Grade 6 Science

Week of February 22 – February 25

Newton's Third Law

Balanced or Unbalanced?

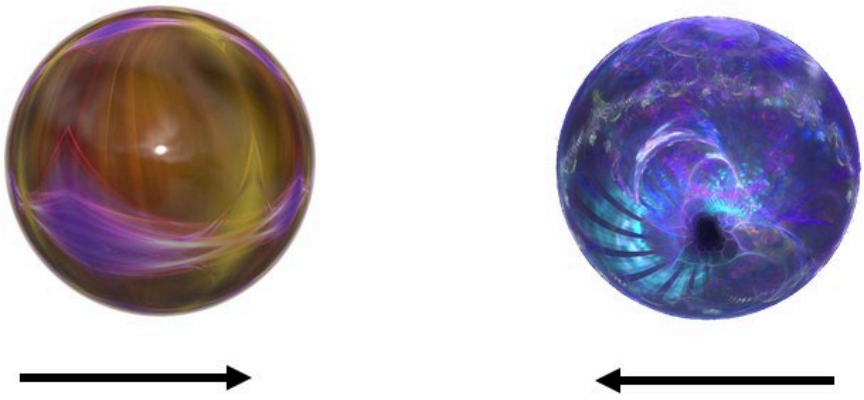
Two Kids Run Into Each Other with Exercise Balls: https://youtu.be/7emtUIOyzBg

As you can see in the above video, one child is both older and bigger than the other child. This child can exert more force than the younger, smaller child. So when they run together with the balls, what happens? The **forces are unbalanced**, and the smaller, younger child goes flying backward.

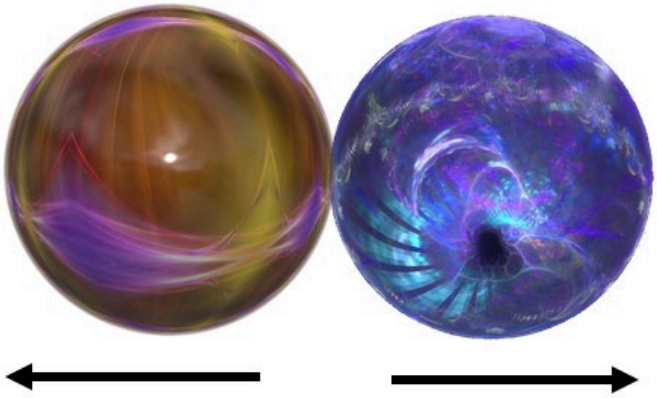
Balanced and Unbalanced Forces and Newton's 3rd Law

- If two objects are moving towards each other and collide that have the **same amount of force** (balanced), both objects will experience forces that are equal in magnitude (strength) and opposite in direction. For example, if you and your friend are playing marbles, and you flick each of your marbles towards each other.

Both marbles have the same mass, and have the exact same forces acting upon them



When they collide, they will change direction, but both will have the same velocity.

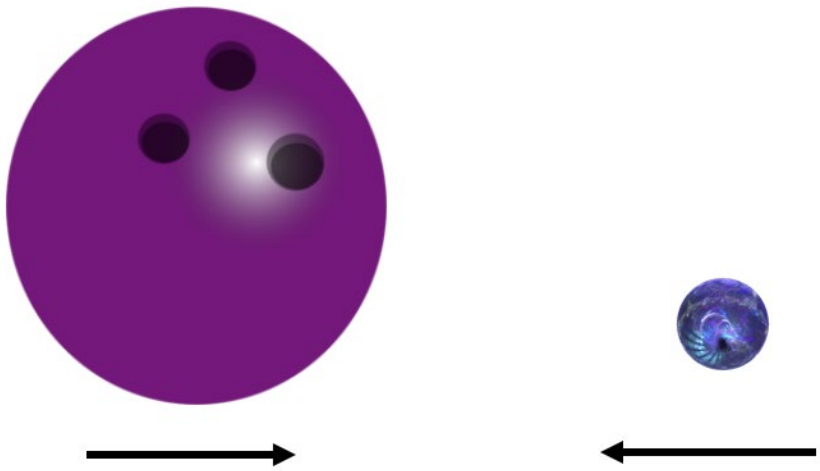


Action: Marbles colliding

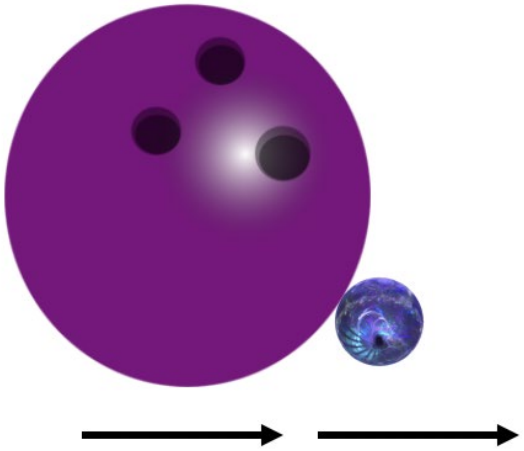
Reaction: Marbles changing direction

- If two objects are moving towards each other, and collide that have **different amounts of force** (unbalanced) the object with more force will continue moving in its original direction, and the object with less force will change directions. For example, if you roll a bowling ball, and your friend rolls a marble towards each other...

