STUDENT BOOKLET

STELR

EARTH, MOON AND SUN

NAME

CLASS

CONTENTS

THE MOTION OF THE EARTH, MOON AND SUN

The Earth, Moon and Sun are constantly moving through space. The Earth is moving around the Sun at approximately 30 kilometres per second. That's around the distance from Sydney to Perth in less than two minutes! The Sun is constantly moving too meaning the Earth is actually moving much faster than this compared to a fixed spot in space.

To understand the motion of the Earth, Moon and Sun it is important to be sure of a few terms to help us to describe their movement.

Research the following terms to find simple definitions that would be used to describe objects moving in space:

(NB. Some of these terms have other definitions that are not related to space. Be sure to choose an appropriate one.)

Orbit: ____

____

Revolution: ____

____

Rotation: ____

____

Axis: ____

____

FAST FACTS:

The Earth rotates on its axis once every 24hrs

The Moon rotates on its axis once every 28 days

The Earth completes a revolution of the Sun in 365.25 days

The moon completes a revolution of the Earth in approximately 28 days

Below is a diagram showing the motion of the Earth, Moon and Sun.

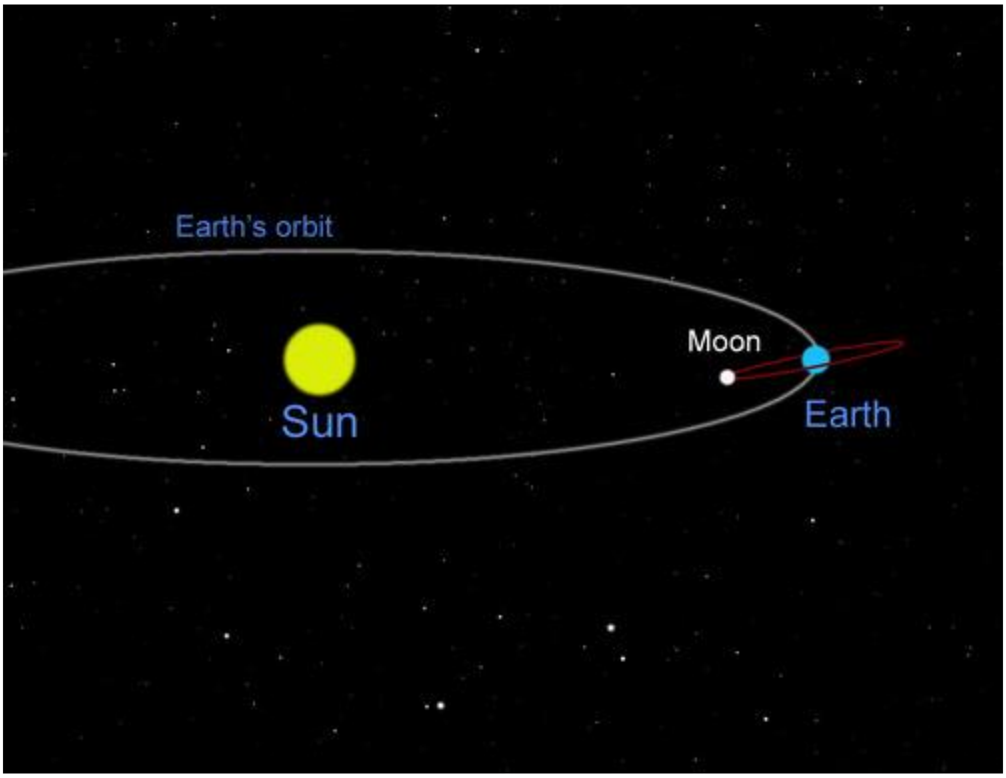


Figure 1: Orbit of the Earth and Moon

Source: http://astrobob.areavoices.com/astrobob/images/Moon_tilt_graphic.JPG

Activity:

Use the diagram above, your definitions and the fast facts to fill in the words in the passage below.

Words to use

revolution	**day**	**side**	**year**	**orbit**
complete	**Sun**	**28**	**24**	**rotate**

The Earth takes 365.25 days to orbit the _________. This is a complete ________________. The time it takes to do so is known as an Earth ___________.

The Earth also rotates on its axis once every _______ hours. This rotation is what causes the Earth to have night and __________.

The Moon is in __________ around the Earth and takes ________ days for a complete revolution. The moon also takes 28 days for it to ____________ on its axis. Since the time of rotation and revolution are the same it means the same __________ of the Moon is always facing the Earth.

Since the Moon is orbiting the Earth as the Earth orbits the Sun it also takes around 365 days for the Moon to make a _________________ revolution around the Sun.

