
PHYSICAL SCIENCE
Putting Up Resistance
Gravity
Sally Ride Science
PASCO
012-13157A

Help System

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In Your World

If you dropped a feather and a hammer at the same time, you could be sure the hammer would hit the ground first, right?

But what would happen if you dropped these two objects on the Moon? An astronaut tried it, and the hammer and feather hit the ground at the same time! What do you think slows a feather's fall here on Earth?

Introduction

Putting Up Resistance

You have learned that all objects falling near Earth's surface accelerate at the same rate – 9.8 meters per second squared. This means an object's velocity increases by 9.8 meters per second (m/s) every second it falls. But you may have doubts about whether everything *really* falls at the same rate. After all, you have seen that some things fall more slowly than others.

A flat sheet of paper, for instance, falls more slowly than the same sheet crumpled into a ball. So what's going on? Air resistance! It's the force of air molecules pushing against a moving object. Air resistance pushes up on a falling object and slows it down. This force affects different objects differently.

▼ You know a crumpled sheet of paper falls faster than a flat sheet.

Introduction

A Soft Landing

A flat sheet of paper has a larger surface area than a crumpled sheet. The larger surface area comes in contact with more air molecules, so there is more air resistance. This slows the paper's fall. The flat sheet flutters to the ground, but the crumpled paper falls like a rock.

What happens when a skydiver opens a parachute? The large surface area of the parachute comes into contact with lots of air molecules. Air resistance slows the jumper's fall enough for a soft landing.

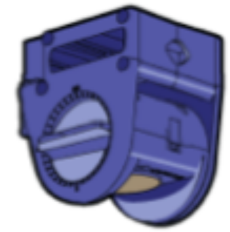
Now it's your turn – investigate air resistance by seeing how a parachute affects the velocity for a falling object.

Air resistance is what makes a parachute work.

Materials and Equipment

Each group needs these materials.

- Motion sensor
- Parachute toy
- Meter stick
- Access to a staircase, balcony, or ladder (optional)
- Rubber band
- Safety goggles for each student



Safety

Add this rule to your regular classroom procedures.

- Wear safety goggles throughout the investigation.

Investigation

Now you will drop a parachute toy – first with the parachute tightly wrapped around the figure, and then with the parachute open. How do you think the time it takes the toy with a closed parachute to fall to the ground will compare to the time it takes the toy with an open parachute? Explain your reasoning.

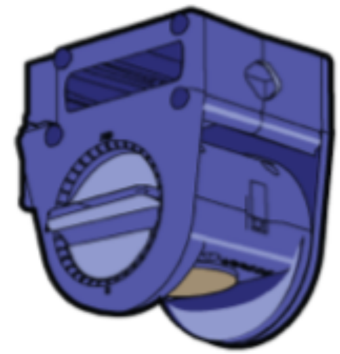
SNAPSHOT

I predict that when I drop a parachute toy, it will . . .

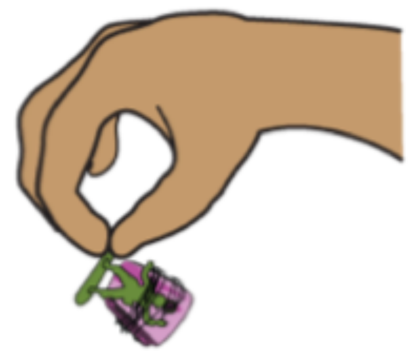
I think this because . . .

