Grade 6 Science

Week of February 8 – February 12

Newton's Second Law

Force and Mass

Second Law and Mass:

Which object takes more force to move across a table - a pencil or a text book? What about the desk? Would it take more force to move?

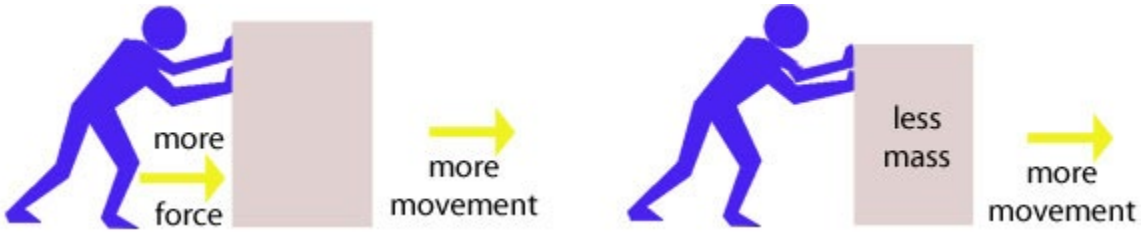
Newton observed this also and made a **second law of motion**. This law says that the greater the mass of an object, the more force is required to move it. That's pretty easy to see - heavier things are harder to move than lighter things.

Second Law and Force:

If you applied the same force on the pencil that you used to move the book, what would the result be? You may notice that the **greater the force** on an object, the **more** it's going to move or ***accelerate*** (speed up or slow down).

Newton's second law also says that the more force that's applied, the more it will move.

So there are two factors that affect the acceleration of an object - the **mass** and the **amount of force** applied.



You'll remember from the unit on gravity that weight and mass are not exactly the same thing. Mass means how much stuff is in an object and weight is the effect of gravity on that object.

Remember that the force needs to be an unbalanced force. If the forces are balanced there will be no change in the motion of the object.

Examples

Example 1:

A skateboarder pushes his foot off the ground with a force of 120N. The skateboard experiences an overall resistance "drag" (friction on wheels and air resistance combined) of 100N. Examine the picture below.

Question: Balanced or unbalanced forces? How can you tell?

Question: Describe the motion.

Example 2:

A boy pushes on a cart with a force of 20N to accelerate the cart. What would happen if you pushed the same cart with twice as much force?

Example 3:

What if the boy above pushes on a cart (no friction) but only needs half the acceleration. How hard should he push?

Example 4:

A hockey puck is shot across a frozen pond. If ice friction and air resistance are neglected, the force required to keep the puck moving at a constant velocity (no acceleration) is:

Example 5:

If an elephant were chasing you, its enormous mass would be most threatening. But if you zigzagged, its mass would be to your advantage. Why?

 Let's observe the resulting acceleration this time: https://youtu.be/ryfpndMXa7I

$$F_{net} = ma$$

This equation describes how a change in motion is related to both force and mass.

Recap:

The **more mass** an object has the **more force** needed to **make it accelerate**.

But will this law hold up in outer space?

Check out this video to find out; make sure you follow along in your Learning Guide!

 STEMonstrations: https://youtu.be/sPZ2bjW53c8

Answers: **Example 1-** Since the forces are not longer EQUAL and OPPOSITE we say that they are unbalanced (since they no longer cancel each other out); Since his push force is greater than the overall resistance of the board, the skater will accelerate (speed up) to the right. Note that if the force is unbalanced, his motion changes (speeds up). **Example 2-** the cart would accelerate by twice as much. F=ma and the mass is the same, so if F is getting bigger, then "a" would be getting bigger. **Example 3-** F = ma. For half the acceleration (speeding up at half the rate), you'd only need half the force (mass is the same). **Example 4-** Since we know that the acceleration is zero, then F = ma = 0. **Example 5-** Changing speed and/or direction takes a net force. The elephant (with it's greater mass) would require a greater net force.

