Demonstration of Learning	**Pacing for Unit**
Various models, quizzes, labs, tests, projects (see Lesson Sequence and Grade 6 - MS Science Instructional Guide)	Trimester 2
Family Overview (link below)	**Integration of Technology:**
Grade 6 Science - Family Overview	OpenSci Ed Virtual Labs Gizmos Demonstration PhEt Simulators
Unit-specific Vocabulary	**Aligned Unit Materials, Resources, and Technology (beyond core resources)**
Agriculture, Air mass, Air mass circulation, Air pressure, Altitude, Anemometer, Aquifer, Atmosphere, Atmospheric pressure, Barometer, Climate, Cloud, Cold front, Cold/warm front, Condensation, Conservation, Consumption, Convection, Coriolis effect, Crystallization, Current, Density, Development, Dew point, Economic, Evaporation, Fertile, Flow, Groundwater, Humidity, Industry, Land usage, Land use management, Latitude, Levee, Longitude, Material world, Mineral, Occluded front, Particle, Precipitation, Preservation, Pressure, Rain shadow, River delta, Runoff, Stationary front, Temperature, Thermometer, Transpiration, Vegetation, Warm front, Water cycle, Water usage, Wetland, Wind direction, Wind speed	See Instructional Guide - Grade 6 - MS Science Instructional Guide (rev. 2026)
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions**
Common Core Standards Connections **ELA/Literacy** RST.6-8.1: Cite specific textual evidence to support analysis of science and technical texts.	• Weather and climate mean the same thing. • Air has no mass or pressure because it cannot be seen. • Air is just oxygen. • Wind is caused by temperature rather than differences in air pressure.

WHST.6-8.1: Write arguments to support claims with clear reasons and relevant evidence. **Mathematics** MP.2: Reason abstractly and quantitatively. MP.4: Model with mathematics. 6.NS.C.5: Positive and negative numbers in context	• Temperature and heat are the same thing. • The water cycle only includes evaporation and precipitation. • Fronts are storms instead of boundaries between air masses. • Warm fronts and cold fronts refer only to the temperature outside. • Wind speed and temperature measure the same thing. • Conservation and preservation mean the same thing. • Consumption only means eating food. • Currents only occur in oceans and not in air. • High pressure means warm temperatures. • Low pressure means cold temperatures..
Connections to Prior Units	**Connections to Future Units**
Elementary School science bundles	Grade 7 Mt. Everest unit Grade 8 Patterns in the Sky unit

Differentiation through *Universal Design for Learning*

	Engagement	Representation	Action & Expression
LT1	"Storm Chasers Lab" analyzing video footage and radar data from tornadoes, hurricanes, and blizzards to identify common storm triggers.	Graphic organizer detailing key severe weather ingredients: moisture, atmospheric instability, temperature contrast, and wind shear/lift.	Create a "Severe Weather Recipe" profile card or record a short forecast breakdown explaining the specific conditions needed for a hurricane or tornado.
LT2	"Before & After Disaster Audit" using satellite imagery to observe land changes caused by flash floods, hurricane surges, and coastal erosion over time.	Comparative scale matrix mapping rapid, localized changes (landslides, sinkholes) vs. slow, widespread changes (river delta shaping, barrier island migration).	Write a Claim-Evidence-Reasoning (CER) report or present a case study demonstrating how a severe weather event altered a specific landscape.
LT3	"Global Current Simulator" testing hot vs. cold water density currents in a tank and observing how spinning globes deflect wind paths (Coriolis Effect).	Labeled global atmospheric model displaying equatorial heating, convective air cells, wind belts (trade winds, westerlies), and ocean conveyor currents.	Construct a physical or digital circulation model and deliver a presentation detailing how ocean/wind currents shape a selected regional climate.
LT4	"Weather Station Tracking Lab" recording real-time temperature, humidity, air pressure, and wind direction as active weather fronts pass through.	Synoptic weather map visual mapping cold fronts, warm fronts, high/low pressure systems, and colliding air mass boundaries (maritime vs. continental).	Graph collected weather station data and write a weather forecast predicting upcoming weather shifts based on approaching air mass interactions.
LT5	"Community Resilience Challenge" evaluating local urban flood and erosion risks caused by paved surfaces and deforestation during heavy storms.	Engineering design blueprint and impact matrix evaluating solutions like permeable pavement, bioswales, rain gardens, and seawalls.	Design and present a prototype or engineered plan (e.g., flood runoff barrier or erosion monitor) to minimize human environmental impact during severe weather.

Supporting Multilingual/English Learners (*CELP standards*)

	Emerging	Expanding	Bridging
LT1	I can match picture cards and label basic factors (temperature, air pressure, moisture) that cause severe weather using a word bank.	I can identify and describe key factors (warm air masses, moisture, rapid pressure drops) that create severe weather using sentence frames.	I can explain in detail how complex interactions between air pressure, temperature, humidity, and wind conditions combine to form severe weather systems.
LT2	I can match pictures of fast and slow Earth changes (volcanoes, weathering, erosion) and place them on simple spatial and time scales using visual cards.	I can describe how different geoscience processes change Earth's surface over various sizes and timeframes using graphic organizers and sentence starters.	I can construct a written, evidence-based explanation demonstrating how large-scale and small-scale geoscience processes reshape Earth's surface across both fast and slow time scales.

LT3	I can label warm and cold areas on a globe model and use arrows to show how sunlight and Earth's rotation move air and water using visual guides.	I can use a model to describe how unequal solar heating and Earth's rotation drive ocean and air currents to form regional climates using sentence frames.	I can develop and explain a complex model illustrating how unequal heating and the Coriolis effect drive atmospheric and oceanic circulation patterns to shape global and regional climates.
LT4	I can record weather data (temperature, rain, air pressure) using visual charts and show how colliding air masses change local weather using icon cards.	I can collect and track weather data to explain how interactions between different air masses lead to predictable weather changes using structured data logs and sentence starters.	I can analyze original weather data to construct an evidence-based explanation detailing how the movement, density differences, and collisions of air masses generate specific weather conditions.
LT5	I can select solution pictures and label simple ways to track and reduce human pollution or damage to an environment using graphic organizers.	I can design a plan to monitor and minimize a specific human impact on the environment using a guided engineering template and sentence frames.	I can apply scientific concepts to design, evaluate, and defend a comprehensive method for continuously monitoring and reducing a human impact on an ecosystem.

Lesson Sequence	Learning Target	Success Criteria	Resources/Assessments/ Assured Learning Experiences See: Grade 6 - MS Science Instructional Guide
Learning Sequence 1: 2 Days			
1-2	**Learning Target 1** I can identify factors that create severe weather systems.	**Phenomena Launch** • I can ask questions about destructive weather. • I can generate ideas to explain the factors of destructive weather.	
Learning Sequence 2: 5 Days			
3-5	**Learning Target 2** I can construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales	• I can identify the steps of the water cycle. • I can identify the factors that influence the cycle of water. • I can describe the role gravity and the sun's energy play in the water cycle	
6	**Flex Day**		
7	**Water Cycle Quiz (MS-ESS2-4)**		
Learning Sequence 1: 13 Days			
8-18	**Learning Target 3** I can develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of *atmospheric* and oceanic circulation that determine regional climates.	• I can analyze weather/climate data to make sense of it. • I can find locations that are on the same latitude. • I can describe the geography of 4 different locations across the United States at the same latitude. • I can describe how altitude and ocean current impact weather at various locations	
19	**Flex Day**		
20	**Common Formative or IAB Practice**		
Learning Sequence 1: 12 Days			
21-29	**Learning Target 3** I can develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and *oceanic circulation* that determine regional climates.	• I can explore the relationship between wind patterns and ocean currents. • I can explain the role of water in climate for the two coastal locations. • I can draw a model to describe the movement of energy in creating severe weather/climate.	

30	**Flex Day**	
31	**Regional Climates Quiz (MS-ESS2-6)**	
Learning Sequence 1: 11 Days		
32-40	**Learning Target 4** I can collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions	• I can explore high and low pressure areas • I can explain the motions and interactions of different air masses. • I can use high and low pressure as predictors for weather conditions
41	**Flex Day**	
42	**Weather Conditions Quiz (MS-ESS2-5)**	
Learning Sequence 1: 11 Days		
43-53	**Learning Target 5** I can apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.	• I can identify human actions that contribute to the greenhouse effect. • I can draw a model showing the impact of the greenhouse effect on weather and climate.
54	**Flex Day**	
55	**Human Impact Quiz ((MS-ESS3-3)**	
56	**Flex Day**	
57	**EOU Assessment**	
58	**IAB Practice**	

NOTE: *IAB can be given at a different point in the unit and all flex days can be used strategically throughout the unit if needed.*

Unit Title	
Unit 3: Sound, Light & Technology Waves	
Relevant Standards	
MS-PS4-1: Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave. MS-PS4-2: Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. MS-PS4-3: Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.	
Essential Question(s)	**Enduring Understanding(s)**
• How do wave properties describe how energy moves and behaves? • What happens when light and sound waves encounter different materials and media? • How do living organisms use the physical properties of sound waves to communicate and survive in their environments? • How can waves be used to send messages, and why are digital signals more reliable than analog signals?	• Waves are repeating patterns of motion that transfer energy from place to place without transferring matter. A wave's amplitude determines the amount of energy it carries (greater amplitude = greater energy), while changes in frequency directly alter its wavelength, pitch, and physical shape. • Animals (such as whales) rely on the behavior of sound waves in physical media to send and receive messages over long distances, using variations in frequency, pitch, and amplitude to fulfill essential biological functions. • When waves meet different materials or travel through new media (solids, liquids, gases, or vacuums), their path and speed change as they are reflected (bounced), absorbed (taken in), or transmitted/refracted (passed through and bent). • Information can be encoded into wave patterns; however, converting continuous analog signals into discrete digitized signals (binary code) makes data transmission far more reliable, precise, and resistant to noise or degradation over long distances.
Demonstration of Learning	**Pacing for Unit**
Various models, quizzes, labs, tests, projects (see Lesson Sequence and Grade 6 - MS Science Instructional Guide)	Trimester 3
Family Overview (link below)	**Integration of Technology:**
Grade 6 Science - Family Overview	OpenSci Ed Virtual Labs Gizmos Demonstration PhEt Simulators
Unit-specific Vocabulary	**Aligned Unit Materials, Resources, and Technology (beyond core resources)**
Amplitude, barrier, bending, brightness, coded, color, communicate, computer, conversion/convert, crest, decode, device, digitize, electricity, electromagnetic, encode, filter, force, frequency, kinetic energy, lens, light wave, machine, mechanical waves, medium, mirror, path, prism, propagation, proportional, radio wave, ray, refracted, resting position, sound wave, speed, trough, transparent, visible light, wavelength	See Instructional Guide - Grade 6 - MS Science Instructional Guide (rev. 2026)
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions**
Common Core Standards Connections **ELA/Literacy** RST.6-8.1: Cite specific textual evidence to support analysis of science and technical texts.	• High Frequency means high volume and vice versa • Sound travels fastest in air because there are fewer particles in the way. • Absorbed light simply disappears inside an object. • Light requires a physical medium (like air) to travel, just

WHST.6-8.1: Write arguments to support claims with clear reasons and relevant evidence. RST.6-8.9: Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. WHST.6-8.9: Draw evidence from informational texts to support analysis, reflection, and research. **Math** MP.2: Reason abstractly and quantitatively. MP.4: Model with mathematics. 6.NS.C.5: Positive and negative numbers in context 6.RP.A.1 & 3/7.RP.A.2 Understanding and using ratios and proportions	like sound waves do. • Loudness/amplitude and pitch/frequency are dependent on each other • In the Doppler Effect, the moving object itself changes the actual frequency/pitch it is producing. • Waves move physical matter from one location to another. • Analog signals are automatically inferior in every scenario because they are older technology.
Connections to Prior Units	**Connections to Future Units**
N/A	High School Physical Science

Differentiation through *Universal Design for Learning*

	Engagement	Representation	Action & Expression
LT1	"Mystery of the Ocean Song" listening to underwater whale vocalizations and investigating how sound travels vast distances through dark water.	Structural diagram illustrating sound wave propagation through a water medium, from whale sound source to receiving whale.	Draw an initial conceptual diagram or construct a digital model mapping how whale sound waves travel through ocean water to convey messages.
LT2	"Slinky & Rope Energy Lab" shaking springs with varying force to observe how input energy changes wave height (amplitude).	Wave anatomy visual (crest, trough, wavelength, amplitude) paired with proportional energy charts showing Energy = Amplitude^2 relationships.	Graph wave amplitude data collected from simulations or slinky labs and write a mathematical description linking wave height to total energy.
LT3	"Soundproofing & Light Box Challenge" shining light and sending sound through mirrors, clear glass, black felt, cardboard, and water.	Ray and wave behavior diagrams showing reflection (bouncing back), absorption (energy captured), and transmission (passing through).	Build a physical or digital interaction model illustrating how light or sound waves behave when hitting different material barriers.
LT4	"Static vs. Binary Challenge" comparing sound distortion on fuzzy vinyl records/landlines against clear digital audio streams and pixel codes.	Comparative signal chart contrasting continuous analog waves (vulnerable to noise and degradation) with discrete digital binary codes (0s and 1s).	Write a Claim-Evidence-Reasoning (CER) argument or construct a technical comparison poster explaining why digitized signals offer more reliable data transfer.