The bowling ball has more mass than the marble



When they collide, the bowling ball will continue to move in the same direction, while the marble will change directions



Action: Bowling ball and marble colliding

Reaction: Bowling ball slowing down slightly (from the force of the marble) and marble changing direction (from the force of the bowling ball)

Newton's Pendulum

As we know, Newton's 3rd Law states that for every action, there is an equal and opposite reaction. Check out the video below to see how a device called Newton's Pendulum demonstrates this law:

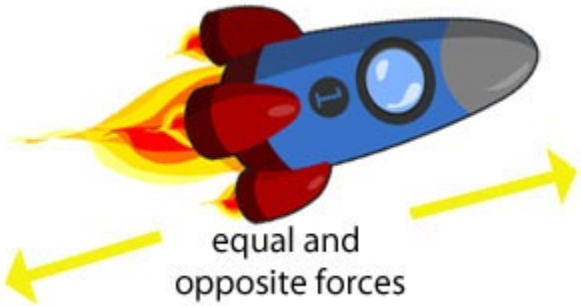
Bill Nye and Newton's Pendulum: https://youtu.be/JtctIfNcgN4

Rockets

Newton's Law's of Motion: https://youtu.be/cP0Bb3WXJ_k

Rockets in space need a force to get them moving. They have nothing to push off of.

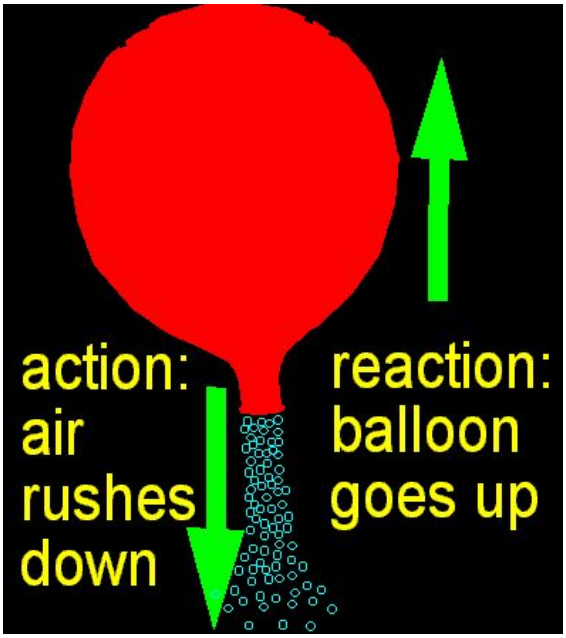
But if they use rocket fuel to create a movement backwards, there will also be a movement forwards and the rocket will move in space.



Imagine you have blown up a balloon. You're pinching the balloon shut so that air cannot escape. But, as soon as you let go, air rushes out of the balloon, sending the balloon shooting up into the air.

Action: Air rushing out of the balloon

Reaction: The balloon shooting up into the air



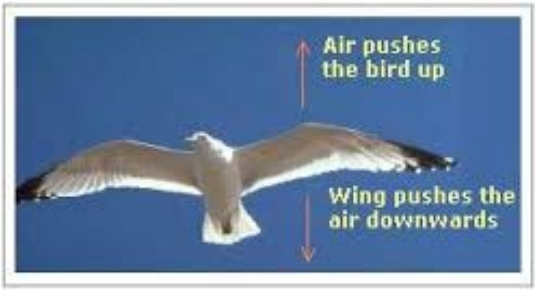
The heavier an object is, the more force you need to be able to send it up into the air. For instance, a balloon will shoot into the air a lot easier than a rocket ship! Check out the Science Max video below to see how more mass needs more force.

Examples

Consider Newton's Third Law and how it applies in the following cases?

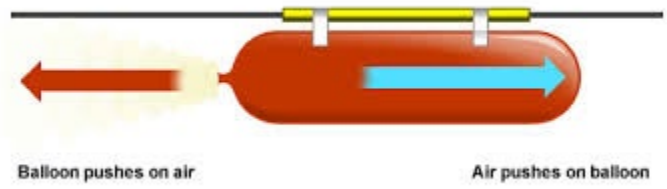
Example 1:

How does a bird flapping its wings rise up into the air?



