

Name: _____

Date: _____

Student Exploration: Sled Wars

Vocabulary: acceleration, energy, friction, kinetic energy, momentum, potential energy, speed

Prior Knowledge Questions (Do these BEFORE using the Gizmo.)

1. A firefighter is trying to break through a door. Is he more likely to break through if he runs at the door very slowly or if he runs at the door very fast? Explain your answer.

He will more likely break through the door if he runs at a faster rate because the force of him hitting the door at a higher speed than at a lower speed is much greater.



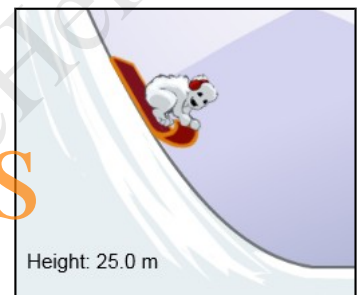
2. Two firefighters are trying to break through a door. One firefighter is heavy, and the other is light. If they run at the same speed, which one is more likely to break through? Explain.

The heavier firefighter is more likely to break through because with more mass, there will be a greater force acted on the door as it makes contact.

Gizmo Warm-up

The ability to crash through doors and cause other changes depends on an object's **energy**. With the *Sled Wars* Gizmo™, you will explore the factors that affect the energy of a sled.

The Gizmo shows a Yeti named Burt riding his sled down a steep hill. Burt plays a game where he tries to wreck as many snowmen as he can.



1. Use the slider to set the **Snowmen** to 5. Check that the height of the sled is 25.0 m. Click

Play (▶). How many snowmen does the sled destroy? **1.23**

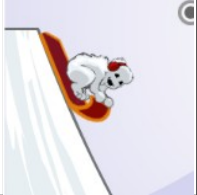
2. Click **Reset** (↺). Set the **Red sled mass** to 200 kg. Click **Play**. How many snowmen does the sled destroy this time? **2.45**

3. Click **Reset**. Drag the sled to the top of the hill so the starting height is 50.0 m. Click **Play**.

A. How many snowmen are destroyed now? **4.90**

B. Why do you think this is so? **When Burt starts higher on the hill, he has more potential energy that is transferred into kinetic energy as he goes down the hill which allows him to destroy more snowmen.**



<p>Activity A: Acceleration and speed</p>	<p>Get the Gizmo ready:</p> <ul style="list-style-type: none"> • Click Reset. Check that One sled is selected. • Set the Red sled mass to 100 kg. • Set the Number of snowmen to 0. • Check that the height of the sled is 50.0 m. 	
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Introduction: **Speed** is a measure of how fast an object is moving. It is defined as distance moved per unit of time. In this Gizmo, the units of speed are meters per second, or m/s.

Question: What factors affect the speed of the sled?

1. **Observe:** With the sled at 50.0 m, click **Play**. Observe the **Red sled speed** speedometer.
 - A. What happens to the sled's speed as it moves down the slope? **It increases**
 - B. **Acceleration** is a change in speed or direction over time. In what *two* ways does the sled accelerate as it descends? **It accelerates downwards and to the right.**
 - C. Click **Reset**. This time, focus on the speed of the sled after it reaches the bottom of the hill. Click **Play**. What do you notice? **It stays the same.**
 - D. Does the sled accelerate after reaching the bottom? **No** Explain. **The acceleration is caused by gravity pulling the sled down the hill, but once the hill's slope reaches 0, gravity can't accelerate the sled any faster.**
2. **Experiment:** Click **Reset**. Set the **Red sled mass** to 10 kg. Click **Play** and then **Pause** (⏸) after the sled reaches the bottom.
 - A. Look at the speedometer. What is the speed of the sled? **31.30m/s**
 - B. Click **Reset**, and change the **Red sled mass** to 200 kg. Click **Play**. What is the speed of the sled at the bottom now? **31.30m/s**
 - C. Try other sled masses. Does the mass of the sled affect its final speed? **No.**

In this Gizmo, there is no **friction**, so there is no force slowing the sled down. As long as there is no friction, the sled's final speed only depends on the starting height. In the real world, friction will affect the sled's final speed.

3. **Explore:** Click **Reset**. Use the Gizmo to measure the sled's final speed when it starts at a height of 10 meters and when it starts at a height of 40 meters. Record these speeds below.

Speed when starting from 10 m: **14.00m/s** Speed when starting from 40 m: **28.00m/s**

How does increasing the starting height affect the final speed? **When the height is quadrupled, the final speed is doubled.**

