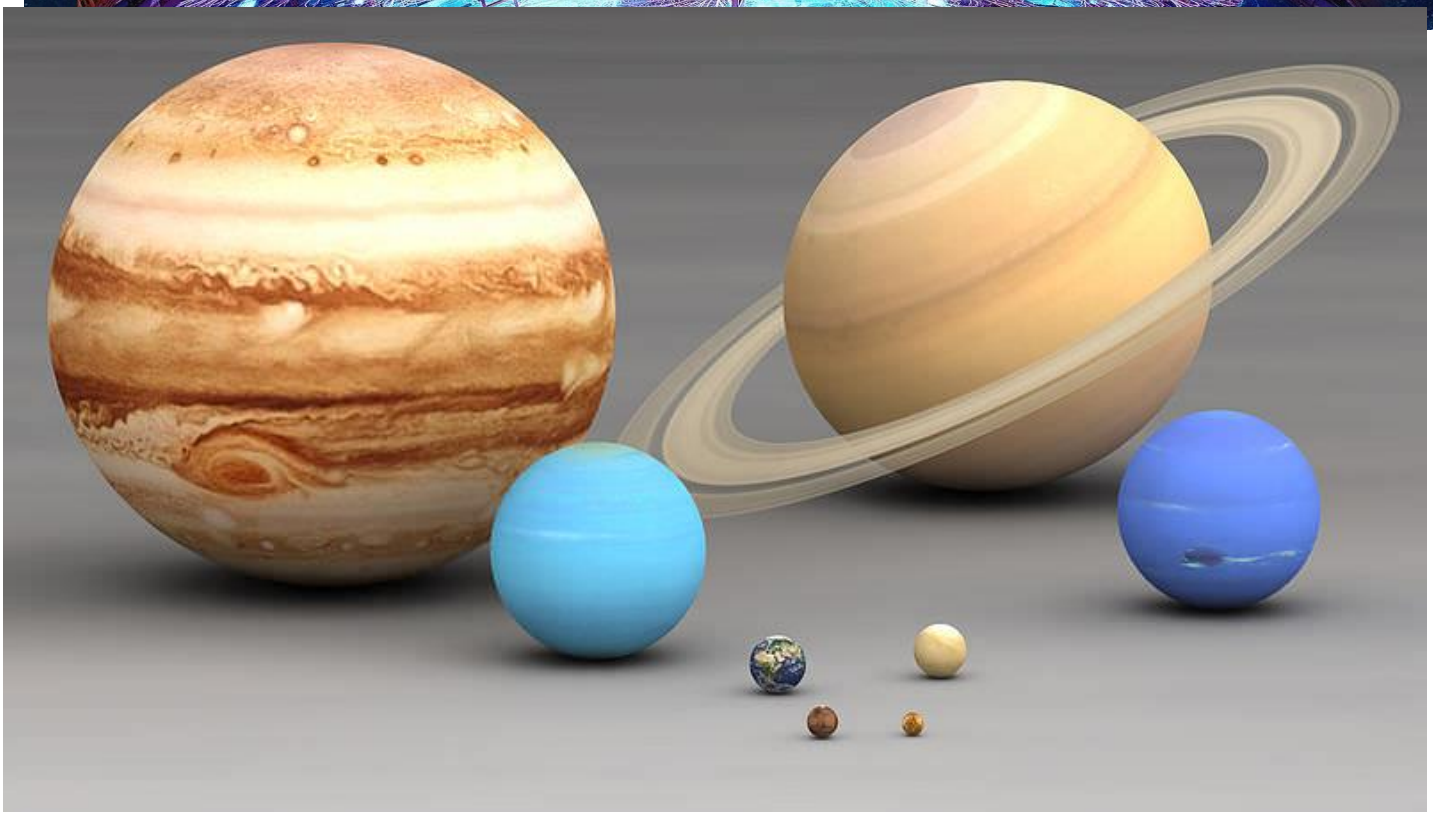
BOOKLET 2

NATURAL SCIENCES AND TECHNOLOGY

TERM 4- PLANET EARTH AND BEYOND

GRADE 6



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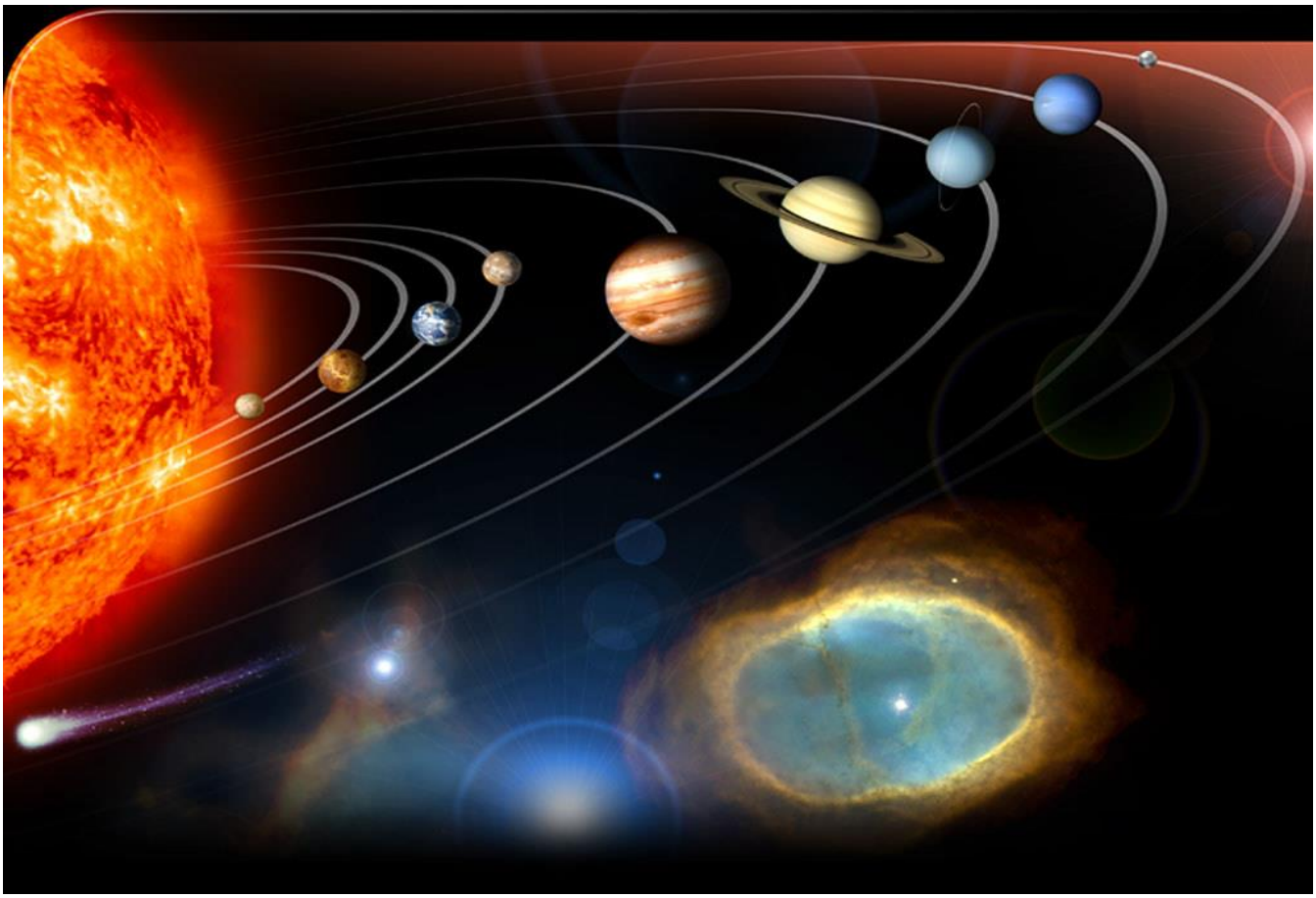
1. THE SOLAR SYSTEM

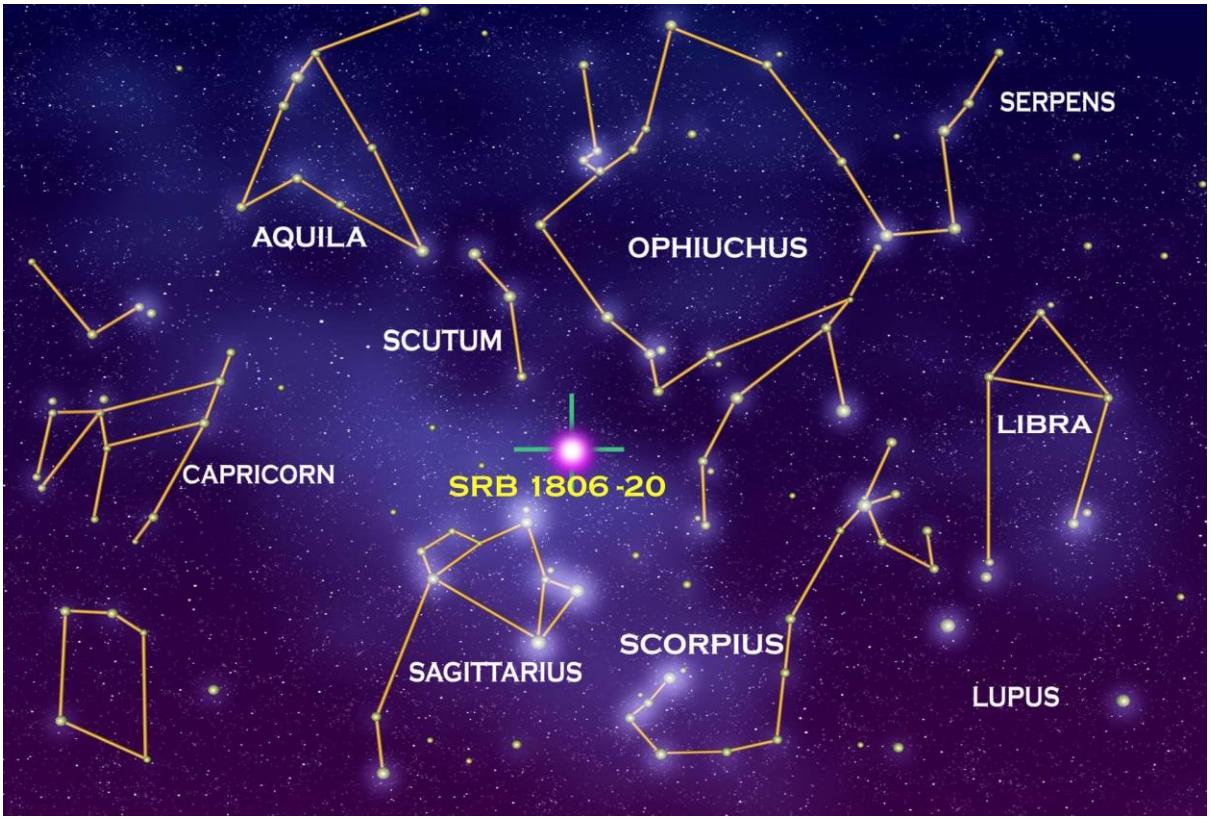


So, what exactly is the Solar System?

The solar system consists of the **SUN and everything that orbits,** or travels around, the SUN. This includes: **the eight planets and their moons, dwarf planets, the countless asteroids, comets, and other small, icy objects**. However, even with all these things, most of the solar system is empty space

OUR UNIVERSE: STARS AND GALAXIES

Our solar system is in a **galaxy** called **the Milky Way**. Our galaxy is just one of many in the universe. The universe is made up of many galaxies: there are more than a billion galaxies of various shapes in our universe! A galaxy consists of many stars. Our sun, which is a star belongs to a **spiral galaxy, the Milky Way**. In each galaxy there are **scattered groups of stars called constellations. Eighty eight constellations have been identified in the Milky Way.** Some of these constellations have been used to help sailors navigate their way across the oceans.



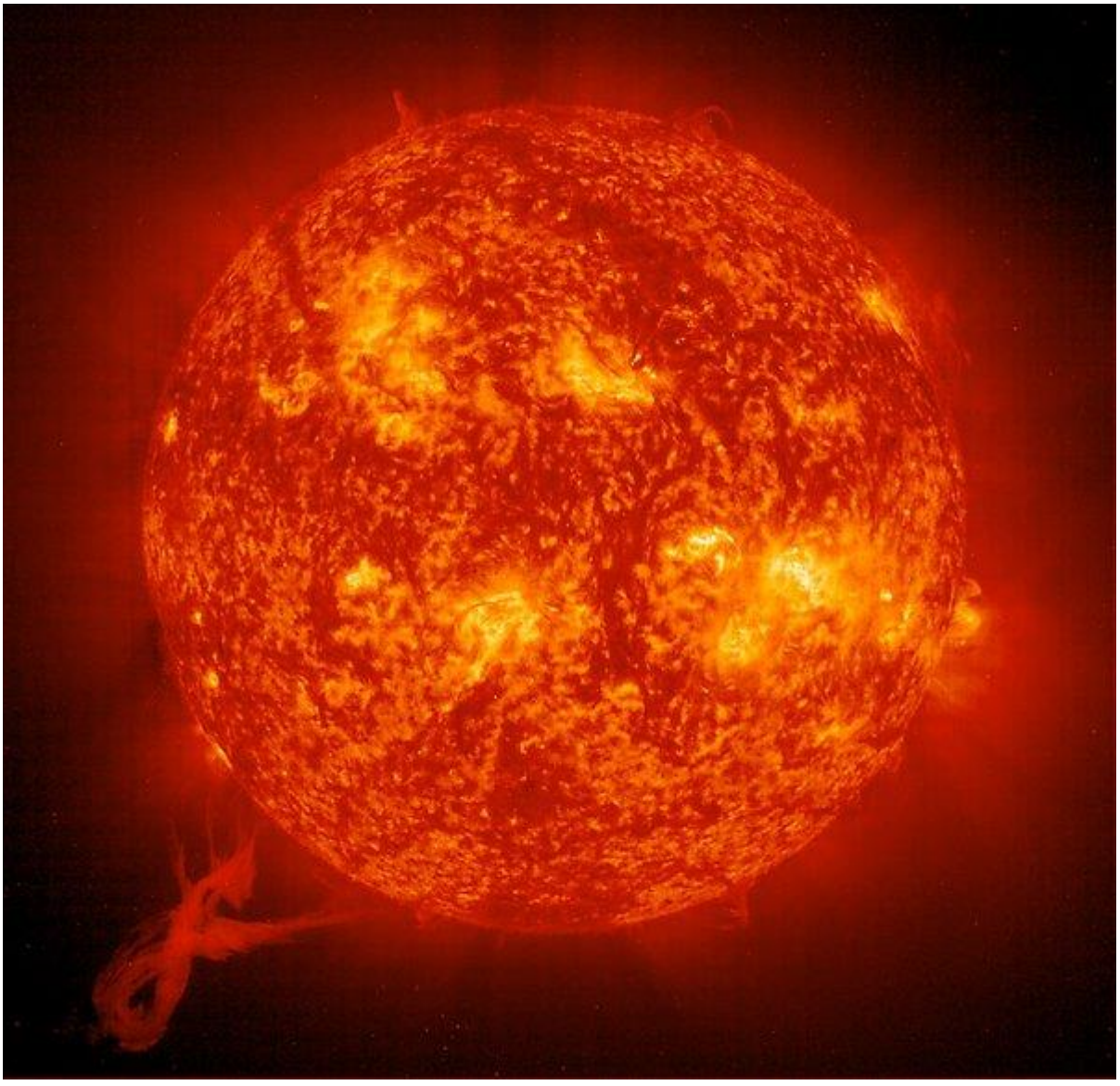
STARS

A star is any **massive body of gases,** mainly **hydrogen and helium** that **generates (creates)** energy by nuclear fusion and therefore **gives off** tremendous amounts of **energy, heat and light. Our sun is a star.**

Watch this: http://youtube.com/watch?v=ZrS3Ye8p61Y

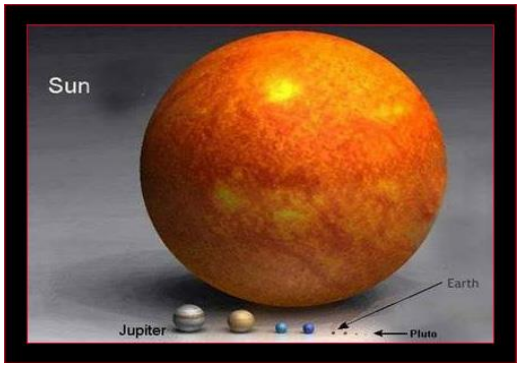
http://youtube.com/watch?v=cSZDZaZgl3Q

The temperature at the centre of the Sun is about 15 000 000 degrees Celsius! The surface is about 5 500 degrees Celsius. That is extremely hot! Can you see the explosion from the surface of the Sun in the picture?!

