Unit 1: Development and Practice of Astronomy (Earth and Space Science)

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Title Section

Department of Curriculum and Instruction

Belleville Public Schools

Curriculum Guide

ASTRONOMY, GRADE 12

Unit I: Development and Practice of Astronomy

Belleville Board of Education

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Unit Overview

This unit describes how ancient civilizations attempted to explain the heavens in terms of geocentric models of the Universe. It summarizes the role of Renaissance science in the history of astronomy. It explains how the observed motions of the planets led to our modern view of a Sun-centered solar system. It describes the major contributions of Galileo, Kepler and Newton to the development of our understanding of the solar system. It also describes how astronomers use the behavior of light, including spectroscopy, to determine integral properties like distance, brightness, temperature, and chemical composition of celestial bodies.

Enduring Understandings

Unit Enduring Understandings

- The scientific method demands that any model or conceptualization of the universe must fit all available data.
- The geocentric universe incorrectly, disprovable proposes that the Earth is the center of the universe, and that all other bodies orbit it.
- Electromagnetic radiation, including visible light, has certain physical properties: wavelength, frequency, energy, and wavespeed; these are interrelatable by the Planck equation, and the mathematical definition of a wave. Moreover, the speed of light is fixed in a vacuum.
- Using his telescope, Galileo collected evidence critical to disproving the geocentric theory: the tidal locking of Mercury, and the transit of Venus.
- Kepler's laws model-- and Newton's laws of motion and universal gravitation explain-- the observed motions of celestial bodies.
- Various kinds of telescope and computer-assisted imaging are used to collect data in astronomy. This is necessitated by the immense distances and life-threatening hazards involved in more direct collection of data.

Essential Questions

Unit Essential Questions

- What situations in ordinary life could benefit from investigation via the scientific method?
- What is the benefit of teaching students about the geocentric theory of the universe if we know it to be false?
- Why did the Church's near limitless power still fail to contain heliocentrism?
- What are the seven types of electromagnetic radiation? What physical properties do they have and how are they interrelated?
- Thousands of observations of the sky are made every night. What made Galileo's observations uniquely important?
- How do we surmount the problems of distance, time, and the harsh conditions of space in order to study it?
- How do we deal with the distortions caused by the atmosphere?

Exit Skills

By the end of Unit 1 Students Should be able to:

- Describe how scientists combine observation, theory, and testing in their study of the universe.
- Explain how our clocks and calendars are linked to Earth's rotation and orbit around the Sun.
- Explain the simple geometric reasoning that allows astronomers to measure the distances and sizes of otherwise inaccessible objects.
- Describe how some ancient civilizations attempted to explain the heavens in terms of Earth-centered models of the universe.
- Summarize the role of Renaissance science in the history of astronomy.
- Explain how the observed motions of the planets led to our modern view of Sun-centered solar systems.
- Discuss the nature of electromagnetic radiation and tell how that radiation transfers energy and information through interstellar space.
- Describe the major regions of the electromagnetic spectrum and explain how Earth's atmosphere affects our ability to make astronomical observations at different wavelengths.
- Tell how we can determine the temperature of an object by observing the radiation that it emits.
- Describe the Doppler effect, and explain how it can be used to determine the velocity of a celestial object.
- Explain the origin of electromagnetic spectra, and describe how they can be used to determine the chemical composition of a celestial object.
- Describe the major contributions of Galileo and Kepler to the development of our understanding of the solar system.
- State Kepler's laws of planetary motion.
- Use Kepler's laws to model and predict the motions of the planets.
- Use Newton's laws of motion and universal gravitation to explain the model predicted by Kepler's laws.
- Explain how the law of gravitation enables us to measure the masses of astronomical bodies.
- Sketch and describe the basic designs of the major types of optical telescopes used by astronomers.
- Explain the advantages of computer image analysis, radio telescopy, and enhancement in the collection of astronomical data.
- Describe how Earth's atmosphere affects astronomical observations, and discuss some of the current efforts to improve ground-based astronomy.
- Explain why some astronomical observations are best done from space and discuss the advantages and limitations of space-based astronomy.

New Jersey Student Learning Standards (NJSLS-S)

NextGen Science Standards

SCI.HS-ESS1-4	Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.
SCI.HS-ESS1-2	Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.
SCI.HS-ESS1-5	Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.
SCI.HS-ESS1-3	Communicate scientific ideas about the way stars, over their life cycle, produce elements.
9-12.HS-ESS1-1	Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.
9-12.HS-ESS1-6	Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.
9-12.HS-ESS1-1.2	Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).
9-12.HS-ESS1-4.5	Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
9-12.HS-ESS1-2.6	Constructing Explanations and Designing Solutions
9-12.HS-ESS1-5.7	Engaging in Argument from Evidence
9-12.HS-ESS1-3.8	Obtaining, Evaluating, and Communicating Information
9-12.HS-ESS1-2.PS4.B.1	Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities.

9-12.HS-ESS1-2.ESS1.A.1	The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.
9-12.HS-ESS1-2.ESS1.A.2	The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe.
9-12.HS-ESS1-4.ESS1.B.1	Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.

Interdisciplinary Connections

Upon completion of this section, please remove all remaining descriptions, notes, outlines, examples and/or illustrations that are not needed or used.

Please list all and any additional **Interdisciplinary Connections/Cross-Curricular** New Jersey Student Learning Standards that link to this unit, and which are not included in the NJSLS section above.

MA.G-CO.A.1	Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
MA.G-CO.A.2	Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).
MA.G-CO.A.4	Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.
MA.G-CO.A.5	Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.
MA.N-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
MA.N-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling.
LA.RI.11-12.1	Accurately cite strong and thorough textual evidence, (e.g., via discussion, written response, etc.), to support analysis of what the text says explicitly as well as inferentially, including determining where the text leaves matters uncertain.
MA.N-CN.B.6	Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.
LA.RST.11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
MA.N-VM.A.1	Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their

	magnitudes (e.g., □, |□|, ||□||, □).
MA.N-VM.A.2	Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.
MA.N-VM.A.3	Solve problems involving velocity and other quantities that can be represented by vectors.
LA.WHST.11-12.1	Write arguments focused on discipline-specific content.
MA.N-VM.B.4	Add and subtract vectors.
MA.N-VM.B.5	Multiply a vector by a scalar.
LA.WHST.11-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
MA.G-GPE.B.4	Use coordinates to prove simple geometric theorems algebraically.
MA.G-GPE.B.7	Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.
LA.SL.11-12.4	Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience.
SOC.6.2.12.D.2.d	Analyze the impact of new intellectual, philosophical, and scientific ideas on how humans viewed themselves and how they viewed their physical and spiritual worlds.
SOC.6.2.12.CS2	Renaissance, Reformation, Scientific Revolution, and Enlightenment: Ideas developed during the Renaissance, Scientific Revolution, Reformation, and Enlightenment led to political, economic, and cultural changes that have had a lasting impact.
VPA.1.3.12.C.2	Create and evaluate performances by citing evidence of specific physical choices, sustained vocal technique, and clearly motivated actions.