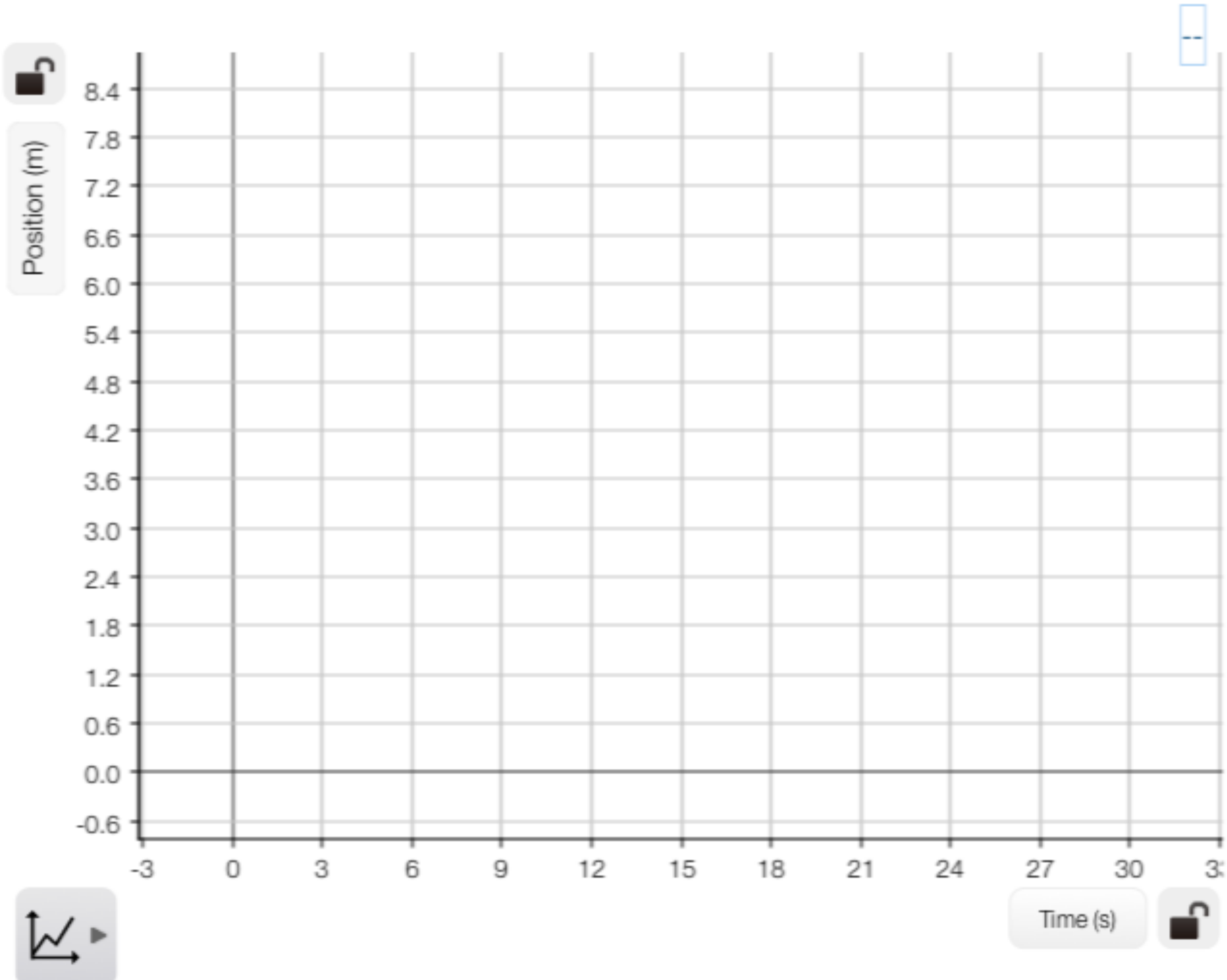
Investigation

1. Set up the motion sensor so the screen faces the floor.
2. Set the motion sensor's range to the "person" icon.
3. Wrap the parachute tightly around the figure. Secure it with a rubber band.
4. Hold the parachute toy still 15 cm under the sensor's screen.
5. Practice dropping the toy directly under the sensor. Be sure to release the toy without throwing it or pushing it downward.



Hold the toy with the parachute tightly wound around the figure 15 cm under the sensor screen.



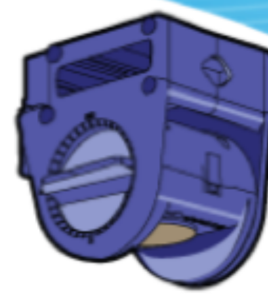


6. Begin recording data.
7. Drop the toy with the parachute tightly wound directly under the sensor.
8. Stop recording data when the toy lands.
9. Label the point on the graph where the toy hit the ground.