PHASES OF THE MOON

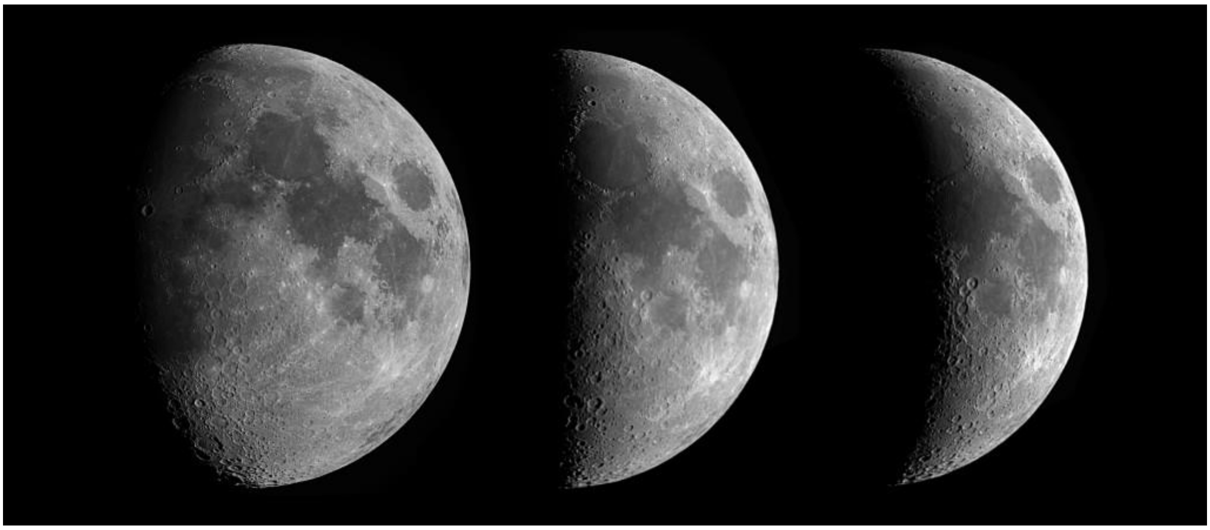


Figure 2: The moon's appearance changes in a regular cycle.
Source: http://farm4.staticflickr.com/3725/10942471793_97914649f7_o.jpg

When you look into the sky and observe the moon over several nights, the moon's shape appears to change. The moon's shape does not actually change; rather we can only see certain parts of it at different times. This is because the moon doesn't radiate (give off) any of its own light. Instead, light reflects off its surface which allows us to see it.

This changing appearance is what is known as the phases of the moon. It is caused by the relative position of the Earth, Moon and Sun. That is, their positions compared to each other.

KEY IDEAS

How can we see the moon?

Why can the moon to look different in the night's sky?

How do the Earth, Moon and Sun move through space?

What are some limitations of using models to explain events in the solar system?

MOON OBSERVATIONS

An important part of being a scientist is being able to make accurate observations as it can allow you to then make informed predictions about events.

The following activity has you tracking the appearance of the moon in the night's sky over a month. You may want to do this on photocopies of these sheets as they will be being cut out in Part 2 once your observations have been completed.

PART 1: MOON OBSERVATIONS

For each of your observations you should:

- record the date
- time you did your observation (try to keep it similar each night)
- shade the part of the moon that is dark and draw the moon's craters if visible
- write a one sentence observation of the moon's shape and appearance

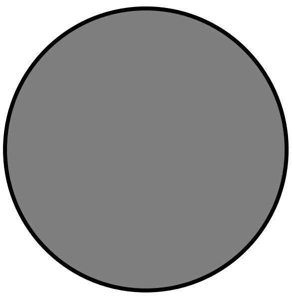
If you are unable to make an observation of the Moon itself due to cloud or it not being in the sky then you should still write this as an observation.

After a few other observations you may be able to go back and draw what you infer the Moon would have looked like on those days.

Vocabulary to help you write clear observations:

- Crescent: when the moon has a shape similar to a banana
- Half-moon: when one side is bright and the other is dark
- Gibbous: when more than half of the moon is able to be seen
- Full: When the complete circle of the moon is visible
- New: Where the moon is not visible

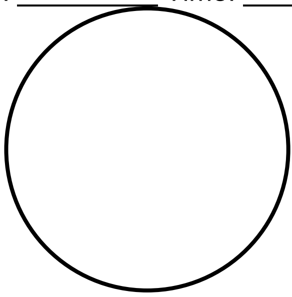
Date: 4th May Time: 6:00pm



Observation: It was a new moon with its shape able to be seen but it was completely dark.

Example

Date: __________ Time: ________



Observation:

____
____
____
____

1

Date: __________ Time: ________ Observation: ______________________________ ______________________________ ______________________________ ______________________________ 2	Date: __________ Time: ________ Observation: ______________________________ ______________________________ ______________________________ ______________________________ 3	Date: __________ Time: ________ Observation: ______________________________ ______________________________ ______________________________ ______________________________ 4
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Date: __________ Time: ________ Observation: 23	Date: __________ Time: ________ Observation: 24	Date: __________ Time: ________ Observation: 25
Date: __________ Time: ________ Observation: 26	Date: __________ Time: ________ Observation: 27	Date: __________ Time: ________ Observation: 28

PART 2: CREATING A FLIPBOOK

Once you have images drawn in order you are going to create a flipbook to see how the moon's shape changes.

Cut out the images you have drawn and arrange them in order from day 1 to day 28 or as many observations as you made.

Staple the images twice down the left hand edge. This has created your flipbook

Hold the flipbook in your left hand and then use the right hand to slowly flick through the images

Observe how the appearance of the moon changed over the month that you observed.

PART 3: COMPARING YOUR OBSERVATIONS TO THE MODEL DIAGRAM

Go to the diagram of the moon revolving around the Earth

Use your observations to place dates on the diagram at the Moon's location.

Do this by comparing the drawings on your observations to what you'd expect to have seen at each point on the diagram.

Question 1

Describe the changes that take place in the Moon's appearance when we view it over the month

Question 2

Describe the movements of the Earth, Moon and Sun that cause the phases of the moon

Question 3

Explain how the Moon's appearance changes shape when it is viewed from Earth

MODELLING THE PHASES OF THE MOON

In this activity you will build a model to help understand and explain the cause of the phases of the moon. This is done through modelling the movement of the Earth, Moon and Sun as well as considering the light that the Sun is giving off (emitting).