Learning Objectives

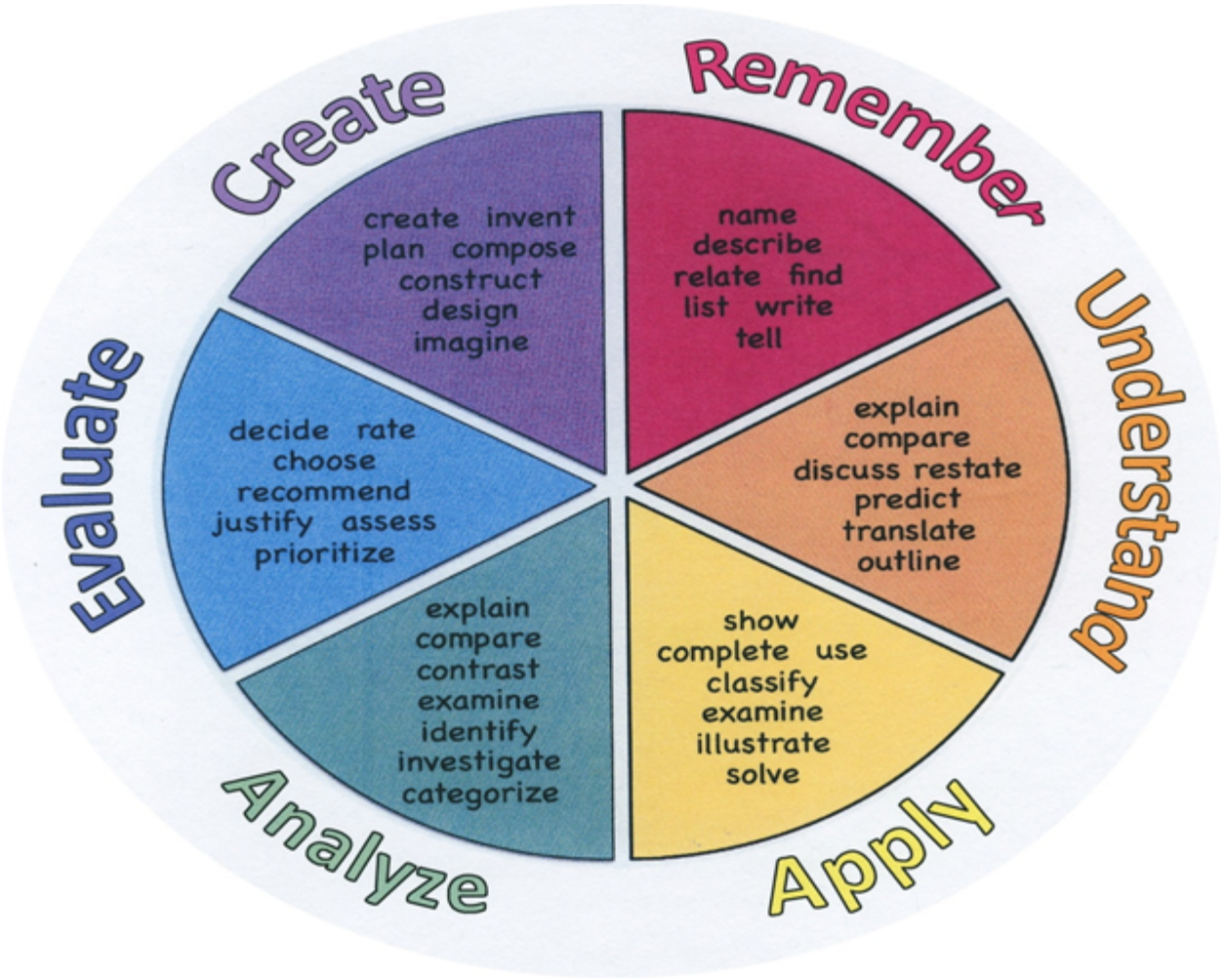
Students will be able to..

- Construct a model that illustrates how our clocks and calendars are linked to Earth's rotation and orbit around the Sun.
- Given appropriate data, determine the distance to a given celestial object.
- Describe how some ancient civilizations attempted to explain the heavens in terms of Earth-centered models of the universe.
- Summarize the role of Renaissance science in the history of astronomy.
- Use Galileo's and Kepler's observations to disqualify the geocentric model. .
- Discuss the nature of electromagnetic radiation and tell how that radiation transfers energy and information through interstellar space.
- Describe the major regions of the electromagnetic spectrum and explain how Earth's atmosphere affects our ability to make astronomical observations at different wavelengths.
- Tell how we can determine the temperature of an object by observing the radiation that it emits.
- Describe the Doppler effect, and explain how it can be used to determine the velocity of a celestial object.
- Explain the origin of electromagnetic spectra, and describe how they can be used to determine the chemical composition of a celestial object.
- Describe the major contributions of Galileo and Kepler to the development of our understanding of the solar system.
- State Kepler's laws of planetary motion.
- Use Kepler's laws to model and predict the motions of the planets.
- Use Newton's laws of motion and universal gravitation to explain the model predicted by Kepler's laws.
- Use the law of gravitation to determine the masses of astronomical bodies.
- Sketch and describe the basic designs of the major types of optical telescopes used by astronomers.
- Explain the advantages of computer image analysis, radio telescopy, and enhancement in the collection of astronomical data.

- Describe how Earth’s atmosphere affects astronomical observations, and discuss some of the current efforts to improve ground-based astronomy.
- Discuss the advantages and limitations of space-based astronomy.

Action Verbs: Below are examples of action verbs associated with each level of the Revised Bloom's Taxonomy.

Remember	Understand	Apply	Analyze	Evaluate	Create
Choose	Classify	Choose	Categorize	Appraise	Combine
Describe	Defend	Dramatize	Classify	Judge	Compose
Define	Demonstrate	Explain	Compare	Criticize	Construct
Label	Distinguish	Generalize	Differentiate	Defend	Design
List	Explain	Judge	Distinguish	Compare	Develop
Locate	Express	Organize	Identify	Assess	Formulate
Match	Extend	Paint	Infer	Conclude	Hypothesize
Memorize	Give Examples	Prepare	Point out	Contrast	Invent
Name	Illustrate	Produce	Select	Critique	Make
Omit	Indicate	Select	Subdivide	Determine	Originate
Recite	Interrelate	Show	Survey	Grade	Organize
Select	Interpret	Sketch	Arrange	Justify	Plan
State	Infer	Solve	Breakdown	Measure	Produce
Count	Match	Use	Combine	Rank	Role Play
Draw	Paraphrase	Add	Detect	Rate	Drive
Outline	Represent	Calculate	Diagram	Support	Devise
Point	Restate	Change	Discriminate	Test	Generate
Quote	Rewrite	Classify	Illustrate		Integrate
Recall	Select	Complete	Outline		Prescribe
Recognize	Show	Compute	Point out		Propose
Repeat	Summarize	Discover	Separate		Reconstruct
Reproduce	Tell	Divide			Revise
	Translate	Examine			Rewrite
	Associate	Graph			Transform
	Compute	Interpolate			
	Convert	Manipulate			
	Discuss	Modify			
	Estimate	Operate			
	Extrapolate	Subtract			
	Generalize				
	Predict				



Suggested Activities & Best Practices

- What situations in ordinary life could benefit from investigation via the scientific method?
  - Construct an infographic or Foldable of the scientific method.
  - Short activity "How many M&M's are in the bag?"
  - Small group inquiry stations with real life situations, e.g. "How could we determine why this plant is sickly?"
- What is the benefit of teaching students about the geocentric theory of the universe if we know it to be false?
  - Sketch/model a comparison of the geocentric and heliocentric models to compare/contrast.
  - YouTube video describing heliocentric vs. geocentric, e.g. "How We Figured Out That Earth Goes Around the Sun"
  - Roleplay/instant debate of heliocentric vs. geocentric.
  - Short reading + questions/Think Pair Share on the flat Earth conspiracy and how we use evidence to debunk it
  - Short reading/Do Now on the history of the atom as a callback to chemistry and evidence-based

change in models

- Why did the Church's near limitless power still fail to contain heliocentrism?
    - Short reading or primary source documents on the role of the Catholic Church in Renaissance Europe
    - Short reading on evidence based thinking
    - Think-pair-share on the scientific and orthodox perspectives
    - Video on the trial of Galileo, e.g. Bertholdt Brecht's Life of Galileo
    - Roleplay/instant debate of the Galileo trial
- What are the seven types of electromagnetic radiation? What physical properties do they have and how are they interrelated?
    - YouTube video on the properties of a wave.
    - YouTube video on the electromagnetic spectrum.
    - PhET simulation + worksheet, Waves and the Electromagnetic Spectrum
    - Construct an infographic identifying and showing the relationships among wavespeed, frequency, and wavelength.
    - Thought exercise: "How would you explain purple to a blind person?"
    - Construct a labeled diagram of the electromagnetic spectrum.
- Thousands of observations of the sky are made every night. What made Galileo's observations uniquely important?
    - YouTube video on Galileo's observations, e.g. "What Galileo Saw With His Telescope"
    - Thought exercise/Do Now: Crime scene: If this was an accident, what would we expect to see that isn't here?"
    - Construct a presentation or informative video on the Galilean evidence
- How do we surmount the problems of distance, time, and the harsh conditions of space in order to study it?
    - YouTube video on how telescopes work, e.g. "Telescopes: Crash Course Astronomy #6"
    - YouTube video on distances, e.g. "Distances: Crash Course Astronomy #25"
    - Diagram the different types of telescopes and how they work.
    - Activity: "Build your own telescope" using magnifying glasses and cardboard tube.
- How do we deal with the distortions caused by the atmosphere?
    - YouTube video on GPS/weather satellites/spy satellites/communications satellites/ISS