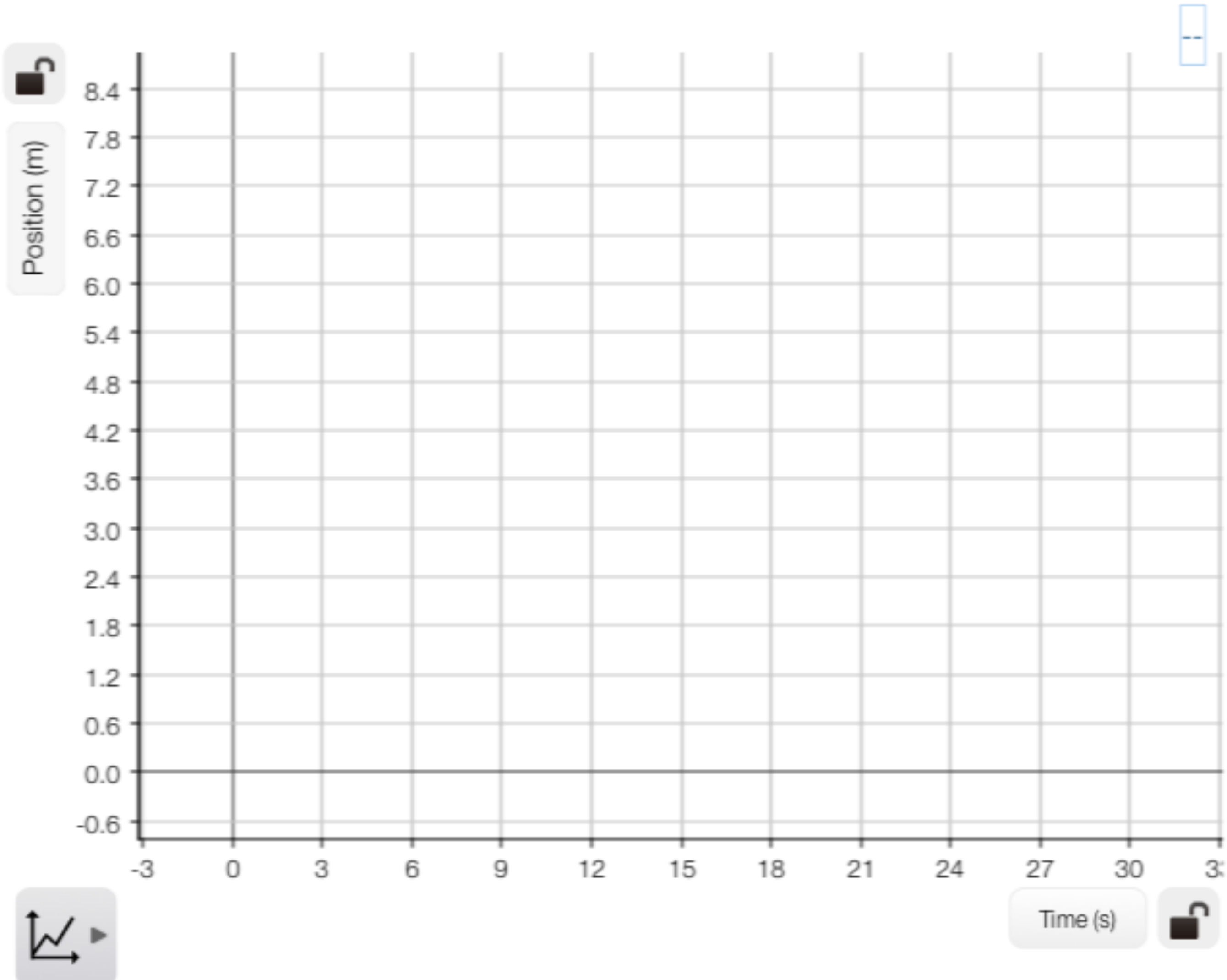
SNAPSHOT

Investigation

10. Unwind the parachute from the figure. Wrap the rubber band around the figure.
11. Hold the toy still with the parachute fully open 15 cm under the sensor's screen.
12. Practice dropping the toy directly under the sensor. Be sure to release the toy without throwing it or pushing it downward.

