3D Science Performance Assessment Tasks

3RD GRADE

MOTION AND STABILITY:

FORCES AND INTERACTIONS

In Partnership with

3DSPA Assessment Tasks were developed by

A member of

In collaboration with

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Task Title	Balanced and Unbalanced Forces and Magnetism

Standards Bundle Information
Performance Expectations • 3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. • 3-PS2-4. Define a simple design problem that can be solved by applying scientific ideas about magnets.
Science and Engineering Practices • Asking Questions and Defining Problems • Planning and Carrying Out Investigations
Cross-Cutting Concepts • Cause and Effect • Interdependence of Science, Engineering, and Technology
Disciplinary Core Ideas • PS2.A: Forces and Motion • PS2.B: Types of Interactions • PS2.B: Types of Interactions
CCSS ELA: • RI.3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. (3-PS2-1),(3-PS2-3) • RI.3.3 Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. (3-PS2-3) • RI.3.8 Describe the logical connection between particular sentences and paragraphs in a text (e.g., comparison, cause/effect, first/second/third in a sequence).(3-PS2-3) • W.3.7 Conduct short research projects that build knowledge about a topic. (3-PS2-1),(3-PS2-2) • W.3.8 Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. (3-PS2-1),(3-PS2-2) • SL.3.3 Ask and answer questions about information from a speaker, offering appropriate elaboration and detail. (3-PS2-3)

CCSS Mathematics:

- MP.2 Reason abstractly and quantitatively. (3-PS2-1)
- MP.5 Use appropriate tools strategically. (3-PS2-1)
- 3.MD.A.2 Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem. (3-PS2-1)

Overview / Introduction of the Assessment Task

In this task students demonstrate their understanding of balanced and unbalanced forces using magnets. It might be a good idea to kickoff the unit by letting students know that they will be using what they learn to design a board game with magnets at the end. That way they can be thinking about it the entire time they are learning about force, motion, and magnetism. It may be helpful to expose your students to a few board games beforehand as well.

Teacher Background

Interactions between any two objects can cause changes in one or both of them. An understanding of the forces between objects is important for describing how their motions change, as well as for predicting stability or instability in systems at any scale. All forces between objects arise from a few types of interactions: gravity, electromagnetism, and the strong and weak nuclear interactions. Interactions of an object with another object can be explained and predicted using the concept of forces, which can cause a change in motion of one or both of the interacting objects. An individual force acts on one particular object and is described by its strength and direction. The strengths of forces can be measured and their values compared. What happens when a force is applied to an object depends not only on that force but also on all the other forces acting on that object.

A static object typically has multiple forces acting on it, but they sum to zero. If the total (vector sum) force on an object is not zero, however, its motion will change. Sometimes forces on an object can also change its shape or orientation.

Objects in contact exert forces on each other (friction, elastic pushes and pulls). Electric, magnetic, and gravitational forces between a pair of objects do not require that the objects be in contact—for example, magnets push or pull at a distance. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.

Resource: A Framework for K-12 Science Education: Practices, Concepts and Cross-Cutting Concepts. Chapter 5: Dimension 3: Disciplinary Core Ideas- Physical Science.

Information for Classroom Use
Connections to Instruction: The purpose of this task is to be a summative assessment on how balanced and unbalanced forces interact in regards to magnetism. The key ideas are that an object at rest remains at rest and an object in motion remains in motion unless an outside force acts on it. Objects in contact exert force, but objects do not necessarily have to be in contact to exert force.
Approximate Duration for the Summative Task: (all components): Approximately 250 minutes
Assumptions: Students will have had experiences with push and pull forces in Kindergarten. The student should also know how to fill out a claim-evidence-reasoning framework. Magnetism is introduced in third grade. The performance task assumes that your students have had experience with board games. It may be helpful to give them some experience with different board games during the course of this unit. The 3DSPA was designed to assess students' ability to perform the task by applying previous knowledge learned to the phenomena in the performance assessment without having been exposed to this specific phenomena in advance.
Materials Needed: Formative Task #1: three ring magnets, pencil, sticky notes Formative Task #2: ceramic donut magnet (ring magnet), small rubber bands, magnetic wands, rectangular magnets, string or yarn, skewers or straws, paper, pencil Formative Task #3: ceramic donut magnet (ring magnet), small rubber bands, magnetic wands, rectangular magnets, string or yarn, skewers or straws, paper, pencil Formative Task #4: 1 paper, pencil, ruler and 2 magnets per group Summative Task: paper, magnets (shape is up to teacher), paper (cardboard, cardstock, etc.), scissors, glue, markers, pros and cons chart template, suggested template for comparing two games, and any other materials that the teacher wants to gather.
Supplementary Resources: Magnet tripod setup for Formative performance task #2 and #3. (I have also seen a magnet on a string suspended from a meter stick with three magnets spaced equally apart [perhaps make a triangle template on a sheet of paper and make copies], which is easier than building the tripod. However, the tripod provides more stability and allows you to move the magnets to different positions while still keeping the overall structure.) Dziengel, A (2015, January 30). Fun science experiments: Magnet magic. Retrieved from http://babbledabbledo.com/fun-science-experiments-magnet-magic/