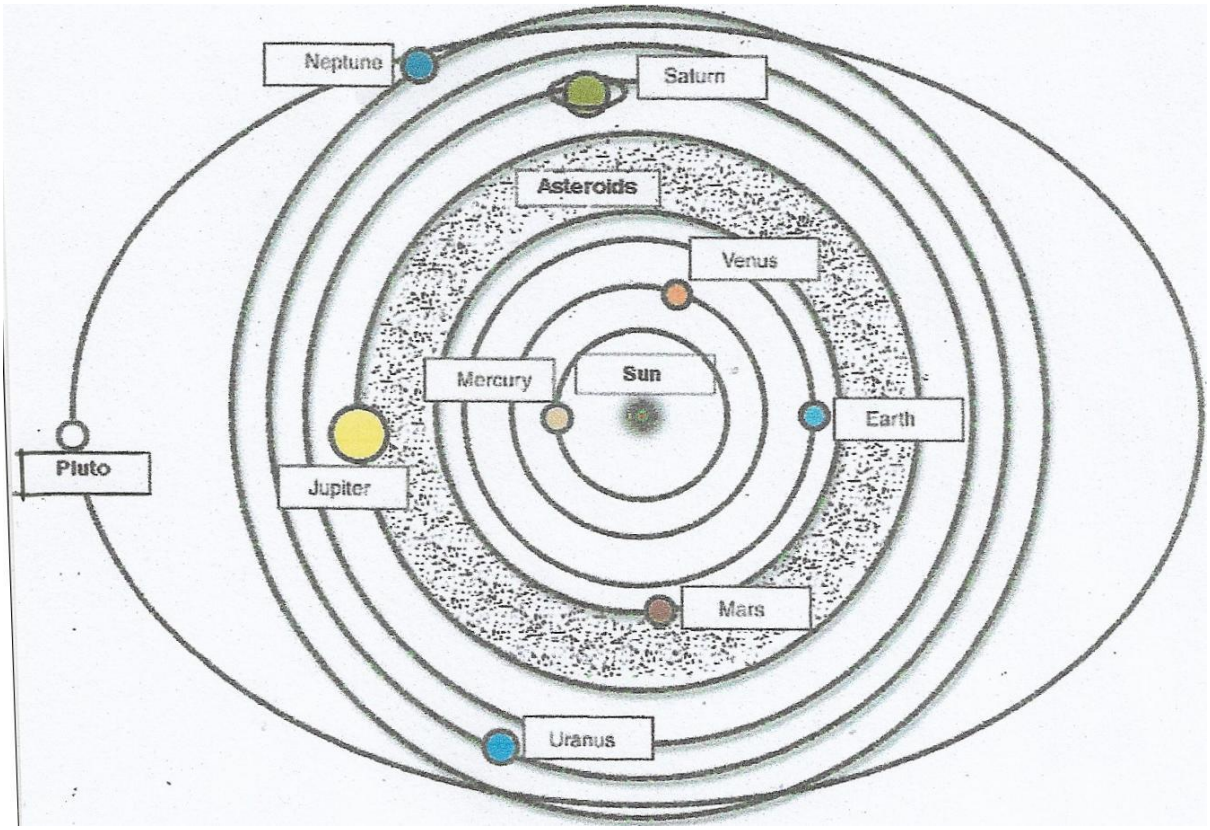


The Sun is about 150 million kilometres (150 000 000km) from Earth and the next nearest star to us after the Sun is over 40 million million kilometres away. (40 000 000 000 000 Km away!!)

Imagine the Sun was the size of a beach ball. Then the Earth would be as small as a pea and the Moon would be as tiny as a pinhead.



There are bodies that orbit some of the stars. We call them PLANETS. Our earth is a planet



PLANETS

"Planets" is a Greek word meaning "wanderer". Up until 2006 scientists had a different definition for planets than the one we use now. Up until then scientists named Pluto (in the Kuiper Belt, after Neptune) and Ceres (in the Asteroid belt, between Mars and Jupiter) planets. With new technology and especially the work of the Hubble telescope, (our good old faithful telescope up in space), scientists began to discover many more celestial bodies "out there". In 2006, the IAU (International Astronomical Union) members gathered at the General Assembly and decided on a new definition for a planet.

So, what is a planet?

A planet is:

- A body that orbits a star, e.g., the sun
- Is large enough for its own gravity to make it round or nearly round
- It must have its OWN orbital path around the sun
- It must have "cleared the neighbourhood" of smaller bodies
- It must not have its own light but reflect the light of the sun

So, with this new definition, our eight planets that fit this definition are:

Mercury Venus Earth Mars Jupiter Saturn Uranus Neptune

Watch this: http://youtube.com/watch?v=mQrlgH97v94

Pluto does not fit this definition because:

- It crosses Neptune's orbital path (doesn't have its own path around the sun)
- It lies in the Kuiper Belt and has lots of smaller bodies surrounding it (hasn't "cleared the neighbourhood of smaller bodies)

Poor old Pluto was kicked out of the "Planet Club". It became known as a DWARF PLANET.

Watch https://youtu.be/b9oou3p1e3w It is excellent!

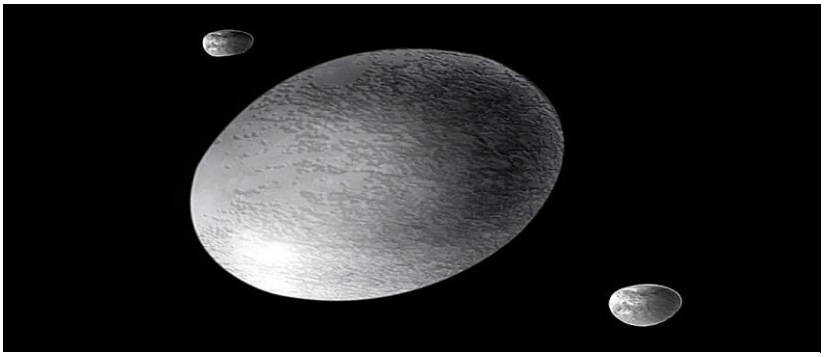
Ceres, located in the Asteroid Belt was first known as a comet. Then it was called a planet. Then an asteroid. Now it is also classified as a DWARF PLANET.

"I wish these humans would make up their minds!!"

SO, A DWARF PLANET IS:

- **A Celestial body that orbits the sun,**
- **Has enough mass to make it round or nearly round**
- **Has not cleared the neighbourhood of smaller bodies**
- **It is not a moon**

- **Does not need to have its own orbital path around the sun**



Haumea, cigar shaped.

OUR DWARF PLANETS NAMED THUS FAR:

DWARF PLANETS FOUND IN THE ASTEROID BELT:

- CERES, found in the Asteroid belt. The largest body in the Asteroid belt. If we compare it to Earth, it is only 1/13 the size of earth! (If Earth was the size of a 20c coin, Ceres would be the size of a poppy seed!) it has no moons.

DWARF PLANETS FOUND IN THE KUIPER BELT:

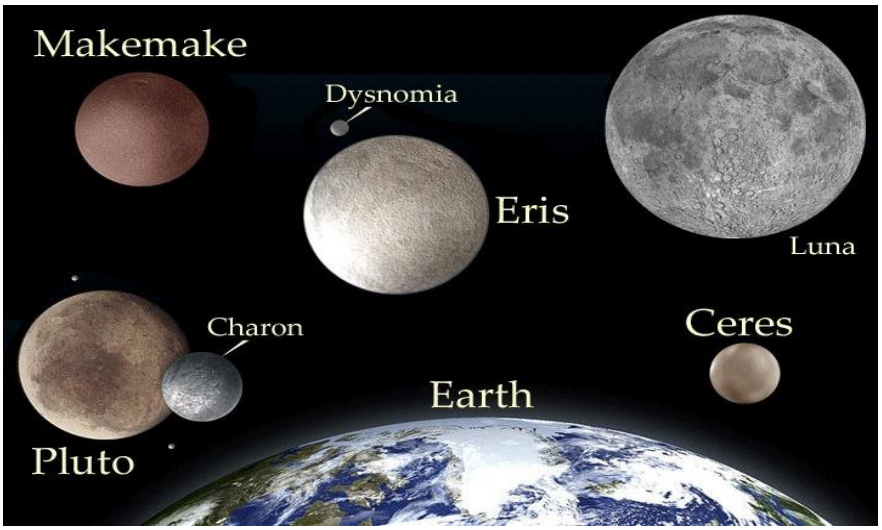
- PLUTO, has five moons: Charon, Nix, Hydra, Styx and Kerebos. However, Charon is almost half the size of Pluto, so scientists are debating whether to call Charon a dwarf planet as well, or leave it as a satellite or moon of Pluto.
- HAUMEA, is shaped like a cigar (almost round). It has 2 moons: Hiiaka and Namake.
- MAKEMAKE, has no moons discovered yet.
- ERIS, was first called Xena. It is larger than Pluto. It has 1 moon: Dysnomia.

https://www.youtube.com/watch?v=evIsmxM5c7o

https://www.youtube.com/watch?v=4tw_RiQp6H8 (Dwarf planet song)

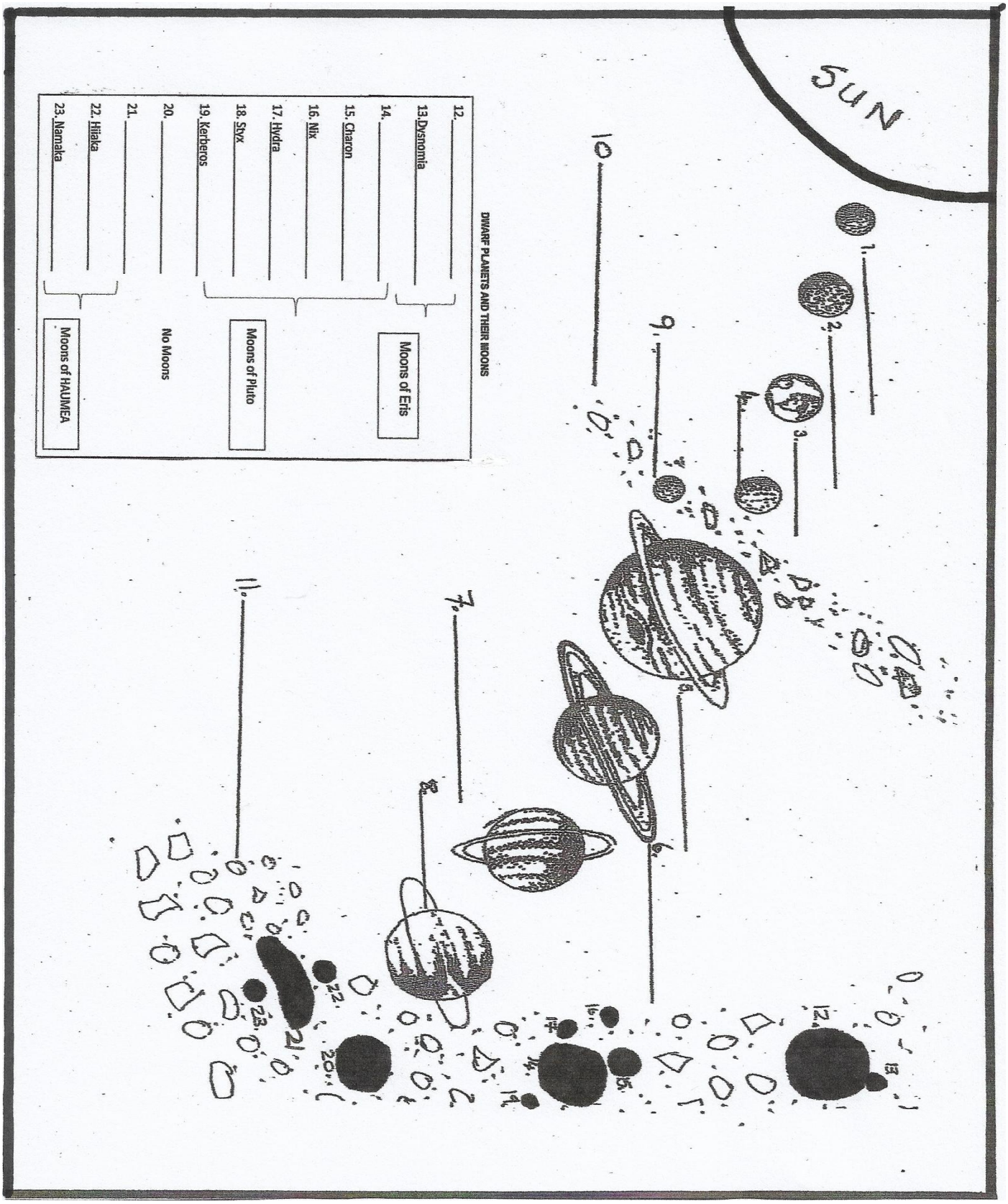
Watch this on our Solar System! You will learn so much!

