

# Balloon Rocket Teacher Notes

## Balloon Rocket

### Educational Objective

To see the phenomenon of Newton's Third Law, which states that for every action there is an opposite and equal reaction, and how it relates to Space.

Although, Newton's Third Law is not a concept taught in the UK Curriculum for Key Stages 2 or 3 introduce the idea to the students because in our testing students were able to understand that the balloon shot down the rocket due to air being released from the balloon. Students just did not know the title of this concept was Newton's Third Law, but once introduced to the topic students were able to make a clear link the Newton's Third Law and space shuttle launches.

### Key Learning

- When the balloon is let go the air escapes the balloon because the balloon wants to return to its initial state, which is the action, and as a reaction the balloon shoots across the string. This clearly displays Newton's Third Law of Motion, which states that for every action there is an opposite and equal reaction.
- For Space exploration a space shuttle uses Newton's Third Law of Motion. During the beginning stages of take off the space shuttle releases lots of Energy in the form of fuel. This causes the space shuttle to shoot upwards overcoming the forces of gravity and eventually the ozone layer.

### Materials

- 1-2 long party balloons
- Plastic straw
- Dental Floss
- Sticky tape
- Two tables/chairs/desks/clamp stands
- Marker
- Ruler or Measuring tape

### Procedure

This experiment should be completed in teams of 3 or more. The challenge of a race should be implemented to provide competition for the students.

- 1- Cut a straw in half. Get rid of the bendy part of the straw.

- 2- Thread the floss through the straw.
- 3- Tie the end of the floss to the two ends of the course. Make sure the floss is pulled as tight as possible.
- 4- Blow up the balloon. DO NOT TIE IT. Hold the end shut.
- 5- Hold the balloon under the straw.
- 6- Tape the balloon to the straw.
- 7- Release the balloon.
- 8- Use the pen to mark how far the balloon travelled.
- 9- Record the distance travelled.

The average distance of all the balloons can be calculated for the experiment. Also, many runs can be completed in which each group can calculate their own average distance.

## **Practicalities**

Long party balloons work better than usual round balloons. Round balloons can be used for this experiment but a pen or pencil needs to be added to the bottom of the balloon to add weight to it.

If using latex balloons ensure there are NO latex allergies in the classroom.

The dental floss can be waxed or un-waxed. It can also be flavoured we recommend using the mint flavour for a minty fresh smell in the classroom. Do not use the end part of the dental floss roll it is not smooth enough for the Balloon Rocket to travel on.

## **Open-ended Investigation**

For a more inquiry-based activity, ask the students to create something that can travel along the string with the furthest distance. Provide them only with materials for the experiment. You can show a test run of the Balloon Rocket and tell them to create something similar to your design. Set requirements of what the students can change and what they cannot change from your original design to make the balloon rocket travel further.

## **Discussion Ideas**

- What is causing the balloon to shoot forward?
  - The balloon is shooting forward due to the balloon releasing air, which shows Newton's Third Law in Action.
- Which direction is the balloon moving with respect to the initial action?
  - The balloon is moving opposite of the initial action which was out of the balloon, and the balloon is moving forward as a reaction.
- Would the amount of balloons effect the outcome of the balloon rocket?
  - If another balloon was added onto the rocket it would travel further due to the fact more air is being released from the balloons.

- Why is it important for space shuttles to release so much energy on take off? Besides gravity what other major barrier must a space shuttle overcome?
  - It is important for space shuttles to release so much Energy during to take off because they must overcome the force of gravity pulling them down. Also, they have to travel a very long distance meaning the initial action must cause a very big and long reaction. The other major barrier a space shuttle must overcome besides gravity is the Earth's atmosphere.

## Extensions

Have two balloon rockets at each end of the string. For this extension to work the course must be straight across and pulled as tightly as possible during the experiment.