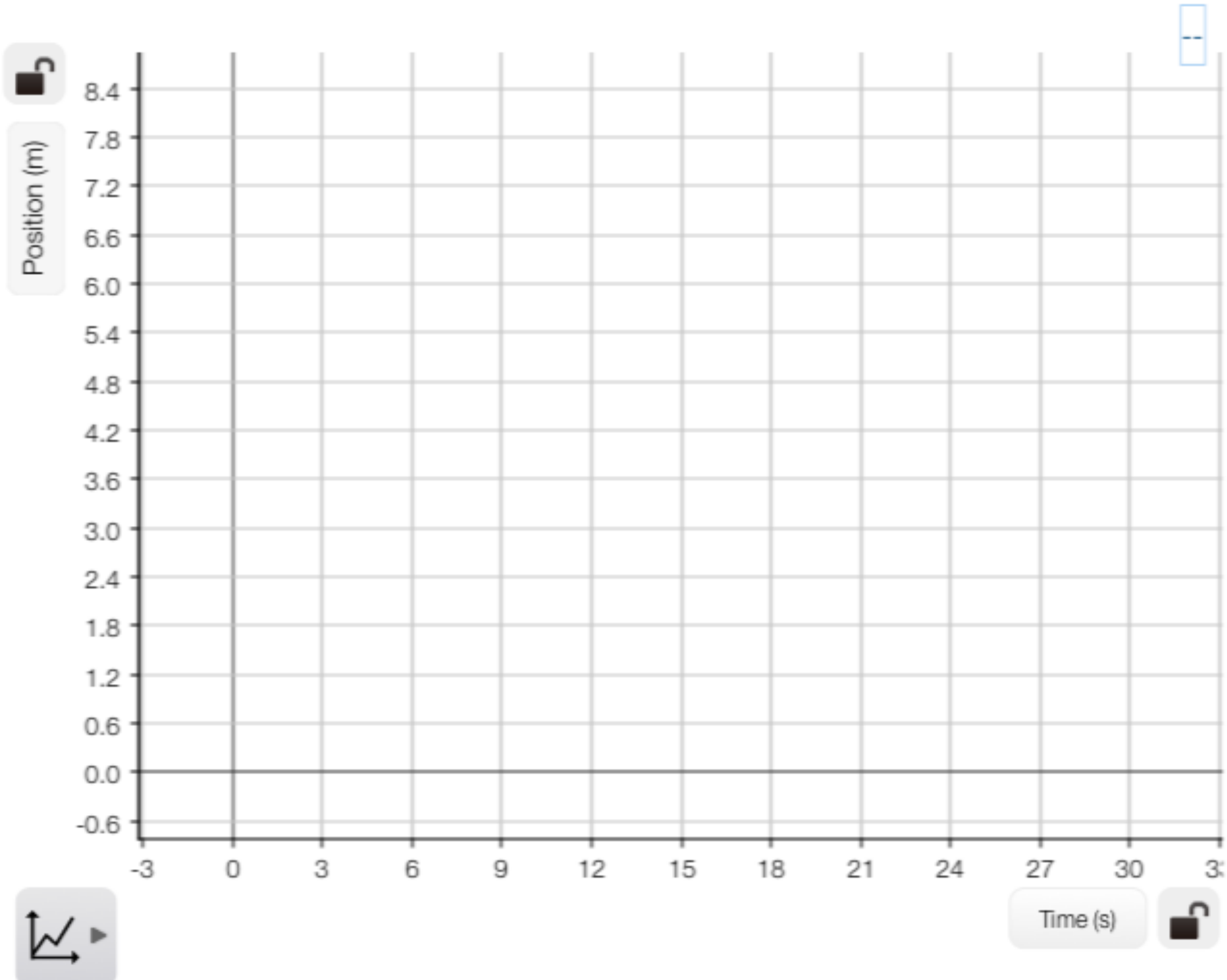


Hold the toy with the parachute open 15 cm under the sensor screen.



13. Begin recording data.
14. Drop the toy with the parachute fully open directly under the sensor.
15. Stop recording data when the toy lands.
16. Label the point on the graph where the toy hit the ground. If the toy went outside the sensor's range, label the point where it was last detected.
17. If necessary, repeat the parachute drop and data recording.