Supporting Multilingual/English Learners (*CELP standards*)

	Emerging	Expanding	Bridging
LT1	I can draw a simple diagram showing sound waves traveling through water between two whales using pre-made labels and arrows.	I can create a labeled model to describe how whale sound waves travel through ocean water to send messages, using sentence frames.	I can construct and explain a detailed initial model illustrating how sound wave emission, transmission through water, and reception enable whale communication over distances.
LT2	I can count wave height (amplitude) on a simple grid and match higher waves to "more energy" picture cards.	I can use a grid graph to measure wave amplitude numbers and describe how higher amplitude means higher energy using sentence frames.	I can use mathematical ratios and graphical models to quantify and prove the non-linear relationship between wave amplitude and wave energy.
LT3	I can match picture cards to show light or sound waves bouncing (reflecting), stopping (absorbing), or passing through (transmitting) different materials.	I can build and use a model to describe how waves reflect, absorb, or transmit through various materials using a structured chart and sentence starters.	I can develop and explain a comprehensive model demonstrating how wave energy is reflected, absorbed, or transmitted depending on the physical properties of different materials.
LT4	I can sort cards showing analog (smooth) and digital (0s and 1s) signals and choose simple evidence cards showing why digital signals have less	I can gather text evidence to write a simple claim explaining why digitized signals are more reliable than analog signals using a graphic organizer and	I can integrate qualitative evidence from scientific sources to construct a written argument supporting the claim that digitized signals transmit

	noise.	sentence starters.	information more reliably with less noise degradation than analog signals.

Lesson Sequence	Learning Target	Success Criteria	Resources/Assessments/ Assured Learning Experiences See: Grade 6 - MS Science Instructional Guide
Learning Sequence 1: 2 Days			
1-2	**Learning Target 1** I can create an initial model to explain how whales communicate.	**Phenomena Launch** • I can brainstorm possible reasons why animals communicate. • I can analyze whale sounds to determine possible communications.	
Learning Sequence 2: 18 Days			
3-20	**Learning Target 2** I can use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave	• I can break down the diverse ways whales use sound for different functions. • I can revise my initial model of whale sounds using my new knowledge of frequency • I can explain how energy transfers to create waves and analyze the factors that change wave frequency • I can identify the properties of a wave and explain how changing amplitude, frequency, and speed alters its behavior • I can describe how changes to the frequency affect the shape (wavelengths) of a wave • I can construct accurate, scale models of waves based on specific mathematical properties and constraints.	
21	**Flex Day**		
22	**Energy and Amplitude Quiz (MS-PS4-1)**		
Learning Sequence 3: 10 Days			
23-31	**Learning Target 3** I can develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. *(MS-PS4-2 Part 1: sound waves)*	• I can differentiate between the various states of matter • I can explain/describe how a medium affects the movement of sound waves • I can explain how a moving source affects the apparent frequency and wavelength of sound waves • I can mathematically model the Doppler Effect by calculating and comparing the changes in frequency and wavelength from a moving sound source • I can explain how an object exceeding the speed of sound generates a shock wave and results in a sonic boom.	
32	**Flex Day**		
33	**Common Formative Assessment or IAB Practice**		
Learning Sequence 4: 6 Days			
34-38	**Learning Target 3** I can develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. *(MS-PS4-2 Part 2: light waves)*	• I can use evidence from a hands-on investigation to construct an argument for how light wave behavior changes when it interacts with different materials. • I can gather evidence by observing how a light beam's path changes when it travels through different media (such as air, water, and glass).	
39	**Flex Day**		
40	**Wave Properties Quiz (MS-PS4-2)**		
Learning Sequence 5: 7 Days			
41-47	**Learning Target 4** I can integrate qualitative scientific and technical information to support	• I can distinguish between analog and digital technologies by comparing how they display, record, and transmit information	

	the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.	• I can simulate and compare how analog and digital signals encode and transmit information. • I can write a well-structured argument that compares analog and digital signals and explains why digital technology is more reliable for transmitting information.
48	**Flex Day**	
49	**Technology Waves Quiz (MS-PS4-3)**	
50	**Flex Day**	
51	**EOU Assessment**	

NOTE: *All flex days can be used strategically throughout the unit if needed.*

Course Title:	Content Area:	Grade Level:	Credit (if applicable)
Grade 7 Science	Science	7	N/A (Middle School Course)

Course Description:

This course utilizes an inquiry-based framework grounded in national standards to foster advanced analytical and scientific literacy skills. Throughout the academic year, students engage in evidence-based scientific and engineering practices (including modeling phenomena, interpreting data, and constructing arguments) across four comprehensive disciplines of study.

Throughout the year, students investigate how living, physical, and Earth systems work together through the lens of structure, function, and interaction. Beginning with the organization of life from cells to body systems, learners explore how parts interact to maintain balance and respond to change. They then turn to Earth's dynamic systems, using Mt. Everest as a model to uncover how internal and external forces shape our planet. Building on these ideas, students apply Newton's Laws of Motion to design and test rollercoasters, connecting physics to real-world engineering. The course culminates in the Congo Medicine Drop challenge, where students use scientific reasoning and design thinking to solve global problems through innovation and teamwork. Across all units, inquiry, collaboration, and hands-on investigation empower students to see science as an interconnected process that explains and improves the world around them.

Aligned Core Resources:	**Connection to the *BPS Vision of the Graduate***
Grade 7 - MS Science Instructional Guide Next Generation Science Standards (NGSS) Cluster/Item Specifications Specifications for Middle School • MS-LS1: From Molecules to Organisms: Structures and Processes • MS-ESS2: Earth's Systems • MS-PS2: Motion and Stability: Forces and Interactions • MS-PS3: Energy • MS-ETS1: Engineering Design	**Meaningfully Contribute to a Global Society** Collaboration during labs and inquiry related activities, social and cross-cultural skills during small and large group discussions and activities **Effectively Communicate in a Global Society** Media literacy through lab activities, investigations and projects, communication, information literacy **Demonstrate Academic Knowledge and Skills** Checking content mastery through labs and assessments, opportunities for critical thinking and problem solving during independent and group analysis
Additional Course Information: ***Knowledge/Skill Dependent courses/prerequisites***	**Link to *Completed Equity Audit***
N/A	Equity Curriculum Review Audit (Gr. 6-8 Science)

Standard Matrix

Standard		Unit 1	Unit 2	Unit 3	Unit 4
MS-LS1-1	Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.	✔			
MS-LS1-2	Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.	✔			
MS-LS1-3	Use arguments supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.	✔			
MS-LS1-8	Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.	✔			
MS-ESS2-1	Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.		✔		
MS-ESS2-2	Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales		✔		
MS-ESS2-3	Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of past plate motions.		✔		
MS-PS2-1	Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.			✔	
MS-PS2-2	Plan an investigation to provide evidence that the change in an object's			✔	

	motion depends on the sum of the forces on the object and the mass of the object.				
MS-PS2-3	Ask questions about data to determine the factors that affect the strength of electrical and magnetic forces.			✔	
MS-PS2-4	Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.			✔	
MS-PS3-1	Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object			✔	
MS-PS3-2	Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.			✔	
MS-ETS1-1	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions			✔	
MS-ETS1-1	Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.				✔
MS-PS3-4	Plan an investigation to determine the relationships among energy transferred, type of matter, mass, and change in the average kinetic energy of particles, as measured by the temperature of a sample.				✔
MS-PS3-5	Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object				✔
MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.				✔
MS-ETS1-4	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.				✔

Unit Links	
Grade 7 Science Unit 1: Body Systems Unit 2: Mt Everest Unit 3: Rollercoasters Unit 4: Congo Medicine Drop	Use of Instructional Time (181 School Days) ➔ Maximum of 177 Content and Assessment Days ➔ 2 Culture and Climate Days at the start of the year ➔ 2 half-days before long school breaks

Unit Title	
Unit 1: Body Systems	
Relevant Standards	
MS LS1-1: Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells. MS LS1-2: Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function. MS LS1-3: Use arguments supported by evidence for how the body is a system of interacting subsystems composed of groups of cells. MS LS1-8: Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.	
Essential Question(s)	**Enduring Understanding(s)**
• How do injuries affect our body from the cellular to the systems level? • What characterizes living organisms? What characteristics of life can be impacted by injury? How might this affect living things? • How do the parts of a cell work together as one functioning unit? How do injuries impact cells and their functions? • How do the body systems interact? How does an injury in one system impact other systems? • What are sense receptors and how do they work? • How do sensory receptors play a role in preventing injury?	• An injury disrupts the structure and function of cells, tissues, and organ systems, triggering a coordinated biological healing process across multiple scales to repair damage. • All living organisms share fundamental characteristics, including cellular organization (being unicellular or multicellular), growth, and the ability to respond to their environment. • A cell operates as an integrated system where specialized organelles perform distinct, complementary functions necessary to sustain cellular life • Multi-cellular organisms are organized hierarchically (from cells to tissues, organs, and organ systems), where individual systems continuously interact and depend on one another to maintain life • Sensory receptors are specialized cells that detect external and internal stimuli and transmit signals through the nervous system to generate body responses. • Sensory receptors detect potential hazards or pain, rapidly sending nerve signals to trigger voluntary or involuntary responses (such as reflexes) that protect the body from damage.
Demonstration of Learning	**Pacing for Unit**
3 Common Assessments (via Pear Assessment) 1 End of Unit Assessment (Performance Task)	51 Days
Family Overview (link below)	**Integration of Technology:**
Grade 7 Science - Family Overview	Open SciEd Virtual Labs Gizmos Demonstration PhET simulators
Unit-specific Vocabulary	**Aligned Unit Materials, Resources, and Technology (beyond core resources)**
Multicellular, unicellular, tissues, organ, system, organism hierarchy, bacteria, colonies, yeast, biotic, abiotic, prokaryote, eukaryote, magnify, microscope, DNA, nucleus, cell wall, cell membrane, algae, chloroplast(s), chromosomes, mitochondrion, diffusion, osmosis, semi-permeable, photosynthesis, cellular respiration, sugar, RNA, energy, cytoplasm, organelle, organization, organ system, response, internal cue, life-sustaining functions, muscular system, anatomy, aorta, artery, automatic, bone, bone marrow, brain, brain stem, cerebellum, cerebrum, circulatory system, connective tissue, cornea,	Non-Consumable • Plant Animal Cell Mystery kit • 3D model of animal and plant cells • 3D models of the human body • Clear slides • Human skeleton model • Microscopes • Rulers • Slides (animal cell (unicellular and multicellular) plant cells, human body cells, • Access to computers for student research • Access to Smartboard and videos • Blindfolds - class set • Calculators • Eye droppers • Triple beam balance or digital balance • White boards • Whiteboard erasers • Stop watches

digestive system, gland, lens, muscle, muscle cell, reflex, sensory, skeletal system, tissue, respiratory system, vertebrate, invertebrate, reproduction, breed, heart, lungs, heart rate, memory, perception, transmit, accuracy, immediate, nerve, receptor, sense receptor, sensory, behavioral response to stimuli, electromagnetic, stimulus, short-term memory, long-term memory, salt, sour, sweet, bitter, nervous system, taste, smell, touch, hear, sight	blood cells, letter e and/or colored string slides) • Stethoscopes Consumable • Cell stain dyes • Chart paper • Colored pencils • Coverslips • Eggs • Index cards • Karo syrup • Legal sized papers • Long swabs • Markers • String • Student composition notebooks • Vinegar • White board markers • Food coloring • Graph paper • Highlighters • White lined paper • Plastic cups clear • Parafilm or saran wrap • Pipettes disposable • Plastic Spoons • Post-it notes •

Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions**
• Students will meet multiple writing and speaking ELA standards throughout the unit culminating in the formal debate at the end of the unit • Students collect and interpret data from heart rate labs, and create graphs using that data. Ties into Math standards • Students craft lab reports, CER (Claim-Evidence-Reasoning) responses, and design proposals using clear structure and evidence. (ELA)	• Scale and size of cells • Cell organelles and design • Living things are not just humans but includes animals and plants, etc • Not every living organism breathes and needs oxygen, has a heart or blood, has eyes etc
Connections to Prior Units	**Connections to Future Units**
N/A	Size and scale will connect to Unit 2

Enduring Understandings: Differentiation through *Universal Design for Learning*

	Engagement	Representation	Action & Expression
LT1	"Papercut to Scab" investigation tracking the step-by-step microscopic and macroscopic changes that occur when skin is damaged.	Multi-scale visual diagram showing injury and repair progression across levels: damaged cells -> clotting tissue -> circulatory and immune system response.	Create a labeled comic strip or step-by-step digital storyboard depicting cellular repair and tissue healing following a minor injury.
LT2	Is It Alive?" station lab comparing seeds, yeast, water, robot toys, and crystals under different environmental conditions.	Comparative chart and Venn diagram contrasting unicellular organisms (e.g., amoeba) with multicellular organisms (e.g., humans) across life traits.	Sort physical card sets of mystery items into living vs. non-living categories with written evidence, or record a video justification
LT3	City Analogy mapping individual cell parts (nucleus, membrane, mitochondria) to real-world operational roles.	Interactive 3D cell diagram and functional flowchart displaying key organelles (nucleus, membrane, cytoplasm, mitochondria, vacuole) working together.	Construct a 3D physical cell model or write a comparative "job profile" portfolio detailing how organelles depend on one another.
LT4	"Body System Teamwork" simulation demonstrating how the digestive and circulatory systems cooperate to deliver nutrients to working muscle cells.	Nested organizational pyramid (cell -> tissue -> organ -> organ system -> organism) paired with system interaction flowcharts.	Design an explanatory infographic or presentation tracing how a necessary resource (like oxygen or sugar) moves from an organ system down to an individual cell.
LT5	"Mystery Sensory Box" investigation testing touch, smell, and sound reception to trace how body senses collect information.	Signal pathway diagram mapping the pathway: Stimulus -> Sensory Receptor -> Sensory Neuron -> Brain -> Motor Neuron -> Response.	Draw a labeled pathway map or record a screencast explaining how a specific sensory receptor (sight, touch, or hearing) sends messages to the brain.

LT6	"Ruler Drop & Hot Surface Reflex Challenge" measuring reaction speeds and comparing voluntary choices to involuntary reflex actions.	Reflex arc diagram contrasting rapid involuntary spinal cord loops (protective reflexes) with slower voluntary brain processing routes.	Write a Claim-Evidence-Reasoning (CER) paragraph or script a short skit explaining why reflexes bypass conscious brain decisions to prevent injury.