This one has many pages of juicy information on space!!



ACTIVITY 1

Using the information you have learnt, fill in the names of the planets and moons



Let's take a closer look at the planets.

Planets are classified by their **distance from the sun, their composition and size.**

DISTANCE FROM THE SUN

INNER PLANETS: Mercury, Venus, Earth, Mars

OUTER PLANETS: Jupiter, Saturn, Uranus, Neptune

Between the inner and outer planets is the Asteroid belt. So, the planets inside the Asteroid Belt are closest to the sun and called the inner planets. The planets outside the Asteroid Belt are further away from thew sun and called the outer planets.

COMPOSITION OF THE PLANETS

ROCKY PLANETS: Mercury, Venus, Earth, Mars

GAS PLANETS: Jupiter, Saturn, Uranus, Neptune

Rocky planets are solid and made mainly of rock. The gas planets are not solid, being composed mainly of gases.

SIZE OF THE PLANETS

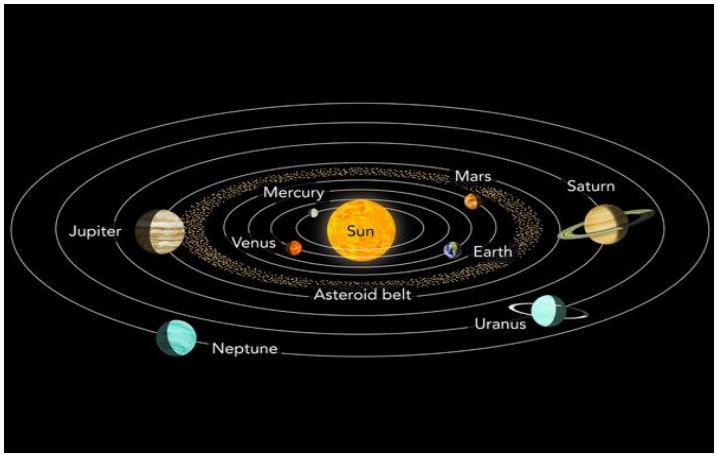
SMALL PLANETS: Mercury, Venus, Earth, Mars

GIANT PLANETS: Jupiter, Saturn, Uranus, Neptune

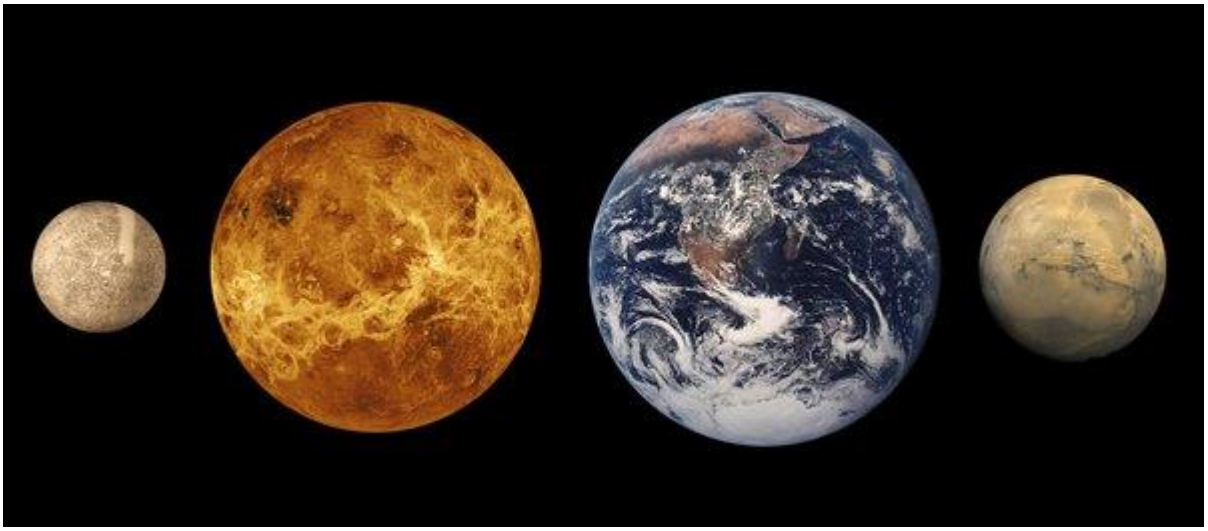
We visit the eight planets

The four inner planets are rocky.

Look at the picture below of the solar system again. The 4 planets closest to the Sun are called the inner planets of the solar system. They all are made of rock; some of them have a thin layer of gas on the outside. Earth has a very thin layer of water and soil too.

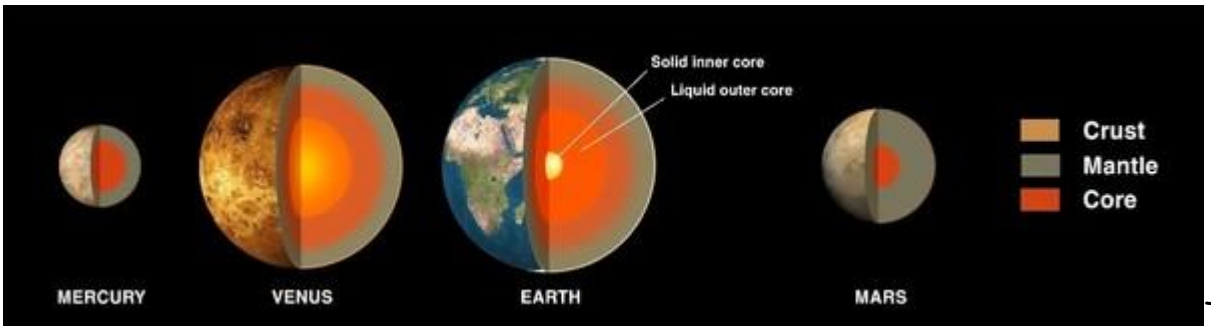


These four inner planets are rocky planets



These are the 4 inner rocky planets. This shows their sizes compared to each other. Can you name them?

The next image shows us what the core of each of the rocky planets looks like. The core is the inner part of the planet and it is made up of different layers.

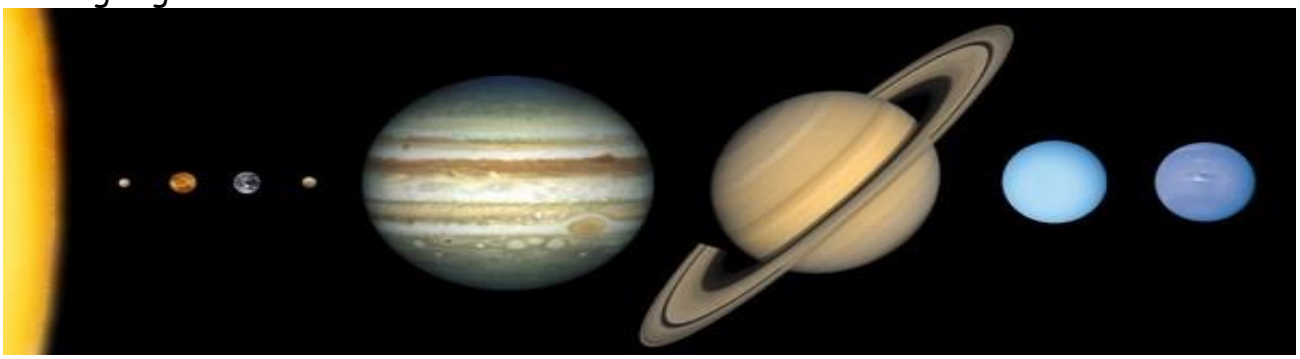


The core of each of the four inner rocky planets of our solar system.

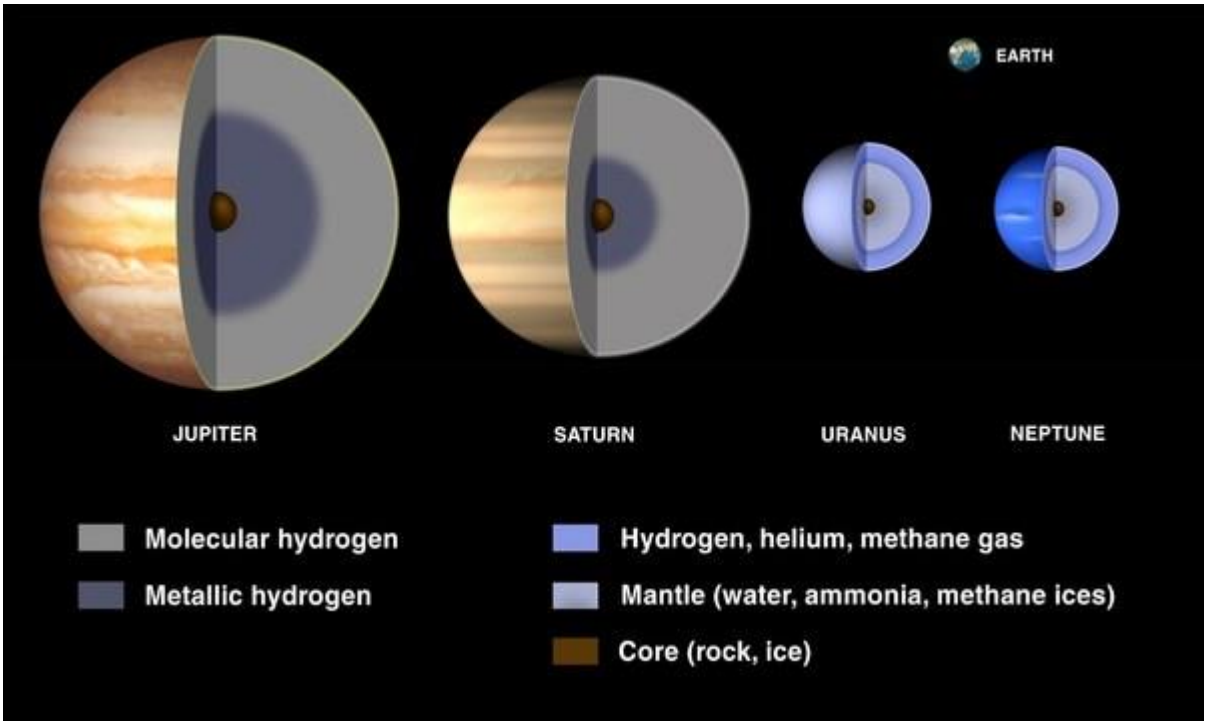
The four outer planets are gas giants.

These planets are very far from the Sun. They don't have a hard surface that a spacecraft can land on. Instead, they are giant balls of very cold gases. Astronomers think that these planets have hot, solid cores, deep down inside them.

This diagram shows the different sizes of the planets. Can you see how much bigger the 4 outer gas giants are?



This next image shows us what the inside of the gas giants is like. There are also different layers of gases.



The four gas giants, showing the gases which make up these planets.

Watch http://www.youtube.com/watch?v=SeC22-94PMw

ACTIVITY 2

LETS HAVE FUN: A QUIZZ!!

Divide your class into 2 groups. Question 1 is posed to group 1. If they get the answer right, they score 2 points. If they get it wrong, group 2 is allowed to answer and score 1 point if they get it right. Question 2 is put before group 2. And so it goes on.

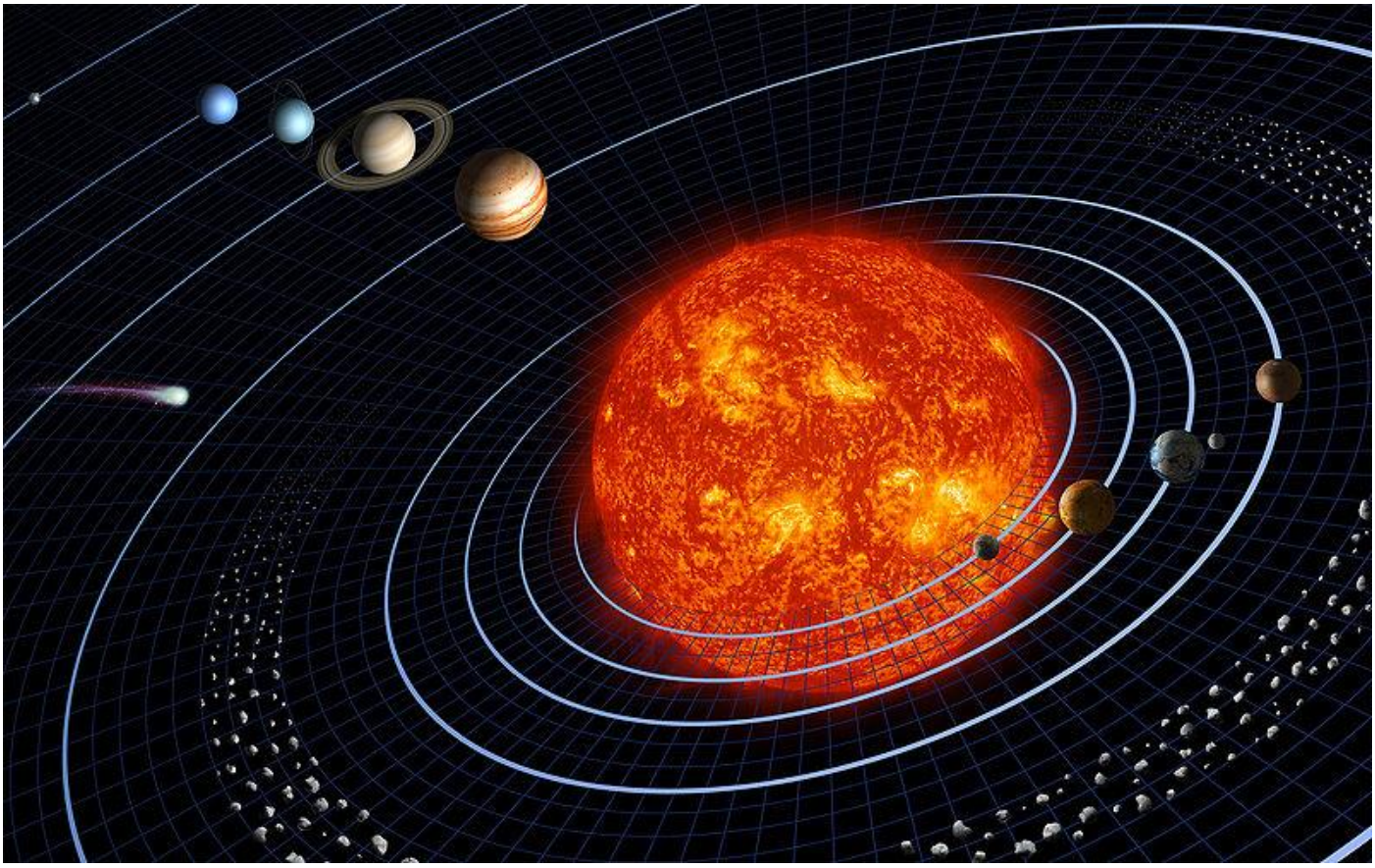
1. Name the four inner planets.
2. What are the inner planets composed of?
3. Name the four outer planets.

