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FARM PHYSICS - TEACHER NOTES

investigating motion, force, and mass

8.PS2.5 Plan and conduct an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

INQUIRY-BASED PHILOSOPHY

Inquiry-based learning is a student-centered approach where learning is driven by questions, investigations, and curiosity. In this activity, students plan and conduct an investigation, collect repeated measurements, calculate means, and use data as evidence to explain motion.

ACTIVITY OVERVIEW

- Students investigate a toy farm vehicle moving down two ramp angles.
- Students test three mass conditions: 0 magnet, 2 magnets, and 4 magnets.
- Students complete three trials for each condition and calculate mean time and mean distance.
- The conclusion emphasizes the relationship among net force, mass, and changes in motion.

MATERIALS AND SET-UP

- Use the same type of toy vehicle for each group.
- Prepare ramps at two consistent angles: low angle and high angle.
- Mark the same release point at the top of each ramp.
- Use the same surface for all groups to reduce friction differences.
- Assign roles: release manager, timer, distance measurer, recorder, and materials manager.

per group of 4 students	*per student*
• toy farm vehicle • 4 magnet weights • adjustable ramp • timer or stopwatch • measuring tape or meter stick • 4 pieces of tape • permanent marker	• pen or pencil • calculator • student packet

RUNNING A COMPLEX LAB WITH MIDDLE SCHOOL STUDENTS

Teacher Model: Demonstrate one full trial without giving students results.
Teacher/Student Model: Use students to model the timer, measurer, releaser, and recorder roles.
Frontload then Go: Review variables, fair tests, and how to calculate mean before students begin.
Check-Ins: Pause after the first three trials to check data quality before groups continue.

TEACHER NOTES ON THE SCIENCE

A steeper ramp increases the component of gravitational force acting along the ramp, so students will often observe a shorter travel time or longer distance. Adding mass can affect motion and stopping distance, but results may vary depending on friction, wheel alignment, surface texture, and how smoothly students release the vehicle. Encourage students to use their actual data rather than forcing a predetermined answer.

FACILITATION SEQUENCE

1. Introduce the agricultural scenario and set up stations with materials.
2. Review net force, mass, gravity, friction, and fair testing.
3. Have students write a hypothesis and identify variables.
4. Model how to release the vehicle without pushing it.
5. Have students collect three trials for each condition.
6. Have students calculate means and compare class patterns.
7. Guide students through the Claim-Evidence-Reasoning (CER) conclusion.

STUDENTS SHOULD DISCOVER

- A steeper ramp increases the component of gravitational force acting along the ramp.
- Changing the vehicle's mass can influence how it moves and stops.
- Motion depends on both the net force acting on the object and its mass.
- Repeated trials and means improve the reliability of scientific investigations.

DATA QUALITY TIPS

- If a vehicle turns sharply, repeat the trial and note why it was repeated.
- Make sure students measure from the bottom of the ramp to the final stopping point unless you choose a different class convention.
- If students measure total distance from the top of the ramp, make sure every group uses the same method.
- Avoid having students push the vehicle; allow gravity and the ramp angle to determine the vehicle's motion.

COMMON STUDENT MISCONCEPTIONS

- Students may think heavier objects always move faster. Ask them to compare data carefully.
- Students may confuse mass with force. Reinforce that mass is a property of the object, while force is a push or pull.
- Students may describe only distance, not time. Prompt them to use both measurements.

EXPECTED EVIDENCE OF LEARNING

- Students can identify ramp angle and mass as variables.
- Students can collect time and distance data across repeated trials.
- Students can calculate a mean for time and distance.
- Students can use evidence to explain how net force and mass affected motion.
- Students can write a CER response using data from the investigation.

SUGGESTED DISCUSSION QUESTIONS

- Which variable seemed to have the strongest effect on motion: ramp angle or mass?
- What happened to the vehicle when the ramp angle increased?
- How did adding magnets change the motion?
- Why are repeated trials and means important in an investigation?
- How might this connect to tractors, trailers, or heavy equipment on hills?

EXTENSION OPTIONS

- Have students graph mean distance for each mass and ramp angle.
- Have students calculate speed using distance divided by time.
- Have students test a third angle after completing the required two angles.
- Have students redesign the ramp system to make the vehicle stop within a target zone.

ASSESSMENT GUIDE

Criterion	4 - Strong	3 - Developing	2 - Needs Support
Planning	Variables and hypothesis are clear.	Most variables are identified.	Variables are missing or unclear.
Data	All trials and means are complete.	Most data are complete.	Data are incomplete.
Evidence	Uses specific mean data.	Uses some data.	Uses little or no data.
Reasoning	Clearly connects force, mass, and motion.	Some connection to concepts.	Concepts are inaccurate or missing.

TEACHER REMINDER

The goal is not for every group to get identical results. The goal is for students to plan and conduct a fair investigation, collect quantitative evidence, calculate means, and explain patterns in motion using force and mass.