Assessment Evidence - Checking for Understanding (CFU)

- Common Benchmark Exam: Astronomy mp1 (Benchmark)
- Unit Test: Historical Astronomy (Summative)
- Unit Test: Intro to Astrophysics (Summative)
- Activity Worksheets/PhET Worksheets (Formative)
- Video Active Notes (Formative)
- NearPod In-Class Multiple Choice (Formative)
- NearPod Class Post-It Brainstorm Board (Formative)
- Infographic Rubrics (Alternate)
- Informative Video Rubric (Alternate)
- Presentation Rubrics (Alternate)
- Quiz: Parts of the Scientific Method (Summative)
- Quiz: Determining Distance (Summative)
- Quiz: Determining Chemical Composition (Summative)
- Quiz: Determining Motion (Summative)
- Quiz: Electromagnetic Spectrum (SUmmative)
- Think, Pair, Share on the scientific and orthodox perspectives (Formative)
- 3D Model Rubric (Alternate)

By identifying the **Evidence of Student Learning with Checking for Understanding (CFU)** techniques used during the lesson and/or for Closure (Madeline Hunter), please list the variety of means used to access students' learning (e.g. quizzes, tests, academic prompts, observations, homework, journals).

- Admit Tickets
- Anticipation Guide
- Common Benchmarks
- Compare & Contrast
- Create a Multimedia Poster
- DBQ's
- Define
- Describe
- Evaluate
- Evaluation rubrics
- Exit Tickets
- Explaining
- Fist- to-Five or Thumb-Ometer
- Illustration
- Journals
- KWL Chart
- Learning Center Activities

- Multimedia Reports
- Newspaper Headline
- Outline
- Question Stems
- Quickwrite
- Quizzes
- Red Light, Green Light
- Self- assessments
- Socratic Seminar
- Study Guide
- Surveys
- Teacher Observation Checklist
- Think, Pair, Share
- Think, Write, Pair, Share
- Top 10 List
- Unit review/Test prep
- Unit tests
- Web-Based Assessments
- Written Reports

Primary Resources & Materials

Class Text: Chaisson, E. & McMillan, S. (2014). *Astronomy today*. Boston: Pearson.

Ancillary Resources

YouTube videos:

- How We Figured Out That Earth Goes Around the Sun: https://www.youtube.com/watch?v=khIzr6610cQ
- How Do Telescopes Work? https://www.youtube.com/watch?v=5v7bN13PjZ8
- Distances: Crash Course Astronomy #25 https://www.youtube.com/watch?v=CWMh61yutjU&list=PL8dPuuaLjXtPAJr1ysd5yGIyiSFuh0mIL&index=25
- Telescopes: Crash Course Astronomy #6 https://www.youtube.com/watch?v=mYhy7eaazIk&list=PL8dPuuaLjXtPAJr1ysd5yGIyiSFuh0mIL&index=6
- What Galileo Saw With His Telescope https://www.youtube.com/watch?v=bCIEYUeXll8&t=574s
- What is Hubble? https://www.youtube.com/watch?v=FEnqDEPsBHQ
- What is the International Space Station? https://www.youtube.com/watch?v=5gTm1cHC-b8

- How does the International Space Station work? https://www.youtube.com/watch?v=oLrOnEmy_GA
- How does GPS Work? https://www.youtube.com/watch?v=FU_pY2sTwTA

Interactives

- PhET Electromagnetic Spectrum: https://phet.colorado.edu/en/contributions/view/3154

Websites

- Bad Astronomy, via the NSF: http://www.badastronomy.com/bad/misc/index.html
- Phys.org: http://www.phys.org
- Space.com, specifically: https://www.space.com/15589-galileo-galilei.html
- Nasa.gov, specifically: https://solarsystem.nasa.gov/news/307/galileos-observations-of-the-moon-jupiter-venus-and-the-sun/

YouTube Channels

- CrashCourse Astronomy
- Spacetime
- National Geographic
- SciShow Space
- BBC Earth Lab
- SciBRIGHT
- How the Universe Works
- NASA
- Science Channel
- Vsauce
- Kurzgesagt
- AsapSCIENCE
- Beyond Science
- The Action Lab

Please list all additional resources that will be used to strengthen this unit's lessons.

Technology Infusion

What **Technology Infusion** and/or strategies are integrated into this unit to enhance learning? Please list all hardware, software and strategies. Please find a technology pedagogy wheel for assistance while completing this section.

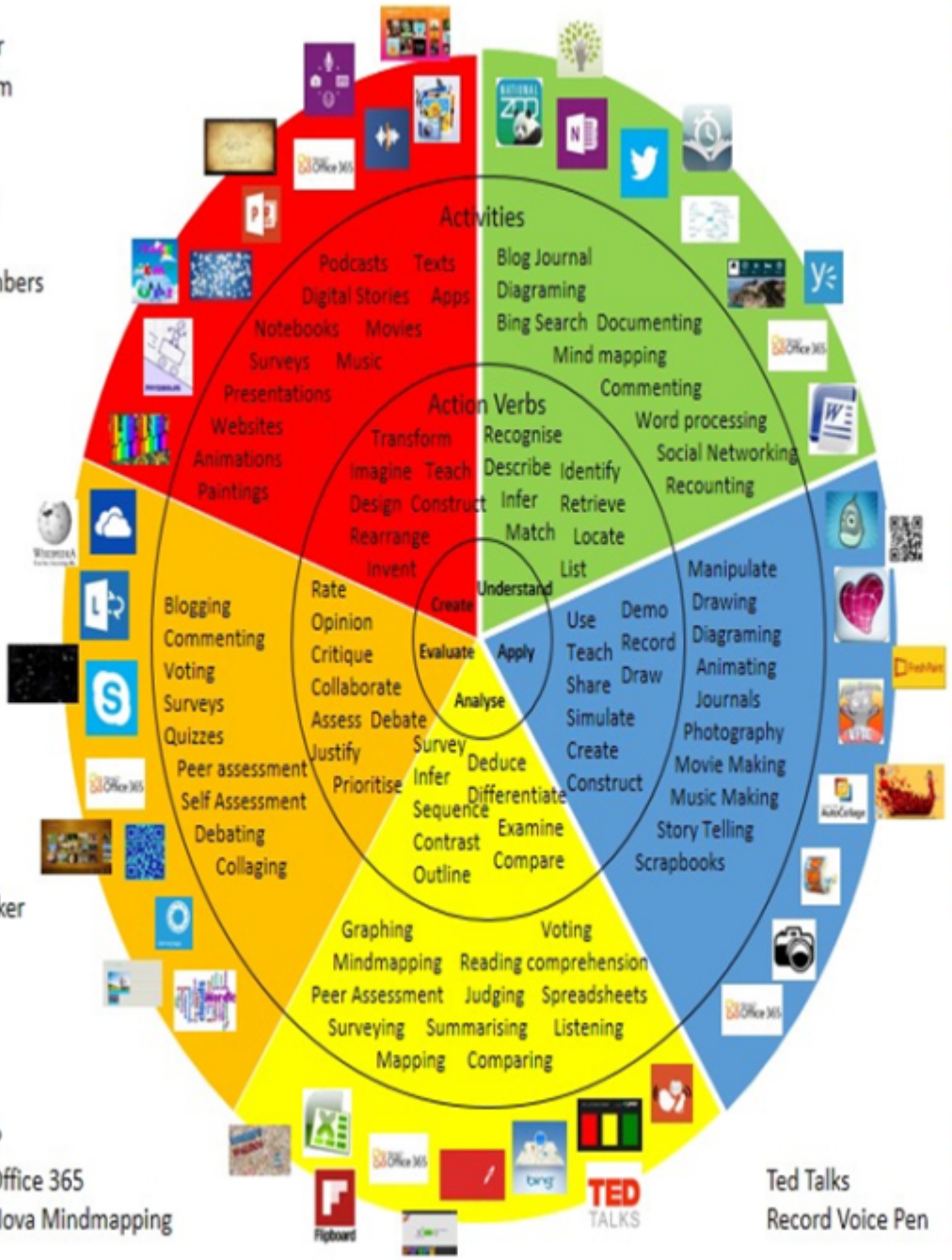
Win 8.1 Apps/Tools Pedagogy Wheel

Podcasts
Photostory 3
Kid Story Builder
Music Maker Jam
Paint A Story
Office 365
MS PowerPoint
Stack 'Em Up
NqSquared Numbers
Physamajig
Xylophone 8