- Release them at the same time or one shortly after the other
- Have two different size balloons
  - What occurs when they collide?
  - Why does that happen?
- Explain what role forces are having in the collision

When two balloons collide at the same with equal amount of air inside the will collide and stop in the middle due to having equal forces upon collision. If one balloon is bigger then the other or released before another the one with greater force will push back on the other one with a small force.

- Have students test out different shape, size, and coloured balloons.
- Test the effect of accessories added onto the balloon such as feathers or wings.
- Have students set up a longer course along the classroom and implement a relay-race
  - One Balloon Rocket is released and when it hits the next one that Balloon Rocket is released, and so on and so forth.

## Links to the Curriculum

- Forces
- Solar System and Beyond
- Mathematics
  - Averages

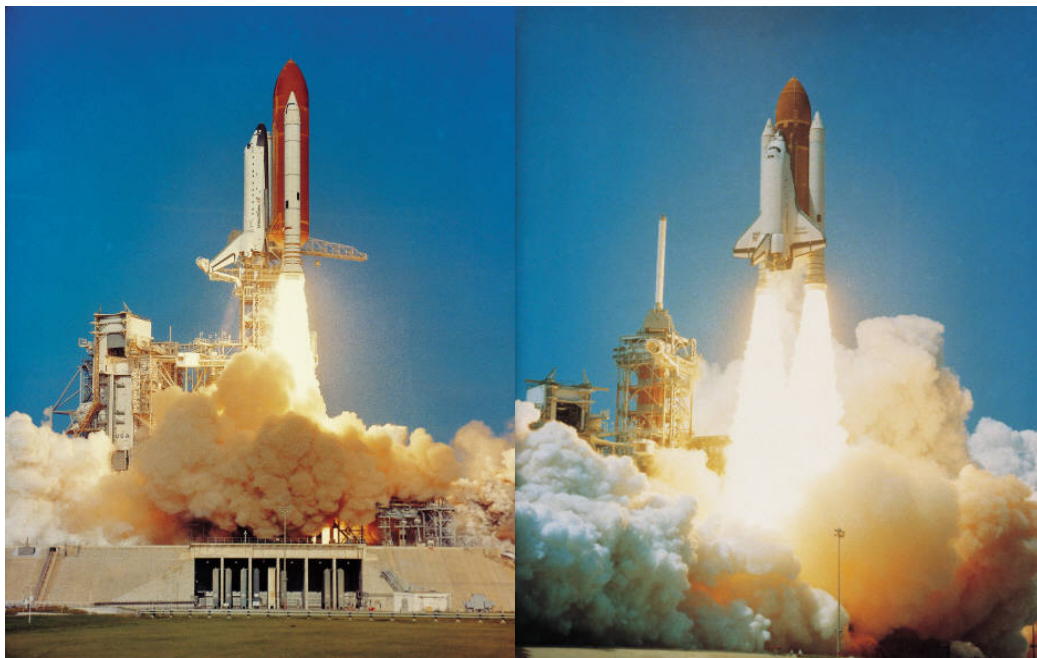
## Links to the Science Museum

- Rocket Show in Launchpad
- Space Gallery

- Discuss historic and modern day space travel
- What information has been received due to Space Exploration
- Gene Cerman drama character in Space Gallery
- IMAX Space Show

## Links to Everyday Life

In order for a space shuttle to be launched into space scientist use Newton's Third Law of Motion, which states for every action there is an opposite and equal reaction. The scientists use this law in order to have the shuttle overcome the forces of gravity; therefore, it releases energy downward to help lift the shuttle upwards.



Fire-fighters use Newton's Third Law of Motion while fighting fires. Fire-fighters use a fire hose, which shoots out water at extremely high speeds. The force of the water coming out of the hose causes a force to react back upon the hose. For this reason many fire-fighters have to securely hold on to the hose and in order to direct it in the correct path.



# Circus Activity Teacher Notes

## Circus Activity

The following three experiments can be used together in stations or individual to explain one topic.

## Cuddling Balloons

### Educational Objectives

Understand the effects of air pressure on objects. Objects will move when there is a change in air pressure.

