Scope and Sequence: A Pathway to Learning

Physical Science
Learning Sequence 1
7th grade

Introduction

This scope and sequence is a product of collaborative efforts from secondary department heads and their respective departments and the Office of Learning and Instruction at the Amphitheater district offices. This document aims to provide a framework for each secondary science course that does the following:

- **Prioritizes standards that have a high impact on student learning**
- **Identifies supporting standards for those priorities (if applicable)**
- **Creates equity of learning between sites**
- **Provides an easy-to-follow framework for personalized learning**

The team started by establishing a set of topics and the order in which they are taught in each course. Within each topic, there are one or more phenomena, essential questions and/or tasks, some key vocabulary and concepts, and priority and support standards. This information

serves as a bare minimum for concepts to cover within each topic. As the content experts, teachers then have the freedom to add to and plan inquiry-based units around the framework provided by this document.

Arc of Inquiry

The Science standards are designed to work within the arc of inquiry, as outlined within the state documentation. When creating this scope and sequence, the arc of inquiry was a driving factor in how essential questions/tasks were designed and how phenomena were chosen. In order to have students critically engage with Science content, it is vital to have open-ended, inquiry-based questions and tasks that challenge student thinking and ask them to apply and interact with the concepts they have learned. For more information about the arc of inquiry, refer to the Arizona Science documentation.

Framework for Success

One of the major goals of this scope and sequence is to provide a definitive framework for teachers to design their units. By emphasizing priority standards, homogenizing *some* key concepts and vocabulary, and providing a topic-wide emphasis (essential questions and phenomena), teachers can then focus on creating rigorous, engaging, and creative units while ensuring what one student is learning at one school will be similar to another student at a different school. This framework does not provide fully-scripted lessons. Instead, it frees up teachers to focus more on the "how" of teaching instead of the "what." Each classroom has learners with different needs, so it is of the utmost importance that teachers focus on meeting those learners where they are but still maintain some equity across sites.

Flexible Document

As teachers work with the document throughout the school year, there will inevitably be feedback for improvements, additions, and/or refinement, and that feedback will be crucial for all parties to continue to make decisions focused on student learning. This is a version of a scope and sequence, and may change or evolve to meet the needs of teachers and the district. However, this scope and sequence represents a starting point for future editions and provides a foundation going forward.

Amphitheater, 7th Grade, Physical Science
Tool 4 – 5E Learning Sequence Outline

Should be addressed through every topic/unit:

- **7.P2U1.1 Collect and analyze data demonstrating how electromagnetic forces can be attractive or repulsive and can vary in strength.**

Unit Name: Domo Arigato, Mr. Roboto
Guiding Question: Do robots have to follow the laws of physics?
Instructional Sequence 1: Is it Magic or is it Science?

What science and/or engineering content will be developed during this learning sequence?	Science and Engineering Practices	Core Ideas of Knowing Science	Crosscutting Concepts and Connections to Using Science
Students explore the ideas that objects are able to interact without touch. Energy can travel through open spaces and can be explained by force fields.	**Science and Engineering Practices:** **Foreground** Constructing explanations ● For qualitative relationships between variables ● Apply scientific reasoning to show why the data are adequate for the explanation or conclusion Analyzing and Interpreting Data ● Analyze and interpret data to determine similarities and differences in findings.	**Core Ideas:** **Foreground** **P2: Objects can affect other objects at a distance** ● Forces that act at a distance (gravitations, electric, and magnetic) can be explained by force fields that extend through space and can be mapped by their effect on a test object (a ball, a charged object, or a magnet, respectively) **Objects can affect other objects at a distance**	**Crosscutting Concepts:** **Foreground** Energy and Matter ● Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). Cause and Effect ● Cause and effect relationships may be used to predict phenomena in natural or designed systems. Systems and system models

	Background Asking Questions ● Ask questions that require sufficient and appropriate empirical evidence to answer. Planning and carrying out investigations ● Collect data and generate evidence to answer scientific questions or test design solutions under a range of conditions. **Constructing Explanations and Designing Solutions** ● Optimize performance of a design by prioritizing criteria, making tradeoffs, testing, revising, and re-testing. ● Undertake design projects, engaging in the design cycle, to construct and implement a solution that meets specific design criteria and constraints. **Obtaining, Evaluating, and Communicating Information** ● Communicate scientific information and/or technical information (e.g. about a proposed object, tool, process,	● Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects.	● Complex systems can be analyzed to determine how they function