Wikipedia
Skydrive
Lync
SkyMap
Skype
Office 365
Puzzle Touch
Easy QR
Memorylage
Life Moments
Word Cloud Maker

Where's Waldo?
MS Excel
Flipboard
Office 365
Nova Mindmapping

Ted Talks
Record Voice Pen



Originally taken from http://www.coetail.com/vzimmer/files/2013/02/iPadagogy-Wheel.001.jpg
And adapted for Windows 8.1 devices by Charlotte Beckhurst @CharBeckhurst

TECH.8.1.12.A.4	Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.
TECH.8.1.12.A.5	Create a report from a relational database consisting of at least two tables and describe the process, and explain the report results.
TECH.8.1.12.A.CS2	Select and use applications effectively and productively.
TECH.8.1.12.B.CS1	Apply existing knowledge to generate new ideas, products, or processes.
TECH.8.1.12.C.CS1	Interact, collaborate, and publish with peers, experts, or others by employing a variety of digital environments and media.
TECH.8.1.12.C.CS2	Communicate information and ideas to multiple audiences using a variety of media and formats.
TECH.8.1.12.E.CS1	Plan strategies to guide inquiry.
TECH.8.1.12.E.CS2	Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
TECH.8.1.12.E.CS3	Evaluate and select information sources and digital tools based on the appropriateness for specific tasks.
TECH.8.1.12.E.CS4	Process data and report results.
TECH.8.1.12.F.CS3	Collect and analyze data to identify solutions and/or make informed decisions.
TECH.8.1.12.F.CS4	Use multiple processes and diverse perspectives to explore alternative solutions.
TECH.8.2.12.E.1	Demonstrate an understanding of the problem-solving capacity of computers in our world.

Alignment to 21st Century Skills & Technology

Mastery and infusion of **21st Century Skills & Technology** and their Alignment to the core content areas is essential to student learning. The core content areas include:

- English Language Arts;
- Mathematics;
- Science and Scientific Inquiry (Next Generation);
- Social Studies, including American History, World History, Geography, Government and Civics, and Economics;
- World languages;
- Technology;
- Visual and Performing Arts.

CRP.K-12.CRP2.1	Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications, and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation.
CRP.K-12.CRP4	Communicate clearly and effectively and with reason.
CRP.K-12.CRP5	Consider the environmental, social and economic impacts of decisions.

CRP.K-12.CRP7	Employ valid and reliable research strategies.
CRP.K-12.CRP8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP.K-12.CRP11	Use technology to enhance productivity.
CAEP.9.2.12.C.2	Modify Personalized Student Learning Plans to support declared career goals.
TECH.8.1.12	Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
TECH.8.1.12.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.12.B	Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
TECH.8.1.12.E	Research and Information Fluency: Students apply digital tools to gather, evaluate, and use information.

21st Century Skills/Interdisciplinary Themes

Please list only the **21st Century/Interdisciplinary Themes** that will be incorporated into this unit.

- Communication and Collaboration
- Critical thinking and Problem Solving
- ICT (Information, Communications and Technology) Literacy
- Information Literacy
- Life and Career Skills

21st Century Skills

Please list only the **21st Century Skills** that will be incorporated into this unit.

- Communication and Collaboration
- Creativity and Innovation
- Critical Thinking and Problem Solving
- ICT (Information, Communications and Technology) Literacy
- Information Literacy
- Life and Career Skills
- Media Literacy

Differentiation

Please identify the ones that will be employed in this unit.

Differentiations:

- Small group instruction
- Small group assignments
- Extra time to complete assignments
- Pairing oral instruction with visuals
- Repeat directions
- Use manipulatives
- Center-based instruction
- Token economy
- Study guides
- Teacher reads assessments allowed
- Scheduled breaks
- Rephrase written directions
- Multisensory approaches
- Additional time
- Preview vocabulary
- Preview content & concepts
- Story guides
- Behavior management plan
- Highlight text
- Student(s) work with assigned partner
- Visual presentation
- Assistive technology
- Auditory presentations
- Large print edition
- Dictation to scribe
- Small group setting

Hi-Prep Differentiations:

- Alternative formative and summative assessments
- Choice boards
- Games and tournaments
- Group investigations
- Guided Reading
- Independent research and projects
- Interest groups
- Learning contracts
- Leveled rubrics
- Literature circles
- Multiple intelligence options
- Multiple texts
- Personal agendas
- Project-based learning
- Problem-based learning
- Stations/centers
- Think-Tac-Toes

- Tiered activities/assignments
- Tiered products
- Varying organizers for instructions

Lo-Prep Differentiations

- Choice of books or activities
- Cubing activities
- Exploration by interest
- Flexible grouping
- Goal setting with students
- Jigsaw
- Mini workshops to re-teach or extend skills
- Open-ended activities
- Think-Pair-Share
- Reading buddies
- Varied journal prompts
- Varied supplemental materials

Special Education Learning (IEP's & 504's)

- What situations in ordinary life could benefit from investigation via the scientific method?
    - Construct an infographic or Foldable of the scientific method.: Preview of content, concepts, and vocabulary. Have student repeat directions to check for understanding. Student working with an assigned partner. Check work frequently for understanding.
    - Short activity “How many M&M’s are in the bag?”: Have student repeat directions to check for understanding. Student working with an assigned partner. Multi-sensory presentation.
    - Small group inquiry stations with real life situations, e.g. “How could we determine why this plant is sickly?”: Center-Based Instruction. Student working with an assigned partner. Check work frequently for understanding.
- What is the benefit of teaching students about the geocentric theory of the universe if we know it to be false?
    - Sketch/model a comparison of the geocentric and heliocentric models to compare/contrast.: Preview content. Have student repeat directions to check for understanding. Student working with an assigned partner. Use prototypes.
    - YouTube video describing heliocentric vs. geocentric, e.g. “How We Figured Out That Earth Goes Around the Sun”: Printed copy of notes provided. Study guides or highlighted text.
    - Roleplay/instant debate of heliocentric vs. geocentric. Preferential role selection; copy of relevant notes provided
    - Short reading + questions/Think Pair Share on the flat Earth conspiracy and how we use evidence to debunk it.: reduced complexity or lexile level, highlighted text, preview content or vocabulary.
    - Short reading/Do Now on the history of the atom as a callback to chemistry and evidence-based change in models.: reduced complexity or lexile level, highlighted text, preview content or vocabulary.