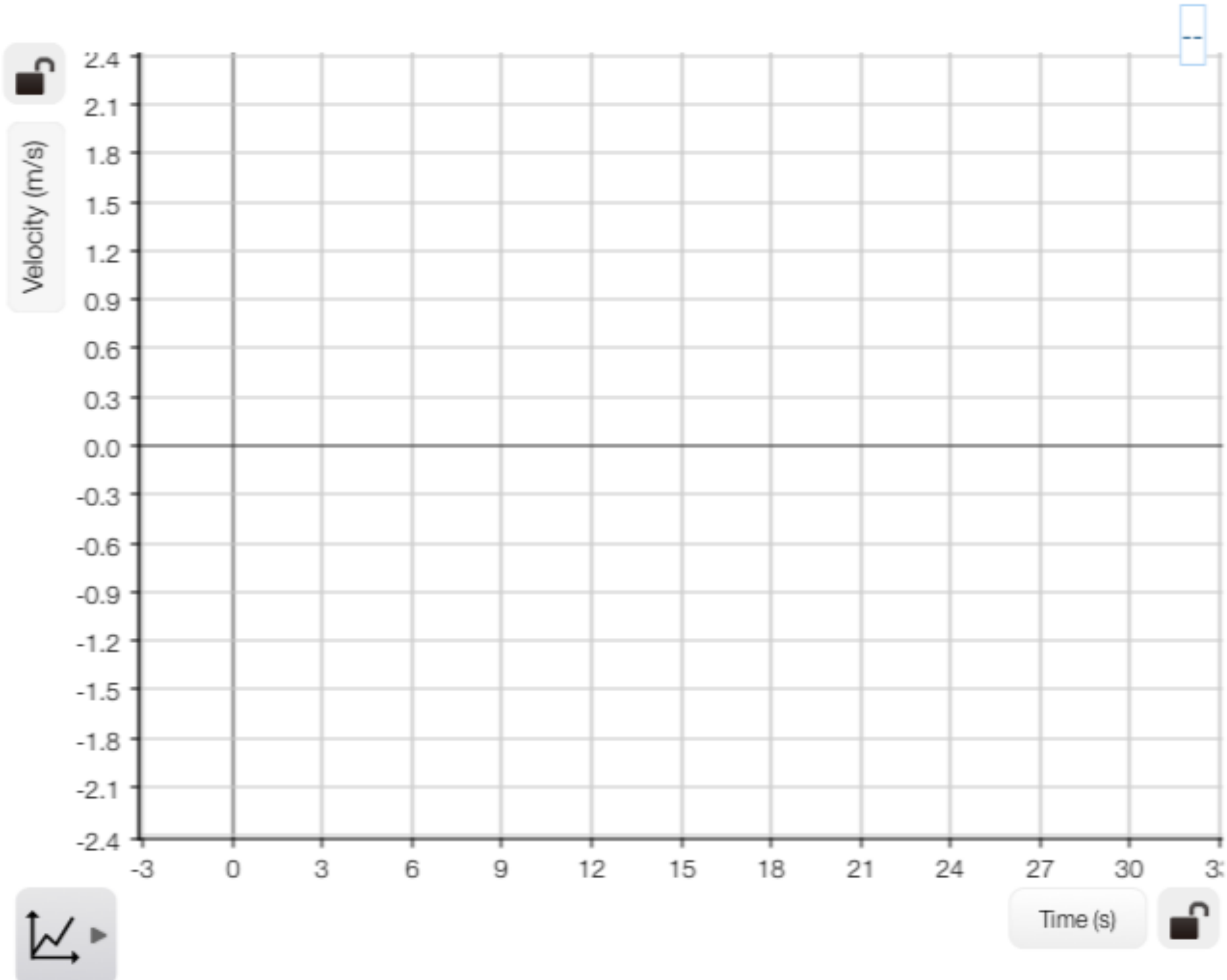
SNAPSHOT



18. Here is your motion data for the trial with the closed parachute and the trial with the open parachute.

    Use the graphing tools to determine the change in time and the change in distance from when the toy left your hands to when it hit the ground.

SNAPSHOT



19. Here is your velocity data for the trial with the closed parachute and the trial with the open parachute.

    Use the graphing tools to determine the average velocity and the maximum velocity from when the toy left your hands to when it hit the ground.

SNAPSHOT

20. In the trial with the open parachute and the trial with the closed parachute, the toy fell the same distance to the ground. In which trial did the toy fall with the greatest velocity just before it hit the ground?

21. What does this information tell you about how the toy accelerated toward the ground with the parachute closed and with the parachute open?

SNAPSHOT

The toy that fell with the greatest velocity just before it hit the ground . . .

This information tells me . . .

Interpretation

1. **How did the time it took for the toy with the closed parachute to fall to the ground compare with the time it took for the toy with the open parachute? Why? Was your prediction confirmed by the data?**

SNAPSHOT

The toy with the closed parachute . . . because . . .

Compared to my prediction . . .

Interpretation

2. **Did your data show that there was another force in addition to gravity influencing the way the toy fell? If so, which way was this force directed? Explain your reasoning.**

SNAPSHOT

In my data, the evidence indicates . . .

This force was directed . . .

I think this is because . . .

3. **Air resistance acts to . . .**

a) slow down an object's fall.
b) speed up an object's fall.
c) add to the pulling force of gravity.
d) cushion an object when it lands.

4. **Which object is likely to encounter the most air resistance?**

a) A marble
b) An egg
c) A flat piece of paper
d) A crumpled piece of paper

SNAPSHOT

Write the letter
of your answer:

Explain the reason you
chose this answer.

Write the letter
of your answer:

Explain the reason you
chose this answer.

5. **How could you change the parachute toy's design so that it would fall faster or slower? Explain how your design changes would work.**

SNAPSHOT

I could change the design of the toy by . . .

My changes would cause the toy to fall . . . because . . .