Tool 4 – 5E Learning Sequence Outline

What connections will be made? **Note**: This information comes from Tool 1			
Standards **Note**: This information comes from Tool 1	**7.P2U1.1 Collect and analyze data demonstrating how electromagnetic forces can be attractive or repulsive and can vary in strength.**		
What prior knowledge is crucial as a foundation for the learning sequence? **Note**: Review the previous grade band(s) for core idea	Students should already have an idea that magnets attract or repel depending on which end of the magnet is facing the other end of the magnet. They should understand that magnets do not have to be in direct contact to exert forces on each other.		
Common Student Ideas **Note**: These ideas come from your experience teaching the topic, and the research on student ideas in science. Sources may include:	Magnets are attractive and repulsive and attract metals Magnets can be strong Magnets can be used to do things		

Atlas of Science Literacy, AAAS *Making Sense of Secondary Science*, Driver	

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Tool 4 – 5E Learning Sequence Outline

<table>
<tr><td colspan="3">Engage: The teacher or a curriculum task helps students become engaged by a natural phenomenon through the use of short activities that promote curiosity and elicit prior knowledge about the phenomenon and associated concepts. The activity should make connections between past and present learning experiences, expose prior conceptions, and organize students' thinking toward the learning outcomes of activities in the instructional sequence.</td></tr>
<tr><td>What teacher is doing (including a brief description of the activity and key questions)</td><td>What students are doing (including ideal student response to selected questions/tasks)

Identify SEP as appropriate</td><td>Anchor Phenomenon

Investigative Phenomenon

Guiding Question

Conceptual Science Storyline</td></tr>
<tr><td>Before students arrive, teacher prepares the Magic in a Jar Trick.

Teacher tells students they will have a chance to recreate the trick or develop one that is similar, but first, as a class, they have to figure out how the trick works.

Teacher instructs students to discuss in their teams how they think the trick works.</td><td>Students observe the teacher perform the Magic in a Jar Trick.

Students are divided into teams of 2 or 3.

Teams brainstorm how the trick works.</td><td>Anchor Phenomenon: Objects can attract other objects, even at a distance

Investigative Phenomenon: Magnetism

Guiding Question: How can I do that magic trick?</td></tr>
</table>

Teacher leads a class discussion as students share how they think the trick works. The teacher should avoid revealing the existence of the magnet for as long as possible, letting students struggle and debate how it works. As a way to help students figure it out, the teacher could repeatedly demonstrate the experiment for them. Teacher tells students: "Now that you know how the trick works, you will get a chance to make your own version so you can try the trick out yourself. Teacher hands each group their own magic in a jar building kit and instructs them to work in their groups to build their version of the magic jar. NOTE TO TEACHER: The supplies in the kits will not all be the same and some kits will yield scenarios that will not work. This is on purpose. The following will be varied among the kits: Magnet strength Magnet size String length NOTE: If students want to modify their supplies, tell them that is not part of the challenge. However, if a group of students is really frustrated that their magic jar won't work, the teacher can tell THAT GROUP that they are correct, their trick will not work. Tell students that observing things that don't work is an important part of learning how they do work. Letting students in on the secret can usually assuage the frustration. Students can	Teacher should lead discussion/debate until students figure out that a magnet is needed to make the trick work. Students work in groups to build their own magic jar. Each group puts a sticky note beside their jar indicating whether it works or not.	**Conceptual Science Storyline** Forces that act at a distance(gravitational, electric and magnetic) can be explained by force fields that extend through space and can be mapped by their effect on a test object.

write in their notebooks what they would change in order to make their trick work. When groups are finished building their magic jars, the teacher takes a poll of the class about which ones worked and which ones did not work. Teacher tells students they will complete a gallery walk, looking at each jar while trying to figure out why some jars worked and others did not. NOTE: Students can record their thoughts during the gallery walk in their notebooks or on a worksheet. Teacher guides students through a gallery walk of all of the jars. At the end of the gallery walk, the teacher can compile students' reasons for why some jars did not work to create a common list that will remain on display for the duration of this sequence.	**Constructing Explanations** Construct explanations for either qualitative relationships between variables. Students prepare their notebooks for the gallery walk, by creating a table they will use to to assess each jar. Students take notes as they complete the gallery walk. **Planning and Carrying Out Investigations** Collect data and generate evidence to answer scientific questions or test design solutions under a range of conditions. All students' answers should be included in the common list that will be on display.	

Linking question from Engage to Explore: Why did only some magic tricks work?