- Why did the Church's near limitless power still fail to contain heliocentrism?
    - Short reading or primary source documents on the role of the Catholic Church in Renaissance Europe: reduced complexity or lexile level, highlighted text, preview content or vocabulary.
    - Short reading on evidence based thinking: reduced complexity or lexile level, highlighted text, preview content or vocabulary.
    - Think-pair-share on the scientific and orthodox perspectives: preview content or vocabulary, provide a few guiding questions for the think phase, or a debate starter for the share phase
    - Video on the trial of Galileo, e.g. Bertholdt Brecht's Life of Galileo : Printed copy of notes provided. Study guides or highlighted text.
    - Roleplay/instant debate of the Galileo trial: preferential role selection; copy of relevant notes provided
- What are the seven types of electromagnetic radiation? What physical properties do they have and how are they interrelated?
    - YouTube video on the properties of a wave.: Printed copy of notes provided. Study guides or highlighted text.
    - YouTube video on the electromagnetic spectrum.: Printed copy of notes provided. Study guides or highlighted text.
    - PhET simulation + worksheet, Waves and the Electromagnetic Spectrum: Preview of content, concepts, and vocabulary. Have student repeat directions to check for understanding. Student working with an assigned partner. Check work frequently for understanding.
    - Construct an infographic identifying and showing the relationships among wavespeed, frequency, and wavelength.: Preview content. Have student repeat directions to check for understanding. Student working with an assigned partner. Use prototypes.
    - Thought exercise: "How would you explain purple to a blind person?": preview content or vocabulary, provide a few guiding questions for the think phase, or a debate starter for the share phase
    - Construct a labeled diagram of the electromagnetic spectrum. Preview content. Have student repeat directions to check for understanding. Student working with an assigned partner. Use prototypes.
- Thousands of observations of the sky are made every night. What made Galileo's observations uniquely important?
    - YouTube video on Galileo's observations, e.g. "What Galileo Saw With His Telescope": Printed copy of notes provided. Study guides or highlighted text.
    - Thought exercise/Do Now: Crime scene: If this was an accident, what would we expect to see that isn't here?": preview content or vocabulary, provide a few guiding questions for the think phase, or a debate starter for the share phase
    - Construct a presentation or informative video on the Galilean evidence.: Preview content. Have student repeat directions to check for understanding. Student working with an assigned partner. Use prototypes.
- How do we surmount the problems of distance, time, and the harsh conditions of space in order to study it?
    - YouTube video on how telescopes work, e.g. "Telescopes: Crash Course Astronomy #6": Printed copy of notes provided. Study guides or highlighted text.
    - YouTube video on distances, e.g. "Distances: Crash Course Astronomy #25": Printed copy of notes provided. Study guides or highlighted text.
    - Diagram the different types of telescopes and how they work.: Preview content. Have student repeat directions to check for understanding. Student working with an assigned partner. Use prototypes.
    - Activity: "Build your own telescope" using magnifying glasses and cardboard tube.: Preview content. Have student repeat directions to check for understanding. Student working with an assigned partner. Use prototypes.

- How do we deal with the distortions caused by the atmosphere?
    - YouTube video on GPS/weather satellites/spy satellites/communications satellites/ISS: Printed copy of notes provided. Study guides or highlighted text.

- printed copy of board work/notes provided
- additional time for skill mastery
- assistive technology
- behavior management plan
- Center-Based Instruction
- check work frequently for understanding
- computer or electronic device utilizes
- extended time on tests/ quizzes
- have student repeat directions to check for understanding
- highlighted text visual presentation
- modified assignment format
- modified test content
- modified test format
- modified test length
- multi-sensory presentation
- multiple test sessions
- preferential seating
- preview of content, concepts, and vocabulary
- Provide modifications as dictated in the student's IEP/504 plan
- reduced/shortened reading assignments
- Reduced/shortened written assignments
- secure attention before giving instruction/directions
- shortened assignments
- student working with an assigned partner
- teacher initiated weekly assignment sheet
- Use open book, study guides, test prototypes

English Language Learning (ELL)

- What situations in ordinary life could benefit from investigation via the scientific method?
    - Construct an infographic or Foldable of the scientific method.: Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Allowing students to correct errors (looking for understanding). Allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning.
    - Short activity "How many M&M's are in the bag?": Decreasing the amount of work presented or required. Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching

key aspects of a topic. Eliminate nonessential information. allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning.
    - Small group inquiry stations with real life situations, e.g. "How could we determine why this plant is sickly?": Decreasing the amount of work presented or required. Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning.
- What is the benefit of teaching students about the geocentric theory of the universe if we know it to be false?
    - Sketch/model a comparison of the geocentric and heliocentric models to compare/contrast.: Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Allowing students to correct errors (looking for understanding). Allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning.
    - YouTube video describing heliocentric vs. geocentric, e.g. "How We Figured Out That Earth Goes Around the Sun": Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Having peers take notes or providing a copy of the teacher's notes. Providing study guides.
    - Roleplay/instant debate of heliocentric vs. geocentric.: Using videos, illustrations, pictures, and drawings to explain or clarify. Having peers take notes or providing a copy of the teacher's notes. Providing study guides. Reducing or omitting lengthy outside reading assignments.
    - Short reading + questions/Think Pair Share on the flat Earth conspiracy and how we use evidence to debunk it.: Decreasing the amount of work presented or required. Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Providing study guides. Allowing students to correct errors (looking for understanding). Reducing or omitting lengthy outside reading assignments. Using computer word processing spell check and grammar check features. Using true/false, matching, or fill in the blank tests in lieu of essay tests. Reducing the number of answer choices on a multiple choice test.
    - Short reading/Do Now on the history of the atom as a callback to chemistry and evidence-based change in models.: Decreasing the amount of work presented or required. Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Providing study guides. Allowing students to correct errors (looking for understanding). Reducing or omitting lengthy outside reading assignments. Using computer word processing spell check and grammar check features. Using true/false, matching, or fill in the blank tests in lieu of essay tests. Reducing the number of answer choices on a multiple choice test.
- Why did the Church's near limitless power still fail to contain heliocentrism?
    - Short reading or primary source documents on the role of the Catholic Church in Renaissance Europe: Decreasing the amount of work presented or required. Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Providing study guides. Allowing students to correct errors (looking for understanding). Reducing or omitting lengthy outside reading assignments. Using computer word processing spell check and grammar check features. Using true/false, matching, or fill in the blank tests in lieu of essay tests. Reducing the number of answer choices on a multiple choice test.
    - Short reading on evidence based thinking: Decreasing the amount of work presented or required. Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Providing study

guides. Allowing students to correct errors (looking for understanding). Reducing or omitting lengthy outside reading assignments. Using computer word processing spell check and grammar check features. Using true/false, matching, or fill in the blank tests in lieu of essay tests. Reducing the number of answer choices on a multiple choice test.
    - Think-pair-share on the scientific and orthodox perspectives: Using videos, illustrations, pictures, and drawings to explain or clarify. Having peers take notes or providing a copy of the teacher's notes. Providing study guides. Reducing or omitting lengthy outside reading assignments.
    - Video on the trial of Galileo, e.g. Bertholdt Brecht's Life of Galileo : Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Having peers take notes or providing a copy of the teacher's notes. Providing study guides.
    - Roleplay/instant debate of the Galileo trial: Using videos, illustrations, pictures, and drawings to explain or clarify. Having peers take notes or providing a copy of the teacher's notes. Providing study guides. Reducing or omitting lengthy outside reading assignments.
- What are the seven types of electromagnetic radiation? What physical properties do they have and how are they interrelated?
    - YouTube video on the properties of a wave.: Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Having peers take notes or providing a copy of the teacher's notes. Providing study guides.
    - YouTube video on the electromagnetic spectrum.: Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Having peers take notes or providing a copy of the teacher's notes. Providing study guides.
    - PhET simulation + worksheet, Waves and the Electromagnetic Spectrum: Decreasing the amount of work presented or required. Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Providing study guides. Allowing students to correct errors (looking for understanding). Reducing or omitting lengthy outside reading assignments. Using computer word processing spell check and grammar check features. Using true/false, matching, or fill in the blank tests in lieu of essay tests. Reducing the number of answer choices on a multiple choice test.
    - Construct an infographic identifying and showing the relationships among wavespeed, frequency, and wavelength. : Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Allowing students to correct errors (looking for understanding). Allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning.
    - Thought exercise: "How would you explain purple to a blind person?": Using videos, illustrations, pictures, and drawings to explain or clarify. Having peers take notes or providing a copy of the teacher's notes. Providing study guides. Reducing or omitting lengthy outside reading assignments. having peers take notes or providing a copy of the teacher's notes.
    - Construct a labeled diagram of the electromagnetic spectrum.: Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Allowing students to correct errors (looking for understanding). Allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning.
- Thousands of observations of the sky are made every night. What made Galileo's observations uniquely important?
    - YouTube video on Galileo's observations, e.g. "What Galileo Saw With His Telescope": Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a

topic. Eliminate nonessential information. Tutoring by peers. Having peers take notes or providing a copy of the teacher's notes. Providing study guides.
    - Thought exercise/Do Now: Crime scene: If this was an accident, what would we expect to see that isn't here?": Using videos, illustrations, pictures, and drawings to explain or clarify. Having peers take notes or providing a copy of the teacher's notes. Providing study guides. Reducing or omitting lengthy outside reading assignments.
    - Construct a presentation or informative video on the Galilean evidence.: Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Allowing students to correct errors (looking for understanding). Allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning.
- How do we surmount the problems of distance, time, and the harsh conditions of space in order to study it?
    - YouTube video on how telescopes work, e.g. "Telescopes: Crash Course Astronomy #6": Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Having peers take notes or providing a copy of the teacher's notes. Providing study guides.
    - YouTube video on distances, e.g. "Distances: Crash Course Astronomy #25": Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Having peers take notes or providing a copy of the teacher's notes. Providing study guides.
    - Diagram the different types of telescopes and how they work.: Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Allowing students to correct errors (looking for understanding). Allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning.
    - Activity: "Build your own telescope" using magnifying glasses and cardboard tube.: Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Allowing students to correct errors (looking for understanding). Allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning.
- How do we deal with the distortions caused by the atmosphere?
    - YouTube video on GPS/weather satellites/spy satellites/communications satellites/ISS: Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Having peers take notes or providing a copy of the teacher's notes. Providing study guides.