Supporting Multilingual/English Learners (*CELP standards*)

	Emerging	Expanding	Bridging
LT1	I can match pictures of an injury to affected body parts and label basic changes using a word bank.	I can describe how an injury disrupts cells, tissues, and organs using a graphic organizer and sentence starters.	I can explain in detail how an injury disrupts the structure and function of cells, tissues, and organ systems across multiple scales.
LT2	I can sort items into living and non-living groups and match visual cards to basic characteristics of life.	I can describe the shared characteristics of living things (cells, growth, response to environment) using sentence frames.	I can analyze whether an unknown specimen is living or non-living by evaluating all fundamental characteristics of life in a written response.
LT3	I can label cell organelles and match their pictures to simple job cards using a visual word bank.	I can describe how different cell organelles work together to keep a cell alive using an analogy chart and sentence starters.	I can explain in detail how specialized organelles function as an integrated system to sustain cellular life.
LT4	I can match body system pictures and trace connections between two systems using color-coded arrows.	I can describe how two or more body systems work together to perform a life function using cause-and-effect sentence frames.	I can analyze and explain how multiple body systems continuously interact and depend on each other to maintain overall body function.
LT5	I can label sense organs and trace a signal path from stimulus to brain using visual cards and arrows.	I can describe how sensory receptors detect stimuli and send nerve signals to the brain using a flowchart and sentence starters.	I can explain in detail how specialized sensory receptors detect internal and external stimuli and transmit signals through the nervous system to generate a body response.
LT6	I can match picture cards of dangerous situations (hazards/pain) to quick protective body reactions.	I can describe how pain receptors trigger rapid voluntary or reflex responses to protect the body using graphic organizers and sentence frames.	I can evaluate and explain how sensory receptors detect hazards and send fast neural signals to trigger protective responses (such as reflexes) that prevent injury.

Lesson Sequence	Learning Target	Success Criteria	Resources/Assessments/ Assured Learning Experiences Grade 7 - MS Science Instructional Guide
Learning Sequence 1: Introduction (4 days)			
1	**Learning Target 1** I can explain how an injury affects the body.	• I can identify an injury I have/had and explain how it impacted other parts of my body. • I can ask scientific questions to help me understand how my injury changed over time.	
2		• I can read an emergency report to gather information on an injury sustained by a middle school student	
3		• I can analyze a doctor's report and develop and start to develop an idea of how the body heals	
4		• I can develop an initial model to show how the body heals.	
Learning Sequence 2: Characteristics of Life (9 Days)			
5-8	**Learning Target 2** I can describe the characteristics that living things possess.	• I can investigate what it means to be alive. • I can list and explain the characteristics of living things.	
9-10		• I can distinguish between different types of cells	
11		• I can classify a living thing as unicellular or multicellular • I can explain why unicellular and multicellular organisms have differences in their cells.	

12-13		• I can properly use a microscope to identify/make observations of different types of cells
Learning Sequence 3: Cell Structure (15 Days)		
14-25	**Learning Target 3** I can explain how the parts of a cell work together as a functioning unit.	• I can identify the parts of a cell and their unique function. • I can explain how the organelles contribute to the cell system as a whole.
26		• I can predict the impact an injury can have on cells of the body.
27-28		• I can describe how the structure of the cell membrane affects the function of a cell as a whole.
Learning Sequence 4: Body Systems (13 Days)		
29-41	**Learning Target 4** I can explain how body systems interact.	• I can identify and organize levels of organization within living things. • I can examine specialized cells in each of the body systems (skeletal, muscular, circulatory, digestive, respiratory) and describe their functions within the correlating body system. • I can describe the components and function of each body system. • I can develop an explanatory model to show how (circulatory, respiratory, digestive, skeletal, muscular) systems work together to support the body as a whole.
Learning Sequence 5: Sensory Receptors (7 Days)		
41-43	**Learning Target 5** I can explain what sense receptors are and how they work.	• I can explain the role of the nervous system in controlling body responses. • I can model the components of the nervous system. • I can compare voluntary and involuntary responses in the body.
44-47	**Learning Target 6** I can explain how sensory receptors play a role in preventing injuries.	• I can explain how sensory experiences create a response in the body. • I can create a model explaining a sensory response at the cellular, tissue, and systems levels (scale/systems).
Culminating Performance Task (3 Days)		
47-49	Students engage in a debate about whether or not youth sports should be full contact	
50	**Flex Day**	
51	**End of Unit Assessment**	

Unit Title

Unit 2: Mt Everest

Relevant Standards

MS-ESS2-1: Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.
MS-ESS2-2: Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales
MS-ESS2-3: Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of past plate motions.
MS-ESS3-1: Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.
MS-ESS3-2: Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

Essential Question(s)	**Enduring Understanding(s)**
• Why are there marine fossils on the top of Mount Everest? • What evidence do we have that Earth has changed over time? • How do plates move? • What effects does plate movement have on Earth's surface? • How and why does the surface of the Earth change? • What geologic forces shape the Earth? • What are natural hazards and how can we predict them?	• Plate movement across the Earth's surface has caused the phenomenon of various landforms having unexpected features based on their present-day locations • Earth is made of moving plates that move great distances, collide, and spread apart over long periods of time • Tectonic processes make new sea floor at ocean ridges and destroy sea floor at ocean trenches • Matter cycles and energy flows on Earth to cause changes in Earth's materials • Moving water on the surface and underground causes weathering and erosion • Weathering and erosion create and destroy landforms and change Earth's surface • Understanding geologic forces helps predict natural hazards such as earthquakes and volcanoes • Mapping history can predict future natural hazards
Demonstration of Learning	**Pacing for Unit**
4 Formative Assessments 1 End of Unit Assessment	49 Days
Family Overview (link below)	**Integration of Technology:**
Grade 7 Science - Family Overview	Open SciEd Gizmos Demonstrations PhEt Simulators
Unit-specific Vocabulary	**Aligned Unit Materials, Resources, and Technology (beyond core resources)**
Collide, heat conduction, transform, transport, heat transfer, heat radiation, thermal energy, heat convection, precipitation, volcanic eruption, chemical, weathering, erosion, sediment, deposition, rock cycle, ice wedge, fault, fold, igneous rock, metamorphic rock, sedimentary rock, volcanic rock, plate tectonics, crust, mantle, outer core, inner core, earthquake, volcanic eruptions, core, pressure, continent, erosion, weathering, magma, lava, igneous, sedimentary, metamorphic, mineral, meteor, crater, continental drift, divergent boundary, convergent boundary, hot spot, fault, tsunami, hurricane, tornado, fracture, folding, compressing, sea floor spreading, layer, ridge, trench, plateau, slope, landslides, floods, caves, convection, density, plate tectonics, geosphere, element, continental, upwelling, convection,	Non-Consumable • 3D model of Earth's layers • Access to computers for student research • Access to Smartboard and videos • Calculators • Earth timeline kit for hallway wall • Fan • Glass jars • Whiteboard erasers • Ice Cube trays • Marble • Marine fossil kits • Pennies • Rulers • Stop watches • Trays • Triple beam balance or electronic scales • White boards Consumable • Rubbing alcohol • Baby oil • Plastic baggies • Plastic knives

subduction, ridge, volcanic, sedimentary, fault, extension, volcanic rock, sedimentary rock, metamorphic rock, agricultural, biosphere, conservation, consumption, deposition, distribution, efficient, energy source, geologic trap, hydrothermal, impact, interdependence, marine sediment, metal ore, organic, petroleum, regulation, renewable energy, subduction zone.	• Chart paper • Clay • Colored pencils • Food coloring • Graph paper • highlighters • Index cards • Legal sized papers • Markers • Milky Ways • molasses • Paper towels • White lined paper • Whiteboard markers • Playdough • Post-it notes • Salt • Sand • Soil • Straws • Student composition notebooks • Sugar cubes • Various fabrics to prevent erosion • Vegetable oil • Vinegar
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions**
• Calculating scale models and density reinforces precision and unit conversions via Math standards • Students craft lab reports, CER (Claim-Evidence-Reasoning) responses, and design proposals using clear structure and evidence. (ELA)	• Weathering and erosion are the same thing • Earth does not change • Size and scale of land formations
Connections to Prior Units	**Connections to Future Units**
Teachers can connect Mechanical and Chemical Weathering to Mechanical and Chemical Digestion, which was taught in the Body Systems unit.	In this unit students are taught how the density of magma inside the mantle affects plate movement. During Bundle 4 (Congo Drop), students are exploring and discussing the density of molecules in different states of matter. They use this knowledge to design a vaccine storage container kept at an optimal temperature.

Differentiation through *Universal Design for Learning*

	Engagement	Representation	Action & Expression
LT1	"Everest Extreme Lab" exploring weather surges, moving glaciers, avalanches, and active mountain growth on the world's highest peak.	Interactive environment map detailing active geologic, atmospheric, and ice (cryosphere) interactions at high altitude.	Write a dynamic system summary or construct a multi-layer diagram illustrating how Mt. Everest is constantly changing.
LT2	"Fast vs. Slow Earth Time" comparing rapid events (avalanches, earthquakes) with the millions of years required to form the Himalayas.	Dual-scale geologic timeline contrasting sudden changes (seconds to days) with slow, deep-time processes (millions of years).	Construct an annotated timeline plotting key events in Everest's geological history across rapid and gradual time scales.
LT3	"Himalayan Cascade Simulation" modeling how underground fault slips trigger surface avalanches, landslides, and river blockages.	Cause-and-effect flowchart mapping system interactions (e.g., tectonic stress -> earthquake -> slope failure -> river damming).	Analyze an environmental event scenario and write predictions using a cause-and-effect chain diagram or written justification.
LT4	"Continental Collision Lab" pushing clay/foam layers together to simulate how the Indian and Eurasian plates crumple and lift land upward.	Cross-section tectonic diagram showing convergent boundary collision, crustal buckling, and high-altitude mountain uplift.	Draft a Claim-Evidence-Reasoning (CER) report or construct a physical/digital cross-section explaining how plate movement built Everest.
LT5	"Global Earthquake Tracker" plotting real-time seismic data to spot patterns along plate boundaries around the world.	World tectonic map overlay connecting plate boundary types (convergent, divergent, transform) to seismic and mountain-building hot spots.	Analyze tectonic movement data to predict future changes in Everest's height and locate high-risk earthquake zones along convergent boundaries.
LT6	"Glacier Carving & Freeze-Thaw Lab" testing how expanding ice breaks rocks apart and sliding glaciers carve out mountain valleys.	Weathering and erosion diagram detailing freeze-thaw physical weathering, glacial carving (U-shaped valleys), and meltwater sediment transport.	Sketch labeled diagrams or record a video explanation detailing how liquid water and ice reshape Everest's rock structures over time.

Supporting Multilingual/English Learners (*CELP standards*)

	Emerging	Expanding	Bridging
LT1	I can match pictures and label factors (extreme weather, moving glaciers, earthquakes) showing Mt. Everest is constantly changing, using a word bank.	I can describe how freezing weather, moving ice, and tectonic forces make Mt. Everest a changing environment using sentence starters and graphic organizers.	I can explain in detail how interacting Earth systems (atmosphere, hydrosphere, geosphere) make Mt. Everest - a dynamic, continually changing environment.
LT2	I can sort pictures of Earth changes onto a timeline into "fast" (earthquakes, avalanches) or "slow" (mountain uplift, erosion) groups using visual cards.	I can use a geological timeline to describe how Earth processes occur over fast and slow time scales using structured templates and sentence frames.	I can analyze a geological timeline to evaluate and explain how Earth's systems change over varying time scales, from sudden events to millions of years.
LT3	I can match cause-and-effect picture cards showing Earth events (e.g., heavy snow -> avalanche; plate collision -> mountain building).	I can describe cause-and-effect relationships in Earth's systems to predict geological events using sentence frames ("If [cause] occurs, then [effect] will happen because...").	I can analyze cause-and-effect relationships across Earth's systems to predict and justify future geological phenomena in a written response.
LT4	I can label plate movements (crashing, pushing up) on diagrams and match them to visual features like mountain ranges using word banks.	I can describe how tectonic plate movement changes Earth's surface and builds mountains over time using graphic organizers and sentence starters.	I can construct a detailed explanation proving how plate tectonics and continental collisions reshape Earth's surface and uplift mountain ranges like Mt. Everest over time.
LT5	I can match plate boundary symbols (convergent, divergent, transform) on a world map to locations of earthquakes or volcanoes using a map key.	I can use patterns along plate boundaries to predict where future earthquakes or mountain growth will happen using map templates and sentence starters.	I can evaluate global plate boundary patterns to explain geological phenomena and predict future tectonic events and landform changes.
LT6	I can label how water and ice change rocks and soil (freezing, melting, carrying away) on diagrams using visual word cards.	I can describe how water and ice break down rocks (weathering) and move materials (erosion) on Mt. Everest using flowcharts and sentence frames.	I can explain in detail how water in liquid and solid states drives weathering, erosion, and glacial carving to reshape Earth's surface materials.

Lesson Sequence	Learning Target	Success Criteria	Resources/Assessments/ Assured Learning Experiences Grade 7 - MS Science Instructional Guide
Learning Sequence 1: Introduction to the Anchor Phenomenon (7 Days)			
1-7	**Learning Target 1** I can explain what makes Mt. Everest a dynamic environment.	• I can differentiate between biotic and abiotic factors of Mount Everest • I can formulate questions that explain how fossils were found on the top of Everest. • I can develop an initial model to describe the changes to Mt Everest over time.	
Learning Sequence 2: Earth's Change Over Time (4 Days)			
8-11	**Learning Target 2** I can use a geological timeline to show how Earth's systems change quickly or slowly over time.	• I can differentiate between Earth's four major spheres; biosphere, hydrosphere, atmosphere, and geosphere and describe interactions among them. • I can identify an event (sphere interactions) in Earth's history as microscopic, global, fast, or slow. • I can create a model of how Earth has changed over time. • I can use size and scale to describe the formation and changes related to Mt Everest.	
Learning Sequence 3: Earth's Dynamic Continents (10 Days)			
12-21	**Learning Target 3** I can use cause and effect relationships to predict phenomena in Earth's systems.	• I can investigate how the continents were arranged. • I can observe and analyze scientific evidence used by Wegener. • I can read and interpret maps and map symbols. • I can use the evidence on the puzzle pieces (land shape, rock type, fossil type) to try to reconstruct the continents.	