Rollercoasters

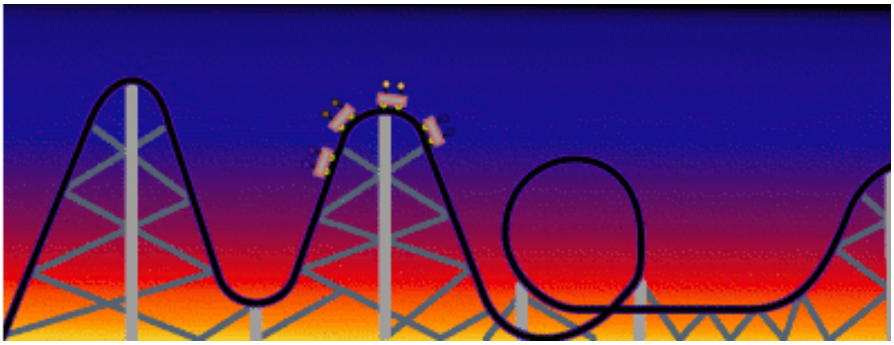
Did you know, that unlike cars and trains, rollercoasters are almost entirely propelled by the **force of gravity**? If you've ever been on a rollercoaster, you'll know that they begin with a steep hill in which the rollercoaster car climbs. But once you reach the top, the force of gravity takes over for the rest of the ride.

- Gravity slows the car down when climbing a hill
- Gravity speeds the car up when descending a hill

So how does Newton's Second Law Relate to Rollercoasters?

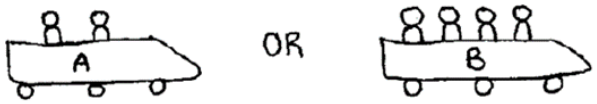
Well, rollercoasters heavily rely on **acceleration**! Rollercoaster designers have to use physics to carefully calculate each part of the rollercoaster so that it runs smoothly.

Think about when you have a rollercoaster with a loop in it. How do you ensure that the rollercoaster car holding all the people in it will be able to safely make it around the loop? Well, we rely on there being **enough acceleration before the loop** to ensure that the coaster is both thrilling, and safe! You'll notice that before every loop, there is either a hill or another loop that helps accelerate the car enough to make it around the loop.

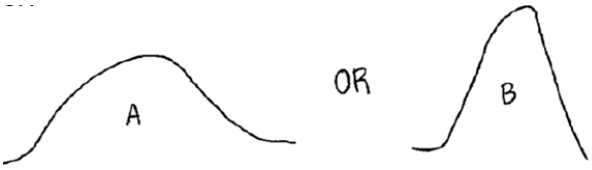


Knowing what you know about Newton's Second Law, answer the following questions in your learning guide:

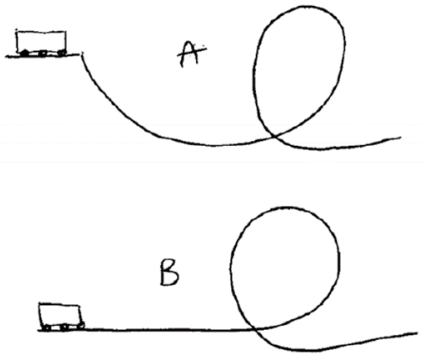
1) Which rollercoaster car will need **more force** in order to **accelerate**?



2) Which hill will give a rollercoaster car **more acceleration** on the way **down the hill**?



3) Which rollercoaster car is **more likely** to **make it around the loop**?



Build your own rollercoaster!

Watch the following video to see how you can build your very own marble rollercoaster using paper and tape! I challenge you to make at least 1 loop in your course.

Paper Rollercoasters: https://youtu.be/U7XYzPfutBs

1. Granny Gertrude is trying to weed her garden. The weed she is pulling has **a mass of 2 kg** and it's starting to uproot from the ground (accelerate) at **1 m/s^2**. What is the **net force** being applied to the weed?

Show all of your work!

2. What are the two factors that affect the acceleration of an object?

3. True or False: If the force being applied to an object is balanced, there will be no change in the motion of the object.

a. True

b. False

4. Watch the following video to answer the following questions. **Video:** STEMonstrations: Newtons 2nd Law of Motion

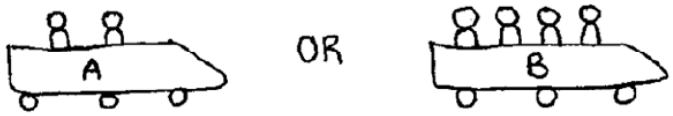
1) Which object accelerated the slowest? Why?