4. Name one of the gases that these planets are made up of.
5. What lies between Mars and Jupiter?
6. Name the dwarf planet that is found there
7. List the requirements needed to be a planet.
8. Why is Pluto no longer a planet?
9. Why is Ceres called a dwarf planet?

USE ALL THE INFORMATION IN THE ARTICLES ABOVE, INCLUDING THE PICTURES, TO FIND YOUR ANSWERS.

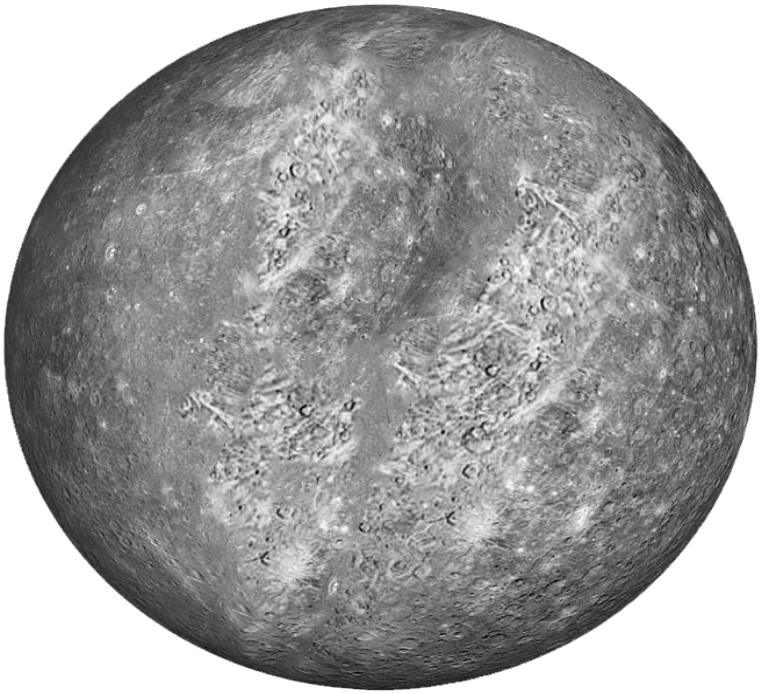
MEMORANDUM

1. Mercury, Venus Earth and Mars
2. They are rocky planets
3. Jupiter, Saturn, Uranus, Neptune
4. Any of the following gases: Hydrogen, Helium, Methane or Ammonia
5. The Asteroid Belt
6. Ceres lies in there
7. Must have enough gravity to make it round or nearly round; it must orbit a star; must have cleared the neighbourhood of smaller bodies; must not have its own light, but reflect the light of the sun.
8. Pluto crosses Neptune's orbital path and has not cleared the neighbourhood of smaller bodies
9. Ceres is round, revolves around the sun, is big enough to be called a dwarf planet but cannot be a normal planet because it has not cleared the neighbourhood of smaller bodies and is not a moon.



LET'S VISIT EACH PLANET

MERCURY



Mercury looks just like our moon because it is grey and full of craters. It is the closest to the sun. It was named after the Roman god, Mercury, the messenger to the other gods. It is the smallest of the eight planets. Mercury's year is shorter than its day! It has the shortest year in the Solar System – 88 days. But from sunrise to sunrise (1 day) it takes 58 days, 15 hours and 30 mins (almost 2 months!) During the day its surface becomes very hot while at night it becomes icy cold.

MERCURY FACT BOX:

DIAMETER: 4 880KM, about the size of the Earth's moon

DISTANCE FROM THE SUN: 58 MILLION KM (15 000 000KM)

LENGTH OF DAY: 58 DAYS 15 HOURS AND 30 MINS

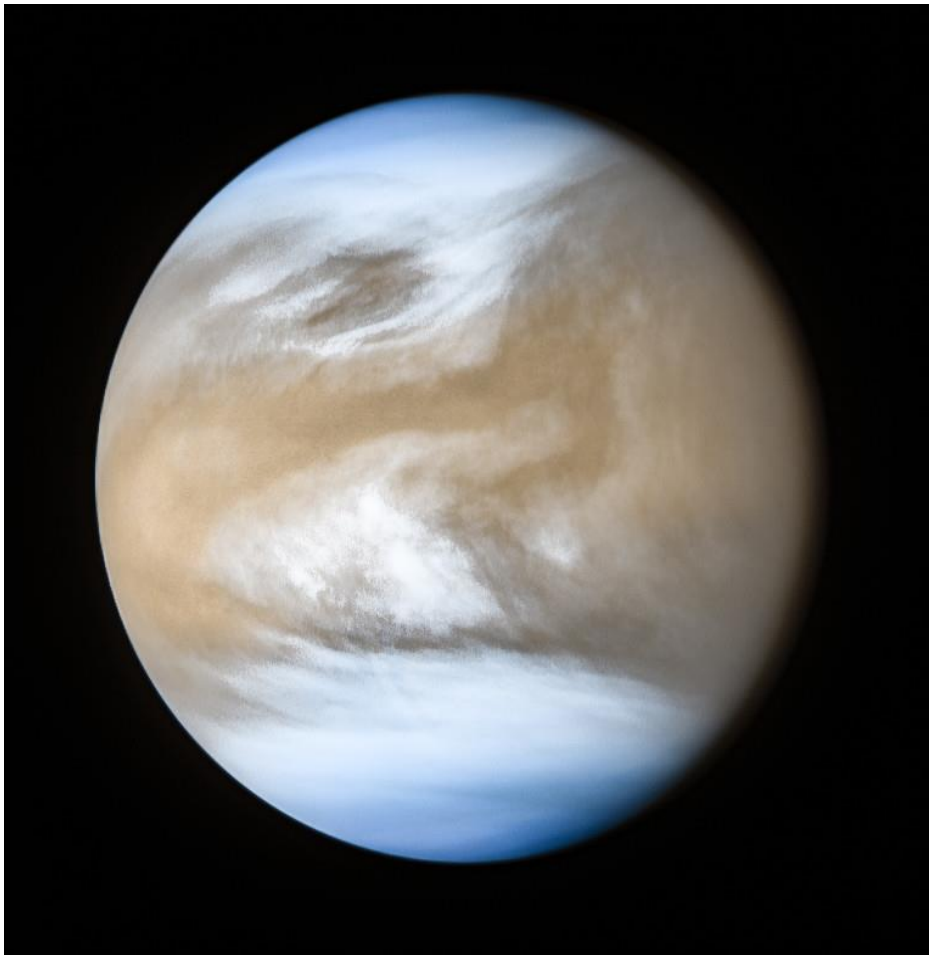
LENGTH OF YEAR: 88 DAYS.

TEMPERATURE: -185°C TO 467°C

SATELLITES (MOONS): 0

VENUS

Venus is the hottest planet in the Solar System. It was named after the Roman goddess of love because it looks like a gleaming gem in the sky. Venus is a hot rocky waste under an atmosphere almost entirely of carbon dioxide…. its own intense global warming! The thick atmosphere traps the sun's heat inside the planet, making it 460°C on average. Venus and Earth are almost the same size. Spacecraft have landed on the surface of Venus and taken photos of its land and atmosphere. There are high mountains, craters and volcanoes on Venus. Venus is unusual because it rotates in the opposite direction to all the other planets



VENUS FACT BOX

DIAMETER: 12 104 KM
DISTANCE FROM THE SUN: 108 MILLION KM (108 000 000KM)
LENGTH OF DAY: 116 DAYS 18 HOURS 0 MINS
LENGTH OF YEAR: 225 DAYS
TEMPERATURE: 460°C
SATELLITES: 0

EARTH

Our Earth is the largest of the rocky, inner planets. It is unique because, as far as we know, it is the only planet that has liquid water on its surface and it supports life. Earth is almost round, but not quite. It bulges at the centre (Equator) and flattens at the Poles. This shape is called a spheroid. Earth's atmosphere contains oxygen. The length of a year on the Earth is 365 days and 6 hours. Every 4 years those 6 hours add up to a day, so we add it in and have a LEAP YEAR, 1 year in every 4 years is 366 days. EARTH TITLS AT AN ANGLE OF 23,5°

EARTH FACT BOX

DIAMETER: 12 756KM
DISTANCE FROM THE SUN: 150 MILLION KM (150 000 000KM)
LENGTH OF DAY: 24 HOURS
LENGTH OF YEAR: 365 DAYS AND 6 HOURS
TEMPERATURE: -89°C TO 58°C
SATELLITES (MOON): 1
AXIAL TILT: 23,5°

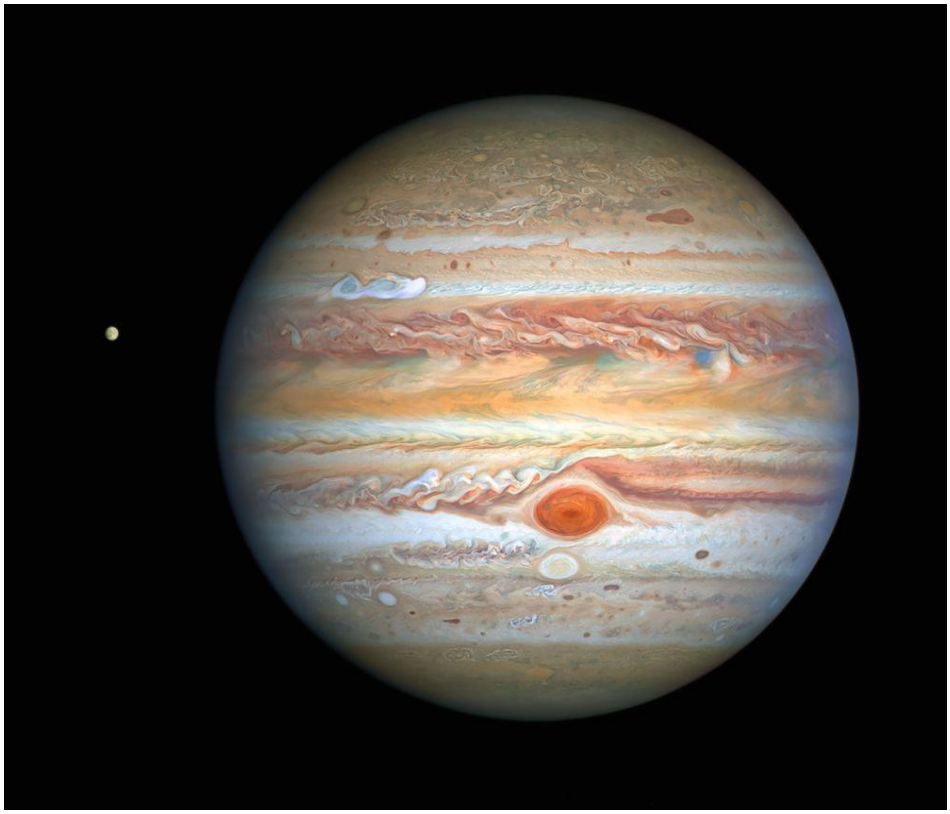
MARS

Mars is named after the Roman god of war and agriculture. It is named as the RED PLANET because of the iron oxide (rust) on its surface. Scientists are exploring Mars in the form of probes, because they believe humans might be able to live on Mars. It very similar to earth: it has frozen water at the poles, it has seasons like earth, but its summer is much colder than ours, its length of day is similar to ours and its tilt is similar to ours. Mars has many craters and mountains. Its largest mountain is OLYMPUS MONS and is a volcano. It is 624km wide and 25km high. The probes or rovers have collected much useful data which scientists are studying. MARS TILTS AT AN ANGLE OF 25°

MARS FACT BOX

DIAMETER: 6 794KM
DISTANCE FROM THE SUN: 228 MILLION KM (228 000 000KM)
LENGTH OF DAY: 24 HOURS 37 MINUTES
LENGTH OF YEAR: 687 DAYS
TEMPERATURE: -133°C to 20°C
SATELLITES: 2: PHOBOS AND DEIMOS
AXIAL TILT: 25°

JUPITER



Jupiter is named after the king of the gods in Roman mythology. It is the largest planet in the Solar System. It is so big that all the other planets can be squeezed inside it! Jupiter spins very fast on its axis…it takes less than 10 hours to rotate once on its axis. A day lasts less than 10 hours. Jupiter is made up of 90% hydrogen and 10% helium with traces of other elements. Large areas of swirling gases on Jupiter's surface form storms. The GREAT RED SPOT on Jupiter is actually a storm that has been raging for over 300 years! Space probes have picked up that Jupiter has rings around it. In fact all the gas giants have rings around them. It has 53 named moons and 26 moons waiting to be named. In 2021 Jupiter has 79 moons. Because of its dense gravity, Jupiter is constantly pulling objects into its orbital path, making them satellites (or moons). The number of moons will keep changing.