- teaching key aspects of a topic. Eliminate nonessential information
- using videos, illustrations, pictures, and drawings to explain or clarif
- allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning;
- allowing students to correct errors (looking for understanding)
- allowing the use of note cards or open-book during testing
- decreasing the amount of workpresented or required
- having peers take notes or providing a copy of the teacher's notes
- modifying tests to reflect selected objectives

- providing study guides
- reducing or omitting lengthy outside reading assignments
- reducing the number of answer choices on a multiple choice test
- tutoring by peers
- using computer word processing spell check and grammar check features
- using true/false, matching, or fill in the blank tests in lieu of essay tests

At Risk

- What situations in ordinary life could benefit from investigation via the scientific method?
    - Construct an infographic or Foldable of the scientific method.: Collaborating (general education teacher and specialist) to modify vocabulary, omit or modify items to reflect objectives for the student, eliminate sections of the test, and determine how the grade will be determined prior to giving the test. Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Allowing students to correct errors (looking for understanding). Allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning.
    - Short activity "How many M&M's are in the bag?": Decreasing the amount of work presented or required. Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning.
    - Small group inquiry stations with real life situations, e.g. "How could we determine why this plant is sickly?": Decreasing the amount of work presented or required. Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning.
- What is the benefit of teaching students about the geocentric theory of the universe if we know it to be false?
    - Sketch/model a comparison of the geocentric and heliocentric models to compare/contrast.: Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Allowing students to correct errors (looking for understanding). Allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning.
    - YouTube video describing heliocentric vs. geocentric, e.g. "How We Figured Out That Earth Goes Around the Sun": Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Having peers take notes or providing a copy of the teacher's notes. Providing study guides.
    - Roleplay/instant debate of heliocentric vs. geocentric.: Collaborating (general education teacher and specialist) to modify vocabulary, omit or modify items to reflect objectives for the student, eliminate sections of the test, and determine how the grade will be determined prior to giving the test. Using videos, illustrations, pictures, and drawings to explain or clarify. Having peers take notes or providing a copy of the teacher's notes. Providing study guides. Reducing or omitting lengthy outside reading assignments.
    - Short reading + questions/Think Pair Share on the flat Earth conspiracy and how we use evidence to debunk it.: Collaborating (general education teacher and specialist) to modify

vocabulary, omit or modify items to reflect objectives for the student, eliminate sections of the test, and determine how the grade will be determined prior to giving the test. Decreasing the amount of work presented or required. Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Providing study guides. Allowing students to correct errors (looking for understanding). Reducing or omitting lengthy outside reading assignments. Using computer word processing spell check and grammar check features. Using true/false, matching, or fill in the blank tests in lieu of essay tests. Reducing the number of answer choices on a multiple choice test.

- Short reading/Do Now on the history of the atom as a callback to chemistry and evidence-based change in models.: Collaborating (general education teacher and specialist) to modify vocabulary, omit or modify items to reflect objectives for the student, eliminate sections of the test, and determine how the grade will be determined prior to giving the test. Decreasing the amount of work presented or required. Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Providing study guides. Allowing students to correct errors (looking for understanding). Reducing or omitting lengthy outside reading assignments. Using computer word processing spell check and grammar check features. Using true/false, matching, or fill in the blank tests in lieu of essay tests. Reducing the number of answer choices on a multiple choice test.

- Why did the Church's near limitless power still fail to contain heliocentrism?
  - Short reading or primary source documents on the role of the Catholic Church in Renaissance Europe: Collaborating (general education teacher and specialist) to modify vocabulary, omit or modify items to reflect objectives for the student, eliminate sections of the test, and determine how the grade will be determined prior to giving the test. Decreasing the amount of work presented or required. Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Providing study guides. Allowing students to correct errors (looking for understanding). Reducing or omitting lengthy outside reading assignments. Using computer word processing spell check and grammar check features. Using true/false, matching, or fill in the blank tests in lieu of essay tests. Reducing the number of answer choices on a multiple choice test.
  - Short reading on evidence based thinking: Collaborating (general education teacher and specialist) to modify vocabulary, omit or modify items to reflect objectives for the student, eliminate sections of the test, and determine how the grade will be determined prior to giving the test. Decreasing the amount of work presented or required. Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Providing study guides. Allowing students to correct errors (looking for understanding). Reducing or omitting lengthy outside reading assignments. Using computer word processing spell check and grammar check features. Using true/false, matching, or fill in the blank tests in lieu of essay tests. Reducing the number of answer choices on a multiple choice test.
  - Think-pair-share on the scientific and orthodox perspectives: Using videos, illustrations, pictures, and drawings to explain or clarify. Having peers take notes or providing a copy of the teacher's notes. Providing study guides. Reducing or omitting lengthy outside reading assignments.
  - Video on the trial of Galileo, e.g. Bertholdt Brecht's Life of Galileo : Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Having peers take notes or providing a copy of the teacher's notes. Providing study guides.
  - Roleplay/instant debate of the Galileo trial: Using videos, illustrations, pictures, and drawings to explain or clarify. Having peers take notes or providing a copy of the teacher's notes. Providing study guides. Reducing or omitting lengthy outside reading assignments.

- What are the seven types of electromagnetic radiation? What physical properties do they have and how are they interrelated?
    - YouTube video on the properties of a wave.: Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Having peers take notes or providing a copy of the teacher's notes. Providing study guides.
    - YouTube video on the electromagnetic spectrum.: Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Having peers take notes or providing a copy of the teacher's notes. Providing study guides.
    - PhET simulation + worksheet, Waves and the Electromagnetic Spectrum: Collaborating (general education teacher and specialist) to modify vocabulary, omit or modify items to reflect objectives for the student, eliminate sections of the test, and determine how the grade will be determined prior to giving the test. Decreasing the amount of work presented or required. Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Providing study guides. Allowing students to correct errors (looking for understanding). Reducing or omitting lengthy outside reading assignments. Using computer word processing spell check and grammar check features. Using true/false, matching, or fill in the blank tests in lieu of essay tests. Reducing the number of answer choices on a multiple choice test.
    - Construct an infographic identifying and showing the relationships among wavespeed, frequency, and wavelength. : Collaborating (general education teacher and specialist) to modify vocabulary, omit or modify items to reflect objectives for the student, eliminate sections of the test, and determine how the grade will be determined prior to giving the test. Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Allowing students to correct errors (looking for understanding). Allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning.
    - Thought exercise: "How would you explain purple to a blind person?": Collaborating (general education teacher and specialist) to modify vocabulary, omit or modify items to reflect objectives for the student, eliminate sections of the test, and determine how the grade will be determined prior to giving the test. Using videos, illustrations, pictures, and drawings to explain or clarify. Having peers take notes or providing a copy of the teacher's notes. Providing study guides. Reducing or omitting lengthy outside reading assignments. having peers take notes or providing a copy of the teacher's notes.
    - Construct a labeled diagram of the electromagnetic spectrum.: Collaborating (general education teacher and specialist) to modify vocabulary, omit or modify items to reflect objectives for the student, eliminate sections of the test, and determine how the grade will be determined prior to giving the test. Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Allowing students to correct errors (looking for understanding). Allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning.
- Thousands of observations of the sky are made every night. What made Galileo's observations uniquely important?
    - YouTube video on Galileo's observations, e.g. "What Galileo Saw With His Telescope": Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Having peers take notes or providing a copy of the teacher's notes. Providing study guides.
    - Thought exercise/Do Now: Crime scene: If this was an accident, what would we expect to see that isn't here?": Using videos, illustrations, pictures, and drawings to explain or clarify.