Explore: Experiences in the Explore phase provide students with a common base of activities within which students wrestle with their current conceptions about a natural phenomenon through the science and engineering practice identified in the standard. Learners may complete activities that help them use prior knowledge to generate new ideas, explore questions, and/or design and conduct an investigation.		
What **teacher** is doing (including a brief description of the activity and key questions)	What **students** are doing (including ideal student response to selected questions/tasks) Identify **SEP** as appropriate	**Anchor Phenomenon** **Investigative Phenomenon** **Guiding Question** **Conceptual Science Storyline**
Teacher sets up Lab Stations for students to rotate through. There are 9 stations total. Students DO NOT have to rotate through the stations in numerical order. 7PhyLS1ExplorePropertiesofMagnetism.docx Teacher gives Lab and Safety instructions to students. Teacher instructs students to rotate through each station and record all data and observations in their notebooks.	**Collect and analyze data** ● **Collect and analyze data demonstrating how electromagnetic forces can be attractive or repulsive and vary in strength**. Students review Lab and Safety instructions Students rotate through each station, recording their data and observations in their notebooks.	**Anchor Phenomenon:** Objects can attract and repel other objects, even from a distance **Investigative Phenomenon:** Magnetism has multiple properties **Guiding Question:** What are some of the properties of magnetism?

		Conceptual Science Storyline The strength of magnetic force decreases as the distance between them increases and these forces are described using the term "fields."

Linking question from Explore to Explain: How do we identify and define the properties of magnetism?

Explain: During the Explain phase students are provided opportunities to demonstrate their conceptual understanding and use of science and engineering practices. In this phase teachers or instructional materials employ sense-making strategies and introduce academic language. An explanation from the teacher or other resources may guide learners toward a deeper understanding, which is a critical part of this phase.		
What **teacher** is doing (including a brief description of the activity and key questions)	What **students** are doing (including ideal student response to selected questions/tasks) Identify **SEP** as appropriate	**Anchor Phenomenon** **Investigative Phenomenon** **Guiding Question** **Conceptual Science Storyline**
Teacher asks students to review and share out their data and observations from the Lab stations in the Explore lesson (teacher choice for share method). Teacher distributes reading passage on The Properties of Magnetism to students 7PhyLS1ExplainPropertiesofMagnetism.docx	Analyzing and Interpreting Data ● Analyze and interpret data to determine similarities and differences in findings. (7.P2U1.1) Students review and share their data and observations from the Lab stations in the Explore lesson	**Anchor Phenomenon:** Objects can attract and repel other objects, even from a distance **Investigative Phenomenon:** Magnetism has multiple properties **Guiding Question:** How do we define and explain the properties of magnetism?

Teacher directs students in close-reading of the passage, starting with numbering each paragraph (there are 9 paragraphs). Teacher directs students to return to their lab notebooks and correlate each Lab Station to the paragraph in the passage that best correlates with their results and observations. Note: Teacher's choice as to whether students may collaborate on this task. Teacher has students review the lists they created in the Engage lesson: reasons why some of the 'magic trick jars' didn't work.	Students close-read the passage, starting with numbering each paragraph. Students return to their lab notebooks and correlate each Lab Station to the paragraph in the passage that best correlates with their results and observations. Sample student response: Station 1 = Paragraph 3 Station 2 = Paragraph 3 Station 3 = Paragraph 6 Station 4 = Paragraph 5 Station 5 = Paragraph 9 Station 6 = Paragraph 8 Station 7 = Paragraph 4 Station 8 = Paragraph 10 Station 9 = Paragraph 7 Students review their list created in the Engage lesson Constructing explanations ● Apply scientific reasoning to show why the data are adequate for the explanation or conclusion	**Conceptual Science Storyline** There are many properties of magnetism and scientists use terms such as 'pole' 'field' 'attract' and 'repel' to describe and define them

Teacher directs students to provide explanations for each of those reasons, using the properties of magnetism and appropriate vocabulary.	Students write explanations (in their notebooks or on a separate piece of paper) for the list of reasons why some of the 'magnetic magic trick jars' did not work. Sample student response: Statement from the list: This one did not work because the string was too short. Explanation: The strength of a magnetic field is affected by distance: The magnetic field's strength decreases as the distance between the magnet and object increases. The magnet is on one end of the string and the paper clip at the other end. The string length (distance) was so short that the magnetic field was not strong enough to attract the paper clip.	

Linking question from Explain to Elaborate: How do we take advantage of the properties of magnetism?

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<table>
<tr><td colspan="3">Elaborate: Teachers or instructional materials challenge and extend students' conceptual understanding and use of science and engineering practices during the Elaborate phase. Through new experiences, the students develop deeper or broader understanding by applying their understanding or practice in a new context. During the Elaborate phase teachers may emphasize the crosscutting concept in the foreground of the instructional sequence.</td></tr>
<tr><td>What teacher is doing (including a brief description of the activity and key questions)</td><td>What students are doing (including ideal student response to selected questions/tasks)

Identify SEP as appropriate</td><td>Anchor Phenomenon

Investigative Phenomenon

Guiding Question

Conceptual Science Storyline</td></tr>
<tr><td>Teacher will ask students what magnets and magnetic fields are used for</td><td>Students will write ideas down in their journal and then share with the class.

Possible student answers:

Electronics (in computers, speakers, cars)
For toys
To make energy</td><td>Anchor Phenomenon:
Magnets can attract and repel other objects, even from a distance.

