NEWTON'S SECOND LAW: MASS, FORCE, AND MOTION

How do mass and force affect motion?

Newton's Second Law of Motion states that the speed and the direction of an object's motion depend on the mass of the object and the sum of all the forces acting upon it.

To better understand Newton's Second Law of Motion, Marissa and Kendrick conduct their own experiments. Read about their experiments, and then answer the questions.

PART 1: SLINGSHOT EXPERIMENT

Marissa has a new slingshot. She wants to figure out which of these two marbles will travel farther.

 **Marble A** is a typical marble.

 **Marble B** is bigger than Marble A, and it has a greater mass.

1. Marissa puts Marble A in the pocket of the slingshot. She pulls the pocket back 12 inches and then releases it. What happens to the marble? Explain why.

The marble flies through the air because the slingshot applies a force to the marble.

2. Marissa then pulls the pocket back 18 inches and launches Marble A in the same direction and at the same angle as before. Will the marble travel farther than before? Explain why or why not.

The marble will travel farther because, by pulling the slingshot back farther before releasing it, Marissa applies a greater force to the marble.

3. Next, Marissa puts Marble B in the slingshot. She pulls the pocket back 18 inches, keeping the direction and angle the same as before, and releases it. Will Marble B travel farther than Marble A did in the previous launch? Explain why or why not.

No, Marble B will not travel farther than Marble A. The slingshot applies the same amount of force to both marbles, but Marble B has a greater mass than Marble A. So, it takes more force to move Marble B the same distance as Marble A.

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Keep going! Answer the questions below.

PART 2: RAMP EXPERIMENT

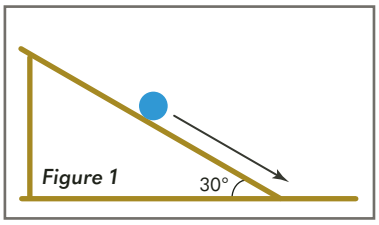
Kendrick is conducting an experiment by rolling balls down a ramp. The ramp is propped up at a 30° angle. The balls are all the same size, but they are different colors and made of different materials.

The blue ball is rubber. It has the least mass.

The red ball is wooden. It has more mass than the blue ball but less mass than the gray ball.

The gray ball is steel. It has the greatest mass.

1. Kendrick holds the blue rubber ball **halfway** up the ramp and releases it *(Figure 1)*. The ball rolls down the ramp and along the floor beyond the end of the ramp.



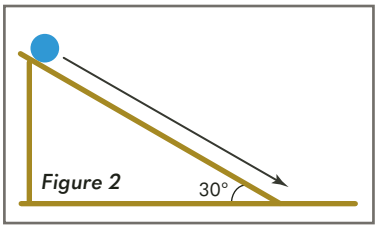
a. What force caused the ball to roll down the ramp?

Gravity

b. Why did the ball continue rolling along the floor after it left the ramp? According to Newton's First Law of Motion, the ball's inertia will cause it to continue rolling after it reaches the floor.

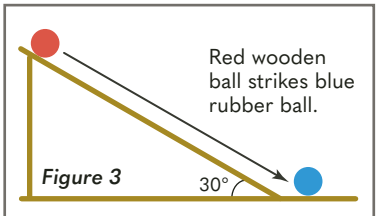
c. What force caused the ball to eventually come to a stop? Friction

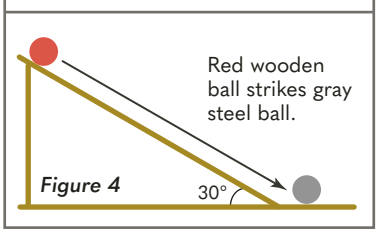
2. Kendrick then places the same blue rubber ball at the top of the ramp and releases it *(Figure 2)*. When the ball reaches the floor, is it moving faster or slower than it was when it was released from halfway up the ramp? Explain why or why not.



The ball accelerates as it rolls down the ramp, so the ball released from the top of the ramp will be moving faster by the time it reaches the floor than the ball released from halfway up the ramp.

3. Kendrick places the blue rubber ball at the base of the ramp. He puts the red wooden ball at the top of the ramp and releases it. The wooden ball rolls down the ramp and strikes the blue rubber ball, causing it to move *(Figure 3)*. Kendrick then repeats this process, but he places the gray steel ball at the base of the ramp instead of the blue rubber ball *(Figure 4)*. Which ball moves farther, the blue rubber ball or the gray steel ball? Explain.





The blue rubber ball will move farther. The red wooden ball provides the same amount of force both times, but the gray steel ball has more mass than the blue rubber ball. It would require more force to move the gray steel ball the same distance as the blue rubber ball.