JUPITER FACT BOX

DIAMETER: 142 800KM

DISTANCE FROM THE SUN: 778 MILLION KM (778 000 000KM)

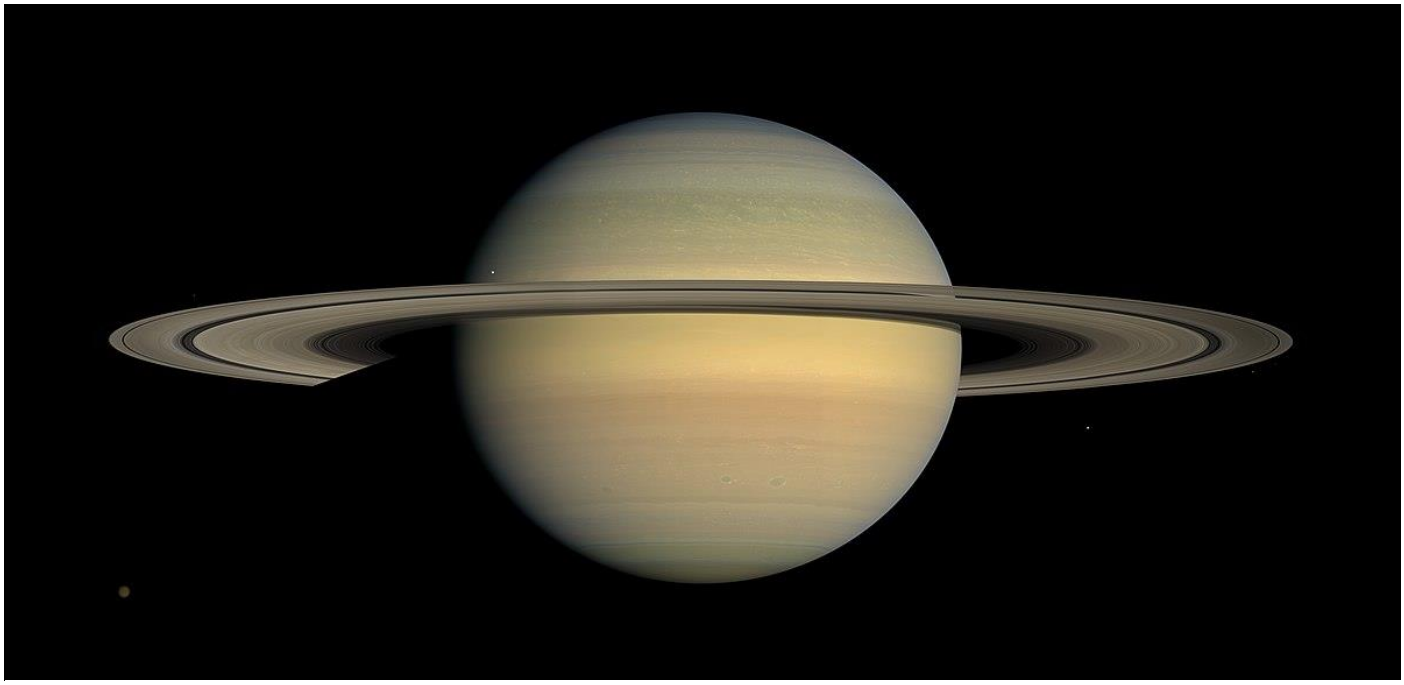
LENGTH OF DAY: 9 HOURS 50 MINUTES

LENGTH OF YEAR: 12 YEARS

TEMPERATURE: -150°

SATELLITES: 79

SATURN



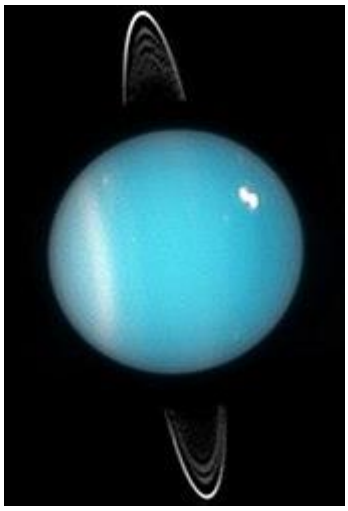
Saturn is named after the Roman god of agriculture. It is the second largest planet in our Solar System. It is known as a ringed planet because its rings can be clearly seen. They are very beautiful to look at. The rings consist of billions of particles of ice and dust. The white spots on Saturn are believed to be powerful storms. Saturn now has more moons than Jupiter! In 2021, the number of moons orbiting Saturn is 82! Saturn is not as dense as other planets, and if we could find an ocean big enough to put Saturn in it, IT WOULD FLOAT!! It has an axial tilt of 27°, but this does not cause changes of seasons.

SATURN FACT BOX

DIAMETER: 120 000KM
DISTANCE FROM THE SUN: 1 429 MILLION KM (1 429 000 000KM)
LENGTH OF DAY: 10 HOURS 14 MINUTES
LENGTH OF YEAR: 29 YEARS
TEMPERATURE: -178°C
SATELLITES IN 2021: 82
AXIAL TILT: 27°

WATCH: https://www.youtube.com/watch?v=BxY8v4lNltM

URANUS

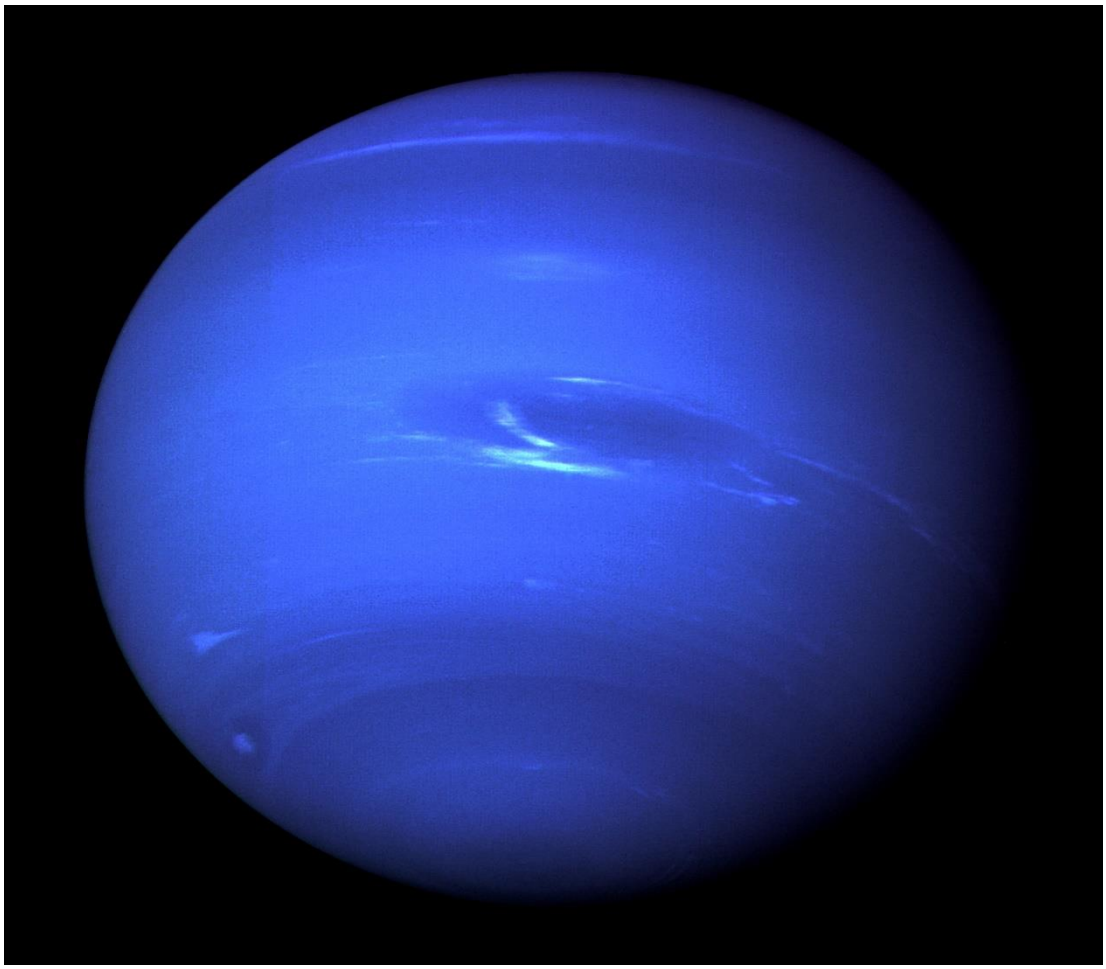


Uranus was the lord of the skies and the husband of Earth in mythology. It is the smallest of the four gas giants but is still much bigger than the Earth. Uranus orbits the sun on its side! It lies sideways as it goes arounf the sun. Because of this the effect is that each pole spends about 22 years in the summer sun and the other 22 years in winter darkness. It also has rings which spin around it side ways. The planet is made up of hydrogen, helium, metane and ammonia. It is the methane which gives it its blue-green colour.

URANUS FACT BOX

DIAMETER: 51 000KM
DISTANCE FROM THE SUN: 2 870 MILLION KM (2 780 000 000KM)
LENGTH OF DAY: 17 HOURS 14 MINUTES
LENGTH OF YEAR: 84 YEARS
TEMPERATURE: -200°C
SATELLITES: 27

NEPTUNE



Neptune is named after the Roman god of water and the oceans. It has a bright blue colour due to the methane in its atmosphere. It has winds of up to 2 000km/h ripping through its atmosphere – the fiercest winds in the Solar System. Neptune also has a huge storm raging on its surface, called the GREAT DARK SPOT. This storm is large enough to contain the Earth! Neptune has 4 rings around it. It is the last planet in our Solar System. It has 14 moons, one of them, TRITON, orbits around Neptune backwards!

NEPTUNE FACT BOX

DIAMETER: 49 500KM
DISTANCE FROM THE SUN: 4 504 MILLION KM (4 504 000 000KM)
LENGTH OF DAY: 16 HOURS 7 MINUTES
LENGTH OF YEAR: 165 YEARS

TEMPERATURE: -210°C
SATELLITES: 14

FUN!!

ACTIVITY: Make a mnemonic

Use the first letter of the names of each planet to help you make a sentence to remember the order of the planets. An example is given:

Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
Mary	Very	Easily	Made	Jam	Sandwiches	Until	Now

M_____

V_____

E_____

M_____

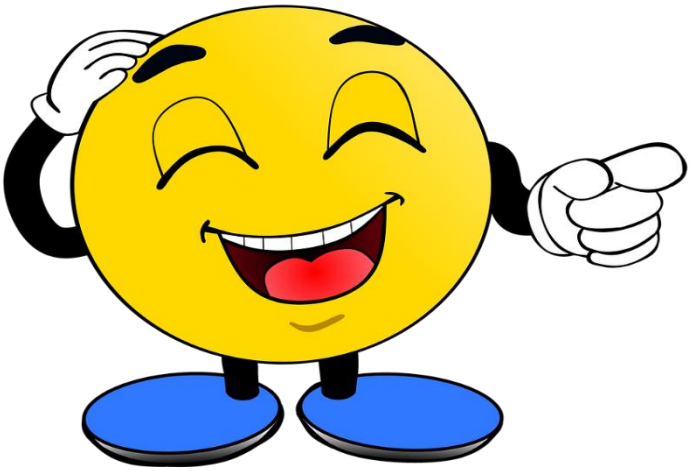
J_____

S_____

U_____

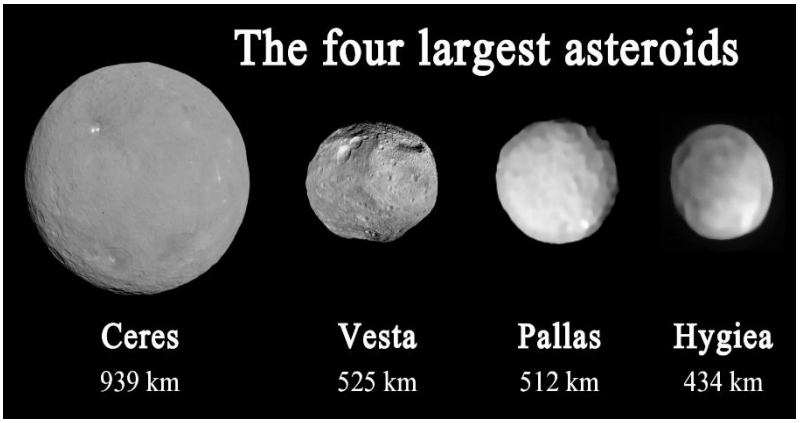
S_____

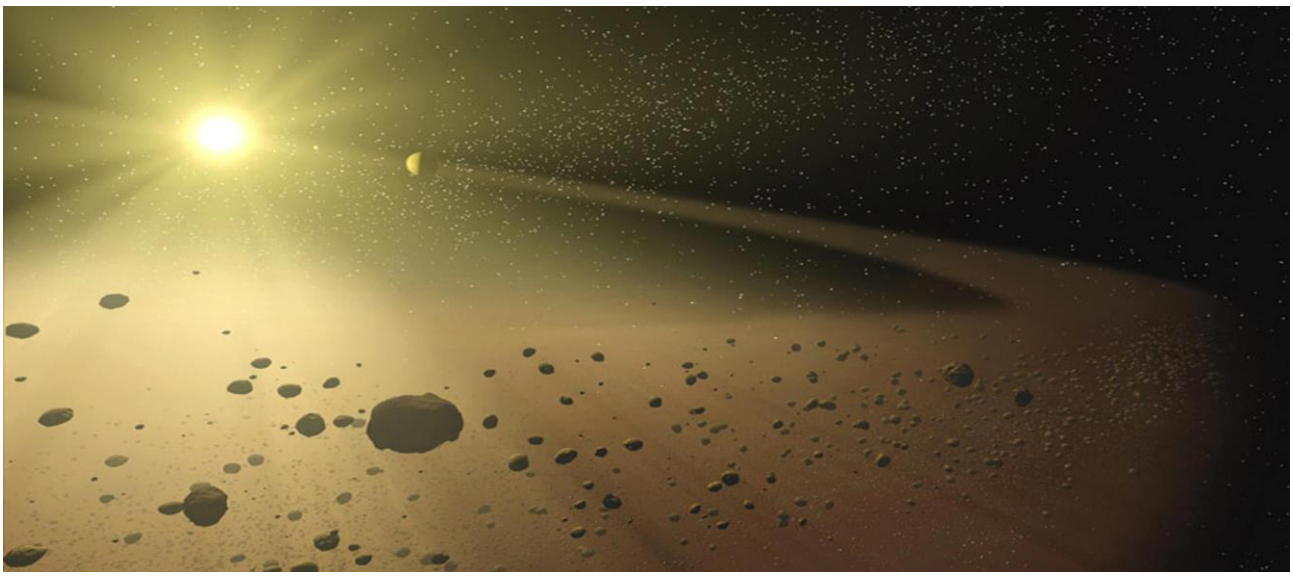
Give it a try! See how many sentences you can make. Compare yours with your friend's

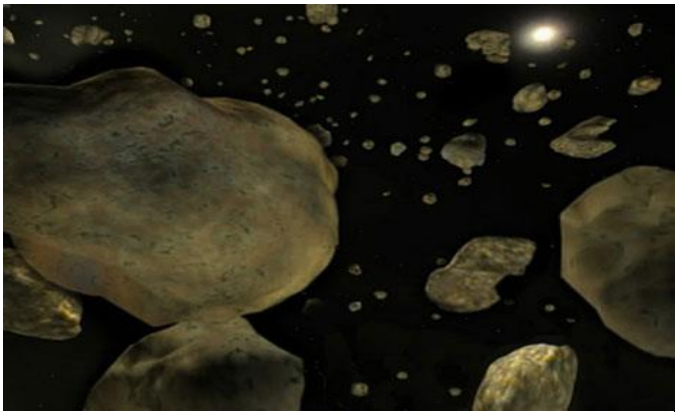


THE ASTEROID BELT

Asteroids are small, rocky objects that orbit the sun. They are lumps of rock from planets that broke up long ago. Some of these rocks are bigger than buildings, whilst others are as small as stones. Although they orbit the sun like planets, they are MUCH SMALLER than planets. Most of them live in the main **Asteroid Belt, a region between the orbits of Mars and Jupiter.** The largest body found in the Asteroid Belt is CERES, a dwarf planet.



