Fix the Fair Test: Force and Motion Investigation Challenge

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Lesson:

Read the passages and examples below to learn about designing a simple fair test to see how force changes the motion of an object. Notice what makes an investigation fair, how to keep one variable changed at a time, and how to use repeated trials and data to support a claim.

> A fair test changes only one variable at a time. A variable is something that can change in an investigation. If you want to learn how force affects motion, keep everything else the same. That way, the data tells you what caused the change.

> In a toy car ramp test, the ramp height can be the one variable. Use the same car, the same ramp surface, and the same starting spot. Then compare how far the car rolls or how fast it moves. If two things change at once, the results are harder to trust.

Parts of a fair test plan

	Toy car on a ramp
What we change (1 variable)	the ramp height
What we keep the same	same car, same surface, same start
What we measure (the data)	how far the car rolls, in cm
How many trials	3 trials, then compare the results

Use these four lines to check any plan. If a line is missing or has more than one change, the test is not fair.

Repeated trials make results more reliable. One run can be unusual, but several runs show a pattern. Record data after each trial, then look for the same result or a clear trend. This is important when testing balloon rockets, toy cars, or paper airplanes.

How far the car rolled (3 trials)

	Trial 1	Trial 2	Trial 3
Ramp height 10 cm	42 cm	39 cm	44 cm
Ramp height 20 cm	78 cm	81 cm	76 cm

Only the ramp height changed. Trials of the same setup are close but not identical, so one trial alone is not enough.

A good investigation also needs a control or comparison condition. That means keeping one setup the same so you can compare it with the changed setup. For example, a balloon rocket on a string can be tested first with less air, then with more air, while the string, tape, and start point stay the same.

When scientists design an investigation, they plan what to change, what to keep the same, and what to measure. They also decide how to record data. A clear plan helps explain how force changes motion in a way that is fair and repeatable.

Fair Test vs. Not Fair

Fair test
keep the same car
same ramp surface
same starting spot
change only the ramp height
repeat the test several times

Not fair
changes both the ramp height and the toy car
tests a balloon rocket only once
two things change at once

Sort each idea by whether it keeps one variable changed at a time.

Example 1: Wrong plan — A student changes both the ramp height and the toy car at the same time. Why it is wrong: two variables changed, so the data would not show which change affected motion. Correct plan: keep the same car and change only the ramp height.

Example 2: Wrong plan — A student tests a balloon rocket only once and says the result is final. Why it is wrong: one trial does not give reliable data. Correct plan: repeat the test several

times and compare the results.

Example 3: Wrong plan — A student measures how much the toy car weighs instead of how far it rolls. Why it is wrong: the measurement does not match the motion question. Correct plan: measure the distance the car rolls or the time it moves.

Example 4: Wrong plan — A student tests a balloon rocket with no comparison setup. Why it is wrong: there is nothing to compare the new test to. Correct plan: keep the string, tape, and start point the same, then compare two balloon amounts.

Instructions:

Read each student plan carefully. Find the mistake, explain why it is a problem, and tell how to fix the investigation so it is fair and useful.

1. A student tests whether a paper airplane flies farther when the wings are folded differently. The student changes the wing fold but also changes the paper type and throws one airplane harder than the other. The student says, 'This is a fair test because I changed several things.' What is wrong with the student's claim, and how should the test be changed to make it fair?

2. A student says, 'I changed the ramp height and also switched to a different toy car, so I learned which change affected the motion.' What is wrong with this plan, and how should it be fixed?

3. A student tests a balloon rocket by measuring how far it travels after each launch. The student writes, “Launch 1: measure the distance. Launch 2: measure the distance. Launch 3: measure the distance.” A classmate says, “This is not a fair test because the student should change the launch distance each time.” Explain why the classmate is wrong and describe what repeated trials show in this investigation.

4. A student tested a paper airplane by counting how many times it spun in the air, but the question was, 'How does wing shape affect how far it flies?' What is the mistake in the measurement?

5. Which plan is better for testing how force affects motion: 'Test a balloon rocket once and use that result' or 'Test it three times and compare the results'? Explain your choice.

6. A student writes, 'My toy car rolled 60 centimeters on the ramp, so the ramp height is the only reason the car moved that far.' Why is this conclusion too quick?

7. A student wants to test a balloon rocket on a string. The plan changes the amount of air but does not include a comparison setup. How should the student fix the plan so the investigation has a control or comparison condition?