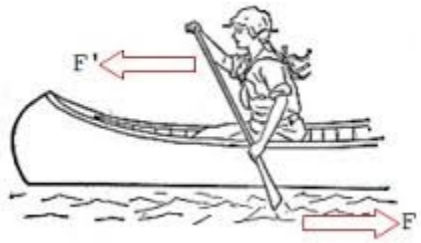
Example 2:

How does a balloon on a string (as below) accelerate when you release the end?



Example 3:

How do you get a canoe moving with your paddle?



Example 4:

There are lots of videos out there of people making the following mistake. Why is this such a bad idea?

Solutions: **Example 1-** As the bird's wings push the air down, the air pushes the bird's wings up; **Example 2-** As the balloon pushes the air out and to the left, the air pushes back on the balloon to the right.; **Example 3-** PAs your paddle pushes the water backwards, the water pushes the paddle forwards.; **Example 4-** As you push on the canoe, you expect to get a good push back from the canoe. Unfortunately the canoe moves very easily, so it can't provide the force you're expecting. Thus the equal and opposite force you'd get from pushing-off on the ground isn't available when you push-off of a canoe.

Demonstrations

For each video shown below, try to identify which of Newton's three laws is being demonstrated. If there is more than one law, try and rank them in order of importance.

Scenario 1

Tablecloth Demonstration: https://youtu.be/JqZOUgACPF0

Tablecloth Chaos: https://youtu.be/lK1ci50DUgc

Scenario 2

Fire Extinguisher on a Skateboard: https://youtu.be/pAb8eT-hU0w

Scenario 3

Ramp Roll: https://youtu.be/HwOKFJpIHts

Scenario 4

https://youtu.be/LPnQiXm1-kw

Solutions: **Scenario 1**- This is a classic demonstration of Newton's First Law. The plates are at rest and want to remain at rest, we say that the heavy plates have a lot of inertia. When the table cloth is pulled quickly, the plates keep their original motion (stationary); **Scenario 2**- This is mainly demonstrating Newton's Third Law. When the fire extinguisher is opened, the chemicals in the extinguisher are pushed out the back (by the pressure inside the container). This backward force (releasing the chemicals) is countered by an equal and opposite force that acts on the man and the skateboard. As a result, the skateboard moves forwards. This would also be an example of Newton's Second Law. The force acts on a heavy mass (man plus skateboard) causing them to accelerate (speed up) in that direction. Since the mass is large, the acceleration is small (speeds up slowly); **Scenario 3**- This is mainly demonstrating Newton's Third Law. When the cylinder rolls down the ramp it pushes down on the ramp. This force is equal and in the opposite direction and causes the ramp to move backwards. This could also be an example of Newton's Second Law. The force acting on the ramp cause the ramp to speed up much more slowly than the cylinder. This is because the mass is large, causing a small acceleration (speeds up slowly.); **Scenario 4**- This is a great example of Newton's Second Law. The forces acting on each of the balls are caused by blowing on the straws and can be considered to be roughly the same. The *smaller the mass*, the more quickly it speeds up (*larger acceleration*). All of the forces cause the balls to accelerate in the same direction of the force (away from the straw). We would also consider Newton's First Law. The more inertia (mass) a ball has, the more it *wants to remain stationary*. We see the heavy steel ball is hard to get moving because it has so much inertia (mass), while the light wooden ball has less inertia and moves easily.

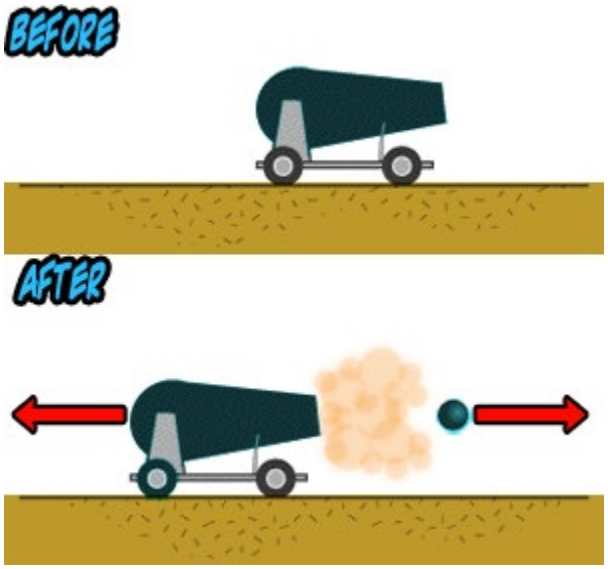
Examples

Consider Newton's Third Law and how it applies in the following cases?