Learning Performances
Students observe an object at rest and explain the cause of its immobility. Students develop an investigation in groups to show how a pair of objects that are in contact exert force (friction, elastic pushes and pulls). Students observe an object's speed and direction of motion when forces are unbalanced or balanced to gather evidence to support or refute their ideas on force and motion. Students predict reasonable outcomes about an object's future speed and direction of motion. Students collaboratively conduct an investigation about the effect of a variable on an object's speed and direction of motion. Students ask questions about what would happen if a variable changes (such as the size of force, the distance between objects, or the orientation of each object relative to each other). Students make predictions about what would happen if a variable changes (such as the size of force, the distance between objects, or the orientation of each object relative to each other). Students collaboratively conduct an investigation about what would happen if a variable changes (such as the size of force, the distance between objects, or the orientation of each object relative to each other). Students define a simple design problem that demonstrates the relationship between unbalanced and balanced forces using magnets. ● Students use research to generate ideas that have the potential to solve a simple design problem that demonstrates the relationship between unbalanced and balanced forces using magnets.

- Students sketch, diagram, or model a chosen solution from brainstormed ideas that demonstrates the relationship between unbalanced and balanced forces using magnets.
- Students create a working system that transfers the design idea into a finished product that demonstrates the relationship between unbalanced and balanced forces using magnets.
- Students test the solution under a range of likely conditions that demonstrates the relationship between unbalanced and balanced forces using magnets.
- Students share, discuss ideas and receive input from peers to revise thinking and models that demonstrate the relationship between unbalanced and balanced forces using magnets.
- Students compare different test models of the same proposed object to determine which design meets the criteria for success.

Performance Assessments

<table>
<tr><th colspan="3">Student Performances</th></tr>
<tr><td rowspan="4">Formative Assessment Task 1</td><td>Learning Performance:

Students observe an object at rest and explain the cause of its immobility.</td><td rowspan="4">Expected Duration:

~50 minutes</td></tr>
<tr><td>Description (Phenomena, Scenario, Task)

Phenomenon: Inertia--An object at rest stays at rest and an object in motion will stay in motion, unless an outside force acts on it.

Scenario/Task: Students will observe an object at rest, discuss the causes of immobility, and then write/draw an explanation of why this is happening.</td></tr>
<tr><td>Directions: Observe three ring magnets on a pencil. Why are they not moving? What keeps them in place? Discuss in small groups what is going on making sure to provide evidence for your opinion (maybe a drawing, acting it out, whatever you need to do to get your idea across). After discussion, go back to your seat and write on a post-it or half-sheet of paper your explanation for this phenomenon. Make sure to include in your explanation how the forces are exerted on the objects and the direction of the force.</td></tr>
<tr><td>Scoring / Teacher Look-For's:

Look for explanation of balanced/unbalanced forces, attraction/repulsion, magnetism, direction of forces, and the cause of these concepts.

Provide feedback so that students know where they stand and what they need to do to improve.</td></tr>
<tr><td rowspan="2">Formative Assessment Task 2</td><td>Learning Performance:

Students predict reasonable outcomes about an object's future speed and direction of motion.