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(Answer Key)

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1. A student tests whether a paper airplane flies farther when the wings are folded differently. The student changes the wing fold but also changes the paper type and throws one airplane harder than the other. The student says, 'This is a fair test because I changed several things.' What is wrong with the student's claim, and how should the test be changed to make it fair?
Hint: A fair test changes only one variable.

Expected Key Points:
- Says the test is not fair
- Explains that more than one variable changed
- Identifies the extra changes, such as paper type and throw strength
- States that only the wing fold should change while other parts stay the same

Evaluation Criteria: Award full credit if the response explains that the test is unfair because multiple variables changed and says the investigation should change only the wing fold while keeping the paper type and throwing force the same. Partial credit may be given for identifying only the unfair multiple changes or for describing one correct control variable.

Explanation: This is not a fair test because more than one variable changed, so the student cannot tell which change affected the flight distance. To make it fair, the student should change only the wing fold and keep the paper type and throw strength the same.

2. A student says, 'I changed the ramp height and also switched to a different toy car, so I learned which change affected the motion.' What is wrong with this plan, and how should it be fixed?
Hint: Two changes at once make data hard to trust.

Expected Key Points:
- Identifies that two variables changed
- Explains why that makes the data unclear
- Gives the fix: keep the same car and change only ramp height

Evaluation Criteria: The answer should identify the two-variable problem and give the correct fix using one variable only.

Explanation: The plan is wrong because two variables changed at once. The student should keep the same toy car and change only the ramp height.

3. A student tests a balloon rocket by measuring how far it travels after each launch. The student writes, “Launch 1: measure the distance. Launch 2: measure the distance. Launch 3: measure the distance.” A classmate says, “This is not a fair test because the student should change the launch distance each time.” Explain why the classmate is wrong and describe what repeated trials show in this investigation.
Hint: Repeated trials mean the same test is done more than once.

Expected Key Points:
- Explains that repeated trials mean repeating the same test more than once
- States that the measurement stays the same in each trial
- Explains that repeated trials make the data more reliable or trustworthy
- Corrects the misconception that the test should change each time

Evaluation Criteria: Score the response for identifying the error in the classmate's reasoning and explaining that repeated trials repeat the same test to make results more reliable. Full credit requires both the correction and the explanation of why repeated trials are useful.

Explanation: The classmate is wrong because repeated trials mean doing the same balloon rocket test several times, not changing the launch distance each time. Measuring the distance after each launch keeps the test consistent and helps make the results more reliable.

4. A student tested a paper airplane by counting how many times it spun in the air, but the question was, 'How does wing shape affect how far it flies?' What is the mistake in the measurement?
Hint: The measurement must match the question.

Expected Key Points:
- Identifies the wrong measurement
- Explains that the measurement does not match the question
- Gives the correct measurement: distance flown

Evaluation Criteria: The answer should identify the mismatch between the question and the measurement, then state the correct outcome to measure.

Explanation: The mistake is measuring spins instead of distance. The student should measure how far the airplane flies because that matches the question.

5. Which plan is better for testing how force affects motion: 'Test a balloon rocket once and use that result' or 'Test it three times and compare the results'? Explain your choice.
Hint: Reliable data comes from more than one trial.

Expected Key Points:
- Chooses the three-time plan
- Explains that repeated trials improve reliability
- Mentions comparing results

Evaluation Criteria: The answer should choose repeated trials and explain why they give better data than one trial.

Explanation: Testing it three times is better because repeated trials make the data more reliable and show a pattern.

6. A student writes, 'My toy car rolled 60 centimeters on the ramp, so the ramp height is the only reason the car moved that far.' Why is this conclusion too quick?
Hint: Think about what else could affect the result.

Expected Key Points:
- Explains that one result is not enough
- Mentions other variables could affect the motion
- Says repeated trials are needed

Evaluation Criteria: The answer should explain why one trial cannot prove the cause and should mention repeated trials and control of other variables.

Explanation: The conclusion is too quick because one result may be unusual, and other variables could also affect the car's motion. The student should use repeated trials and keep other parts the same.

7. A student wants to test a balloon rocket on a string. The plan changes the amount of air but does not include a comparison setup. How should the student fix the plan so the investigation has a control or comparison condition?
Hint: A comparison condition stays the same for comparison.

Expected Key Points:
- Explains that a comparison setup is needed
- States what should stay the same
- Describes comparing the unchanged setup with the changed setup

Evaluation Criteria: The answer should describe a control or comparison condition and tell how to add it to the balloon rocket test.

Explanation: The student should keep one setup the same, such as the same string, tape, and start point, and then compare it with the balloon rocket that has a different amount of air.