Models are used in science to help simplify concepts to make them easier to understand or to picture. Models can have limitations though and so it is important that we consider what these might be when we use them.

Work in small groups to create the model.

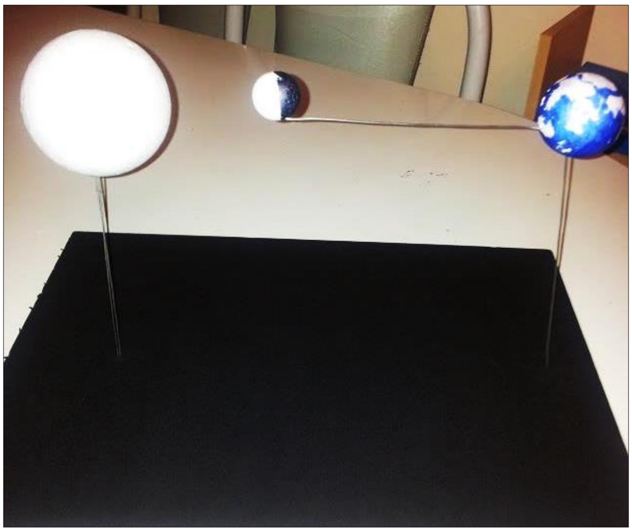


Figure 3: A model to demonstrate the movement of the Earth, Moon and Sun to produce the phases of the Moon.

Equipment needed

- 1 Sheet of Black cardboard
- 3 Styrofoam balls (1 small, 1 medium, 1 large)
- Several lengths of strong wire (needed to support the foam)
- Pliers (to bend wire if needed)
- Glue
- Sticky tape
- Black marker pen

Figure 4: Equipment needed

General Tips to build the model

Several pieces of wire may be needed underneath the largest 2 Styrofoam balls to support their weight

Use several pieces of sticky tape underneath the cardboard hold the wire in place so as to support the Styrofoam ball without moving.

Colour the Earth and the Moon before trying to attach.

Make sure only half of the moon is shaded black

For the support between the Moon and the Earth bend the wire in the same direction at each end.

The Sun can be glued in place but only use the sticky tap underneath to support the Earth and Sun

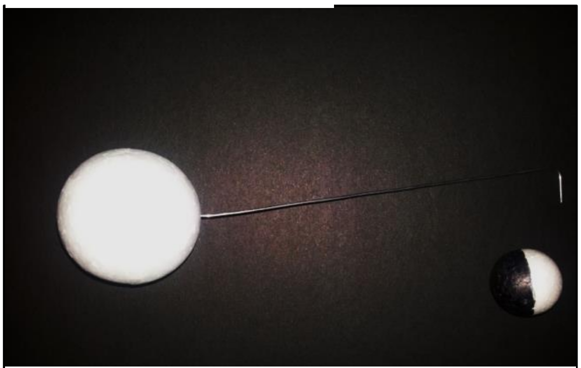


Figure 5: Bend each end of the wire and press into the underside of the Styrofoam balls

USING THE MODEL TO UNDERSTAND PHASES

The Moon should be able to revolve around the Earth and also rotate on its axis so that the white half is always pointing directly toward the Sun.

One half is white and the other half dark because the Moon doesn't produce any of its own light but rather just reflects it off its surface.

To get a picture of what the moon would look like from Earth:

- Point the white half of the moon toward the Sun
- Place your eyes just above the Earth as though you are looking at the Moon from Earth
- Observe how much of the Moon is white and dark
- Move the Moon to a different location and repeat steps 1-3

This should give you a general idea about how the Moon's appearance changes.

On the following page is a diagram that shows the movement of the moon around the Earth with half of the moon always being lit by the Sunlight.

The inner set of circles are for you to use your model to then draw the moon as it would appear to you on Earth if you looked into the sky.

The New moon has been done for you and is completely dark. This is because you can only see the shaded part of the moon and none of the illuminated (bright) part.

Figure 6: Use several pieces of wire, taped in different directions underneath to support the Sun and Earth

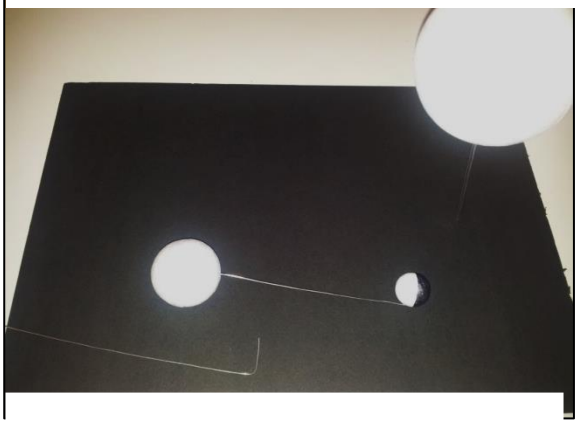


Figure 7: Bend the ends of wire in the same direction and press into the base of the Earth and Moon

Figure 8: A finished model with the Sun fixed in place and the Moon free to revolve around the Earth and rotate on its axis

Draw the appearance of the Moon at each position as it would be observed in the sky as viewed from Earth.