Having peers take notes or providing a copy of the teacher's notes. Providing study guides. Reducing or omitting lengthy outside reading assignments.

- Construct a presentation or informative video on the Galilean evidence.: Collaborating (general education teacher and specialist) to modify vocabulary, omit or modify items to reflect objectives for the student, eliminate sections of the test, and determine how the grade will be determined prior to giving the test. Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Allowing students to correct errors (looking for understanding). Allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning.

- How do we surmount the problems of distance, time, and the harsh conditions of space in order to study it?
  - YouTube video on how telescopes work, e.g. "Telescopes: Crash Course Astronomy #6": Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Having peers take notes or providing a copy of the teacher's notes. Providing study guides.
  - YouTube video on distances, e.g. "Distances: Crash Course Astronomy #25": Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Having peers take notes or providing a copy of the teacher's notes. Providing study guides.
  - Diagram the different types of telescopes and how they work.: Collaborating (general education teacher and specialist) to modify vocabulary, omit or modify items to reflect objectives for the student, eliminate sections of the test, and determine how the grade will be determined prior to giving the test. Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Allowing students to correct errors (looking for understanding). Allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning.
  - Activity: "Build your own telescope" using magnifying glasses and cardboard tube.: Collaborating (general education teacher and specialist) to modify vocabulary, omit or modify items to reflect objectives for the student, eliminate sections of the test, and determine how the grade will be determined prior to giving the test. Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Allowing students to correct errors (looking for understanding). Allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning.
- How do we deal with the distortions caused by the atmosphere?
  - YouTube video on GPS/weather satellites/spy satellites/communications satellites/ISS: Using videos, illustrations, pictures, and drawings to explain or clarify. Teaching key aspects of a topic. Eliminate nonessential information. Tutoring by peers. Having peers take notes or providing a copy of the teacher's notes. Providing study guides.

- allowing students to correct errors (looking for understanding)
- teaching key aspects of a topic. Eliminate nonessential information
- allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning
- allowing students to select from given choices

- allowing the use of note cards or open-book during testing
- collaborating (general education teacher and specialist) to modify vocabulary, omit or modify items to reflect objectives for the student, eliminate sections of the test, and determine how the grade will be determined prior to giving the test.
- decreasing the amount of workpresented or required
- having peers take notes or providing a copy of the teacher's notes
- marking students' correct and acceptable work, not the mistakes
- modifying tests to reflect selected objectives
- providing study guides
- reducing or omitting lengthy outside reading assignments
- reducing the number of answer choices on a multiple choice test
- tutoring by peers
- using authentic assessments with real-life problem-solving
- using true/false, matching, or fill in the blank tests in lieu of essay tests
- using videos, illustrations, pictures, and drawings to explain or clarify

Talented and Gifted Learning (T&G)

- What situations in ordinary life could benefit from investigation via the scientific method?
    - Construct an infographic or Foldable of the scientific method.: Create a plan to solve an issue presented in the class or in a text. Complete activities aligned with above grade level text using Benchmark results. Above grade level placement option for qualified students. Cluster grouping. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Multi-disciplinary unit and/or project. Allow students to work at a faster pace. Utilize project-based learning for greater depth of knowledge.
    - Short activity "How many M&M's are in the bag?": Create a plan to solve an issue presented in the class or in a text. Complete activities aligned with above grade level text using Benchmark results. Advanced problem-solving. Higher order, critical & creative thinking skills, and discovery. Cluster grouping. Flexible skill grouping within a class or across grade level for rigor. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Multi-disciplinary unit and/or project. Utilize project-based learning for greater depth of knowledge.
    - Small group inquiry stations with real life situations, e.g. "How could we determine why this plant is sickly?": Create a plan to solve an issue presented in the class or in a text. Complete activities aligned with above grade level text using Benchmark results. Advanced problem-solving. Higher order, critical & creative thinking skills, and discovery. Cluster grouping. Flexible skill grouping within a class or across grade level for rigor. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Multi-disciplinary unit and/or project.
- What is the benefit of teaching students about the geocentric theory of the universe if we know it to be false?
    - Sketch/model a comparison of the geocentric and heliocentric models to compare/contrast.: Create a plan to solve an issue presented in the class or in a text. Complete activities aligned with above grade level text using Benchmark results. Above grade level placement option for qualified students. Cluster grouping. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Multi-disciplinary unit and/or project. Allow students to work at a faster pace. Utilize project-based learning for greater depth of knowledge.

    - YouTube video describing heliocentric vs. geocentric, e.g. “How We Figured Out That Earth Goes Around the Sun”: Create a plan to solve an issue presented in the class or in a text. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Utilize exploratory connections to higher-grade concepts.
    - Roleplay/instant debate of heliocentric vs. geocentric.: Debate issues with research to support arguments. Create a plan to solve an issue presented in the class or in a text. Complete activities aligned with above grade level text using Benchmark results. Advanced problem-solving. Higher order, critical & creative thinking skills, and discovery. Cluster grouping. Flexible skill grouping within a class or across grade level for rigor. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Multi-disciplinary unit and/or project. Utilize project-based learning for greater depth of knowledge.
    - Short reading + questions/Think Pair Share on the flat Earth conspiracy and how we use evidence to debunk it.: Debate issues with research to support arguments. Create a plan to solve an issue presented in the class or in a text. Complete activities aligned with above grade level text using Benchmark results. Advanced problem-solving. Above grade level placement option for qualified students. Higher order, critical & creative thinking skills, and discovery. Cluster grouping. Flexible skill grouping within a class or across grade level for rigor. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Multi-disciplinary unit and/or project. Allow students to work at a faster pace.
    - Short reading/Do Now on the history of the atom as a callback to chemistry and evidence-based change in models.: Debate issues with research to support arguments. Create a plan to solve an issue presented in the class or in a text. Complete activities aligned with above grade level text using Benchmark results. Advanced problem-solving. Above grade level placement option for qualified students. Higher order, critical & creative thinking skills, and discovery. Cluster grouping. Flexible skill grouping within a class or across grade level for rigor. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Multi-disciplinary unit and/or project. Allow students to work at a faster pace.
- Why did the Church’s near limitless power still fail to contain heliocentrism?
    - Short reading or primary source documents on the role of the Catholic Church in Renaissance Europe.: Debate issues with research to support arguments. Create a plan to solve an issue presented in the class or in a text. Complete activities aligned with above grade level text using Benchmark results. Advanced problem-solving. Above grade level placement option for qualified students. Higher order, critical & creative thinking skills, and discovery. Cluster grouping. Flexible skill grouping within a class or across grade level for rigor. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Multi-disciplinary unit and/or project. Allow students to work at a faster pace.
    - Short reading on evidence based thinking.: Debate issues with research to support arguments. Create a plan to solve an issue presented in the class or in a text. Complete activities aligned with above grade level text using Benchmark results. Advanced problem-solving. Above grade level placement option for qualified students. Higher order, critical & creative thinking skills, and discovery. Cluster grouping. Flexible skill grouping within a class or across grade level for rigor. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Multi-disciplinary unit and/or project. Allow students to work at a faster pace.
    - Think-pair-share on the scientific and orthodox perspectives.: Create a blog or social media page about their unit. Debate issues with research to support arguments. Create a plan to solve an issue presented in the class or in a text. Complete activities aligned with above grade level text using Benchmark results. Advanced problem-solving. Higher order, critical & creative thinking skills, and discovery. Flexible skill grouping within a class or across grade level for rigor. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Multi-disciplinary unit and/or project. Allow students to work at a faster pace.