Investigative Phenomenon:
Magnets are used in multiple ways.

Guiding Question:
What can magnets do?

Conceptual Science Storyline</td></tr>
</table>

Teacher will have the students break into groups. Teacher will give students a list of uses for magnets: https://sciencing.com/uses-magnets-daily-life-8056272.html, (http://www.howmagnetswork.com/uses.html Teacher will ask students to pick the top 5 uses of magnets in their opinion As a group, teacher will have students identify the five uses they selected and then for each one, describe what properties of magnetism happen in that use.	**Constructing Explanations** Construct explanations for either qualitative relationships between variables. Students will read the uses of magnets in everyday life. Groups will pick the top five uses that they consider important to them from the options. Students use this template: uses of magnets to describe what properties of magnetism (from their lab/reading) are in effect for each use they selected. Example: A compass	Electric and magnetic forces (electromagnetic) can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents or magnetic strengths involved and on the distances between the interacting objects. Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small. Except when one or both objects have large mass- for example Earth and the sun.

Teacher will lead a class discussion about what the students discovered.	Uses a bar magnet to line up with the north pole of Earth's magnetic field. Students will share their findings with the class.	
Teacher will tell the students that now they will look at the future of magnetic uses. Teacher will ask students what how they thing magnets might be used used in robotics as a class they will make a brainstorm list	Student answers will vary depending on understanding and experience: To hold robots together To let robots do tasks (like picking up something) To run its functions. - make electricity	
Teacher will Then show the students some examples of robots that use magnets to function: 3d printed robot Link 1 Link 2 Biology robot Link	Students will pick one of these robots. They will use the handout to explain what they think the robot is doing with magnetic forces.	

Teacher will ask students to look at these robots and use what they have learned about magnetism to explain how they think these robots use magnetic forces. The focus will be on : what is magnetic? How is the robot using the magnetic forces?		

Linking question from Elaborate to Evaluate: What kind of magnet-powered delivery system can you create?

Evaluate: Experiences in the Evaluate phase encourage students to assess their conceptual understanding and use of the practices. The experiences allow teachers to evaluate student progress toward achieving the Standard(s). No new ideas are introduced during the Evaluate.		
What **teacher** is doing (including a brief description of the activity and key questions)	What **students** are doing (including ideal student response to selected questions/tasks) Identify **SEP** as appropriate	**Anchor Phenomenon** **Investigative Phenomenon** **Guiding Question** **Conceptual Science Storyline**
Teacher replays the National Geographic video showing the MIT magnetic robots, pausing the video at 0:48 so the text "In the future, the robots may be deployed inside your body to deliver medicine or take tissue samples." remains on the board. Teacher tells students: "We are going to be zooming into the body for your next design challenge. Teacher plays a video of inside an artery. Teacher tells students: "Your challenge is to design and build a functioning prototype for a medicine delivery vessel that moves using magnet forces."		Electric and magnetic forces (electromagnetic) can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents or magnetic strengths involved and on the distances between the interacting objects. Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small. Except when one or both objects have large mass- for example Earth and the sun.

Teacher hands students copies of both the design brief document prototype assessment checklist. Teacher shows students the blood vessel prototype. Teacher instructs teams to record at least two different design ideas in their notebooks with sketches and notes. Teacher instructs teams to discuss the design ideas, listing the pros and cons of each design. Teacher tells teams to either choose one of their designs or find a way to combine the best elements of both or all of their designs.	Students read both documents. Student teams begin by brainstorming ideas. Each student records their team's design ideas in their notebooks. Students record the pros and cons of each design in their notebooks. **Constructing Explanations and Designing Solutions** ● Optimize performance of a design by prioritizing criteria, making tradeoffs, testing, revising, and re-testing. Student teams select a design and begin building it. **Constructing Explanations and Designing Solutions** ● Undertake design projects, engaging in the design cycle, to construct and implement a solution that meets specific design criteria and constraints. Student teams take notes in their notebooks to document their progress as they build, test, and modify their prototype.	

As each group presents their prototype, the teacher checks for understanding by asking each group: 1) to describe how the magnets are being used to make the machine move; 2) to hypothesize what the effect would be of using stronger/weaker magnets; 3) to hypothesize how the motion of the machine would change if the magnets had to be further away.	Each student team completes a Prototype Assessment Checklist. Student teams present their prototype to the class. **Obtaining, Evaluating, and Communicating Information** • Communicate scientific information and/or technical information (e.g. about a proposed object, tool, process, system) in different formats (e.g., verbally, graphically, textually, and mathematically). As each student team presents its prototype, the other students record the following in their notebooks: a sketch of the machine prototype, including the locations of all the magnets used in its motion arrows showing the direction the machine moved one idea that they might use if they were going to redesign their prototype.	