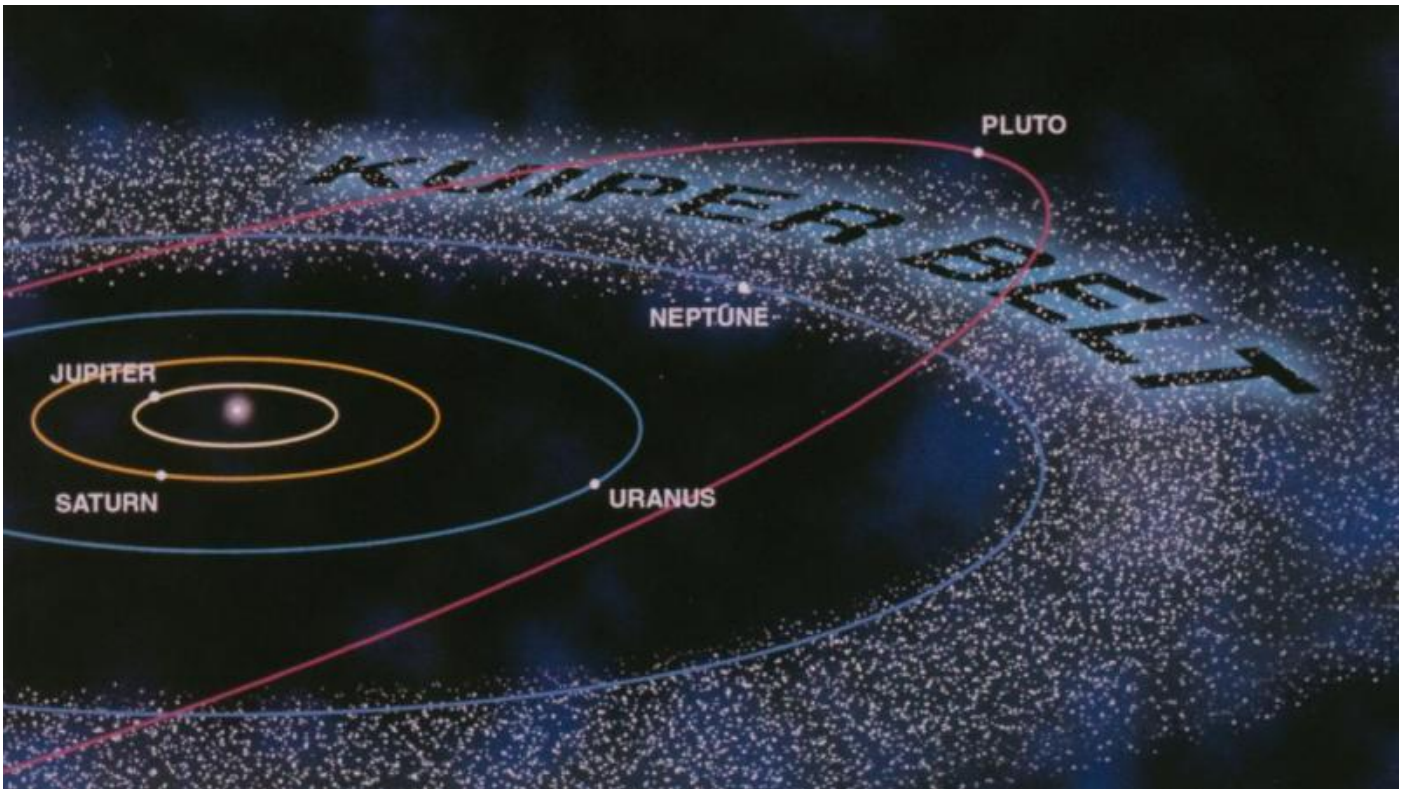




THE KUIPER BELT

The Kuiper belt is a doughnut-shaped ring of icy objects orbiting around the sun, starting just after the orbit of Neptune. Scientists are studying the Kuiper belt by means of the space probe, NEW HORIZONS, which flew by Pluto in 2015 and took photos of it. It is now investigating objects in the Kuiper Belt. There may be hundreds of thousands of icy bodies larger than 100km and estimated millions or more comets in the Kuiper Belt. Pluto, Eris, Makemake and Haumea are dwarf planets in the Kuiper Belt.

This picture shows Pluto's orbital path crossing Neptune's orbital path. Pluto live in the Kuiper Belt, shown in the picture behind the orbit of Neptune



COMETS

Comets are lumps of ice and rock that travel from the far outer solar system to orbit our sun. As the comet nears the sun, the ice melts and gives off gas jets and clouds of dust. We see this as a dramatic tail, shining in reflected sunlight. Such a tail can stretch for many millions of kilometres. Some comets take thousands of years to orbit the sun, whilst others take less than 100 years. The most famous comet is Halley's comet which takes 75 years to orbit the sun. It comes into Earth's sight every 75 years. It was last seen in 1989 and will be seen again in 2061.

METEOROIDS, METERORITES AND METEORS

What is the difference between meteoroids meteors and meteorites?

When meteoroids enter Earth's atmosphere (or that of another planet, like Mars) at high speed and burn up, the fireballs or "shooting stars" are called meteors. When a meteoroid survives a trip through the atmosphere and hits the ground, it's called a meteorite.

NOTE TO TEACHERS

Scientists and new technology are always finding new facts about space. When you research, **always check the date of the article you are reading**. Facts become outdated so fast that it's best to reference articles that are near to the year you are in. Also, you will notice that not all information given on the internet about planets, etc are the same. They give different

sizes, length of days, years etc. This gets a bit frustrating! Some articles round off numbers which is why they can be different.

Encourage learners to reference the "MY DICTIONARY PAGE' to help them understand terms used in these articles. Also, so that they may expand their vocabulary.

One of the best episodes of videos for school science are done by BILL NYE THE SCIENCE GUY. He made a lot of episodes in the 1990's. Below is the link to one of his space videos.

https://www.dailymotion.com/video/x3jyutv

SPACE: TERMINOLOGY AND DEFINITIONS

Use an English dictionary, a Science dictionary, the information in textbooks or any other source you can find, to answer the following questions:

1. Define a star (what is a star?) (2)

_____

_____

2. Define a planet. (4)

_____

_____

_____

_____

3. Define a moon. (3)

_____

_____

_____

4. What is the difference between an asteroid and a meteor? (4)

_____

_____

_____

_____

5. What is the difference between a meteor and a meteorite? (3)

_____

_____

_____

6. What is a "shooting star"? Is it really a shooting star? (2)

_____

_____

7. What is the difference between a constellation and a galaxy? (2)

_____

_____

8. Define a comet. (3)

_____

_____

_____

9. Define a dwarf planet (4)

_____

_____

_____

_____

10. What is the difference between "rotation" and "revolution"?

(with regards to planets) (2)

_____

_____

11. What day is used for the Leap year every 4th year? (1)

_____

TOTAL: 30

MEMORANDUM

Note to teachers: Encourage the use of advanced terminology such as "define" in the class room instead of "what is...". Once learners understand key terminology in questions during lessons, they can improve their marks during tests and exams.

1. A star is a burning ball of gas that generates energy by nuclear fusion, giving off heat and light.
2. A planet is a body that **orbits a star** in its own **orbital path**, is big enough for its **gravity** to make it round, must have **cleared the neighbourhood** of smaller bodies, does not have its own light but **reflects the light of the sun**.
3. A natural satellite that orbits a planet and is lit up by the sun, it does not have its own source of light.
4. An **asteroid** is a rocky body varying in size that orbits the sun in the Asteroid Belt. A **meteor** is a body made from rock and metal that enters the Earth's atmosphere and burns up.
5. A **meteorite** is parts of a meteor that entered the Earth's atmosphere but did not burn up. They landed on the Earth. A meteor burns up.
6. A **shooting star is a meteor**: a body made from pieces of rock and iron that enter the Earth's atmosphere and becomes so hot from friction with the air particles that it glows white. It appears as a white streak in the sky.
7. A **galaxy** is an independent system of starts, planets, dust and gas existing in space. A **constellation** is a group of starts.
8. A **comet** is a lump of ice and rock orbiting the sun in a non-circular orbit. As it nears the inner part of our solar system, the sun heats it up to produce a tail of gas which glows white.
9. A **dwarf planet** is a celestial body that is in orbit around the sun, has sufficient gravity to make it round/nearly round, has not cleared the neighbourhood of smaller bodies, is not a satellite and does not have its own light but reflects the light of the sun.
10. **Rotation** – planet spins on its own axis, it turns a full circle on its own axis.

    Revolution – planet orbits around the sun in an orbital path, it travels a complete circle around another body.
11. 29 February.

OUR MOON

The moon is a natural satellite of the earth. It is 384 000 km away from the earth. It spins on its axis with one side permanently facing the earth. The moon takes +- 29 days to turn once on its own axis. In other words one of our days (24 hours) is equal to 29 days of the moon. The moon has no atmosphere. We thought the moon had no water until ice was discovered on its surface in 1998.

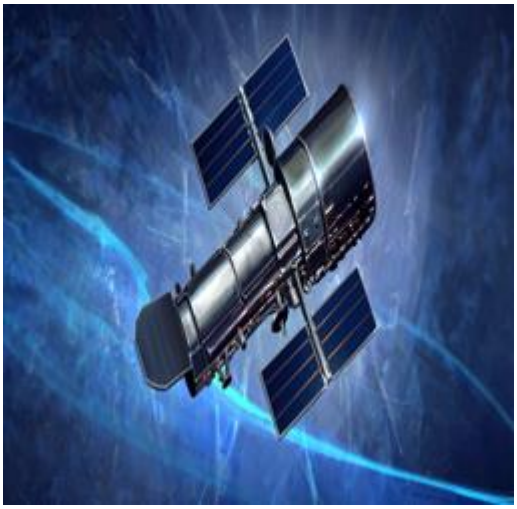
On its sunlit side temperatures reach up to 110°c, but during the two-week lunar night, temperatures drop to -170°c.

The earth is 12 742 km in diameter and 40 000 km around the equator. The moon is 3 476 km in diameter.

The moon does not have fits own light but reflects the light of the sun. There are still footprints on the moon from the first astronauts who landed on the moon July 16th, 1969 (Neil Armstrong, Mike Collins and Buzz Aldrin).

MOONS (SATELLITES)

A moon is actually a satellite! A satellite is classified as **an object that orbits another.** In other words, it is an object that travels around another object. **A moon that orbits a planet is a natural satellite.** Man, has put many artificial satellites into orbit around our earth. These satellites are used for GPS, communication, weather observation, spying for armies, etc. Other satellites are our ISS (International Space Station) and the Hubble telescope.



So, a moon is a:

- **Natural satellite orbiting a planet**

- **It does not have its own light but reflects the light of the sun**

✓ We can see our moon in the sky because the sun's light shines onto its surface. It affects our ocean tides because its gravity pulls on the water.

✓ It is covered with craters, mountains and flat plains.

✓ When we look at the moon's we see lighter areas which are the mountains, and darker areas which are flat plains.

✓ The moon has no atmosphere so there is no wind. That is why the craters and mountains do not get weathered away. During the first moon landing by man in 1969, the Apollo 11 landed on a flat plain. Neil Armstrong's footprints are still on the moon!!

✓ The moon is covered in fine dust called **regolith**. This is the dust of smashed rocks in space.

HOW MUCH HAVE YOU LEARNT?

Using the available resources, answer the following questions:

- The sun is a star
- The earth is a planet
- The moon is a natural satellite

1. What is a natural satellite?

   _____

   _____

2. What is an artificial satellite?

   _____

   _____

3. What is the size of the moon?

   _____

4. What is the size of the earth?

   _____

5. The average temperature of the earth is 25°C.
6. What is the maximum temperature on the moon? _____°C
7. What is the minimum temperature on the moon? _____°C
8. Why is there such a big difference between the maximum and minimum temperatures on the moon? THINK!

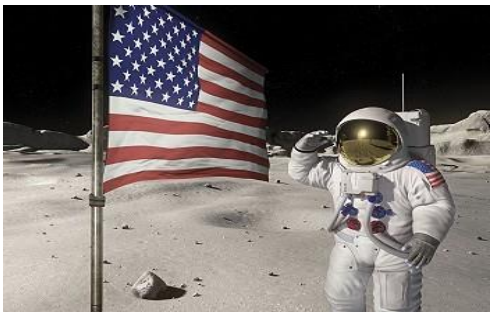
   _____

   _____

   _____

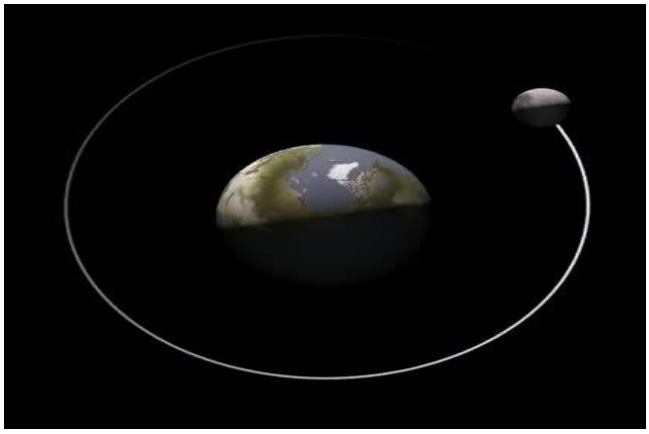
   _____

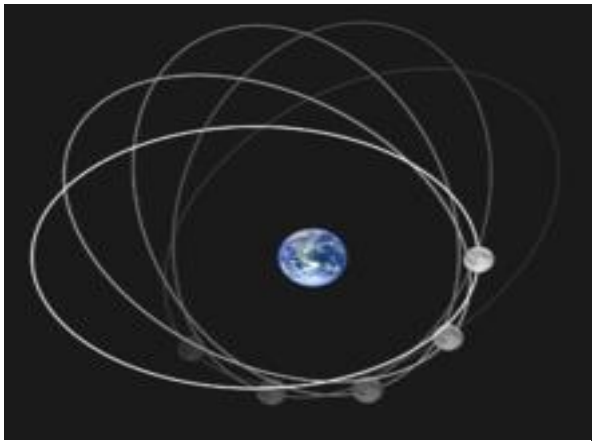
   _____

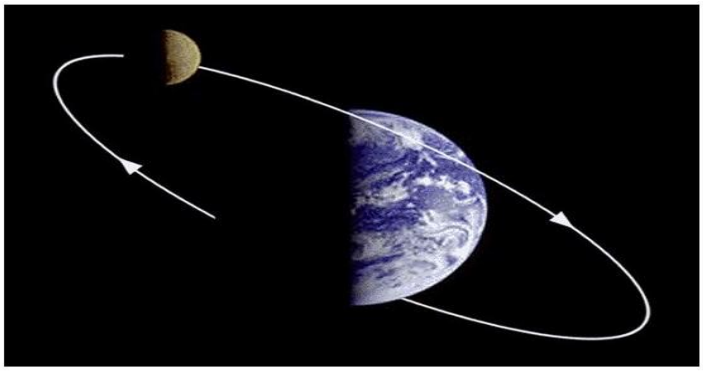


MEMORANDUM

1. A natural satellite is a celestial body orbiting a planet
2. An artificial satellite is a man-made object launched into space to orbit a planet
3. The size of the moon: 3 476km in diameter
4. The Earth is 12 742km in diameter and 40 000km around the equator
5. Maximum temperature on the moon is 110°C
6. Minimum temperature on the moon is -170° C
7. There is a big difference between the maximum and minimum temperatures on the moon because it takes the moon 29 days to rotate on its axis, so one side is facing the sun for about 14 days whilst the side away from the sun is in icy darkness for 14 days. Also the moon has no atmosphere to filter the sun's rays so the heat is concentrated. On the dark side there is no atmosphere to trap in a bit of the sun's previous warmth.