### Key Learning

- A difference in air pressure can either attract or repel objects in certain directions depending on where the areas of pressure change occur.
- For example, in this experiment when students blow between the balloons the outside area of the balloons experiences a higher air pressure than in between the balloons.
- Low air pressure is observed in between the balloons because of higher air speed travelling through that area.

### Materials

- 2 regular round balloons
- String or ribbon
- Coat hanger
- Water
- Scissors

### Procedure

- 1- Fill a deflated balloon completely with water, without letting it expand.
- 2- Blow the balloons up to about a 45cm circumference. (about the size of a small coconut)
- 3- Tie the balloons shut.
- 4- Cut two pieces of string equal in length with scissors
- 5- Tie the string onto the ends of each balloon (one string per balloon)
- 6- Tie the other ends of the string to the bottom part of the coat hanger, the balloons should hang around 20 to 30cm long.
- 7- Make sure each balloon is tied at equal length and are separated no more than **5 cm** from each other. (DIAGRAM)

- 8- Hang the coat hanger from a stable surface so that the balloons are dangling freely in the air (at equal length). Or have someone hold the hanger steady.
- 9- Balance the balloons and ensure they are steady.
- 10- Blow in between the two balloons
- 11- Observe what occurs

## Practicalities

Wire coat hangers work much better than plastic hangers, due to being very easy to tie the balloon onto.

Any type of round balloons can be used for this experiment.

## Open-Ended Investigation

Set a challenge for the students to have them try to have the two balloons to touch each other. The students who do this with the maximum distance between the balloons, smallest size balloons, and in the shortest amount of time win.

## Discussion Ideas

- What force is causing the results?
  - Explain why you observe those results.
    - These results occur due to a change in air pressure. When the air is blown in between the balloons low pressure is observed due to the high speed of the air travelling through. On the outside of balloons is high pressure and high pressure travels to low pressure causing the balloons to “cuddle”
- Where did you blow the air on the balloons?
  - The air was blown in the middle of the two balloons
- In what location was it most effective to blow in order to have the balloons/rolls meet one another?
  - The most effective way to do this experiment was to blow in the middle of the balloons. Although, it may have appeared that blowing at the sides would bring the balloons together it did not. The only time the balloons would touch if blowing from the sides would be if the balloons were not steady and hit each other due to that.
- Will the speed in which the air is blown affect the experiment? Why?
  - Yes, the higher the speed of the air blown the more drastic of a change to low pressure will occur. This is because the speed of the air is directly proportional to the observation and degree of air pressure.

## Extensions

- Attempt to make four balloons come together.
  - How should the balloons be set up?
  - How many people do you need to blow?

During our testing of this extension we did not obtain results, but it is still a good investigation for your students, which will provoke scientific discussions. Who knows maybe your students can figure a way out we did not try.

## Links to Curriculum

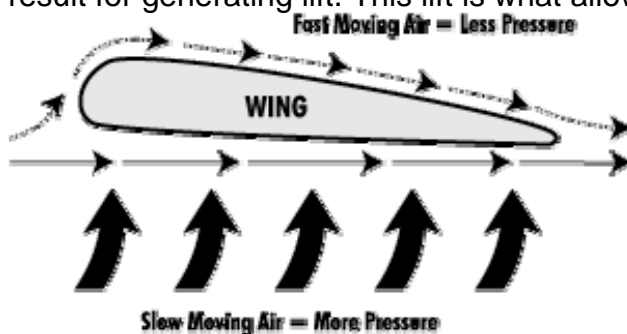
- Forces
- Pressure and its moments
- Geography and Weather

## Links to Science Museum

- Flight Gallery
  - Discuss the shape of the plane and where the change in air pressure occurs
- Feel the Force Show

## Links to Everyday Life

Airplanes follow the same concept when they are being designed. The designers must understand the effects of air pressure on the airplane in order to determine whether or not the plane will be capable of flying. Knowing that air pressure travels less on top of the wing and more on the bottom is the result for generating lift. This lift is what allows airplanes to fly in the sky.



