Invisible Pulls

Plan fair tests of electric and magnetic forces

PS.3.b "Plan and carry out investigations to identify the factors that affect the strength of the electric and magnetic forces between objects."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each factor the investigators change, circle what they measure, and number the conditions they keep the same. Use your marks to see how each test links a cause to an effect.

Testing Forces Without Touching

1. At a science museum, a team designs a display that moves a steel washer without touching it. They attach the washer to a spring scale and pull it sideways with a bar magnet. The scale shows the pull when the washer stays at a marked spot. To test whether separation matters, they move the magnet to measured distances from that spot. They keep the same magnet and washer, and record the scale reading at each distance. They repeat each reading three times. At larger gaps, the readings are smaller, evidence that distance affects magnetic force in this setup.

2. The team also wonders whether using more magnets changes the pull. They compare one bar magnet with two identical bar magnets stacked in the same orientation. For each test, they measure the gap from the washer to the nearest magnet face, keep the washer at its marked spot, and use the same spring scale. They repeat the readings, because a single reading may be affected by how steadily someone holds the magnets. A stronger pull with two magnets would support the idea that the magnet arrangement matters. Changing both the gap and the stack would not show which change caused a different reading.

3. Across the room, another group tests electric force. A charged plastic rod attracts a neutral foil ball hanging from a thread. The ball shifts sideways, so the group measures its sideways shift from its resting position after it stops moving. They test several measured gaps between the rod and the settled ball, using the same rod, ball, and thread. They charge the rod the same way before each trial, but they know this does not guarantee exactly equal charge. Dry air and humid air can also affect how long a rod stays charged. They record the room conditions and repeat trials.

2 ANSWER WITH EVIDENCE

Use the passage

1. In the first magnetic test, what does the team change and measure? Name two conditions they keep the same.

2. To test the number of magnets, why must the team keep the gap to the nearest magnet face the same?

3. In the electric-force test, what does the group change and measure? Why do they charge the rod the same way before each trial?

4. Suppose the electric-force trials are done on both a dry day and a humid day. What should the group record, and why does it matter?

3 YOUR TURN

Your own words

Design a new test to find out whether the number of wire turns on an electromagnet affects its pull on a steel washer. Explain what you will change and measure, how you will keep the current and at least two other conditions the same, and how you will repeat the test.

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PART 1 · READ AND MARK

Underline each factor the investigators change, circle what they measure, and number the conditions they keep the same. Use your marks to see how each test links a cause to an effect. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	In the first magnetic test, what does the team change and measure? Name two conditions they keep the same.	**They change the magnet-to-washer distance and measure the spring scale reading. They keep the magnet and washer the same.**
2	To test the number of magnets, why must the team keep the gap to the nearest magnet face the same?	**If the gap also changes, a different scale reading could be caused by distance rather than the number of magnets.**
3	In the electric-force test, what does the group change and measure? Why do they charge the rod the same way before each trial?	**They change the rod-to-ball gap and measure the ball's sideways shift. Using the same charging procedure helps limit changes in charge, though it cannot guarantee equal charge.**
4	Suppose the electric-force trials are done on both a dry day and a humid day. What should the group record, and why does it matter?	**They should record the room conditions for each trial. Humidity can affect how long the rod stays charged, so it could affect the ball's shift.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would make coils with different numbers of wire turns around the same iron core. For each coil, I would adjust a current-limited power supply until an ammeter shows the same current. I would keep the same washer at the same measured gap from the core and use a spring scale to measure the pull while the washer stays in place. I would switch the power on only long enough to take a reading. I would repeat each measurement three times and compare the readings.

Accept plans that vary only the number of turns while measuring a consistent indicator of pull. Current, core, washer, and gap should remain controlled, with repeated trials.