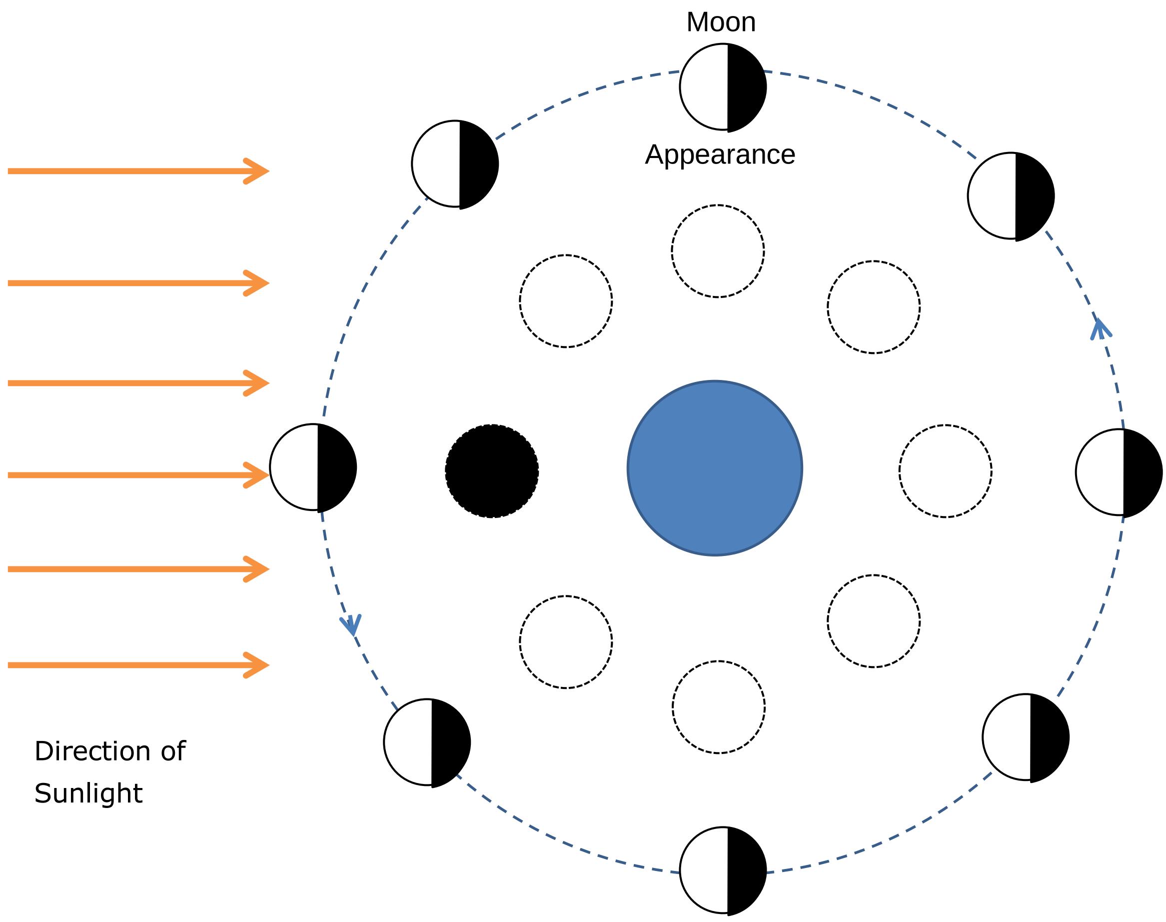


Figure 9: To help demonstrate the phases of the moon

Question 1

What are some limitations of using this model to explain the phases of the moon? Consider factors like size and distance between objects in your response.

PHASES OF OTHER OBJECTS

Often we think of the moon as having phases but it is not the only object in space that does. Below is an image of the Earth as viewed from the moon.

Figure 10: Earth as viewed from the moon

Source: http://www.nasa.gov/images/content/54427main_MM_image_feature_102_jw4.jpg

Using this image discuss with a partner whether the following statements are true or false

Statement	True or False
The Earth gives off its own light for it to be seen on the moon	
The shape of the Earth is constantly changing	
The appearance of the Earth will change if you continued to view it on the moon over time	
You can observe phases of Earth if you are on the moon	
The Sun gives off its own light	
If you observed the Sun from the Moon it would have phases	

UNDERSTANDING ECLIPSES

Images of solar and lunar eclipses can be spectacular. Watching an object like the Sun fade into darkness can be eerie. The Sun's energy is constantly radiating outward in all directions, so how can it become dark like the image above? Equally why can the moon which normally takes 28 days to complete all of its phases suddenly go from completely glowing to dark and back to bright again in a matter of hours or even minutes?

Figure 11: Image of a solar eclipse

Source: http://www.nasa.gov/images/content/

706822main_20121113-totaleclipse-orig_full.jpg

Figure13: A red Moon before the darkness of a lunar eclipse

Source: http://solarsystem.nasa.gov/scitech/images/inset-20040715-625-1-large.jpg

KEY IDEAS

What is the difference between a lunar and solar eclipse?

How is a lunar eclipse different from the phases of the moon?

What is the difference between radiating light and reflecting light?

SOLAR ECLIPSE

As you watch the following clip think about how the Sun can fade into darkness as shown in this clip.

http://youtu.be/9S2hzP_wuqM

Write some brief thoughts about how you think this occurs

___

___

ACTIVITY: MODELLING SOLAR ECLIPSES

In small groups, you are going to devise a model that can demonstrate how a solar eclipse can occur.

You have limited material available. You find a torch (or light bulb), a coin and your head.
These can represent the objects of the Sun, Moon and Earth.

Discuss with your group how you could model a solar eclipse.

Draw a diagram showing what your group did with each of these objects to model how the Sun can appear dark.

Describe what each object did and how this is similar to a solar eclipse.