<http://ksnn.larc.nasa.gov/pokemon/unseen/images/wing.gif>

Builders also use air pressure within certain tools. An air nail gun uses a change in air pressure to move the piston within the gun. With the move of the piston the gun propels the nails into deep and thick materials, such as a slab of wood.





[http://www.bishop-gmbh.com/images/aircraft\\_design.jpg](http://www.bishop-gmbh.com/images/aircraft_design.jpg)

## **Airplanes vs. Bottles:**

The similarities of Air Flow

### **Educational Objective**

Understand the need for circular shaped objects for flight, and how air travels along those objects.

### **Key Learning**

- When you blow directly in front of a circular object the air is not stopped by this object, instead it travels around the object. This demonstrates the movement of air around objects.
- This is an important topic to understand because the ability for air to travel around an object allows the ability to fly to exist.

### **Materials**

- Plastic circular bottle (500mL to 2L)
- Strips of paper (about 10cm long and 2.5 cm wide)
- Sticky tape

### **Procedure**

1. Tape end of the 10cm strip of paper to table or desk.
2. Place bottle about 10cm in front of sheet of paper
3. Blow air directly at the middle of the bottle (DIAGRAM)
4. Observe movement of paper

### **Practicalities**

The bottle can be any size, but must be circular to show the significance of an airplane's wings shape. To help the bottle stay in place about one quarter of the bottle should be filled with liquid.

## Discussion Ideas

- Why is the paper moving even with a bottle directly in front of it?
  - This is due to air's ability to move around circular objects. For that reason the bottle is not stopping the air from moving it is just obstructing its path forcing it to travel around the bottle.
- Describe the significance of the experiment in terms of flight.
  - This is important for flight because the shape of the wing must be circular to allow air to travel around it. This helps provide the airplane lift as well.
- Will changing the distance between the bottle and the piece of paper alter the results? Why or why not?
  - Pushing the bottle further away, will only affect the experiment if it is placed significantly further away. For example, not on the same desk as the piece of paper. If moving the bottle closer to the piece of paper no change will be seen to the experiment.
- How does the speed of the air travelling effect the fluttering of the piece of paper?
  - The faster it travels the more the piece of paper flutters.
- Draw the movement of air that occurs in the experiment. (Template for bottle)
- Draw the movement of air around a plane's wing. (Template for Wing)

## Extensions

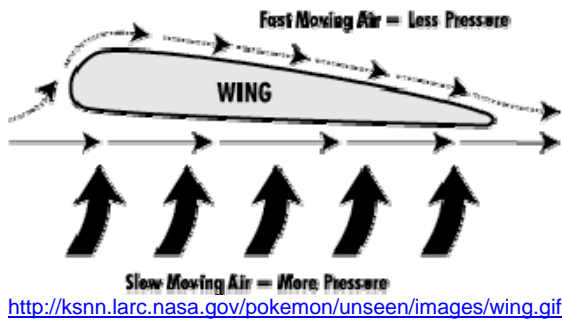
- Use different shaped and size bottles. Observe the differences or similarities in the movement of paper.
- Change the distance of the bottle from the paper along with the distance between you and the bottle.
- Try using a straw to blow onto the bottle
- Try blowing air harder and softer at the bottle.
- To study the concept of lift use the Paper Wing experiment

## Links to the Science Museum

- Flight Gallery
- Discuss how air travelled over different wings throughout history

## Links to Everyday Life

A wing on an airplane provides the ideal shape for air to travel over and around. When air travels over the wings of an airplane it helps provide lift for the airplane, providing it with the ability to take off.



Formula one racing cars are designed with a spoiler on the end and in the front of the car. The spoilers are essentially upside down wings, and provide stability to the formula one car. When a racing car reaches high speeds it begins to lift off the ground this is because the rest of the car is essentially designed to be a wing. Therefore, the spoiler provides stability for the car to stay on the ground.