    - Video on the trial of Galileo, e.g. Bertholdt Brecht's Life of Galileo : Create a plan to solve an issue presented in the class or in a text. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Utilize exploratory connections to higher-grade concepts.
    - Roleplay/instant debate of the Galileo trial.: Debate issues with research to support arguments. Create a plan to solve an issue presented in the class or in a text. Complete activities aligned with above grade level text using Benchmark results. Advanced problem-solving. Higher order, critical & creative thinking skills, and discovery. Cluster grouping. Flexible skill grouping within a class or across grade level for rigor. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Multi-disciplinary unit and/or project. Utilize project-based learning for greater depth of knowledge.
- What are the seven types of electromagnetic radiation? What physical properties do they have and how are they interrelated?
    - YouTube video on the properties of a wave.: Create a plan to solve an issue presented in the class or in a text. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Utilize exploratory connections to higher-grade concepts.
    - YouTube video on the electromagnetic spectrum.: Create a plan to solve an issue presented in the class or in a text. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Utilize exploratory connections to higher-grade concepts.
    - PhET simulation + worksheet, Waves and the Electromagnetic Spectrum.: Create a plan to solve an issue presented in the class or in a text. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Utilize exploratory connections to higher-grade concepts. Utilize project-based learning for greater depth of knowledge.
    - Construct an infographic identifying and showing the relationships among wavespeed, frequency, and wavelength.: Create a plan to solve an issue presented in the class or in a text. Complete activities aligned with above grade level text using Benchmark results. Above grade level placement option for qualified students. Cluster grouping. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Multi-disciplinary unit and/or project. Allow students to work at a faster pace. Utilize project-based learning for greater depth of knowledge.
    - Thought exercise: "How would you explain purple to a blind person?": Create a blog or social media page about their unit. Debate issues with research to support arguments. Create a plan to solve an issue presented in the class or in a text. Complete activities aligned with above grade level text using Benchmark results. Advanced problem-solving. Higher order, critical & creative thinking skills, and discovery. Cluster grouping. Flexible skill grouping within a class or across grade level for rigor. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Multi-disciplinary unit and/or project. Allow students to work at a faster pace.
    - Construct a labeled diagram of the electromagnetic spectrum.: Create a plan to solve an issue presented in the class or in a text. Complete activities aligned with above grade level text using Benchmark results. Above grade level placement option for qualified students. Cluster grouping. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Multi-disciplinary unit and/or project. Allow students to work at a faster pace. Utilize project-based learning for greater depth of knowledge.
- Thousands of observations of the sky are made every night. What made Galileo's observations uniquely important?
    - YouTube video on Galileo's observations, e.g. "What Galileo Saw With His Telescope": Create a plan to solve an issue presented in the class or in a text. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Utilize

exploratory connections to higher-grade concepts.
    - Thought exercise/Do Now: Crime scene: Create a blog or social media page about their unit. Debate issues with research to support arguments. Create a plan to solve an issue presented in the class or in a text. Complete activities aligned with above grade level text using Benchmark results. Advanced problem-solving. Higher order, critical & creative thinking skills, and discovery. Cluster grouping. Flexible skill grouping within a class or across grade level for rigor. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Multi-disciplinary unit and/or project. Allow students to work at a faster pace.
    - Construct a presentation or informative video on the Galilean evidence.: Create a plan to solve an issue presented in the class or in a text. Complete activities aligned with above grade level text using Benchmark results. Above grade level placement option for qualified students. Cluster grouping. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Multi-disciplinary unit and/or project. Allow students to work at a faster pace. Utilize project-based learning for greater depth of knowledge.
- How do we surmount the problems of distance, time, and the harsh conditions of space in order to study it?
    - YouTube video on how telescopes work, e.g. “Telescopes: Crash Course Astronomy #6”: Create a plan to solve an issue presented in the class or in a text. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Utilize exploratory connections to higher-grade concepts.
    - YouTube video on distances, e.g. “Distances: Crash Course Astronomy #25”: Create a plan to solve an issue presented in the class or in a text. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Utilize exploratory connections to higher-grade concepts.
    - Diagram the different types of telescopes and how they work.: Create a plan to solve an issue presented in the class or in a text. Complete activities aligned with above grade level text using Benchmark results. Above grade level placement option for qualified students. Cluster grouping. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Multi-disciplinary unit and/or project. Allow students to work at a faster pace. Utilize project-based learning for greater depth of knowledge.
    - Activity: “Build your own telescope” using magnifying glasses and cardboard tube.: Create a plan to solve an issue presented in the class or in a text. Complete activities aligned with above grade level text using Benchmark results. Advanced problem-solving. Above grade level placement option for qualified students. Cluster grouping. Flexible skill grouping within a class or across grade level for rigor. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Multi-disciplinary unit and/or project. Allow students to work at a faster pace. Utilize project-based learning for greater depth of knowledge.
- How do we deal with the distortions caused by the atmosphere?
    - YouTube video on GPS/weather satellites/spy satellites/communications satellites/ISS.: Create a plan to solve an issue presented in the class or in a text. Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities. Utilize exploratory connections to higher-grade concepts.
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- Above grade level placement option for qualified students
- Advanced problem-solving
- Allow students to work at a faster pace

- Cluster grouping
- Complete activities aligned with above grade level text using Benchmark results
- Create a blog or social media page about their unit
- Create a plan to solve an issue presented in the class or in a text
- Debate issues with research to support arguments
- Flexible skill grouping within a class or across grade level for rigor
- Higher order, critical & creative thinking skills, and discovery
- Multi-disciplinary unit and/or project
- Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities
- Utilize exploratory connections to higher-grade concepts
- Utilize project-based learning for greater depth of knowledge

Sample Lesson

Unit Name: Development and Practice of Astronomy

This lesson will introduce heliocentric and geocentric models of the solar system. The presentation will go through some of the greatest thinkers and their contributions to each model. This includes a presentation, and a foldable template for students to link the contributors to the model and their input.

NJSLS: SCI.HS.ESS1-4 ; 9-12.HS-ESS1-4.ESS1.B.1 ; 9-12.HS-ESS1-4.5

Interdisciplinary Connection: SOC.6.2.12.CS2 ; SOC.6.2.12.D.2.d

Statement of Objective: Students will be able to evaluate the heliocentric and geocentric models of the solar system. Students will be able to trace the historical development of the models. Students will be able to defend the heliocentric model of the solar system.

Anticipatory Set/Do Now: As organized by Nearpod, students will watch a ten-minute Prezi presentation entitled “Who Was Right, while completing a relatively simple graphic organizer to help frame their thoughts.

Learning Activity: Whole class call-out or walk-up construction of a Venn diagram using the Smart TV. Briefly review the major aspects of Venn diagrams during this process. Correct student misconceptions during this process.

Paired construction of an infographic or Foldable: Using construction paper and various other art supplies, triplets of student should construct an infographic or Foldable with which they can later use to instruct a family member or friend who does not take Astronomy. The group should also construct a short assessment, either on paper or by using Google Forms, that they can administer to the person they’ve taught. The student should correct the assessment before submitting it for evaluation.

Student Assessment/CFU's: Teacher review via Nearpod of student Do Now responses. Teacher observation and cold-call, perhaps with index cards, speak-for-the group, or individual whiteboards during the learning activity. Evaluation of the infographic or Foldable student product using a relevant rubric; evaluation of the students’ peer teaching results by looking at the corrected version of the student-designed assessment.

Materials: Various art supplies, student Chromebooks, grouping furniture, class printer, SmartTV or whiteboard.

21st Century Themes and Skills: Communication and Collaboration, Creativity and Innovation, and Critical Thinking and Problem

Solving.

Differentiation/Modifications: ELL: Provide relevant words (bubbles) for the graphic organizer and focus instead on how the terms are related (stems); preferential pairing with a non-ELL student; use a word wall to review pronunciation. At-risk students: study guides/guided notes rather than/in addition to the graphic organizer; peer teaching instead of sending the assessment home; use of the student's Foldable or infographic during testing. G&T: Select students could perform as the key figures in the geocentric vs heliocentric argument rather than using the introductory video; if this option is selected, plan for the lesson to go over more than one day. An alternative assessment could be of much higher-order thinking, such as: "A theory begins to circulate about the Internet that the Earth is in fact flat. How could you use the evidence in this lesson to falsify this theory?"

Integration of Technology: student Chromebooks; Prezi automated cloud presentation software; Google Earth; SmartTV.