		• I can interpret the evidence to formulate a hypothesis on why the continents were once together. • I can read an article on Alfred Wegener and his Continental Drift Theory and discuss the strengths and weaknesses of his theory. • I can predict how today's continents might shift millions of years from now.
Learning Sequence 4: Earth's Interior Layers (3 Days)		
22-24	**Learning Target 4** I can explain how Earth's surface changes over time and how plate movement affects the surface.	• I can investigate whether the same types of earth materials exist on the surface and deep below the top of Mt. Everest. • I can read about core samples, investigate and compare rock samples, and observe the surface and underground characteristics of various mountains. • I can investigate the Earth's layers and explain how convection contributes to plate tectonics. • I can construct and label a foldable model of the Earth's layers.
Learning Sequence 5: Plate Boundaries/Geological Events (9 Days)		
25-33	**Learning Target 5** I can use patterns of Earth's movement to predict future events and explain how plate boundaries relate to geological phenomena.	• I can identify types of plate boundaries and what forms at each type. • I can identify where earthquakes and volcanoes would occur on a map. • I can predict where and when a catastrophic event will occur. • I can use graphs, charts, and images to identify patterns in data. • I can identify cause and effect relationships used to predict phenomena in natural or designed systems.
Learning Sequence 5: Weathering and Erosion (11 Days)		
34-44	**Learning Target 6** I can explain how water affects Earth's materials and surface processes.	• I can define and identify examples of weathering and its types. • I can define and identify erosion and deposition and what causes it. • I can explain stability and change in natural or designed systems that are constructed by examining the changes over time and processes at different scales, including the atomic scale.
Culminating Performance Task (3 Days)		
45-47	Students create a virtual or physical animation on how Everest was formed	
48	**Flex Day**	
49	**End of Unit Assessment**	

Unit Title
Unit 3: Rollercoasters

Relevant Standards
MS-PS2-1: Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. MS-PS2-2: Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. MS-PS2-3: Ask questions about data to determine the factors that affect the strength of electrical and magnetic forces. MS-PS2-4: Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. MS-PS2-5: Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact. MS-PS3-1: Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object MS-PS3-2: Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. MS ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

Essential Question(s)	Enduring Understanding(s)
• What concepts of physics/force and motion contribute to a well engineered roller coaster? • What causes objects to change their motion? • How is energy conserved? • How does energy define a successful roller coaster? • How do forces act in pairs? • How do the masses of objects and their distance from each other impact their gravitational pull? • How can magnetic forces defeat the pull of gravity?	• Forces always come in equal and opposite pairs (Newton's third law). • An object's motion changes when unbalanced forces are applied. Heavier objects are harder to speed up or slow down than lighter ones. • To measure motion accurately, we must all agree on a shared starting point (reference frame) and units of measurement. • Gravity is an attractive force between all objects with mass. It is most noticeable between very large objects. • Energy of motion (kinetic energy) increases with an object's mass and speed. • Energy can be stored in a system (potential energy) depending on the positions of objects. • Forces like gravity, magnetism, and electricity act across distances through invisible "fields."

Demonstration of Learning	Pacing for Unit
3 Formative Assessments 1 End of Unit Assessment 1 PBL Assessment (Roller coaster build/presentation)	46 Days

Family Overview (link below)	Integration of Technology:
Grade 7 Science - Family Overview	OpenSci Ed Virtual Labs Gizmos Demonstration PhEt Simulators

Unit-specific Vocabulary	Aligned Unit Materials, Resources, and Technology (beyond core resources)
Conservation of momentum, energy transfer, transfer, force, balanced force, friction, direction of a force, impact, net force, inertia, action/reaction, gravity, acceleration, Newton, thrust, lift, applied force, balanced force, collision, force, unbalanced force, position over time, net force, attraction, conductor, electric current, electric field, electromagnetic field, electromagnet, frequency, induction, insulator, permanent magnet, polarity,	Non-Consumable • Balls that can be attached to a string (wiffle) • Basketball (could possibly be borrowed from gym) • Calculators • Coins (penny, dime, quarter) • Dropper poppers - enough for stations • Marbles • Matchbox cars/physics carts • Meter sticks/tapes/rulers • Newton's cradle - one for class • Ping pong balls • Some paper clips or other small magnetic objects

repulsion, resistance, voltage, orbit, magnitude, galaxy, solar system, satellite, force fields, ellipse, proportional, period, Conductor, electric charge, electric current, electric force, electromagnetic field, electromagnet, frequency, induction, insulator, magnetic field lines, magnetic force, permanent magnet, polarity, repulsion, resistance, voltage, direction, magnitude, ampere, charged particle, volts, gravity, Forms of energy, magnitude, motion energy, proportional, ratio, square root, potential energy, elastic collision, inelastic collision, Electron, proton, distribution of charged particles, electrical charge, negatively charged, positively charged, neutrally charged, magnetic polarity, conductor, insulator, electromagnet,

- Film canisters
- Hockey pucks
- Hole punch
- Hand crank flashlight or radio
- Iron filings
- large iron nail (about 3 inches)
- Launch tracks (2 per room)
- Magnet sets (cube magnets, preferably strong, permanent magnets like neodymium)
- Stop watches
- string
- Various balls and ramps - enough for stations
- Recording device
- Stuffed animals
- Wooden blocks
- Weights/ washers
- White boards
- Whiteboard erasers

Consumable

- About 3 feet of THIN COATED copper wire
- Alka Seltzer
- Balloons
- Chart paper
- Colored pencils
- D size battery (new)
- Graph paper
- Highlighters
- Index cards
- Legal sized papers
- Markers
- notecards
- Paper receipt tape
- Pencils
- Plastic cups
- Plastic ziplock bags
- Post-it notes
- Student composition notebooks
- White board markers
- White lined paper

Opportunities for Interdisciplinary Connections:

- Calculating velocity reinforces precision and unit conversions. Via Math standards.
- Rollercoaster design challenges integrate formulas for force, acceleration, and energy transfer, strengthening algebraic thinking.
- Students craft lab reports, CER (Claim-Evidence-Reasoning) responses, and design proposals using clear structure and evidence. (ELA)
- Group projects emphasize listening, discussion, and presentation skills aligned with speaking and listening standards. (ELA)

Anticipated misconceptions

- That forces are only working when an object is moving
- Gravity is due to mass between 2 objects
- Balanced vs Unbalanced forces directions of movement
- Mass and weight are the same concept

Connections to Prior Units

N/A

Connections to Future Units

When designing a medicine container in Unit 4, students may want to consider how fast the container will be falling.

Differentiation through *Universal Design for Learning*

	Engagement	Representation	Action & Expression
LT1	"Thrill Factor Challenge" analyzing POV videos of famous roller coasters to identify where riders feel weightless, pushed back, or pulled sideways.	Comprehensive force map labeling velocity vectors, normal force, friction, air resistance, and gravity throughout a coaster loop and drop.	Design a labeled schematic or present an analysis detailing how speed, direction, and forces interact to create a safe yet thrilling ride.
LT2	"Marble Acceleration Lab" launching marbles down tracks with varying slopes, surface textures, and obstacles to observe speed and direction changes.	Net force diagrams (Newton's 1st & 2nd Laws) illustrating how unbalanced forces cause acceleration, deceleration, or direction shifts.	Write a Claim-Evidence-Reasoning (CER) report or construct force diagrams explaining how unbalanced forces change a coaster car's motion.
LT3	"Energy Skate Park Simulation" tracking potential energy (PE) converting into kinetic energy (KE) and thermal energy loss via friction.	Energy transformation bar graphs (PE + KE + Thermal = Total Energy) mapped onto track heights (highest hill, loops, flat brakes).	Plot PE/KE values across key coaster track points and explain why initial hill height limits total energy available for the rest of the ride.
LT4	"Collision & Braking Lab" crashing	Newton's 3rd Law force pair diagrams	Draw labeled force-pair vectors for key

	sensors or carts together to observe equal and opposite reaction forces during impacts and stops.	highlighting interaction pairs (e.g., cart pushing track vs. track pushing cart, wheels on track, brakes on car).	coaster interactions and present a written or video explanation of equal and opposite forces.
LT5	"Magnetic Launch & Drop Challenge" testing magnetic braking systems vs. gravitational acceleration on different mass coaster carts.	Gravitational force models (mass and distance relationships) paired with magnetic field diagrams showing non-contact magnetic launch and braking mechanisms.	Create a comparative diagram or write an analysis detailing how cart mass affects gravity and how magnetic forces can launch or safely brake a coaster.

Supporting Multilingual/English Learners (*CELP standards*)

	Emerging	Expanding	Bridging
LT1	I can match picture cards and label basic forces (push, pull, gravity, friction) on a roller coaster diagram using a word bank.	I can describe how forces like gravity and friction affect a roller coaster's motion using graphic organizers and sentence starters.	I can explain in detail how force, mass, and motion principles work together to design a safe and well-engineered roller coaster.
LT2	I can select pictures showing balanced forces (no motion change) vs. unbalanced forces (speed up, slow down, turn) using visual cards.	I can describe how unbalanced forces cause objects to speed up, slow down, or change direction using cause-and-effect sentence frames.	I can explain and justify how net forces and mass affect an object's speed and direction of motion using scientific principles.
LT3	I can label high points as "potential energy" and moving points as "kinetic energy" on a roller coaster track diagram using visual icons.	I can describe how potential energy transforms into kinetic energy as a coaster moves using sentence frames and energy bar charts.	I can explain in detail how energy is conserved (potential converting to kinetic and thermal/friction) to allow a roller coaster to complete its track.
LT4	I can draw matching arrows to show opposite push and pull forces on picture cards (e.g., cart pushing on track, track pushing on cart).	I can describe how forces always act in equal and opposite pairs using sentence starters ("When Object A pushes on Object B...").	I can explain and evaluate how force pairs (action-reaction) act on interactive objects within a roller coaster system.
LT5	I can match cards to show that heavier or closer objects have more gravity, and label magnetic brakes stopping a coaster using a visual key.	I can describe how mass and distance change gravitational force, and how magnetic forces work against gravity to slow a coaster using sentence frames.	I can explain in detail how mass and distance affect gravitational pull and how magnetic fields interact with gravity to control coaster motion.

Lesson Sequence	Learning Target	Success Criteria	Resources/Assessments/ Assured Learning Experiences Grade 7 - MS Science Instructional Guide
Learning Sequence 1: Introduction to the Anchor Phenomenon (1 Day)			
1	**Learning Target 1** I can explain the concepts of physics, force, and motion that contribute to a well-engineered roller coaster.	• I can develop an initial model to describe how a well designed roller coaster works. • I can formulate questions to explain how a roller coaster works?	
Learning Sequence 2: Inertia and Net Force (5 Days)			
2-6	**Learning Target 2** I can explain what causes objects to change their motion.	• I can model and identify the forces acting on a roller coaster. • I can differentiate between forces acting on an object at rest and an object in motion. • I can apply Newton's 1st law, the concept of inertia and net force, to describe the motion of an object.	
Learning Sequence 3: Energy (7 Days)			
7-13	**Learning Target 3** I can explain how energy is conserved and how it defines a successful roller coaster.	• I can define energy and identify different types of energy. • I can describe the relationship between potential and kinetic energy and apply that relationship to the Law of Conservation of Energy. • I can predict the success of a roller coaster design based on potential and kinetic energy.	
Learning Sequence 4: Force, Mass and Acceleration (9 Days)			
14-32	**Learning Target 4** I can explain how forces act in pairs.	• I can use Newton's 2nd Law to describe the relationship between force, mass, and acceleration.	

		• I can use Newton's 3rd Law to describe the relationship of an action force and a reaction force. • I can use Newton's Laws to redesign a model of a roller coaster..
Learning Sequence 5: Gravitational Pull (7 Days)		
33-39	**Learning Target 5** I can explain how the masses of objects and their distance impact gravitational pull and how magnetic forces can interact with gravity.	• I can design and conduct an investigation to collect data on how the masses of objects and their distance affects gravitational fields. • I can design and conduct an investigation to collect data on how the properties of a magnet affects the size of its magnetic field.
Culminating Performance Task (5 Days)		
40-44	Students design a rollercoaster to demonstrate their understanding of forces and energy.	
45	**Flex Day**	
46	**End of Unit Assessment**	

Unit Title
Unit 4: Congo Medicine Drop

Relevant Standards
MS PS3-3: Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. MS-PS3-4 Plan an investigation to determine the relationships among energy transferred, type of matter, mass, and change in the average kinetic energy of particles, as measured by the temperature of a sample. MS-PS3-5: Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object. MS ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. MS ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Essential Question(s)	Enduring Understanding(s)
• How does energy move between objects and through different types of matter? • Why is temperature not a measure of the total amount of energy in a system? • What scientific principles determine how effectively a design can minimize thermal energy transfer? • How do we evaluate the trade-offs between different design solutions to find an optimal result? • How can scientific reasoning and design thinking be applied to solve complex global humanitarian problems?	• Energy naturally flows from warmer objects to cooler objects, a process that can be managed by selecting specific materials that act as conductors or insulators. • Temperature measures the average kinetic energy of particles, but total energy depends on both that average and the mass/amount of matter present in the system. • Minimizing heat transfer requires limiting the three methods of energy flow by selecting materials and configurations that resist these transfers. • Engineering involves balancing multiple constraints and testing iterative designs; comparing data from these tests reveals which features most effectively meet success criteria. • Designing solutions for real-world problems, like medicine delivery, requires applying core physics principles (like thermal energy) while strictly adhering to the specific environmental constraints of the problem.