To confirm the accuracy of your solar eclipse model watch the following videos:

Path of the Earth, Moon and Sun

http://youtu.be/Ned9c-QVA0M

then

A shadow on the Earth

http://youtu.be/Uz8HzPmdoiM

Now draw a diagram to show the path of the Earth, Moon and Sun during a solar eclipse

LUNAR ECLIPSE

During a lunar eclipse, the Moon becomes dark quite quickly.

Since the Moon does not give off its own light, rather just reflects it off its surface the position of the Earth, Moon and Sun must be different than a solar eclipse.

ACTIVITY MODELLING LUNAR ECLIPSES

Using the same materials of a torch, coin and your head discuss and then model how you could show how the Moon becomes dark during a lunar eclipse when viewed from Earth.

Draw a diagram showing what your group did with each of these objects to model how the Sun can appear dark.

Describe what each object did and how this is similar to a lunar eclipse.

____

____

To confirm the accuracy of your lunar eclipse model watch the following video.

How does a lunar eclipse work?

http://youtu.be/mbT50-rppaU

Now draw a diagram to show the path of the Earth, Moon and Sun during a lunar eclipse.

REVIEW

Answer the following multiple-choice questions:

Which of the following correctly identifies the objects that radiates (give off its own) light and those that reflect light off its surface.

Radiates light	Reflects light
Earth	Moon and Sun
Moon and Sun	Earth
Sun	Earth and Moon
Earth and Moon	Sun

A lunar eclipse occurs when

A. the Earth is between the Sun and the Moon
B. the Moon is between the Earth and the Sun
C. the Sun is between the Moon and the Earth

A solar eclipse occurs when

A. the Earth is between the Sun and the Moon
B. the Moon is between the Earth and the Sun
C. the Sun is between the Moon and the Earth

Compare solar and lunar eclipses. To compare you need to look at similarities between each as well as their differences.

____

____

____

____

SEASONS

KEY IDEAS

What causes the seasons?

How can different places on the Earth have different amounts of sunlight?

Why would the Earth being tilted affect our seasons?

We have all experienced different seasons. Sometimes we sweat when we go outside into the heat of the day and at other times of the year we feel cold when we step outside.

There are times when plants spring into new growth and other times where they might lose their leaves or grow very little.

The seasons follow a cyclical pattern of summer, autumn (called fall in the northern hemisphere), winter, spring. The seasons have a great impact on our lives influencing things such as the clothes we wear, the time we spend inside or outside as well to the types of fruit and vegetables and other foods that are available to eat.

So why does the Earth have seasons?

Consider why you think seasons occur.

Write down or draw a diagram to help explain your thoughts as to why we have seasons.

Spend a few minutes sharing your thoughts with others.

Watch the following video to see some other people's views about the cause of the seasons

http://www.youtube.com/watch?v=b3TRUDKpoAs&feature=share&list=PL772556F1EFC4D01C&index=33

Activity: Observing and inferring from diagrams

Below are four diagrams showing the Earth tilted on its axis from North through to South and the Equator that separates the northern hemisphere from the southern.

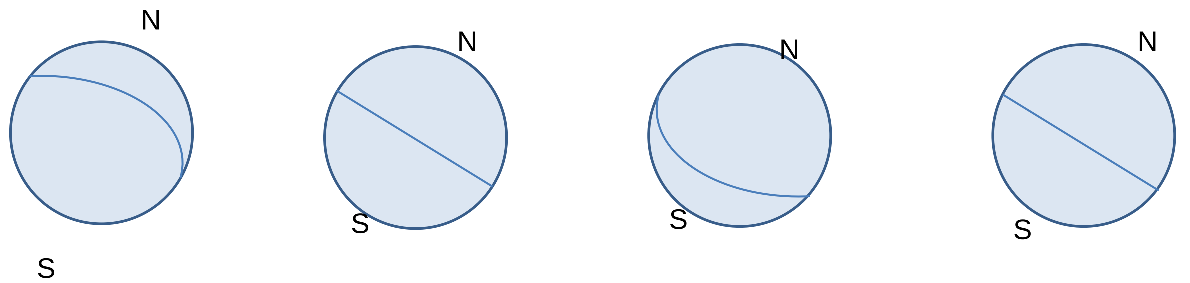


diagram A diagram B Diagram C diagram D

Figure 12: How the Earth would look at different times of the year when viewed from the Sun

The Sun can shine onto the Earth as shown in each of the diagrams

Identify the diagram or diagrams where:

More of the southern hemisphere is visible	
More of the northern hemisphere is visible	
The same amount of both hemispheres are visible	
More sunlight hits the southern hemisphere	
Less sunlight hits the southern hemisphere	
It would be summer in the southern hemisphere	
It would be summer in the northern hemisphere	
It would be winter in the northern hemisphere	

These questions will help you understand why the Earth experiences different seasons