## Paper Flyer

### Educational Objectives

To show that a change in air pressure can cause objects to be lifted depending on their shape.

### Key Learning

- Differences in air pressure can cause objects to be lifted depending on its shape.
- Curved or circular portions of a plane wing take a longer time for air to travel over, meaning the air must travel at a faster speed over the wing. While the air travelling along the flat surface of the wing does not have to increase its speed. These factors cause a difference in air pressure and provide lift for an airplane.

## Materials

- Sheet of A4 paper
- Straw
- String in length about 60 cm long
- Sticky tape

## Procedure

- 1- Fold the paper vertically.
- 2- Tape the two short ends of the paper together, still preserving the oval shape in the middle.
- 3- Make a crease at the bottom of the oval shape.
- 4- Make a hole in the middle of the folded paper.
- 5- Stick a straw through the hole.
- 6- Tape the straw to the paper.
- 7- Thread string (60cm) through the straw.
- 8- Tie knot at bottom of the string.
- 9- Hold two ends of the string.
- 10- The oval shape should be facing the ceiling.
- 11- Spin in the direction the oval side is facing.
- 12- Observe what happens.

## Practicalities

Students could get dizzy during this experiment. Make sure students are taking breaks in between experiment runs.

## Open-Ended Investigation

Try to have the students figure out how to generate lift with the proposed resource. Do not tell them the direction the paper wing needs to be on the string, or what must occur for the paper wing to be lifted up on the string.

## Discussion Ideas

- What happened to the paper flyer?
  - What caused this?
    - The paper flyer lifted into the air. This is due to a change in air pressure. When spinning around with the paper flyer lift occurred due to the speed going across the wing making a difference in air pressure. The difference in air pressure causes the paper to lift.
- How does this relate to airplanes?

- This relates to airplanes because they use the same concept to force lift with their airplane, and the wing of the airplane is the same shape of the paper flyer.

## Extensions

- Try having students repeat this experiment with the wing placed upside down on the string.
  - Students should observe that no lift is generated with this set-up. Have students explain why this occurs, and describe the importance of the shape of the paper flyer.

## Links to the Curriculum

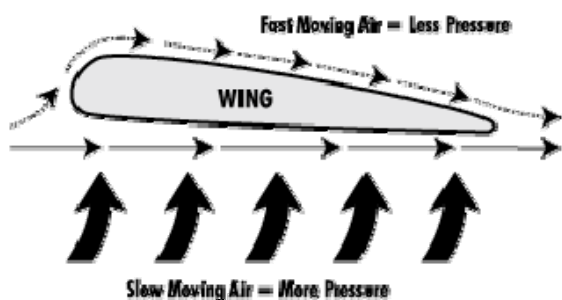
- Forces
- Pressure and its moments

## Links to the Science Museum

- Flight Gallery
  - Discuss the shape of the wing and how the help generate lift for the plane
- Feel the Force Show

## Links to Everyday Life

Airplanes use this concept when constructing their wings. Based on the shape of the wing, lower air pressure can travel on top of the wing while higher air pressure travels on the bottom. This generates the lift that airplanes use to fly.



<http://ksnn.larc.nasa.gov/pokemon/unseen/images/wing.gif>

# Spinners Teachers Notes

## Spinners

This experiment can be used in the Flight Gallery or in the Classroom

### Educational Objectives

To demonstrate how air influences the flight of an object based on its design.

### Key Learning

- When objects with flat wings are dropped, the time it takes to travel to the ground is delayed by the resulting air resistance that acts against the object's falling motion, which causes the wings to spin.

### Materials

- Paper template
- Paper clip

Extension:

- Box of paper clips

### Procedure

Refer to Picture Procedure

- 1- Fold the spinner where indicated
- 2- Attach one paper clip at the base of the spinner
- 3- Release (Drop) the spinner
- 4- Observe what happens

### Practicalities

The more accurate the spinner is folded in regards to the template, the better the results will be. If using in the museum, make sure that no artefacts will be interfered with in the experiment.