Demonstration of Learning	Pacing for Unit
1 Mid Unit Assessment 1 End of Unit Assessment 1 Engineering Build	21 Days

Family Overview (link below)	Integration of Technology:
Grade 7 Science - Family Overview	OpenSci Ed Virtual Labs Gizmos Demonstration PhEt Simulators Ck-12

Unit-specific Vocabulary	Aligned Unit Materials, Resources, and Technology (beyond core resources)
Temperature, kinetic energy, energy transfer, conductor, insulator, convection conduction and radiation, Volume, collide, collision, heat conduction, particle, stored energy, transfer, average, proportional, ratio, thermal energy, Potential energy, heat energy, closed system, open system, friction, joule, force, transformation of energy, thermometer, Fahrenheit, Celsius, pendulum, sound energy, conservation of energy,	Non-Consumable • glass beakers • Heat lamps • hot plate • Hot water maker (such as a hot pot or microwave) • Ice cube trays • Ice melting blocks (arbor) • Ice packs • Infrared Laser thermometers • Metal Flatware (spoons) • Thermometers • Thermoses, Lunch boxes, coolers (various, encourage students to bring in their own) Water/Ice Pitcher Consumable

	• aluminum foil • black construction paper • Bubble wrap • Cardboard pieces • Chart paper • Cotton Balls • Craft Sticks • Dixie and plastic Cups • markers • Styrofoam pieces • Tape (masking, packing) • Multiple Colored construction paper squares • Mylar • Student Composition notebooks • Several materials (metal, cloth, plastic) • Sticky notes • Various colors of felt • Various materials for creating insulators. • various materials for investigation (choice)
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions**
• The Congo Medicine Drop project invites discussion on global health equity, humanitarian aid, and the role of technology in solving social problems. (Social Studies) • Students craft lab reports, CER (Claim-Evidence-Reasoning) responses, and design proposals using clear structure and evidence. (ELA)	• Objects that are stationary have no energy • The idea that heat moves towards cold, and not the other way around • Energy is not destroyed if used • Heat and temperature are the same
Connections to Prior Units	**Connections to Future Units**
Gravity from Unit 3	N/A

Differentiation through *Universal Design for Learning*

	Engagement	Representation	Action & Expression
LT1	"Insulation Audit Lab" testing everyday materials (foam, bubble wrap, wool, foil) to see which keeps ice melted the slowest in high heat.	Material comparison matrix mapping structural features (trapped air pockets, reflective foils) to low thermal conductivity.	Write a material evaluation report or create a material selection guide rating insulators on their ability to maintain cold temperatures.
LT2	"Particle Speed Simulation" observing how adding thermal energy speeds up water molecules and causes liquid in thermometers to expand.	Visual diagrams contrasting thermal energy (total kinetic energy of particles) vs. temperature (average kinetic energy) with sensor data plots.	Graph temperature changes over time and write an explanation connecting temperature sensor readings directly to microscopic particle motion.
LT3	"Thermal Touch Mystery" touching room-temperature metal, plastic, and wood to investigate why metal feels colder despite being at identical temperatures.	Rate-of-transfer diagrams showing thermal conductors quickly pulling heat energy away from skin vs. thermal insulators doing so slowly.	Write a Claim-Evidence-Reasoning (CER) response explaining why human touch registers the rate of heat transfer rather than actual temperature.
LT4	"Heat Transfer Race" measuring how fast thermal energy moves through different material masses, surface areas, and temperature differences.	Flowcharts detailing conduction, convection, and radiation mechanisms driven by temperature differences until thermal equilibrium is reached.	Analyze experimental data and construct an explanation detailing how mass, surface area, and material type alter the rate of energy transfer.
LT5	"Thermos Dissection" taking apart insulated flasks to identify vacuum gaps, reflective coatings, and stoppers designed to block heat flow.	Annotated cross-section diagram showing how vacuum layers eliminate conduction/convection and shiny walls reflect radiative heat transfer.	Draw and label a system diagram of a thermal containment structure, detailing how each component blocks a specific heat transfer method.

Supporting Multilingual/English Learners (*CELP standards*)

	Emerging	Expanding	Bridging
LT1	I can label materials as insulators or conductors using picture cards and a visual word bank.	I can describe how different materials trap or block heat to keep things warm or cool using sentence frames.	I can explain in detail how specific material structures and thermal properties are engineered to minimize heat transfer and maintain temperatures.
LT2	I can match thermometer readings to picture cards showing fast or slow	I can describe how temperature measurements show the thermal	I can explain in detail how temperature measures average kinetic energy and

	particle movement.	energy (particle motion) in an object using data charts and sentence starters.	how total thermal energy is observed and quantified in an object.
LT3	I can match hot/cold objects to arrow cards showing energy moving into or out of my hand.	I can describe why objects feel hot or cold based on whether thermal energy flows toward or away from my body using sentence frames.	I can explain in detail how human thermal sensation depends on the direction and rate of heat conduction between an object and skin.
LT4	I can draw arrows showing heat moving from warm to cold objects and sort picture cards of factors like mass or material type.	I can describe how thermal energy moves from warm to cool materials and identify factors (material type, mass, temperature difference) using cause-and-effect sentence starters.	I can explain in detail how thermal energy transfers between materials and analyze how factors like mass, temperature gradient, and surface area impact transfer rates.
LT5	I can select picture cards showing ways to trap heat (lids, foam layers) and sort them into "traps heat" or "lets heat escape" bins.	I can describe how insulation and closed barriers slow down heat loss using graphic organizers and sentence starters.	I can explain in detail how thermal energy transfer can be minimized using sealed systems, insulators, and reflective barriers to contain heat.

Lesson Sequence	Learning Target	Success Criteria	Resources/Assessments/ Assured Learning Experiences Grade 7 - MS Science Instructional Guide (
Learning Sequence 1: Introduction to the Anchor Phenomenon (1 Day)			
1	**Learning Target 1** I can explain how materials are designed to maintain temperatures.	• I can ask questions to understand the design specifications for a cold medicine delivery to a desert climate. • I can understand the design criteria for an aerial medicine drop into a village in Sub-Saharan Africa. • I can create an initial model to describe how I might keep the medicine cold as it is dropped into a village in the Congo.	
Learning Sequence 2: States of Matter and Temperature (4 Days)			
2-5	**Learning Target 2** I can explain how the energy in an object is measured and observed.	• I can design and conduct investigations to understand the relationship between matter, state, and energy change. • I can make connections between temperature and molecular speed. • I can make connections between molecular speed and effectiveness of medicine.	
Learning Sequence 3: Energy Transfer (2 Days)			
6-7	**Learning Target 3** I can explain why objects feel hotter or colder.	• I can construct explanations about how energy is transferred out of hotter objects to colder ones. • I can gather and analyze data about the variables (types, states, and amounts of matter) that affect energy transfer through designed and natural systems. • I can investigate the thermal properties of different materials.	
Learning Sequence 4: Maintaining and controlling Temperature (3 Days)			
8-10	**Learning Target 4** I can explain how energy is transferred between materials and identify the factors that impact energy transfer.	• I can construct explanations about which types of materials allow for less heat transfer. • I can gather and analyze data about the variables (types, states, and amounts of matter) that affect energy transfer through designed and natural systems. • I can test materials and designs for keeping objects cold, and apply that information to designing a medicine drop container that will help keep the medicine at a controlled temperature.	
Learning Sequence 5: Designing a Temperature Controlled Container (3 Days)			
11-13	**Learning Target 5**	• I can construct explanations about which types of	

	I can explain whether and how heat can be contained.	materials allow for less heat transfer. • I can gather and analyze data about the variables (types, states, and amounts of matter) that affect energy transfer through designed and natural systems. • I can test materials and designs for keeping objects cold.
Culminating Performance Task (6 Days)		
14-19	Students building and test a temperature controlling container	
20	**Flex Day**	
21	**End of Unit Assessment**	

Course Title:	Content Area:	Grade Level:	Credit (if applicable)
Grade 8 Science	Science	8	N/A (Middle School Course)

Course Description:

This course utilizes an inquiry-based framework grounded in national standards to foster advanced analytical and scientific literacy skills. Throughout the academic year, students engage in evidence-based scientific and engineering practices (including modeling phenomena, interpreting data, and constructing arguments) across four comprehensive disciplines of study.

In the physical sciences, students analyze atomic structures, chemical reactions, and the thermodynamic properties of matter. The life science and genetics modules investigate cellular growth, ecosystem dynamics, and the mechanisms of inheritance, specifically modeling how DNA mutations and reproductive methods generate biological diversity. Students then scale their understanding to evolutionary biology and geology, utilizing data from the fossil record and plate tectonics to analyze natural selection and Earth's history. Finally, the curriculum culminates in Earth and space systems, where students evaluate gravitational forces and the celestial geometry responsible for cyclical patterns such as tides, eclipses, and seasonal variations.

Aligned Core Resources:	Connection to the *BPS Vision of the Graduate*
Grade 8 - MS Science Instructional Guide Next Generation Science Standards (NGSS) Cluster/Item Specifications Specifications for Middle School • MS-ESS1: Earth's Place in the Universe • MS-ESS2: Earth's Systems • MS-PS1: Matter and its Interactions • MS-PS2: Motion and Stability: Forces and Interactions • MS-LS1: From Molecules to Organisms: Structures and Processes • MS-LS2: Ecosystems: Interactions, Energy, and Dynamics • MS-LS3: Heredity: Inheritance and Variation of Traits • MS-LS4: Biological Evolution: Unity and Diversity	**Meaningfully Contribute to a Global Society** Collaboration during labs and inquiry related activities, social and cross-cultural skills during small and large group discussions and activities **Effectively Communicate in a Global Society** Media literacy through lab activities, investigations and projects, communication, information literacy **Demonstrate Academic Knowledge and Skills** Checking content mastery through labs and assessments, opportunities for critical thinking and problem solving during independent and group analysis
Additional Course Information: ***Knowledge/Skill Dependent courses/prerequisites***	**Link to *Completed Equity Audit***
N/A	Equity Curriculum Review Audit (Gr. 6-8 Science)

Standard Matrix

Standard		Unit 1	Unit 2	Unit 3	Unit 4
MS-ESS1-1	Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.				✔
MS-ESS1-2	Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.				✔
MS-ESS1-3	Analyze and interpret data to determine scale properties of objects in the solar system.				✔
MS-PS2-4	Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.				✔
MS-PS2-5	Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.				✔
MS-LS1-1	Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.	✔			
MS-LS2-4	Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.	✔	✔		

MS-LS1-4	Use arguments based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.		✔		
MS-LS1-5	Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.	✔	✔		
MS-LS3-2	Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.	✔			
MS-LS4-5	Gather and synthesize information about technologies that have changed the way humans influence the inheritance of desired traits in organisms.		✔		
MS-LS4-2	Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.		✔		
MS-LS4-3	Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.		✔		
MS-LS4-4	Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.		✔		
MS-LS4-6	Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.		✔		
MS-ESS1-4	Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.		✔		
MS-ESS2-2	Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.				✔
MS-ESS2-3	Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.		✔		
MS-LS4-1	Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.		✔		
MS-PS1-1	Develop models to describe the atomic composition of simple molecules and extended structures.			✔	
MS-PS1-3	Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.			✔	
MS-PS1-4	Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.			✔	
MS-PS1-2	Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.			✔	
MS-PS1-5	Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.			✔	
MS-PS1-6	Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.			✔	

Unit Links

Grade 8 Science
- Unit 1: Cell, Genetics and Heredity
- Unit 2: Natural Selection and Evolution
- Unit 3: Chemistry
- Unit 4: Space

Use of Instructional Time (181 School Days)
- ➔ Maximum of 177 Content and Assessment Days
- ➔ 2 Culture and Climate Days at the start of the year
- ➔ 2 half-days before long school breaks

Unit Title	
Unit 1: Cell, Genetics and Heredity	
Relevant Standards	
MS-LS1-1 Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells MS LS1-5 Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. MS-LS2-4 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. MS-LS3-2 Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.	
Essential Question(s)	**Enduring Understanding(s)**
• How do cells create more cells? • How is genetic information passed from parent to offspring? How does this create genetically diverse offspring and genetic variation and diversity? • How do variations in DNA impact outcomes in organisms?	• Cells can only be created from existing cells • Genetic information is passed from parent to offspring in the form of DNA through sexual reproduction. Sexual reproduction creates genetically diverse offspring by combining DNA of 2 genetically different parents. This in turn creates diversity within the larger population and helps species live longer. • Variations in DNA can also occur which then impact the protein created and then the traits of the organism. This follow the central dogma of DNA → Protein → Trait
Demonstration of Learning	**Pacing for Unit**
Various models, quizzes, labs, tests, projects (see Lesson Sequence and Grade 8 - MS Science Instructional Guide)	~60 days
Family Overview (link below)	**Integration of Technology:**
Grade 8 Science - Family Overview	OpenSci Ed Virtual Labs Gizmos Demonstration PhEt Simulators
Unit-specific Vocabulary	**Aligned Unit Materials, Resources, and Technology (beyond core resources)**
Multicellular, unicellular, bacteria, prokaryote, eukaryote, DNA, nucleus, chromosomes, mate, breed, probability, gene, genetics, genome, genotype, phenotype, environment, growth, development, DNA, predator, prey, competition, biodiversity, development, allele, dominant trait, recessive trait, hereditary information, Punnett square, protein. NGSS Middle School Science Specifications	Ziploc bags, marbles, paper clips, multicolor beads, toothpicks, (any assorted small items), pennies, microscopes, prepared specimen slides for microscopes, graph paper, poster paper, large easel pads, assorted play-doh, dice, colored pencils, markers, rulers, Inner Fish Movie DVD, PTC paper
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions**
• Collecting data, graphing, and analyzing traits within a population, exponential growth • Probability for predictions of outcomes for offspring • Health/wellness topics (genetic diseases, sexual reproduction)	• Dominant traits are “stronger” than recessive ones • Punnett Squares will show exactly what is going to happen from an outcome • Traits are only controlled by 1 gene • Mutations are always “bad”
Connections to Prior Units	**Connections to Future Units**
7th grade cells/human body	High school biology Unit 2- Natural Selection and Evolution
Differentiation through *Universal Design for Learning*	