2. MOVEMENTS OF THE EARTH AND PLANETS

The planets and moons move in 2 ways:

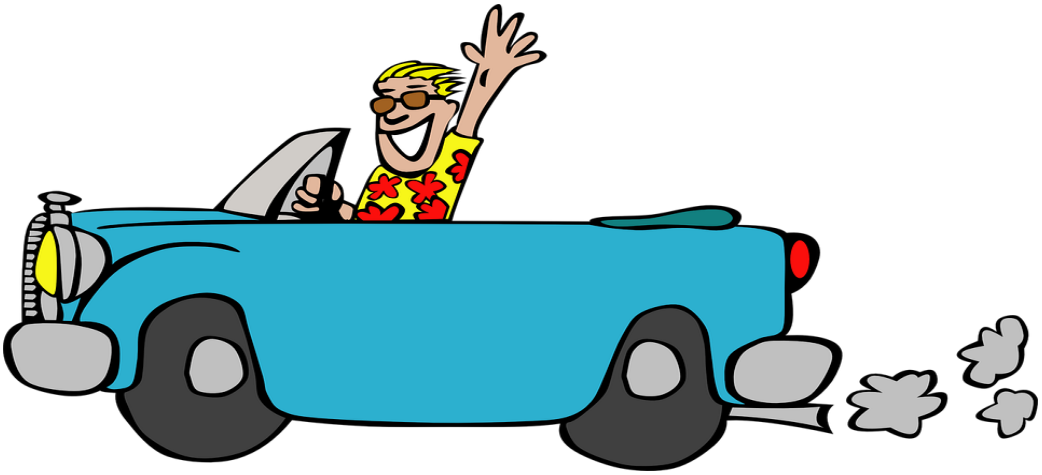
- ROTATION
- REVOLUTION

What is rotation?

Rotation is the spinning movement of an object around its own axis. Like a ballerina spins around on her tip toes so a planet rotates on its own axis. Planets rotate on their own axis. They spin around on the spot.

What is revolution?

Revolution is the movement of one object going around another object in an orbital path. (The path it travels around the other object is called the orbital path.)
Like me revolving around the soccer field in my Volvo, a planet revolves around the sun.

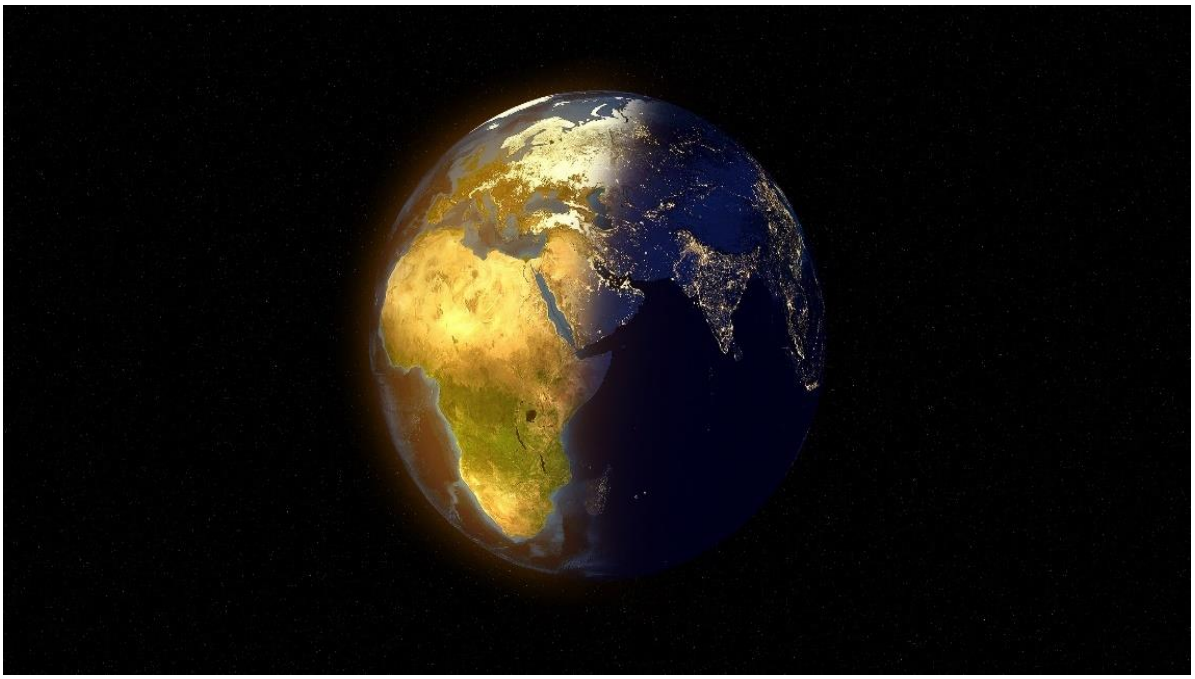


So, a planet rotates around its axis while it is revolving around the sun

ROTATION OF THE EARTH

It takes the Earth 24 hours to rotate around its axis once! The Earth spins at a speed of 1609km/h! Because it rotates, we have day and night. The side facing the sun has day time whilst the sun facing away from the sun has night time. As the Earth turns, the side facing the sun turns away from the sun and has night, whilst the sun that was facing away from the sun turns towards it and has day.

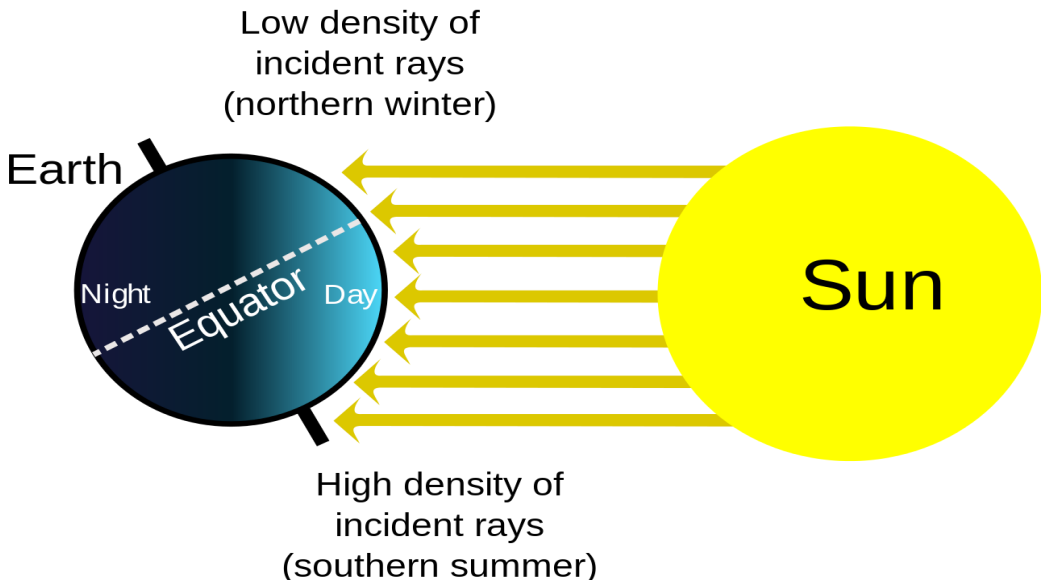
WATCH: http://www.youtube.com/watch?v=Zi6FkABFcQY (shows earth rotating and moon revolving around earth)
Day and night: https://www.youtube.com/watch?v=hPa7bu1q7D4



REVOLUTION OF THE EARTH

The Earth travels around the sun in its own orbit. One complete revolution takes 365 days and 6 hours. This is called 1 year. Because the Earth is tilted as it travels, we have seasons.

WATCH: https://www.youtube.com/watch?v=WgHmqv_-UbQ



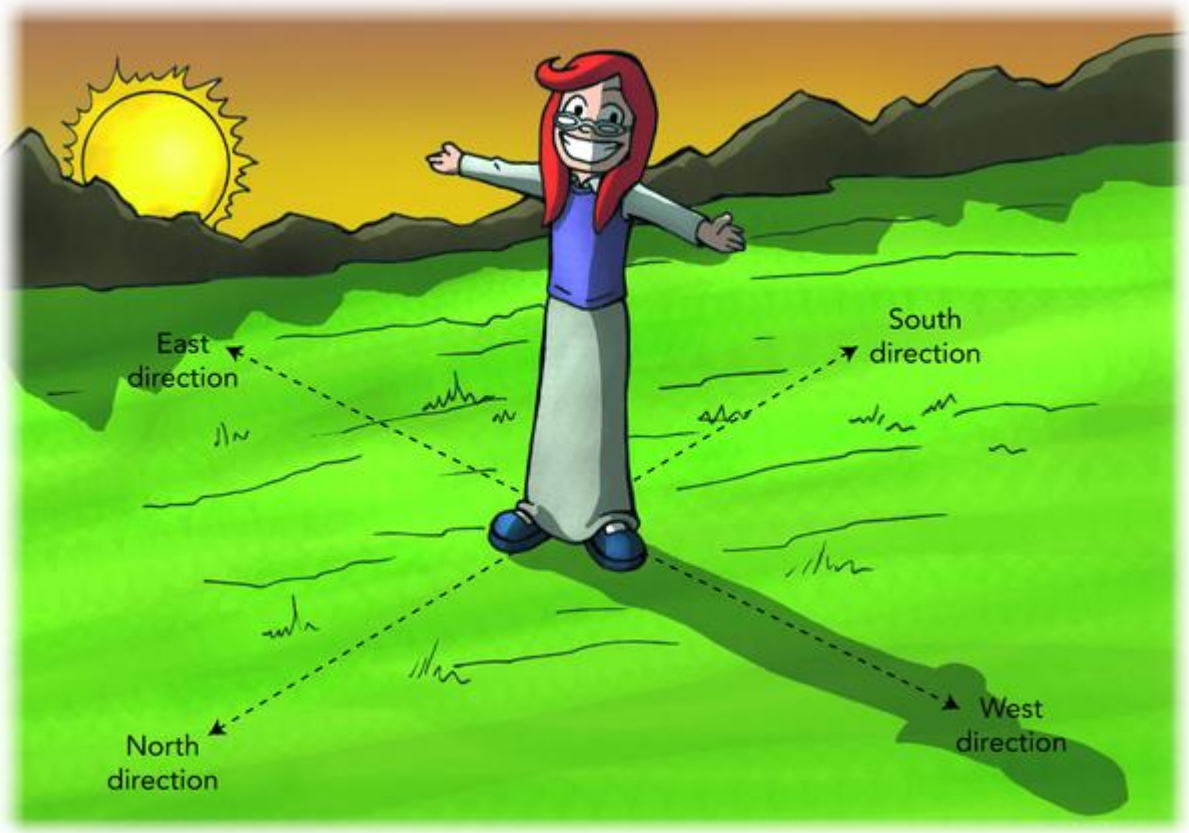
Day and night

- rotate
- spin
- rotation
- direction

Short video showing the Sun, Earth and Moon systemhttp://www.youtube.com/watch?v=W47Wa7onrIQ

During the day, it appears as though the Sun moves across the sky as it rises (comes up) in the morning and sets (goes down) in the evening.

East and West are two directions you must know. If you point at the Sun when it appears to rise in the morning, you are pointing in the direction of East. If you point at the place where the Sun sets, you are pointing direction of West. Have a look at the picture of Sophie. Sophie loves to get up early and watch the sunrise. She is standing with her arms stretched out, pointing in the directions East and West.



You can tell the direction from the rising and setting of the Sun.

Find East and West

MATERIALS:

- a place where you can stand in the early morning

INSTRUCTIONS:

1. Look at the picture of Sophie at sunrise and answer the questions.

QUESTIONS:

Which is Sophie's right hand? Show her right hand with your finger.

Why do we see a shadow of Sophie on the ground?

In which direction is her shadow pointing?

If Sophie looks straight in front of her, in which direction is she looking?

Now find the direction of East in your classroom. You must point to the place where you see the Sun come up in the morning. In the classroom, stretch out your arms and point in the direction of East and West. Clean the floor and stick some insulating tape on the floor so that everyone can remember which direction is East and which direction is West.

What does the word "direction" mean? You can walk in a **direction** towards a place. If the wind blows, you see leaves moving in the same **direction** as the wind. Remember, a direction is not a place that you can reach!

Let's have a discussion. To discuss something is to talk about it and your ideas with someone else or a group of people. Turn to your classmate next to you and discuss the following question. Write your answer down, then write your partner's answer down.

Where does the Sun go at night? Why do we get day and night?

Your answer is:

Your partner's answer is:

Earth

- revolve
- revolution
- rotate
- orbit

By now you know that all the planets revolve (travel) around the Sun. Each planet has its own pathway. This is called its orbit. We can also say planets orbit the Sun. Earth also moves in its own orbit around the Sun. This movement is called the **revolution** of the Earth around the Sun. We can also say that the Earth **orbits** around the Sun.

We have now come across two new words: rotation and revolution. Remember, these are not the same thing! Let's do an activity using our own bodies to understand the difference between revolution and rotation.