Students collaboratively conduct an investigation about the effect of a variable on an object's speed and direction of motion.</td><td rowspan="2">Expected Duration:

~2 50 minute sessions</td></tr>
<tr><td>Description (Phenomena, Scenario, Task)

Phenomenon: Students investigate which force is stronger--attraction or repulsion?

Scenario/Task: Students will design an investigation with magnets to test one variable and make conclusions about the speed and direction of motion when attraction and repulsion forces are applied.</td></tr>
</table>

	Directions: You will have two magnets and a ruler. Discuss with a partner/group how you could test which force is stronger in a magnet--attraction or repulsion. Keep in mind what variable you want to test. Also bear in mind that you will need to perform the test several times to make sure your data is correct. Conduct your test. You will need to collect data and record your findings on a chart. (Teacher will guide students on how to make a chart.) Write down your results and conclusion. Compare your results with another group. Revise your conclusion if needed. Share your results with the whole class and see how it fits in with the whole test. Revise your conclusion if needed.	
	Scoring / Teacher Look-For's: Make sure they are testing one variable at a time and that they are doing multiple trials when gathering data. Also check that their data is readable. Discuss overall findings as a class and address any misconceptions whole group. Give students a chance to revise.	
Formative Assessment Task 3	Learning Performance: Students ask questions about what would happen if a variable changes (such as the size of force, the distance between objects, or the orientation of each object relative to each other). Students make predictions about what would happen if a variable changes (such as the size of force, the distance between objects, or the orientation of each object relative to each other). Students collaboratively conduct an investigation/observe teacher demonstration about what would happen if a variable changes (such as the size of force, the distance between objects, or the orientation of each object relative to each other).	Expected Duration: ~2 50 minute sessions
	Description (Phenomena, Scenario, Task) Scenario/Task: Students describe the effect on a magnet when changing the size of a force, the distance between objects, or the orientation of the objects by using one variable to change the given magnet tripod design.	
	Directions: Design an investigation that explores the effect of the distance between objects, the orientation of objects, and/or the size of force.	

	Have students generate a list of different things they would like to test in regards to the magnets (e.g., distance, orientation, strength, the height of the swing, size of magnet, etc.). Set up a chart (according to the variables they want to test) to record your findings. Make sure you note what changes you made to the original design. Include an explanation of the balanced and unbalanced forces that are exerted on the hanging magnet. Try testing everything at once, hopefully they are seeing that they are not getting conclusive information about anything because too many things are happening at once. Build the given design for a magnet tripod (see image in the resources section at the bottom). How can you change the original design to modify the direction or motion of the hanging magnet? If time is an issue, simply tie a ring magnet to a string and suspend it from a meter stick. Rest the meter stick between two tables or chairs and have the three magnets be on the floor. Later, kids might want you to place the magnets more precisely, so have some paper, a marker, and a ruler handy.	
	Scoring / Teacher Look-For's: Do students understand the concept of having a control? Do they understand the concept of changing only one variable at a time? Can they present their data in a way that makes sense? Provide feedback so that students know where they stand and what they need to do to improve. Give students a chance to go back and revise any misconceptions.	
Formative Assessment Task 4	Learning Performance: Students observe an object's speed and direction of motion when forces are unbalanced and balanced to gather evidence to support or refute their ideas on force and motion.	Expected Duration: ~50 minutes
	Description (Phenomena, Scenario, Task) Phenomena: Scenario/Task: In the previous performance task, they were exploring the importance of having only one variable to test. This task is to help them hone this skill/idea so that they can test balanced and unbalanced forces.	
	Directions: Use the design from the previous performance task (magnet tripod) to explore an object's speed and direction of motion when forces are unbalanced and balanced to support or refute their ideas of force and motion. Because they should now know the importance of testing only one variable at a time, they should be better equipped to test the balanced and unbalanced forces.	

<table>
<tr>
<td rowspan="2"></td>
<td colspan="2">After building the tripod, decide how to investigate balanced and unbalanced forces using the magnets.

Set up a chart to record your findings. Make sure you note what changes you made to the original design. Include an explanation of the balanced and unbalanced forces that are exerted on the hanging magnet and how they affect the magnet’s motion.</td>
<td rowspan="2"></td>
</tr>
<tr>
<td colspan="2">Scoring / Teacher Look-For’s:

Watch for variables and controls. Make sure they include ideas about balanced and unbalanced forces and motion.