	Engagement	Representation	Action & Expression
LT1	Conduct a "Classroom Inventory of Traits" (e.g., earlobe attachment, tongue rolling). Use anonymous digital polling (like Mentimeter) to show real-time diversity in the room.	Provide information about human genetic diversity in multiple formats. Use a short documentary video and/or infographic.	Students will all take a poll on certain traits they have, generate a graph to show the variation of traits in the classroom and have students create a written summary or graph to represent the data and see the classes diversity
LT2	Show time-lapse videos of a seed growing into a tree or a salamander embryo developing. Ask: "Where did the extra 'stuff' come from?"	Provide color-coded diagrams of mitosis of use interactive digital simulations (like PhET or Gizmos) where students can manipulate cell division.	Students will choose a mode of presentation: act it out, draw a comic strip, make a poster to explain how cell division is responsible for an organism's growth
LT3	Use a "Climate Roulette Wheel" where you divide the classroom floor into two ecosystems using masking tape. • Side A (Asexual): Every student is handed an identical card: *"Optimal Temperature: 22°C (72°F)."* • Side B (Sexual): Every student gets a unique card with a range of temperature tolerances (e.g., Some have 15°C, some 22°C, some 30°C). • Spin a digital wheel or pull a card that changes the classroom "weather" drastically (e.g., *An Ice Age hits! The temperature drops to 12°C!*).	Use graphic organizers (like a Venn diagram or T-chart) with visual icons (e.g., a lightning bolt for speed/asexual, a jigsaw puzzle for variety/sexual) to help students organize advantages and disadvantages.	Students act as "Species Consultants." They choose how to deliver their advice to an endangered species: write a quick paragraph for survival recommendations, create a pros/cons poster, or record a 30-second audio clip.
LT4	Use a "Who's the Parent?" games with photos of animals (dogs, birds) where students match offspring to parents based on visible traits.	Use colored beads, Lego bricks, or distinctly colored paper strips to represent genetic information moving from parent to offspring. Use interactive digital simulations (like PhET or Gizmos) that allow students to "breed" virtual organisms and see the DNA transfer in real-time.	Students write a "Genetic Will" for an organism, describing exactly what "assets" (traits/genes) they are leaving behind to their offspring and how.
LT5	Relate the concept to a smartphone: The phone is the Chromosome, the apps are the Genes, and the specific settings/versions of those apps are the Alleles.	Utilize nesting tools to visually demonstrate this "Russian doll" concept. You can use physical nesting boxes (a small box inside a bigger box) or an interactive digital graphic where zooming in reveals the smaller structures.	Students build 3D models using everyday objects (e.g., beads, pipe cleaners, or LEGOs) to show how these structures fit inside one another
LT6	Use a "Create a Monster" activity, where students flip coins to determine which alleles they get from "Mom" and "Dad" monsters, resulting in a unique baby monster.	Provide "Guided Diagrams" where some parts are filled in and others are blank, allowing students to focus on the flow of information rather than just drawing.	Students can draw or use digital drawing tools (like Canva or Jamboard) or physical manipulatives (colored yarn to represent chromosomes) to record their model. Draw or build their "offspring monster" to represent the randomized traits they got. They demonstrate understanding by tagging their monster with a label explaining why it has 3 eyes (For example EE is dominant for 3 eyes "Got one 'E' from Mom and one 'E' from Dad").
LT7	Frame it as a "Genetic Mystery." Use the "Blue People of Kentucky" or a fictional royal family mystery that students must solve using a pedigree.	Provide scaffolding for Punnett squares. Offer templates with varying levels of support—some completely blank, some with color-coded boxes, and some partially filled in. Use step-by-step interactive modules to	Give students a choice of "Case Files." They can write a "Doctor's Report" explaining the probability of a trait or create a video tutorial teaching a peer how to solve the square.

		teach logic.	
LT8	Play the game of "Telephone." The original message is the DNA; the "mutation" is the error that happens down the line, changing the final "trait" (the sentence).	Use a "sentence mutation" analogy. Show how changing one letter in a sentence (e.g., "The cat ate the rat" to "The bat ate the rat") changes the entire meaning, just like changing a DNA base pair changes a protein. Provide "before and after" DNA sequence strips. Show "Before and After" visuals of proteins. Use the "Recipe Analogy": If you change one word in a recipe (Salt instead of Sugar), the "trait" of the cookie changes completely.	Students explore a real world mutation (like the Rock Pocket Mouse changing color to survive on dark lava rock). They choose how to model the effect: design a "Before & After" comic strip, write a short diary entry from the perspective of the mouse, or use a digital simulator (like PhET) to record a video explanation.

Supporting Multilingual/English Learners (*CELP standards*)

	Emerging	Expanding	Bridging
LT1	I can identify physical traits that make humans different by pointing to or labeling pictures using simple words.	I can describe how humans have different traits using sentence frames (e.g., "One way humans are different is...").	I can explain how genetic differences create diversity in human populations using specific academic science vocabulary.
LT2	I can label the stages of cell division using a visual model or color-coded sequencing cards that match the colors used in the classroom diagram.	I can summarize how cell division helps organisms grow using a graphic organizer or sequence words.	I can explain using a word bank how cell division is responsible for an organism's growth.
LT3	I can match pictures of advantages and disadvantages to the correct type of reproduction on a basic T-chart.	I can compare sexual and asexual reproduction using sentence frames (e.g., "An advantage of sexual reproduction is...").	I can judge whether a plant or animal species will survive a disaster based on how they reproduce.
LT4	I can show which traits come from parents by drawing lines on a simple family trait diagram.	I can describe how parents pass traits to their offspring using simple sentences.	I can write a short paragraph explaining the exact path genetic information takes across generations.
LT5	Color-code the smartphone analogy activity strictly to the 3D building materials (e.g., Chromosome = Blue Pipe Cleaner = Blue Phone Case; Gene = Red Bead = Red App).	I can order alleles, genes, traits, and chromosomes from smallest to largest using a visual model.	I can explain the difference between a chromosome, a gene, and an allele, and how they all end up making a physical trait.
LT6	During the "Create a Monster" activity, provide a visual checklist where a "Heads" coin flip corresponds directly to a red sticker and "Tails" to a blue sticker.	I can create and label a diagram to show how parents create offspring with different traits.	I can create a model and explain exactly how sexual reproduction makes sure that children look different or similar to their parents.
LT7	Use a color-coded grid. Dominant letters (B) are bolded and red; recessive letters (b) are lowercase and blue.	I can fill in a partially completed Punnett square and state the most likely outcome.	I can analyze a punnett square/pedigree and explain how a trait was passed down through generations.
LT8	Use the "Telephone" game visually. Give the student a picture sequence with one deliberate error introduced, and have them point out where the error occurred and circle the parts of the sequence it affected.	I can use a model to show how a DNA mutation changes a trait, using sentence frames to explain the change.	I can model how DNA mutations can change the outcome of a trait.

Lesson Sequence	Learning Target	Success Criteria	Resources/Assessments/ Assured Learning Experiences See: Grade 8 - MS Science Instructional Guide
Learning Sequence 1: Intro to Phenomenon (~2 Days) How is Albinism inherited?			
1 - 2	**Learning Target 1** I can explain how humans have different genetics to create diversity.	• I can use a model to demonstrate how humans inherit traits.	

Learning Sequence 2: Cells and Reproduction (~27 Days)		
3-9	**Learning Target 2** I can explain how cell division is responsible for an organism's growth.	• I can list the reasons why cells divide. • I can use evidence to explain the purpose of asexual reproduction for cell growth. • I can create a model that shows how an organism uses asexual reproduction to repair a cut. • I can explain why unicellular and multicellular organisms use cell division to create identical daughter cells for growth.
10-13	**Learning Target 3** I can evaluate the advantages and disadvantages (patterns) of sexual and asexual reproduction on a species' chance of (cause and effect) survival.	• I can identify components of asexual reproduction. • I can identify components of sexual reproduction. • I can identify advantages and disadvantages of each type of reproduction.
13-27	**Learning Target 4** I can apply concepts of reproduction to describe how genetic information is passed on.	• I can explain that genetic information is passed to organisms through cell division. • I can explain that DNA is organized on chromosomes and that chromosomes are divided during cell division. • I can explain that two contributing sources of DNA (chromosomes) are required for reproduction in mammals. • I can compare and contrast each method of reproduction. (time, type of cells, genetic diversity, amount of daughter cells, number of parents) • I can construct an explanation to explain which method of reproduction would be needed to heal a cut on a hand. • I can construct an explanation to explain how an amoeba reproducing in a pond increases its species' chances of survival. (reading passage)
28	**Flex Day**	
29	**Cell Division and Reproduction Quiz**	
Learning Sequence 3: Genetics and Heredity (~21 Days)		
30-31	**Learning Target 5** I can explain the relationship between alleles, genes, traits, and chromosomes.	• I can determine which traits I have using a traits inventory chart. • I can analyze which traits are most and least common within our class population
32-38	**Learning Target 6** I can create a diagram to model how sexual reproduction produces genetic variation from parents to offspring.	• I can define a gene and use a model of a chromosome to explain where a gene can be located. • I can explain the relationship between genes and traits. • I can list traits of an organism and represent different alleles for each trait. • I can explain the relationship between genes and alleles and how alleles are a factor in genetic diversity. • I can use a model to differentiate between and relate chromosomes, DNA, genes, and alleles. • I can create a model to track the inheritance of a trait from parents to offspring. • I can analyze the genetics of two parents in the potential of a gene being present in their offspring.
39-47	**Learning Target 7** I can analyze and draw conclusions from a pedigree/punnett square.	• I can predict the probabilities of an offspring inheriting a given trait. • I can use a punnett square to organize the potential inheritance of a trait. • I can use a punnett square to predict the likeliness of a trait being inherited. • I can evaluate the potential of a trait being present in

		offspring using either a punnett square or pedigree chart.
48-49	**Flex Days**	
50	**Pedigrees and Punnett Squares Quiz**	
Learning Sequence 4: DNA & Traits (~10 Days)		
51-58	**Learning Target 8** I can create a model to explain how mutations in DNA can affect the outcome of an organism's traits.	• I can identify the structure and function of DNA. • I can define a genetic mutation. • I can define the function of a protein in organisms. • I can explain how DNA codes for proteins which determine an organism's traits. • I can differentiate between harmful, helpful, and neutral mutations. • I can model how structural changes in DNA can lead to harmful, helpful, and neutral mutations • I can explain the connection between genes, proteins and traits. • I can explain how changes in DNA bases may affect the outcome of the protein
59	**Flex Day**	
60	**Heredity and Genetics Test**	

Unit Title	
Unit 2: Natural Selection and Evolution	
Relevant Standards	
MS-LS1-4 Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. MS LS1-5 Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. MS-LS2-4 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. MS-LS4-1 Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth, under the assumption that natural laws operate today as in the past. MS-LS4-2 Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships MS-LS4-3 Analyze displays of pictorial data to compare patterns of similarities in embryological development across multiple species to identify relationships not evident in the fully formed anatomy. MS-LS4-4 Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment. MS-LS4-5 Gather and synthesize information about technologies that have changed the way humans influence the inheritance of desired traits in organisms. MS-LS4-6 Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. MS-ESS1-4 Construct a scientific explanation based on evidence from rock strata for how the geologic timescale is used to organize Earth's 4.6-billion-year-old history. MS-ESS2-3 Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of past plate motions	
Essential Question(s)	**Enduring Understanding(s)**
What evidence from the fossil record is there to determine that organisms change over time?	Organisms change over time in response to the changing environment. Organisms that have traits that help them survive will live longer, reproduce more often, and therefore pass those beneficial traits down to offspring. Organisms that do not have beneficial traits will die off before they are able to reproduce and pass any of the traits down. Over time, this changes the frequency of specific traits in a given population. Over millions of years this is called evolution which occurs through natural selection.
Demonstration of Learning	**Pacing for Unit**
Various models, quizzes, labs, tests, projects (see Lesson Sequence and Grade 8 - MS Science Instructional Guide)	~19 days
Family Overview (link below)	**Integration of Technology:**
Grade 8 Science - Family Overview	OpenSci Ed Virtual Labs Gizmos Demonstration PhEt Simulators
Unit-specific Vocabulary	**Aligned Unit Materials, Resources, and Technology (beyond core resources)**
Natural selection, artificial selection, evolution, adaptation, resources, reproduction, offspring, breeding, genetic engineering, DNA, cloning, inherit, hereditary, proteins, diversity, trend, beneficial, probability, distribution, adaptation, DNA, dominant traits, recessive traits, homologous, analogous, diversity, extinction,, extinct, unicellular, multicellular, organelles, ancestry, species, evolve,	Listed in the Unit 1 since these bundles are connected

Opportunities for Interdisciplinary Connections:	Anticipated misconceptions
• Graphing • Mathematical representation of changes in traits in population over time due to Natural Selection • History of life on Earth - relative fossil dating, superposition	• Organisms want to adapt to their environment, so they choose to change • Humans always negatively impact the environment and organisms living in it
Connections to Prior Units	**Connections to Future Units**
• Unit 1- heredity and how DNA is passed from parent to offspring • Unit 1- a mutation can result in an adaptation • 7th grade, fossil record/sedimentary rocks	High school biology Unit 4- space - Earth's creation and geologic timeline

Differentiation through *Universal Design for Learning*

	Engagement	Representation	Action & Expression
LT1	"Mammoth Mystery Investigation" analyzing climate change data, human hunting pressure, and habitat loss during the Pleistocene epoch.	Cause-and-effect timeline mapping environmental shifts (warming temperatures, loss of tundra vegetation) alongside mammoth population decline.	Write a case study analysis or construct a digital timeline explaining how environmental shifts and low genetic diversity drove mammoth extinction.
LT2	"Dog Breeding vs. Wild Wolves" comparing how humans select dog traits (e.g., size, coat) vs. how nature selects traits in wild wolves.	Comparative T-chart highlighting key components: selective agent (human vs. environment), variation, overproduction, differential survival, and trait inheritance.	Sort real-world scenarios into natural or artificial selection and present a written or visual breakdown comparing their selective pressures.
LT3	"Family Trait Inventory" investigating inherited physical traits passed down through sexual reproduction versus acquired non-genetic traits.	Punnett square visual models, pedigree charts, and diagrams contrast sexual reproduction (genetic shuffling) with asexual reproduction.	Solve genetic cross scenarios using Punnett squares or create an infographic illustrating how selected traits pass across generations.
LT4	"Rock Pocket Mouse / Peppered Moth Simulation" tracking coat color shifts before and after environmental changes (lava flows, industrial soot).	Line graphs and frequency distribution charts showing trait shifts (e.g., dark coat % vs. light coat %) over multiple generations in changing environments.	Analyze population frequency data and write a Claim-Evidence-Reasoning (CER) essay describing how a trait's prevalence changed over time.
LT5	"Bird Beak Adaptation Lab" testing different tool "beaks" on various food types to observe survival and reproductive success rates.	Evolutionary fitness diagram showing how favorable trait variations lead to higher survival, successful mating, and greater offspring production.	Record a video presentation or draft an explanatory narrative describing how a specific trait variation provides a competitive advantage.
LT6	"Fossil Layer Timeline Puzzle" excavating and sequencing fossil stratum cards to trace anatomical changes in horse or whale ancestors.	Geologic time scale charts, fossil layer diagrams (strata), and evolutionary tree diagrams showing appearance, diversification, and extinction events.	Analyze a fossil record dataset and write an empirical evidence summary detailing patterns of life, anatomical shifts, and mass extinctions over time.