### Open-Ended Investigation

Have students design their own spinner without using the template provided. The template can be used by the teacher to guide their students in the right direction.

## Discussion Ideas

- What forces acted on the spinner?
  - In what direction to the forces act?
    - Air resistance is acting on the spinner along with gravity
    - Air resistance is working opposite the spinner and gravity is working with the spinner
- What causes the spinner to actually spin?
  - Air resistance is causing it to spin since it is pushing back on the flaps causing it to spin.
- Discuss the relationship between air resistance and speed.
  - The faster an object moves the less of an effect air resistance has on it.

## Extensions

- Try this experiment using more than one paper clip or other materials such as feathers.
  - What happens to the speed of the spinner?
  - Place the paper clips in other locations
    - Does this alter the results? Why?
- Try this experiment by changing the shape and size of the spinner
  - Try rolling the base of the spinner instead of folding it (DIAGRAM)
    - Can you get the spinner to land on its base?
    - How did you achieve this?
  - What effect does each change have?
  - Explain why
- Try throwing the spinner in the air
  - Observe what happens
- Explain the affect of mass on the spinner. Why is that occurring?

## Links to the Curriculum

- Forces and their effects
  - Air resistance
- Speeding Up!
  - Speed and its effect on air resistance

## Links to the Science Museum

- Flight Gallery

## Links to Everyday Life

Understanding how air travels through the blades of the helicopter and the importance of air resistance is critical for ensuring efficient and sustainable flight. Facilities such as hospitals and police station rely on helicopters to transport passengers or cargo over vast distances. Having this reliability allows these facilities to run smoothly and adequately.



<http://www.truckee-fire.org/images/images/Careflight%20lifting%20pad.jpg>  
[http://lh3.google.com/qtf\\_vzoBbaw/RkSZhXEsKxI/AAAAAAAAANC/M4kQ\\_RT4dDw/s800/100\\_0066.JPG](http://lh3.google.com/qtf_vzoBbaw/RkSZhXEsKxI/AAAAAAAAANC/M4kQ_RT4dDw/s800/100_0066.JPG)

Skydivers and army paratroopers use the force of air resistance with every jump they take. When jumping out of an airplane the force of gravity is pulling them down to Earth. The paratroopers then release their parachute. Releasing their parachute allows the force of air resistance to counteract the force of gravity. This allows the paratroopers to safely reach the ground.



<http://www.army.mil/nz/rdonlyres/106e6e3e-f65a-42a0-818d-29d1728ffde2/0/wn06003342.jpg>  
[http://www.blackfive.net/main/2005/09/paratroopers\\_at.html](http://www.blackfive.net/main/2005/09/paratroopers_at.html)



# **Light Upon Earth's Rotation Teacher Notes**

## **Light Upon Earth's Rotation**

### **Educational Objective**

To draw connections between the rotation of the Earth and the occurrence of night and day, seasons, and length of day and year, this is displayed in this experiment by the slow turning of the spherical object with a light source directly on it. The connections can be made from observing one object in a certain area and realizing it takes on full turn to return to its starting point and that is equal to a day.

### **Key Learning**

- The importance of rotational movement of Earth on its on axis

### **Materials**

- Sphere shaped object around 90cm in circumference (beach ball, globe, football etc)
- Direct light source (torch, slide or overhead projector)
- Blu tack (similar material)
- String
- Small figurines or other objects, (4.0-5.0cm in length and weigh no more than a pound)

Extension:

- Golf tees or corks

### **Procedure**

- Attach a 30cm piece of string to the spherical object (that represents the Earth). If there is no clear place to attach string make a new for the object. (DIAGRAM WITH OWN INSTRUCTIONS)
- Attach the small figurine to the sphere shaped object with blu tack. Ensure the figurine is on there securely.
- Hold the sphere shaped object in the middle of the room.
- Shine the light source directly at the sphere shaped object from the side
- Slowly turn the Earth (Ask students which direction the Earth should spin, they should respond with to the right or counter clockwise)
- Attach another figurine anywhere on the sphere shaped object with blu-tack.
- Slowly turn the Earth again
- Observe how the light hits the figurines

## Practicalities

The light source must be large enough to illuminate the whole Earth. If using an overhead projector you can cancel out the “extra” light by using a sheet of paper with a hole cut out of its center. Place this piece of paper over the light source.