Example 1:

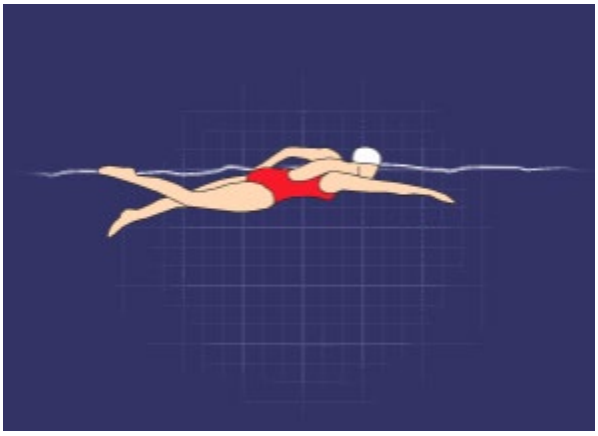
If you watch old pirate shows, you'll see the canons jump backwards during each shot.

If you were to use more gun powder to put a bigger force on the ball, what happens?



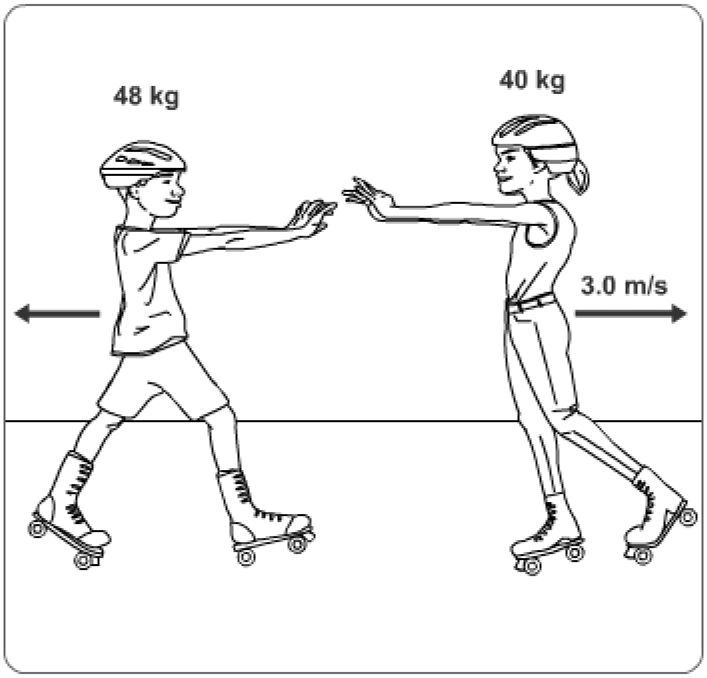
Example 2:

Swimmers make their hands flat when they push back on the water, but try to keep out of the water when they move their hands to the front. Why is this?



Example 3:

Two people on roller skates push off of each other. What do you know about the speed in which the boy is pushed away?



Solutions: **Example 1-** The bigger the force on the canon ball, the bigger the force on the canon. Therefore, the canon would jump backwards even more; **Example 2-** The swimmer wants the water to push them forward, not backwards. Therefore when pushing the water backwards, they push with as big of force as possible. When they push the water forwards (are going forward) they want to push as little as possible, so they stay in the air, then "spear the water; **Example 3-** The both experience equal and opposite forces, so we consider Newton's Second law (F = ma). Since the Force is the same and the boy's mass is bigger, we note that his acceleration will be smaller. Therefore his velocity will be less then 3 m/s.

1. Watch the following video to answer the following questions. Video: Newtons 3nd Law of Motion

Describe the forces involved when 2 people collide.

When two objects with unequal masses collide, they _____

Acceleration is _____.

The object with smaller mass will _____.

What happens when a baseball bat hits a baseball?

Summary:

2. For every action there is an _____ and _____ reaction.

When 2 things collide, they press against each other with _____ force in _____ directions.

When two things with uneven mass collide, the objects _____.

The object with the smaller mass will _____.

3. If two objects are moving towards each other, and collide that have the _____ of force (balanced), both objects will experience forces that are _____ (strength) and _____ in direction.

4. If two objects are moving towards each other, and collide that have _____ amounts of force (unbalanced) the object with _____ will continue moving in its original direction, and the object with _____ will change directions.

5. If two people on skates push each other, the force on each is _____ and _____. If one of the skaters is much bigger than the other (more mass), then the _____ will have less change in motion.

6. Describe three examples where people or animals use Newton's Third law to move themselves (don't reuse any from the examples in lessons).

a. _____

b. _____

c. _____

7. When a car hits a mosquito, they exert equal and opposite forces on each other. What's the real difference experienced by the mosquito vs the car?