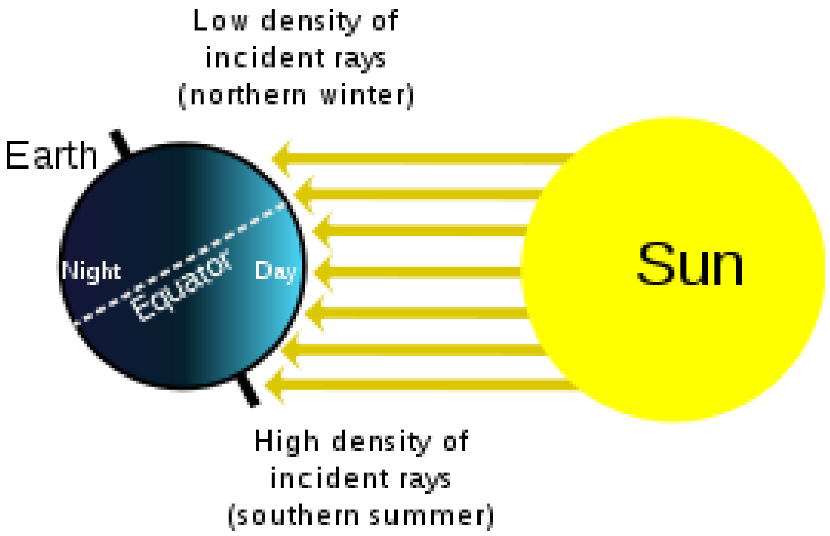


Figure 13: Summer in Australia

Source: http://upload.wikimedia.org/wikipedia/commons/thumb/1/12/Seasons.svg/266px-Seasons.svg.png

As you can see on the diagram above there is more light (indicated by more arrows) hitting the southern hemisphere than are hitting the northern hemisphere. This is because the Earth is tilted on its axis as it moves around the Sun. The southern hemisphere is tilted toward the sun, while the northern hemisphere is tilted away.

This would mean that it would be summer in Australia due to more light hitting the in the southern hemisphere than the north. It would also mean that it would be winter in the northern hemisphere since it is receiving less sunlight. That is why we can be here in Australia often sweating and feeling really hot over December and January whilst often it could be cold and snowing in the northern hemisphere.

Diagrams, similar to the one below, are often used to explain the seasons in terms of the tilt of the Earth on its axis and its movement around the Sun.

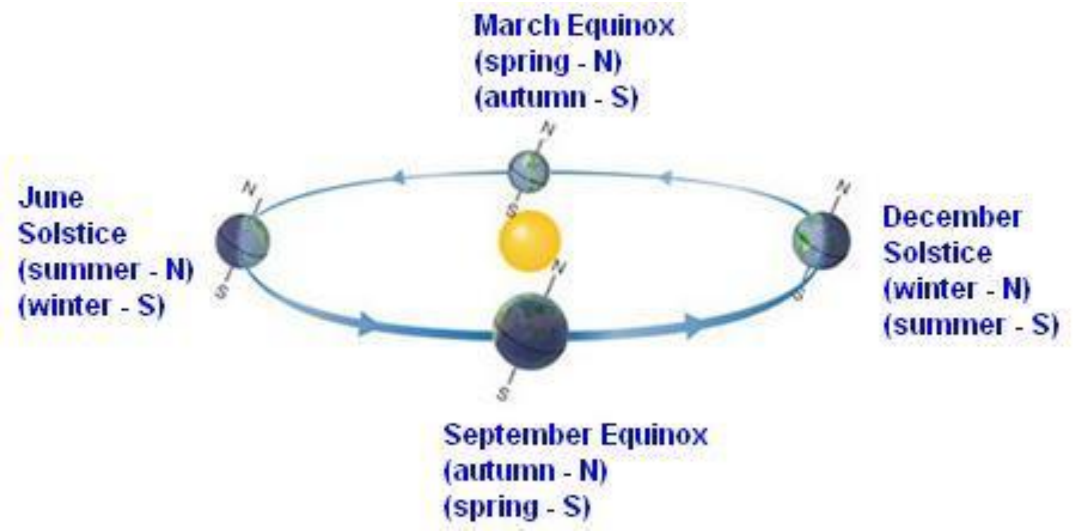


Figure 14: Seasons are caused by the Earth's tilt as it orbits around the Sun

Source: http://upload.wikimedia.org/wikipedia/commons/8/86/Seasons.jpg

These diagrams are sometimes misinterpreted due to them being a two dimensional image of something that is happening in three dimensions. An example of this is that the Earth looks much closer to the Sun in March and September. This is not the case. Whilst the Earth does move in an elliptical orbit it is nowhere near as dramatic as these diagrams sometimes imply. This leads to a misconception that it is how close the Earth is to the Sun that determines the seasons. While the distance can play a small part it is the Earth's tilt that is far more significant.

Answer true or false to the following questions

Statement	True or False
1. Summer is usually the hottest season	
2. When it is winter in the southern hemisphere it will be spring in the north	
3. Seasons are mainly caused by how far the Earth is away from the Sun	
4. The Earth is tilted on its axis as it moves around the Sun	
5. Seasons are mainly caused by the tilt of the Earth on its axis	
6. The season after summer is autumn	
7. If the axis is tilted toward the Sun then that hemisphere will receive less sunlight than the other	
8. Two dimensional diagrams of the Earth and Sun have limitations because they are trying to represent something that occurs in three dimensions	

GRAVITY

KEY IDEAS:

What is meant by 'gravity'?

Which objects have gravity?

Does gravity affect all objects the same?

Share your current thoughts about gravity

Gravity, it's a term that is often used but not always well understood. How much do we really know about what it is or what it does?

Write what you think gravity is or what it does? (N.B. this doesn't have to be right. It is just what you understand gravity to be at the moment)

Share your response with a person near you.

What is similar with your responses?

What is different between your responses?

Now watch a short video to see what others have thought about what gravity is and what it does.

http://www.youtube.com/watch?v=mezkHBPLZ4A&list=PL772556F1EFC4D01C&feature=share&index=25

GRAVITY

Many of us have heard the story of Sir Isaac Newton who is reported to have understood the force of gravity when an apple fell from a tree and onto his head. Whilst it is unlikely that it occurred in just that way, Newton did help us understand this unusual force due to gravity. He even used it to help explain the reason for the motion of planets and moons around each other which we'll explore in more detail later.