Supporting Multilingual/English Learners (*CELP standards*)

	Emerging	Expanding	Bridging
LT1	I can point to and label visual causes of mammoth extinction (e.g., humans, ice melting) using an illustrated word bank. I can match pictures of parent organisms to offspring showing inherited traits (e.g., long fur to long fur).	I can describe why the woolly mammoth went extinct and how it inherited traits using sentence frames (e.g., "The mammoth went extinct because its inherited traits did not help it...").	I can explain the biological causes for the woolly mammoth extinction using Unit specific vocabulary. I can explain the different paths (dominant, recessive, or artificial selection) that organisms take to inherit specific traits from their parents.
LT2	I can sort pictures of animals into categories of "shaped by nature" (Natural Selection) or "shaped by humans" (Artificial Selection).	I can describe the components of natural and artificial selection using a comparative T-chart or sentence starters.	I can compare and contrast the core components of natural selection and artificial selection to show how they both change a species.
LT3 &4	I can circle or point to the traits in a picture that help an animal hide or survive in its environment. I can identify if a trait went up or down	I can use data from a simulation to describe how a trait increases or decreases over time using a graphic organizer.	I can use scientific evidence and vocab to explain how nature selects for or against specific traits, causing them to increase or decrease in a population over time.

	by looking at a simplified bar graph or population chart.		I can explain how helpful trait variations give certain individuals a competitive advantage to survive and reproduce in their environment.
LT5	I can label a diagram of rock layers to show which fossils are the oldest (bottom) and newest (top). I can match fossil drawings to modern animals that look similar to them.	I can describe patterns in the fossil record (like change or extinction) using a timeline and sentence frames.	I can analyze and interpret fossil data to explain how life on Earth has changed, branched out, or gone extinct throughout history using a timeline, images and data..

Lesson Sequence	Learning Target	Success Criteria	Resources/Assessments/ Assured Learning Experiences See: Grade 8 - MS Science Instructional Guide (rev. 2026)
Learning Sequence 1: Introduction to Phenomenon (~2 Days) The case of the missing wooly mammoths			
1-2	**Learning Target 1** I can explain the biological causes for the woolly mammoth extinction.	• I can use a model to explain a scientific phenomenon using my initial thinking.	
Learning Sequence 2: Natural vs. Artificial Selection (~10 Days)			
3-5	**Learning Target 2** I can identify the components of natural selection and artificial selection. **Learning Target 3** I can explain the different ways organisms can inherit selected traits from parents	• I can explain how traits are naturally selected. • I can explain how traits are artificially selected • I can differentiate between natural selection and artificial selection. (timing, human vs nature, causes, reasons, environmental factors) • I can use scientific evidence to demonstrate/model how artificial selection affects the genetic population of a species. • I can create and defend a model to demonstrate which type of selection (artificial/natural) would be best to reverse engineer a Woolly Mammoth.	
6	**Artificial Selection Quiz**		
7-10	**Learning Target 4** I can use evidence to describe how, over time, natural selection may lead to increases and decreases of specific traits in a population. **Learning Target 5** I can explain how variations of traits in a population can increase individuals' probability of surviving and reproducing.	• I can define and identify adaptations in a species. • I can identify reasons why an organism would need certain adaptations in order to survive in specific environments/conditions. • I can organize data into a graph to determine if an adaptation is helpful, harmful or neutral in a population. • I can connect the adaptations of a species to the predominance of that trait in the population. • I can use patterns as evidence to predict future generations of traits in a population. • I can use evidence to argue if factors related to an adaptation led to the extinction (cause and effect) of the woolly mammoth.	
11	**Flex Day**		
12	**Natural Selection Quiz**		
Learning Sequence 3: Fossil Patterns (~7 Days)			
13-17	**Learning Target 6** I can analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life throughout history.	• I can use patterns as evidence from the fossil record to show common ancestry • I can explain/model common ancestry between organisms using embryological evidence. • I can use evidence from the fossil record to support the argument that organisms change over time.	

		• I can identify homologous and analogous structures between organisms. • I can create a model to demonstrate how the woolly mammoth could be reverse engineered using a living ancestor.
18	**Flex Day**	
19	**Fossil Record Quiz**	

Unit Title
Unit 3: Chemistry

Relevant Standards

MS-PS1-1 Develop models to describe the atomic composition of simple molecules and extended structures
MS-PS1-2 Analyze and interpret data on the properties of substances before and after the substances interact to determine whether a chemical reaction has occurred.
MS-PS1-3 Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
MS-PS1-4 Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed
MS-PS1-5 Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.
MS-PS1-6 Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

Essential Question(s)	Enduring Understanding(s)
What is matter made of? How does the natural world constantly satisfy the Law of Conservation of Matter?	Everything is made of matter, which is made of atoms even though we can't see them. All matter is neither created nor destroyed, it is just recycled into something different over and over and over again.
Demonstration of Learning	**Pacing for Unit**
Various models, quizzes, labs, tests, projects (see Lesson Sequence and Grade 8 - MS Science Instructional Guide)	~45 days
Family Overview (link below)	**Integration of Technology:**
Grade 8 Science - Family Overview	OpenSci Ed Virtual Labs Gizmos Demonstration PhEt Simulators
Unit-specific Vocabulary	**Aligned Unit Materials, Resources, and Technology (beyond core resources)**
Element, compound, mixtures, homogenous, heterogeneous, pure substances, solution, reactant, product, compound, matter, mass, volume, density, solubility, dissolve, flammability, odor, gas, solid, liquid, chemical bonds, atom, molecule, pure substance, particle, pressure, carbon dioxide, negative impact, natural gas, oil, phase, phase change, thermal energy, kinetic energy, pure substance, compound, thermometer, melting, freezing, condensation, vapor, heat, vibrate, collide,	Iodine, hydrogen peroxide, distilled water, gloves, cornstarch, baking soda, vinegar, sand, salt, iron fillings, coffee filters, beakers, magnets, Vitamin C tablets, luminol, glow sticks, balloons, alka seltzer tablets, matches, candles, powdered laundry detergent, steel wool, digital scales, calculators, stopwatches
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions**
There are many opportunities for students to practice Science and Engineering Practice skills during this unit by demonstrating a chemical reaction.	• Every chemical reactions results in an explosion • Once something is "destroyed' it is gone forever
Connections to Prior Units	**Connections to Future Units**
Math- solving equations 7th grade energy transfer	High school chemistry High School Physical Science

Differentiation through *Universal Design for Learning*

	Engagement	Representation	Action & Expression
LT1	Give pairs a plastic syringe (no needle) capped with a piece of clay or a finger. Challenge them to push the plunger all the way down. When it bounces back or resists, ask: *"If the tube is completely*	Provide multiple ways to "see" the unseen. Use macro-to-micro animations (like zooming into a balloon filled with gas) and provide a structured CER (Claim, Evidence,	Provide choices for constructing their first argument. Students can complete a simple C-E-R (Claim, Evidence, Reasoning) writing template with sentence starters: "Even though I can't

	empty, what is fighting against your hand?" Place a blown-up balloon over the mouth of an empty glass bottle. Submerge the bottom of the bottle in a bowl of ice water, and watch the balloon suddenly deflate and get sucked *inside* the bottle. Ask: *"What just happened here? Write a rumor, a guess, or a bold statement explaining the trick."*	Reasoning) graphic organizer. Offer sentence stems for the initial claim (e.g., "Even though I cannot see the air, I argue it exists because...").	see air, it is matter because..."
LT2	The "Lego Deconstruction" Challenge: Dump a pile of mismatched Lego bricks on a table. Challenge students to sort them. Explain that individual bricks are atoms, connected bricks of the *same* color are elements (like oxygen gas), and structures built from *different* colors are compounds. Ask: *"How many unique structures can we make out of just three basic colors?"*	Create an explicit, color-coded visual key for atoms (e.g., Red = Oxygen, White = Hydrogen). Provide clear, side-by-side visual examples distinguishing an element (pure substance of one atom type) from a compound (different atoms chemically bonded).	The Sticky Note Brainstorm: Instead of making students write a formal paragraph right away, allow them to write their initial claim on a digital Padlet wall or a physical sticky note to post on the whiteboard.
LT3	The "Glow Stick vs. Hand Warmer" Sensory Lab: Crack open a glow stick (chemical reaction releasing energy/light) and open a disposable hand warmer (chemical reaction releasing heat). Have students physically hold them. Introduce the terms *exothermic* and *endothermic* through what their fingers feel, not a textbook slide. The "Alka-Seltzer Time Bomb": Drop an Alka-Seltzer tablet into a film canister filled with water, snap the lid on, and wait for it to pop. Ask: *"What invisible signals did the chemicals send to tell us they were changing into something new?"*	Use a visual checklist or icon-based anchor chart showing the 5 signs of a chemical reaction (color change, gas production, temperature change, light, precipitate). Provide simple, color-coded energy flow diagrams showing energy going in (absorbing) versus energy coming out (releasing).	Use interactive energy graphs that compare exothermic reactions (energy goes down/released) and endothermic reactions (energy goes up/absorbed). Color-code them: use bright red arrows for heat leaving a reaction, and cool blue arrows for heat entering a reaction. Have students explore a station lab. To show what they observed, they can complete a digital photo-journal where they snap pictures of the reactions and label the "signs," write a summary paragraph, or verbally check in with the teacher at each station.
LT4	The Collapsing Soda Can Stunt: Heat a small amount of water inside an aluminum soda can, then quickly invert it into ice water. The can instantly crushes itself with a loud *pop*. Ask: *"Who stepped on the can? How did temperature just manipulate the invisible air pressure inside?"*	Utilize interactive digital simulations like PhET States of Matter. This allows students to physically pump in more gas molecules, crank up the heat, and watch the pressure gauge rise while seeing how the particles behave.	Give choices for explaining the particle behavior. Students can act it out kinesthetically (e.g., standing close and vibrating as a solid, then spreading out and moving fast as a gas), draw a multi-panel comic strip, or complete a structured matching matrix.
LT5	Draw a giant T-chart on the classroom floor using painter's tape, with a balance beam/see-saw triangle drawn right in the middle under the yield arrow (-->).Give students giant whiteboards or large heavy blocks representing different molecules. If the left side has 4 Hydrogen blocks and the right side only has 2, have the students on the left side dramatically pretend to tip over because their side is "too heavy." The students must physically shout out what blocks need to be added to the lighter side to make the human see-saw perfectly level.	Provide a physical or digital Reactant vs. Product T-Chart to help students keep inventory of their atoms. Use physical tokens or colored chips to physically build the molecules on both sides of a "balance beam" graphic organizer so they can visually see when the scale is level.	Offer a "Choose Your Adventure" tier system. Level 1: Draw the molecules to show they are even. Level 2: Solve the equations using math coefficients. Level 3: Fix an incorrectly balanced equation and write a note explaining the mistake.
LT6	Frame a scenario where students are stranded on a freezing, rainy island. They have to choose between a heavy, natural	Provide alternating media types: a podcast episode discussing plastic synthesis, an infographic showing the	Students take on the role of a "Product Designer." They select an item (like a shoe or a piece of furniture) and choose

	wool blanket (absorbs water, gets heavy, but stays warm) or a lightweight, synthetic nylon jacket (waterproof, windproof, but can melt if it gets too close to the campfire). This addresses the misconceptions that "natural is always perfect" and "synthetic is always bad." It reframes the topic around human problem-solving, engineering, and real-world trade-offs.	lifecycle of a natural wood product vs. plastic, and texts with simplified definitions of "natural" and "synthetic."	how to present their material choices: pitch a design to the class arguing why they chose synthetic vs. natural materials, design a labeled poster, or write a comparative summary essay.

Supporting Multilingual/English Learners (*CELP standards*)

	Emerging	Expanding	Bridging
LT1	I can point to and label physical evidence that shows invisible air exists (e.g., a scale tipping, a balloon expanding) using simple vocabulary words. I can choose the correct claim to explain a phenomenon from a 3-choice visual menu bank.	I can state a claim about unseen matter and point to evidence using sentence frames (e.g., "I claim that air exists because when I...").	I can write an initial argument to prove that matter exists even when it cannot be seen.
LT2	I can match the vocabulary words (*atom, element, compound*) to their corresponding color-coded physical models or Lego analogies.	I can build and describe models of atoms, elements, and compounds using a visual key and simple sentences.	I can create a clear, testable claim that gives a scientific explanation for an observed phenomenon.
LT3	I can identify if a reaction feels hot or cold and circle icons representing visible clues of a chemical change (e.g., bubbles, color changes).	I can describe the characteristics of a reaction and note if energy goes in or out using a graphic organizer.	I can explain how energy moves into or out of a chemical reaction, causing temperature changes. I can analyze a chemical change and explain the specific characteristics that prove a new substance was created.
LT4	I can label images of a solid, liquid, and gas and point to what happens to particle speed when heat is added.	I can describe how temperature and pressure change states of matter using cause-and-effect sentence frames.	I can explain the relationship between temperature, pressure, and particle movement during changes in states of matter using unit specific vocab.
LT5	I can draw lines to match and tally identical atoms on the reactant side and product side of a visual equation to see if they are equal.	I can balance a simple chemical equation using a reactant/product T-chart scaffold.	I can balance a chemical equation using math and explain how it proves that mass cannot be created or destroyed.
LT6	I can sort everyday items into categories of "From Nature" or "Man-Made / Lab" using a visual T-chart.	I can compare a natural substance to a synthetic one using a Venn diagram and simple comparative words.	I can evaluate and write a paragraph comparing why society needs both natural and synthetic materials despite their environmental impacts.