Provide feedback so that students know where they stand and what they need to do to improve. Give students a chance to revise their work.</td>
</tr>
<tr>
<td></td>
<td colspan="2">Learning Performance:

Students define a simple design problem that demonstrates the relationship between unbalanced and balanced forces using magnets.

● Students use research to generate ideas that have the potential to solve a simple design problem that demonstrates the relationship between unbalanced and balanced forces using magnets.
● Students sketch, diagram, or model a chosen solution from brainstormed ideas that demonstrates the relationship between unbalanced and balanced forces using magnets.
● Students create a working system that transfers the design idea into a finished product that demonstrates the relationship between unbalanced and balanced forces using magnets.
● Students test the solution under a range of likely conditions that demonstrates the relationship between unbalanced and balanced forces using magnets.
● Students share, discuss ideas and receive input from peers to revise thinking and models that demonstrate the relationship between unbalanced and balanced forces using magnets.
● Students compare different test models of the same proposed object to determine which design meets the criteria for success.</td>
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<tr>
<td rowspan="2">Final Task:</td>
<td colspan="2">Phenomena: Balanced and Unbalanced forces are exerted with magnetism.</td>
<td rowspan="2">Expected Duration: ~5 50 minute sessions

Suggested Materials: various styles of magnets (including magnet strips, ring, wand, bar, horseshoe, etc.), cardboard,</td>
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<tr>
<td>Goal: Your task is to design a game in which magnets are used to move game pieces forward, backward, or to keep them in place using repelling and attracting forces. Maybe consider a game design for people that have special</td>
<td>Role: You are a game designer for a toy company.</td>
</tr>
</table>

	needs and cannot use their hands (cast, injury, etc.).		cardstock, markers, crayons, glue, tape, scissors, construction paper)
	Audience: You need to convince customers to purchase your game.	Situation: The challenge involves not touching the game pieces with your hands.	
	Product / Performance: You need to design a game that demonstrates the relationship between unbalanced and balanced forces using magnets. You will present your design in the form of a 2 minute commercial in which you will explain the rules and demonstrate how to play. (Teachers may want a question and answer period after each presentation for clarification purposes.)		
	Directions: As the game designer for a toy company you are going to design a game in which the players use magnets to move their game pieces using the repelling and attracting forces. You may not touch the game pieces with your hands, but you may control the game pieces with magnets. You may choose the shape of magnet that you think will best work. Your game board may be no larger than your desk. Give your game a name that reflects how it uses magnetism and helps the players understand something about how it is played. You will create a 2 minute commercial that will demonstrate for your future customers how the game is played. Your commercial needs to include an explanation of how the game works and an explanation of the balanced and unbalanced forces as well as the attraction and repulsion forces exerted with magnets (teachers create a template of sorts for the commercial so that students can make sure they touch on the forces in the commercial as well as how it is played). After the commercial, use the checkbric to grade for that particular portion. As you watch the commercials, students will compare designs of the other models (you may choose your own), by recording the pros and cons of each game (including your own) on a chart. When all groups have presented, choose the best two games and justify why their game is best by answering on a sheet of paper (suggested template) or in their notebooks: How does this game demonstrate the use of balanced and unbalanced forces? How does this game demonstrate the attracting and repelling forces of magnets? What makes this game challenging in a fun way? What is an improvement you would make to the original design?		