A gravitational force is a force of attraction pull objects toward each other. Sometimes you may hear of objects being referred to as bodies. When talking about forces a 'body' is really just an object that has mass.

Figure 15: Gravity acts in both directions. A person is drawn to the Earth just as much as the Earth is drawn toward the person

Since you have mass and you are on planet Earth, which is without a doubt massive, there is a force of attraction between you and the Earth. This is the force due to gravity and is what holds us to the surface. It is not just the Earth that has a gravitational pull, however, any object that has mass has a gravitational pull.

The strength of that pull depends on two factors;

- the mass of each of the objects and
- how far apart they are from each other.

As the mass of the objects gets greater than the gravitational force experience between them is greater.

This is why you are far more attracted to the Earth by gravity than you are attracted to the person sitting closest to you right now!

The force of gravity is not just acting to pull small objects toward large ones. It is actually a force that draws each object toward the other. As an example, you are not only attracted toward the Earth due to gravity but the Earth is equally drawn towards you. We don't observe this though, because the Earth has so much more mass than you do that it is much more difficult to get it to move toward you.

The other factor is distance. The further apart two bodies are the weaker the gravitational force. This is why we are held to the Earth's surface rather than to the Sun. Even though the Sun has a mass about 300,000 times greater than Earth, the distance to it is so great that means the gravitational force is much weaker than it is between Earth and us.

Use the text above to help you in completing the following passages by choosing the best word or phrase.

a) The Earth (is / is not) the only object that has gravity.

b) A gravitational force is a force of (attraction / repulsion).

c) It acts between any objects that have (direction / mass).

d) The smaller the mass the (greater / smaller) the gravitational force acting.

e) Another factor that can affect the size of a gravitational force is the distance between objects. The closer objects are together the (greater / smaller) the size of the gravitational force.

f) The size of the force pulling you toward the Earth is (less than / the same as / greater than) the size of the force pulling the Earth toward you.

Video activity: Watch the following video twice.

- The first time just watch it straight through without taking notes.
- Before you watch it the second time, read through the questions below and then watch the video again and jot down notes to assist you in answering the questions.

http://www.youtube.com/watch?v=aJc4DEkSq4I&list=PL772556F1EFC4D01C&feature=share&index=26

Notes: (just write brief points that will help you to be able to answer the questions below)

What is a free body diagram used for?

In a diagram how do you show the direction a force is acting?

How can you indicate larger forces in a diagram (that is having a bigger magnitude)?

Where do you draw the start of the arrows on a free body diagram?

Draw a diagram showing the size and directions of the two forces that are acting on the person below.

Activity: Mass and distance simulation

The following simulation shows how the size of the forces acting between two objects change as you vary their masses and the distance between them.

Go to the simulation at the site below and spend the first few minutes just getting used to varying the size of each object and the distances between them.

http://phet.colorado.edu/sims/html/gravity-force-lab/latest/gravity-force-lab_en.html

To investigate this in a scientific way only one factor (or variable) should be changed at a time. That is, we should only change the mass of one of the objects or the distance between the objects but not both at once. This is because in changing two things at once we can't be sure of which factor influence the force or by how much.

Steps in order to do this

- Line up 'Mass 1' with 0 metres on the ruler.
- Set the variables (mass 1, mass 2 and distance) to be as shown in the table below.
- Record the force (to do this only write from the first non-zero number e.g. for 0.000000004713 N you would just write 4713 in the table.

In this table we are looking at how changing the mass of the second object affects the force.

The first one has been done for you.

mass 1 (kg)	mass 2 (kg)	distance between mass centres (m)	Force on mass 1 (x10-12 N)	Force on mass 2 (x10-12 N)
10	10	1	6291	6291
10	20	1		
10	30	1		
10	40	1		
10	50	1		

N.B. You could plot a line graph of 'mass 2' against 'Force on mass 1' to help you with the following questions.

Questions:

What do you notice about the force on mass 1 and mass 2 for any of your results?

Describe the trend in the graph by choosing the appropriate words.

As the mass of object 2 increases the gravitational force (increases / decreases) at a constant rate. That is, a doubling of the mass would (halve / double) the gravitational force acting on the masses.

Extension activity:

Your task is to design a table that would let you test how changing the distance affects the force on each mass.

- You will need to consider how many columns to draw, what their headings should be and which values would need changing.
- Look back at the table we used to see how mass 2 affected the force to assist you.
- After drawing up your table you should take the measurements and complete the table using the simulation

How distance affects the gravitational force on masses

You may like to draw a line graph of your results. This can be done on graph paper or using a spreadsheet. Note a smooth curve is better to draw between points on this graph.

Describe the trend in the graph of how distance affects the gravitational force.

Video activity:

Watch the following video twice through each.

The first time just watch it straight through without taking notes.

Before you watch it the second time, read through the questions below and then watch the video again and jot down notes to assist you in answering the questions.

http://www.youtube.com/watch?v=_mCC-68LyZM&feature=share&list=PL772556F1EFC4D01C&index=30

Notes: (just write brief points that will help you to be able to answer the questions on the next page)

Questions:

Describe whether a heavy bowling ball and a basketball that are dropped from the same height hit the ground at the same time.

Would the same force be exerted if the same heavy bowling ball and the basketball were each dropped onto your foot?

Acceleration is the rate at which the speed of an object is changing. If a ball is dropped does it accelerate as it falls or travel at the same speed?