5. Fill in the blanks: On a rollercoaster…

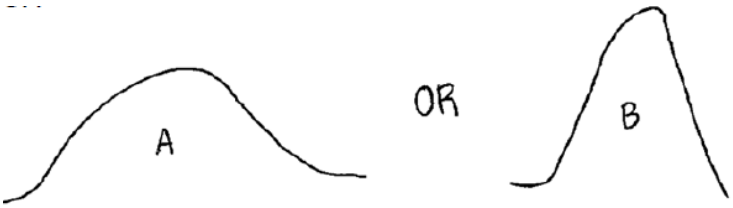
• Gravity _____ the car down when climbing a hill

• Gravity _____ the car up when descending a hill

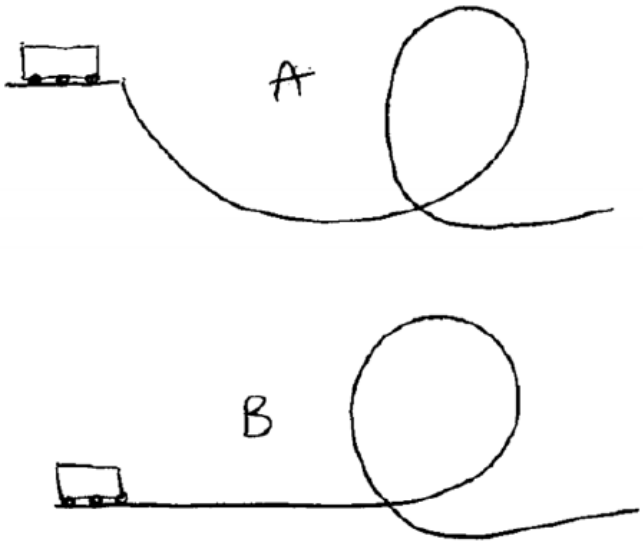
6. Which rollercoaster car will need more force in order to accelerate? Circle the correct answer.



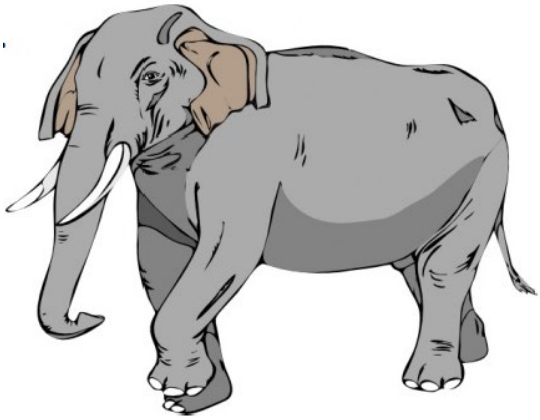
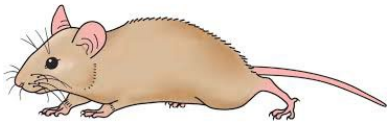
7. Which hill will give a rollercoaster car more acceleration on the way down the hill? Circle the correct answer.

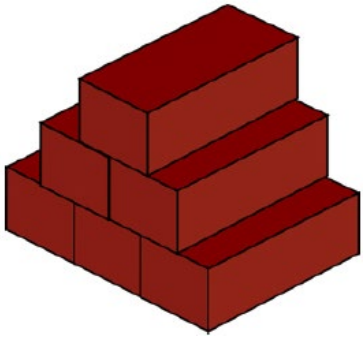


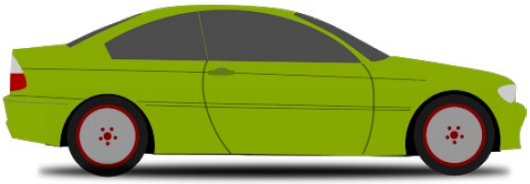
8. Which rollercoaster car is more likely to make it around the loop? Circle the correct answer.

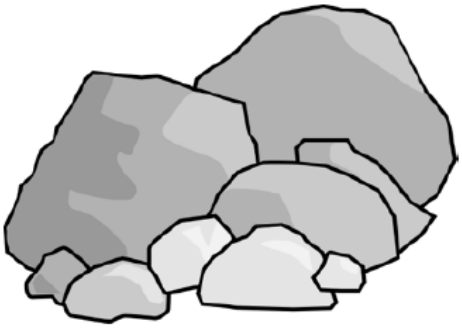


9. If you applied the **same amount of force** to each object below, which would accelerate faster? For each pair, **circle** the object that would **accelerate faster**.

a.  or 

b.  or 

c.  or 

d.  or