When using the blu-tack to attach figurines it works best to first place it on the sphere shaped object and then attach the figurines to the sphere shaped object. You can also wrap the blu tack around the bottom of the figurine for a better hold.

## Open-ended Investigation

If using a globe ask the students to place the figurines on a location where neither of the figurines will ever be in light or darkness at the same time. Also, ask the students to place the figurines in locations where one sees the sunset the other sees the sunrise at the same time.

If not using a globe, ask students to draw the continents and certain countries onto the sphere shaped object.

## Discussion Ideas

- In what location does the sun rise and set?
  - The sunrises in the east and sets in the west.
- Would this change if the Earth rotated in the opposite direction?
  - The sun would then rise in the west and set in the east.
- Compare the location of where the sun sets with the two figurines?
  - Which one sees light first?
  - Can both be in light and darkness at the same time?
  - Or can only one be in light and the other be in darkness?
- Discuss why the Earth is split into time zones and why it is.
  - The Earth is split into time zones so that there is consistency with time all over the world. This way at 10pm in China it will be dark and when it is 10pm in the United Kingdom it will also be dark. Otherwise it could be light during normal hours in the United Kingdom, but in China it would be light during the times of 10pm to 5am for example. This compensates for the Earth’s rotation to allow all people throughout the world to experience the schedule.
- Discuss how long days are and why they are that long.
  - The length of a day is 24 hours, and that is due to the fact it takes the Earth 24 hours to spin about its on axis.
- Does the length of day change based on location? At the equator or at either pole?
  - The day length is still technically a 24 hour day, but at the poles not as much daylight is observed, and at the equator there isn’t as much darkness observed.
- What would occur if the Earth rotated faster or slower?

- If the Earth rotated faster the day length would be shorter than the usual 24 hours, and if the Earth rotated slower the day would last longer than 24 hours.
  - Ask your students if they wished the Earth rotated faster or slower? What would they do with the extra or decreased amount of time?
- Discuss the importance of the Earth's rotation? What would occur if the Earth didn't rotate?
  - The importance of the Earth's rotation is that without it certain locations would be in constant sunlight and others would be in constant darkness. We do not know if life could exist in such a situation, but it would not be pleasant in either situation. The rotation allows life to exist in "normal" schedule and routine with day and night.

## Extensions

- Attach a golf tee or cork to the Earth with blu tack at the location of your school. (latitude)
- Slowly turn the globe counter clockwise
- Observe the shadows made by the golf tee
- Attach three golf tees at different latitudes but along the same meridian longitude (place at the same point vertically)
  - One at the equator
  - One at your location
  - One near the either pole
- Have three students observe one of the golf tees
- Slowly spin the Earth
- Have students call out their golf tee (top, middle, bottom) as it crosses over the day-night boundary
- Observe the shadows

Discuss with the students the direction, size, and pattern of the shadows given off by the golf tees. Ask where the shortest shadow points. Compare it to the shadows given off by the previous figurines. Discuss the difference in day-night boundary and shadows depending on the position along the longitude. Also, you can take your classroom outside and ask for them to look at their own shadows and discuss those as well.

## Links to Curriculum

- Earth, Sun, and Moon
  - Key Stage 2
- Geography

## Links to Science Museum

- Space Gallery
  - Discuss the rotation of Earth and its importance to life and Space travel

- Extend the idea of Earth's rotation with the Moon's rotation around the Earth and its effect