CheckBric

Student Name ____

Teacher Name ____

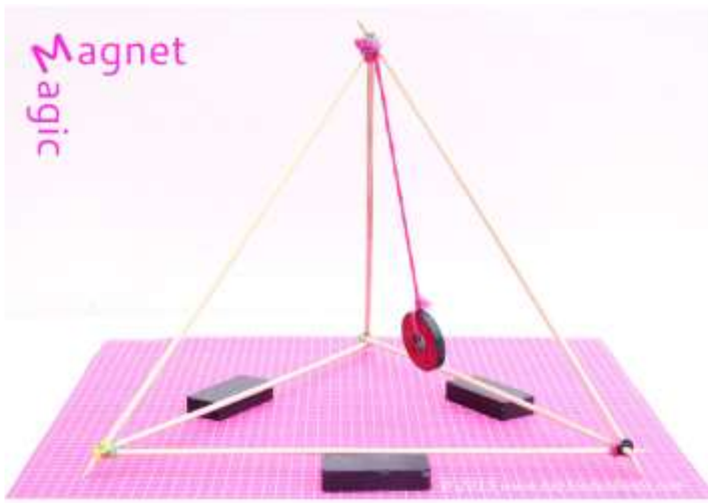
Learning Performance: Students define a simple design problem that demonstrates the cause and effect relationship between unbalanced and balanced forces using magnets.					**Comments**
Evidence Statements:					
Define a simple design problem ● Work collaboratively with a group to generate possible ideas to solve the problem ● Collaboratively select one design solution	**1**	**2**	**3**	**4**	
Model unbalanced and balanced forces using magnets as well as attraction and repulsion ● Create a working system ● Test under a range of conditions	**1**	**2**	**3**	**4**	
Within the commercial explain cause and effect relationship ● Student is able to explain the attraction and repulsion forces and what causes them. ● Student is able to explain the balanced and unbalanced forces acting on the game pieces.	**1**	**2**	**3**	**4**	
LP Total:					
Learning Performance: Students compare different test models of the same proposed object to determine which design meets the criteria for success.					**Comments**
Evidence Statements:					
Test two different solutions (other than their own) of the game. ● Students record pros and cons on a chart.	**1**	**2**	**3**	**4**	
Compare different solutions of unbalanced and balanced forces using magnets. ● Students use the terms attraction, repulsion, unbalanced and balanced accurately.	**1**	**2**	**3**	**4**	
Justify reasoning for choosing one design over another. Included in the explanation is how well the "winning" group explained forces (attraction, repulsion, balanced, and unbalanced) as well as how the game itself was fun to play.	**1**	**2**	**3**	**4**	
LP Total:					

4 Exemplary	Work at this level is of exceptional quality. It is both thorough and accurate. It exceeds the standard. It shows a sophisticated application of knowledge and skills.
3 Proficient	Work at this level meets the standard. It is acceptable work that demonstrates application of essential knowledge and skills. Minor errors or omissions do not detract from the overall quality.
2 Developing	Work at this level does not meet the standard. It shows basic, but inconsistent application of knowledge and skills. Minor errors or omissions detract from the overall quality. Your work needs further development.
1 Emerging	Work at this level shows a partial application of knowledge and skills. It is superficial (lacks depth), fragmented or incomplete and needs considerable development. Your work contains errors or omissions.

Item Production Information

Copyrighted Material and Sources

Dziengel, A (2015, January 30). Fun science experiments: Magnet magic. Retrieved from http://babbledabbledo.com/fun-science-experiments-magnet-magic/



Notes:

<u>Suggested Anchor Phenomena</u>

How does a compass work? How does an electromagnet affect a compass?

<u>Suggested Instructional Phenomena</u>

- For balanced and unbalanced forces without magnets you could use: tug of war, teeter totters, pushing against a wall, roller coasters, slides/sleds, scooters, soccer/baseball/sports.
- Ring magnets and how they can repel and attract in an impressive way.
- Can magnets work through different media (water, hand, paper, etc.)? How thick does the media have to be before the magnet no longer works? Can magnets "magically" make things move across the table?
- Does a magnet's shape matter? What happens when you break a magnet?
- Magnetic field viewer (baby oil and steel filings) to see the field.
- Which is stronger the magnetic force of attraction or the force of repulsion?
- Temporary magnets--either electromagnets or rubbing (show how electromagnets can pick up cars)
- Magnet jars...separating magnetic from non-magnetic materials (recycling centers can use this)
- Suspend a paper clip between two magnets?
- Explore modern uses for magnets (roller coasters, bullet trains, MRIs, refrigerator doors, monorails, magna-doodles, Wooly Willie, motors, credit cards, anti-theft devices, etc.)
- Solve design problems with magnets (instead of poky pins, we could attach name tags with magnets or the function of cow magnets, or magnetic paint).