Lesson Sequence	Learning Target	Success Criteria	Resources/Assessments/ Assured Learning Experiences See: Grade 8 - MS Science Instructional Guide
Learning Sequence 1: Introduction to Phenomenon (~4 Days) Why does a candle go out when a glass is put over it?			
1-3	**Learning Target 1** I can construct an initial argument that matter exists even if I can't see it. I can create an initial claim to explain a phenomenon	• I can explain that solids, liquids and gases contain atoms that have unique properties. • I can make observations and ask questions about the phenomenon • I can make an initial claim to explain the outcome of the phenomenon	
Learning Sequence 2: Atoms, Elements, and Compounds (~6 Days)			
4-8	**Learning Target 2** I can chemically model the ingredients of atoms, elements, and compounds.	• I can describe the structure of an atom • I can use the periodic table to find information about various elements	

		• I can compare and contrast atoms, compounds and molecules. • I can explain the difference between substance and mixtures, including how to separate them.
9	**Atoms, Molecules, Compounds Quiz**	
Learning Sequence 3: Chemical Reactions (~20 Days)		
10-18	**Learning Target 3** I can explain the relationship between energy and a chemical reaction. I can describe the characteristics of a chemical reaction.	• I can define energy. • I can define the law of conservation of energy. • I can describe the difference between chemical and physical properties. • I can use chemical and physical properties to identify a substance. • I can model the conservation of atoms in a simple chemical reaction used to break down sugar.
19-28	**Learning Target 4** I can explain the relationship between temperature, pressure, and states of matter.	• I can model the impact of temperature on the different states of matter. • I can investigate how a change in temperature impacts matter (atoms and compounds). • I can explain the relationship between temperature and pressure.
29	**Flex Day**	
30	**Chemical Physical Changes Quiz**	
Learning Sequence 4: Balancing Chemical Equations (~5 Days)		
31-34	**Learning Target 5** I can balance a chemical equation	• I can identify and define the products and reactants of a chemical reaction. • I can count the amount of atoms that are present in the reactants and products. • I can balance a chemical reaction so that the products and reactants are equal. • I can use the law of conservation of matter to prove that a chemical equation is balanced.
35	**Balancing Chemical Equations Quiz**	
Learning Sequence 5: Natural vs. Synthetic Materials (~10 Days)		
36-43	**Learning Target 6** I can compare the importance of natural vs synthetic substances.	• I can define what a natural substance is • I can define what a synthetic substance is • I can explain advantages and disadvantages of natural and synthetic substances • I can explain why synthetic substances are more popular than natural substances in today's society
44	**Flex Day**	
45	**End of Unit Test**	

Unit Title	
Unit 4: Patterns in the Sky	
Relevant Standards	
MS-PS2-4 Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects MS-PS2-5 Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact MS-ESS1-1 Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and the seasons. MS-ESS1-2 Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system MS ESS1-3 Analyze and interpret data to determine scale properties of objects in the solar system MS-ESS1-4 Construct a scientific explanation based on evidence from rock strata for how the geologic timescale is used to organize Earth's 4.6-billion-year-old history. MS-ESS2-2 Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.	
Essential Question(s)	**Enduring Understanding(s)**
What patterns can be used to make predictions about phenomena in the night sky?	Patterns control everything in the natural universe. These patterns can be used to reliably make predictions about almost all the phenomena in the night sky.
Demonstration of Learning	**Pacing for Unit**
Various models, quizzes, labs, tests, projects (see Lesson Sequence and Grade 8 - MS Science Instructional Guide)	~53 days
Family Overview (link below)	**Integration of Technology:**
Grade 8 Science - Family Overview	OpenSci Ed Virtual Labs Gizmos Demonstration PhEt Simulators
Unit-specific Vocabulary	**Aligned Unit Materials, Resources, and Technology (beyond core resources)**
Orbit, magnitude, galaxy, solar system, ellipse, proportional, period, gravity, eclipse, tide, force, day, night, vacuum, satellite, terrestrial planet, gas giant, planetary rings, dwarf planet, sun, inner planet, outer planet, comet, Inertia, force, mass, weight, orbit, names of planets	Flashlights, protractors, lightbulbs, lamps, styrofoam balls, batteries, pencil compasses, gravity table, solar eclipse goggles, globe, heat lamp, graph paper, poster paper, coloring supplies, trundle wheel, large tape measure, scientific calculators
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions**
• Graphing sunlight (length of the day and intensity of the sun) based on latitude position on Earth. • Graphing tide data based on the moon's position in orbit around the Earth. • Creating models of orbital motion (moon phases, eclipses, planetary motion).	• The moon is only visible at night. • The Northern and Southern hemispheres have opposite seasons due to the temperature variations created by changing sun intensity and length of a day. • There is no gravity in space based on astronauts experiencing microgravity. • There is no dark side of the moon. The moon has a day and night side. Due to the moon's rotation period, the same side of the moon always faces the Earth.
Connections to Prior Units	**Connections to Future Units**
Unit 2- law of superposition 7th grade plate tectonics 7th grade forces and motion 7th grade geologic timelines	High school physical science
Differentiation through *Universal Design for Learning*	

	Engagement	Representation	Action & Expression
LT1	Project an image or show a video clip of Stonehenge, an Egyptian pyramid alignment, or a Mayan temple during an equinox (where the sun creates a snake-like shadow moving down the stairs). Tell students that ancient civilizations didn't have iPhones, Google, or watches, yet they built billion-pound stone structures that perfectly predict the exact day the seasons change. Ask, how did they hack the sky? What repeating patterns did they notice that we are missing today because we look at screens instead of the horizon?"	Use time-lapse videos showing the apparent motion of stars, the sun, and the moon across the sky over 24 hours.	Students can choose how to show a cosmic pattern (like day/night or star paths): write a traditional myth explaining a constellation pattern, map a pattern out digitally on Google Slides, or use a physical flashlight and globe to verbally demonstrate the pattern to a partner.
LT2	Project an image of a famous skyscraper (like the Empire State Building or the Burj Khalifa). Tell students that the height of the building represents Earth's timeline from the bottom floor (Earth's birth) to the very top antenna (today). Ask students to guess where on the building humans first show up. Drop a digital marker down the building. Reveal that all of human history fits into a thin layer of paint on the very roof of the building, and the dinosaurs are down around the 95th floor.	Provide physical or visual timeline models (e.g., a 5-meter long cash register tape or a roll of toilet paper representing geologic time). Use side-by-side infographic size comparisons—such as showing Earth as a marble next to the Sun as a basketball.	Give choices for representing the massive scale: students can design an infographic "History of Earth" brochure, write a script for a time-travel movie, or complete a digital drag-and-drop sequencing activity. Utilize interactive zoom tools (like Scale of the Universe 2) that allow students to scroll from the size of a human all the way out to galaxies. Provide a clear, visual matrix chart that categorizes objects by size, composition (rocky vs. gas), and atmosphere.
LT3	Use a digital weight simulator where students type in their current weight to see how heavy they would be on different celestial bodies. Students can also calculate this instead of using a simulator.	Use interactive digital simulations (like PhET or Gizmos) where students can manipulate different masses to show gravity's impact.	Give choices for explaining gravity's role: write a "What If?" sci-fi survival entry describing what happens if gravity drops by half, create a step by step diagram of an orbit, or complete a structured fill in the blank concept map.
LT4	Students use a "Ball on a Stick" Lab to make observations about moon phases. Turn off the classroom lights and give each student a styrofoam ball. (The Moon) Shine a bright projector lamp from the front of the room (The Sun). As students move their own bodies (Earth) in a circle, the styrofoam ball naturally displays every single moon phase right in front of their eyes.	Provide interactive 3D models that show a split-screen view: one side showing the Sun-Earth-Moon system from space, and the other side showing how it looks from an observer standing on Earth. Use clear, aligned diagrams mapping high/low tides to specific lunar phases.	The Moon Phase Comic Strip: Students choose how to model the cycles: draw a 8-panel comic strip starring the Moon changing shapes, build a 3D stop motion video using clay models, or complete a digital labeling assessment on a platform like Canvas or Google Drawings.
LT5	Read a letter from a fictional student in Australia celebrating Christmas on a hot beach while it's snowing in Connecticut. Ask: *"If we are all on the same planet revolving around the same sun, how is this weather chaos possible?"* Give pairs a flashlight and a sheet of grid paper. Have them shine the light directly straight down (90 degree angle) and count how many grid squares are lit up (highly concentrated, bright light). Then, tilt the flashlight at a sharp angle and watch the same amount of light spread out and weaken across the paper. Ask: "How does this explain why direct summer sunlight burns your skin, while slanted winter sunlight leaves you freezing?"	Use the Seasons and Daylight Interactive (or similar interactive widgets like those on EarthFix or PBS LearningMedia) where students can drag Earth around its orbit and watch a live graph track the hours of daylight changing in real time.	Have students act as a "Meteorologist." They choose how to explain why it's winter in New York but summer in Australia: write a weather report transcript, record a video forecast using a globe as a prop, or fill out a structured cause and effect graphic organizer.
Supporting Multilingual/English Learners (*CELP standards*)			

	Emerging	Expanding	Bridging
LT1	I can point to and label visual patterns in the sky (e.g., day/night, changing constellations) using simple words and visual stamps.	I can describe how objects in the sky move in predictable patterns over time using a sentence frame.	I can explain the connections between moving objects in space and the predictable patterns we see from Earth.
LT2	I can sort celestial objects by size from smallest to largest and identify where humans belong on a visual geologic timeline.	I can compare the sizes of different space objects and describe human existence on a timeline using scale words.	I can explain the massive scale of Earth's history and write a summary showing how small human existence is compared to geologic time. I can analyze a scale chart of the solar system to explain how different space objects compare to each other in size and distance.
LT3	I can circle variables (e.g., larger mass, closer distance) that make a gravity vector arrow grow stronger in a visual simulation.	I can describe how gravity keeps planets in motion using a cause-and-effect graphic organizer.	I can explain how gravity acts as the structural glue that controls the orbits and movements of objects across the universe.
LT4	I can sequence cards of the 8 moon phases in order and match an eclipse to its matching 3-body visual alignment.	I can sequence moon phases and describe the alignment of the Sun, Earth, and Moon during eclipses.	I can explain the relationship between the moving positions of the sun, Earth, and moon, and how they create phases, tides, and eclipses.
LT5	I can point to and select which picture shows summer vs. winter based on the length of a shadow and the number of daylight hours on a chart and/or graph.	I can describe how Earth's tilt causes different seasons using a diagram and sentence starters.	I can explain how the constant angle of Earth's tilt creates opposite seasons in the Northern and Southern hemispheres as we orbit the sun.

Lesson Sequence	Learning Target	Success Criteria	Resources/Assessments/ Assured Learning Experiences See: Grade 8 - MS Science Instructional Guide (rev. 2026)
Learning Sequence 1: Introduction to the Phenomena (~2 Days)			
1-2	**Learning Target 1** I can make connections between objects in the sky and patterns in the universe.	• I can make observations and ask questions about phenomena seen in the sky	
Learning Sequence 2: Objects in the Night Sky (~11 Days)			
3-12	**Learning Target 2** I can explain human existence relative (scale) to Earth's geologic time. I can analyze the differences in scale properties for different celestial objects (planets, stars, sun, moons, asteroids, comets) in Space.	• I can identify simple patterns in the night sky. • I can differentiate between stars, planets and other objects seen in the night sky. • I can estimate and calculate relative size and distance of objects in space. • I can analyze, interpret, and illustrate scale properties of objects in space.	
13	**Scale of the Solar System Quiz**		
Learning Sequence 3: Gravity and Orbital Motion (~11 Days)			
14-22	**Learning Target 3** I can explain how gravity impacts patterns and motion in the universe and on Earth.	• I can model the motion of the Earth, Sun, and Moon. • I can define gravity. • I can develop a model to describe the role of gravity in the patterns and motions within the universe. • I can relate orbital periods of different planets to the strength/magnitude of the Sun's gravity. • I can comprehend and illustrate that gravity is the force that keeps the solar system, the Milky Way Galaxy, and the universe together and in motion.	
23	**Flex Day**		

24	**Gravity Quiz**	
Learning Sequence 4: Moon Phases, Eclipses, Tides (~11 Days)		
25-34	**Learning Target 4** I can explain how moon phases, tides, and eclipses are related to the movements of the sun, Earth and moon.	• I can model the motion of the moon around the Earth • I can use evidence to explain how the motion of the Earth, Sun and Moon causes moon phases • I can identify and model moon phases • I can identify the location of the Sun, Earth and moon in a lunar eclipse • I can identify the location of the Sun, Earth, and Moon in a solar eclipse • I can describe the frequency of solar and lunar eclipses throughout the year • I can explain how the position of the moon impacts the Earth's tides
35	**Moon Quiz**	
Learning Sequence 5: Seasons (~18 Days)		
36-50	**Learning Target 5** I can explain how seasons are affected by Earth's position around the sun and the angle of Earth's tilt on its axis.	• I can define and identify key vocabulary (longitude, latitude, northern hemisphere, southern hemisphere, equator) about the Earth • I can create a graph to organize and analyze data on day lengths for each month. • I can identify the length of a day fluctuates more at locations closer to the poles. • I can describe how daylight hour patterns change at different geographic locations (latitudes) on Earth throughout the year • I can identify the sun's intensity is higher the closer a location is to the equator. • I can use evidence to explain why the Earth is tilted • I can make the conclusion that although the length of the day is longer at the poles in the summer than near the equator, the angle of the sun is more intense, leading to a warmer climate near the equator.
51	**Seasons Quiz**	
52	**Flex Day**	
53	**End of Unit Test**	