CORPS
Central Oklahoma Rural Partnership For Science

Pattern Analysis of Student Thinking (PAST)
3-PS2-3 - Assessment Task – Magnetic Force

PE – **Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.**

DCI – Types of Interactions: Electric and magnetic forces between a pair of objects do not require that they be in contact. 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.

TASK 1 – Analyze experimental data for patterns showing the relationship between attraction distance and the strength of a magnet's force.

Purpose	Student Response Themes	Examples of Student Responses	Possible Teacher Instructional Moves
This task is designed to engage students in analyzing experimental data from an investigation in which attraction distance between a donut magnet and a paper clip is measured using increasing numbers of stacked magnets. Students should notice patterns in the data showing that attraction	**Question 1** • Student notices that the attraction distance increases with the addition of each magnet. • Student notices that with each magnet added the attraction distance increases by 2 cm.	• "Every time they added a magnet the distance went farther." • "numbers going up" • Each one of the magnets made the distance go two times more." • "It's going by twos." • "a two plus two pattern"	Teacher can conduct a whole class discussion of the data to help students find patterns. Students can be given opportunities to analyze similar types of data in different contexts. This gives them an opportunity to see data analysis modeled in different ways and scaffolds them to be able to analyze and interpret data on their own. Provide students with opportunities to identify other patterns related to
	Question 2 • Student should predict 10 cm. • Student should add a point to the graph and complete the line for (x,y) = (5,10)	N/A	

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distance increases with magnet strength. They are presented with a graph of the data, predict the next data point based on this pattern, and explain their prediction. Students generate an evidence-based explanation for data from the investigation about the relationship between magnet strength and attraction distance.	**Question 3** • Student describes the established pattern of strength vs. distance and how it continues in this case • Student uses number strategies for continuation of the pattern without necessarily connecting to the idea of strength and distance	• "I looked at the graph and saw that every time you add a magnet it goes up by 2 cm." • "The higher the magnets go, the higher the centimeters go." • "It is counting by twos." • "It goes up and across one box at a time." • "because the pattern is multiply the magnet number by 2 to get centimeters" • "I counted to the next number up."	properties of magnets. Have them conduct investigations that they design themselves to gain experience with generating evidence to show cause and effect. Examples: • Design an investigation to prove that magnets can both attract and repel other magnets. • Design an investigation to see which type of magnet can pick up the greatest amount of weight (mass). • Design an experiment to find out if the weight (mass) of a magnet is related to its strength.
	Question 4 • Student uses patterns from the graph to explain that stronger magnets can pull things from greater distances. • Student uses patterns from the graph to explain that more magnets stacked together are stronger or have more power (force). • Student explains that more magnets stacked together are stronger or have more power (force) but does not refer to data patterns.	• "When you add magnets it gets stronger and the distance gets bigger because it can pull farther out to get the paper clip." • "The graph shows that it is easier to attract the paper clip when you make the magnet stronger by adding more magnets." • "More magnets have more force to pull the paper clip." • "because the magnet gets more power and the force is bigger." • "The magnet gets a lot stronger."	

Focus SEP/CCC: Students identify patterns from a graph of experimental data. They use this data as evidence to construct an explanation for the effect of magnetic strength on the attraction distance (magnetic field) between objects.

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TASK 2 – Utilize data from the previous task to make a supported claim about the relative strength of several different types of magnets based on attraction distance data for these new magnet types.

Purpose	Student Response Themes	Examples of Student Responses	Possible Teacher Instructional Moves
This task is designed to engage students in analyzing and synthesizing data from two similar experiments to make a supported claim about relative strengths of different types of magnets based on attraction distance.	**Question 1** • Strongest - bar magnet **Question 2** • Weakest - single donut magnet	N/A	Have students share their explanations with a partner and allow them to make changes to their explanations. Provide students with additional data sets related to magnetic properties that allow them to synthesize data to draw a conclusion. Have students explore the strength of multiple types of magnets to see if/how size, shape, or mass are related to strength or attraction distance.
	Question 3 • Student uses data from both investigations to connect strength with attraction distance. • Student uses data from Task 2 to indicate that larger attraction distance indicates more strength but does not refer to Task 1. • Student uses perception of magnet size or shape instead of numbers from the chart as evidence. • Student uses data to make an incorrect inference.	• "The chart shows that the bar magnet has the most distance (12) and the donut magnet has the least (2). We learned that more distance means more strength." • One donut magnet was 2 cm and the bar was 12 cm, so the bar must be the strongest." • "The bar magnet was strongest because it pulled farthest – 12 cm." • "Bar magnets are 12 cm and 1 donut magnet is 2 cm so bar magnets are heavier." • "Bar magnet has a lot of metal and the donut magnet doesn't have that much." • "The bar is long and the donut is short." • "Donut magnet is the strongest because it started to move at only 2 cm but the bar magnet is weakest because it moved at 12 cm."	

Focus SEP/CCC: Students analyze two sets of data to make claims about the effect of the strength of different types of magnets on attraction distance.

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TASK 3 – Use evidence from the investigations in Task 1 and Task 2 to make a supported claim about the findings in a related investigation about the strength of magnetic force in the four magnets from Task 2.			
Purpose	**Student Response Themes**	**Examples of Student Responses**	**Possible Teacher Instructional Moves**
This task is designed to engage students in using data from the previous investigations to make a claim about the number of paper clips the magnets used in these investigations will pick up. It requires them to make the inference that the stronger a magnet is, the more paper clips it will pick up and relate this to what they learned about the strength of the magnets from the previous data. Students should choose **Table C** because the order of strength from largest to smallest in Task 2 is: bar, stack of 4 donuts, cylinder, and single donut. This matches the number of paper clips in Table C from largest to smallest (36, 16, 10, 4).	• Student connects data from previous investigations about the relative strengths of the bar, cylinder, single-donut, and 4-donut magnets and applies it to choosing Table C as the most likely outcome, using the reasoning that the number of paper clips held increases with the strength of the magnet as determined by attraction distance. • Student connects data from previous investigations but considers only some of the data. Seriation is not correctly considered. • Student does not use attraction distance from previous investigations as evidence of magnetic strength. • Student uses properties of the magnets (shape, size, etc.) that are unrelated to attraction distance to make inferences about strength and number of paper clips picked up.	• "Table C – Bar magnet had most clips (36) and biggest attraction distance (12 cm). The others were in same order after that." • "Table C, because we saw before that the bar magnet was strongest, the 4 donut stack was next, the cylinder was next, and the donut magnet was weakest." • "I chose Table A because the bar magnet was the strongest and it would have got a lot more clips." • "Table A - The bar magnet got 36 paper clips and the donut magnet got only 4." • "I chose Table A because in Table B, I don't think one donut magnet could pick up 36 paper clips." • "Table A – The bar is big, the cylinder is long, the donut is small, and the stack of 4 is also long."	Students at this grade level may not have had much experience with synthesizing data from multiple data sets. This assessment could be done in several sessions with a discussion at the end of each Task to help students consolidate their learning and make connections to the previous data set. Offering more opportunities for students to utilize two different data sets to reach a single conclusion can help them develop skills for making evidence-based claims.
Focus SEP/CCC: Students make a claim about the probable results of a related data set using evidence from previous investigations about the strength of different types of magnets.			

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