Is it true to say that if objects accelerate at the same rate they would have the same gravitational force acting on them even if the objects have different masses?

Explain your answer. (Consider your answer to the previous questions to help)

Sometimes objects that are dropped such as a feather and a hammer will not hit the ground at the same time. This is because the gravitational force is not the only force acting. There is often air resistance which is a force that acts in the opposite direction than it is falling. This air resistance can slow a feather far more than it can a hammer.

Watch the following video to see how a feather and a hammer act when dropped on the moon where there is no air.

http://youtu.be/akGm0YPkwGM

Compare the motion of a hammer and feather dropped on Earth to when they are dropped on the moon.

Give a reason for any differences

PLANETARY MOTION AND GRAVITY

KEY IDEAS

What keeps the planets in orbit?

Why doesn't the moon crash into the Earth?

Does gravity affect all objects the same?

Is it really zero gravity in space?

In an earlier lesson we looked at the motion of the Earth, Moon and Sun; the Earth orbiting the Sun and the Moon orbiting the Earth as it does so. But what exactly keeps them in those orbits? Why don't they just move away from or travel past each other?

Once again part of the answer is this mysterious gravitational force of attraction. Gravity provides a force between all objects that have mass and so, since the Earth, Moon and Sun all have mass they are all being attracted toward each other.

If this is the case though, why do they remain in orbit and not just crash into each other over time?

Activity: Computer simulation of gravity and orbits

This activity uses a computer simulation found at
http://phet.colorado.edu/en/simulation/gravity-and-orbits

This can either be downloaded or run from the web but does require java to operate. This means it may not work on some tablet devices.

Once open you will see two tab at the top; 'Cartoon' and 'To Scale' in which you can view the simulation.

'Cartoon' shows the Sun Earth and Moon with distances exaggerated so it is easier to visualise.

'To scale' shows the relative size and distances of the Earth Sun and Moon. While for most of this activity we'll be using the 'Cartoon' tab so we can see what is happening easier, it is good to switch back to the 'To scale' just to have a more accurate perspective of what is going on.

Spend the first 5-10 minutes just exploring the simulation selecting the Earth, Moon and Sun or various combinations of those and then running the simulation.

You should also try showing the gravity force, velocity (similar to the speed but showing the direction it is moving in) and path.

You are also able to vary the size of the Sun and planet to see how this affects its path.

After becoming familiar with the controls and what they do choose the 'Cartoon' tab and then click reset all. You should then work systematically through these steps to more about the cause of the motion of the Earth, Moon and Sun.

Guided investigation using the simulation

Select the Earth and Sun only and then choose to show the path and press play.

Describe the path

Select 'Gravity Force' as it moves.

Why are two force arrows shown?

What do you notice about the size of each of the force arrows?

In which direction does the force arrow on the Earth always point?

If this was the only thing occurring then the Earth and Sun should just be attracted toward each other and collide. Another factor influences the Earth's motion.

Select 'velocity' to show the direction of the Earth's velocity (speed) as it orbits

What do you notice about the direction of the velocity compared to the gravitational force?

Select to turn gravity off. This shows how the Earth would move if there was no influence of gravity due to the Sun.

What do you notice about the path from when you turned gravity off?

Turn gravity back on and then click 'reset'

Increase the mass of the Sun a lot using the 'Star' sliding scale.

What do you notice about the path the Earth would take if the Sun's mass was much larger? Suggest a reason for this.

Reset the mass of the star to be that of Our Sun and press reset

Increase the mass of the Earth a lot using the 'Planet' sliding scale.

What do you notice about the path the Earth would take if the Earth's mass was much larger? Suggest a reason for this.

Write a brief summary of your findings about gravitational force and the planet's velocity from this investigation. You may like to use diagrams to assist

OPEN INVESTIGATION:

Using the simulation you are to undertake an investigation in pairs or in threes of either

The Earth and the Moon

The Earth, Moon and Sun *(challenging)*

Your group should discuss

Which investigation you choose to undertake?

What you'd like to find out about those objects in terms of force and velocity?

How you intend to do this in a systematic way similar to the one performed before with the Earth and the Sun.

How you intend to present a summary of your findings e.g. visually, written, audio, etc. or a combination of these.

You may also like to look at these videos to spark different ideas about what you might like to investigate

Is there gravity in space?

http://www.youtube.com/watch?v=d57C2drB_wc&feature=share&list=PL772556F1EFC4D01C&index=27

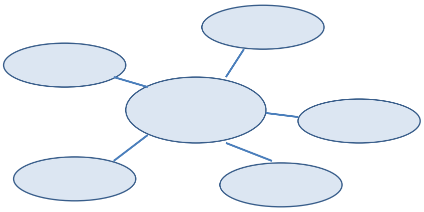
The moon orbits the earth

http://www.youtube.com/watch?v=zN6kCa6xi9k&feature=share&list=PL772556F1EFC4D01C&index=31

BRINGING IT ALL TOGETHER:

Over these lessons you have looked at different phenomena that can be experienced on Earth such as the phases of the Moon, eclipses, the seasons. You've investigated the motion of the Earth, Moon and Sun as well as how the force due to gravity influences objects both here on Earth as well as out in space.

Summarising activity:



In this task you need to look back over what you have done and develop a concept map to draw together the key ideas that you have covered and how they relate to each other.

Be creative, use diagrams or put anything down that you think helps remind you of important points and how they occur.

Remember this concept map is to help you to remember so be sure to make it personalised by adding your own thoughts, diagrams and connections between ideas.

GLOSSARY

Term	Meaning