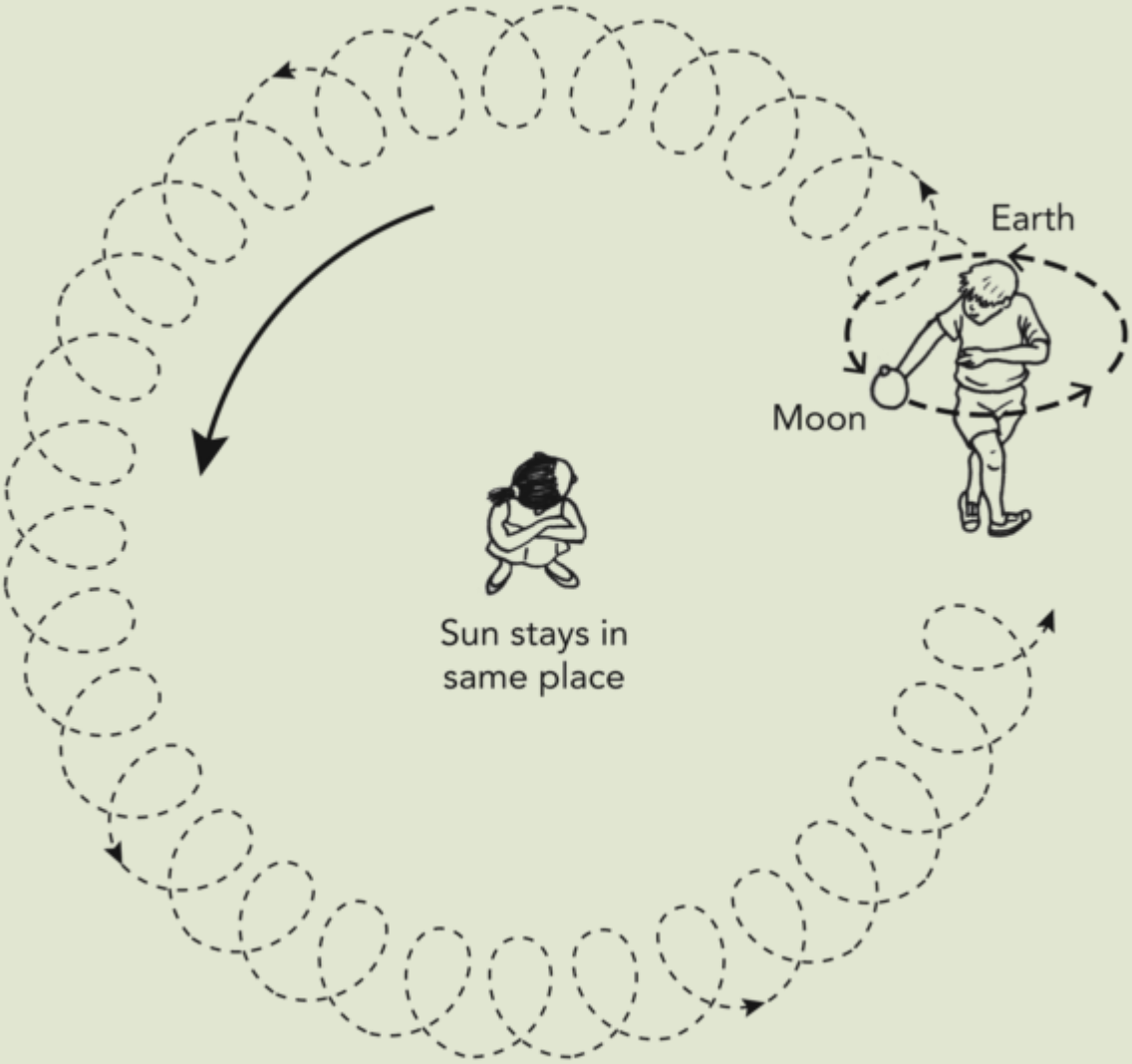
Make a model of the Earth revolving around the Sun

MATERIALS:

- room to move around

INSTRUCTIONS:

1. We are going to use our bodies to understand the difference between revolving and rotating.
2. First, the whole class must stand, and spread out. Now spin around with your arms out, staying on one spot. This is called rotation! The Earth rotates like this on its axis.
3. Now get into pairs. One learner must stand in one spot and the other learner must walk in a circle around the other person. This is revolution. The second learner is revolving around the learner standing still in the middle. The Earth revolves around the Sun like this.
4. Now, let's put both movements together! As the Earth rotates on its axis, it also revolves around the Sun. This might be tricky! Spin around (rotate) while also moving in a big circle around your partner (revolve). Look at the picture below.



The learner is rotating (spinning) and revolving around his partner.

QUESTIONS:

In this model, who represents the Sun and who represents the Earth?

Every 4 years we have a leap year, which is when there is one extra day in the year. This is because the Earth actually takes 365.25 days to revolve around the Sun, and not just 365 days. So every 4 years, we have an extra day to account for these quarter days.

When you are spinning and walking in a circle around your partner, sometimes you face your partner and sometimes your back is to your partner. Which of these represents day for you and which represents night for you?

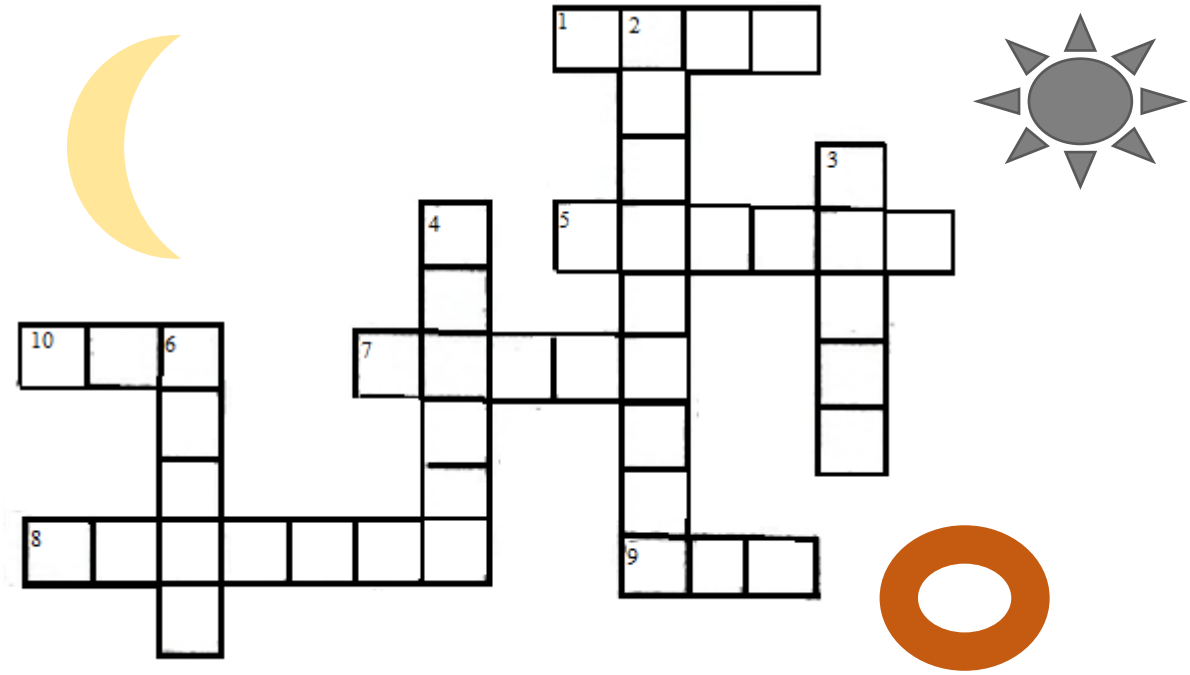
You could spin around very quickly, but how many hours need to pass for the Earth to rotate once?

You could also move around your partner quite quickly. In reality, how long does it take for the Earth to go once around the Sun?

REMEMBER:

- Wherever we are, we can find the East - West direction by the place where the Sun rises and sets.
- The Earth spins on its axis once in 24 hours. This spinning is called rotation.
- The part of the Earth that faces the Sun experiences daylight, and the part that is turned away from the Sun experiences night.
- The Earth travels in its orbit right around the Sun. This travel in orbit is called revolution.
- A complete travelling of the Earth around the Sun makes a year.

HOW MUCH DO YOU REMEMBER? COMPLETE THE CROSSWORD PUZZLE



DOWN:

2. Chunks of rock between Mars and Jupiter

3. Ice balls with a tail, sometimes seen in our night sky

4. The Milky Way is part of our ...

6. Our sun and all the stars and planets orbiting to make up the .... System

ACROSS

1. Our nearest planetary neighbour called the "red planet"

5. Also called a "shooting star"

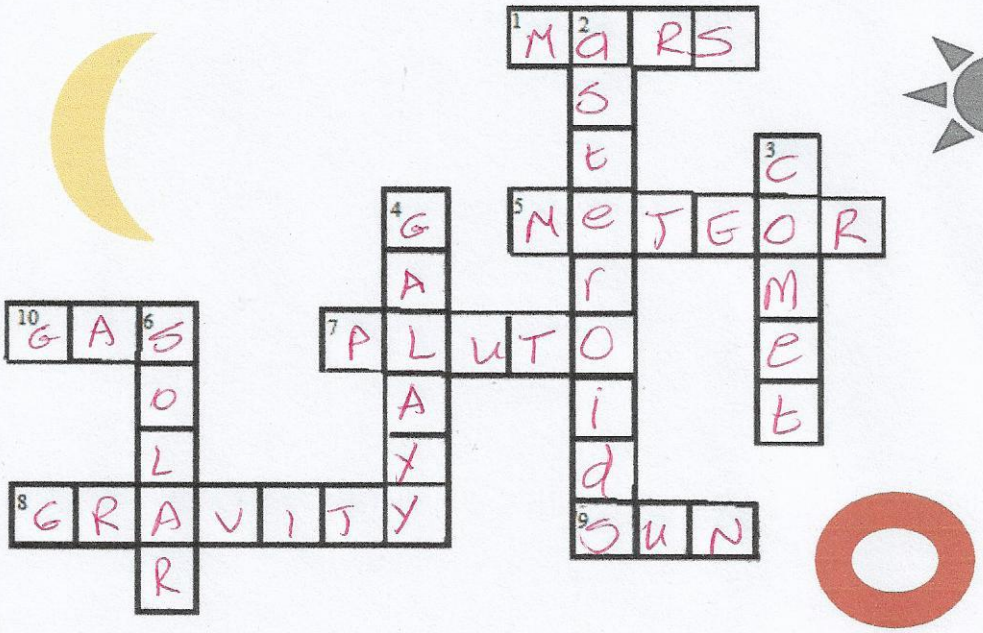
7. The dwarf planet next to Neptune

8. The force that keeps us from flying into space

9. Generates energy by nuclear fusion

10. The sun is a burning ball of...

MEMORANDUM



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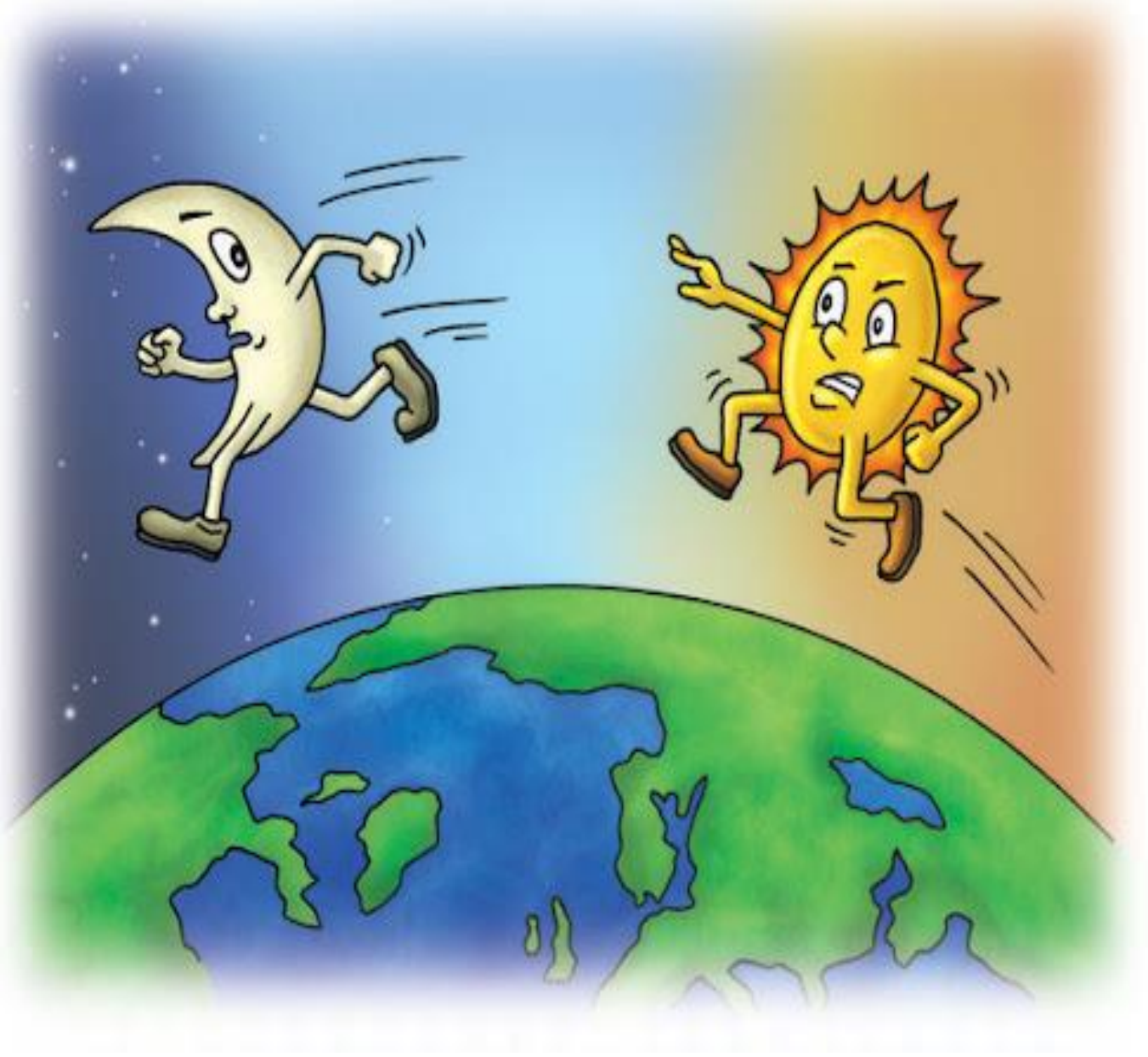
3. THE MOVEMENT OF THE MOON



Topic: The movement of the moon

Subtopic: Rotation (Moon)

The moon is spinning, and complete rotation takes about 28 days.

Links to be used

http://www.youtube.com/watch?v=exIpL0Uhr_k&feature=related

http://www.youtube.com/watch?v=OZIB_leg75Q&feature=related

Notes:

From Earth, we see only one side of the Moon and that is because the moon rotates on its axis once. The rotation of the moon takes place from West to East. The force of gravity holds the moon in its position. As the moon rotates only one side of the moon is lit by the sun and the other side faces away and for the reason it is dark. The moon is a hard rock that has no light of its own. The moon only shines because of the light from the sun that falls on it.

Activity1 - Does the Moon rotate?

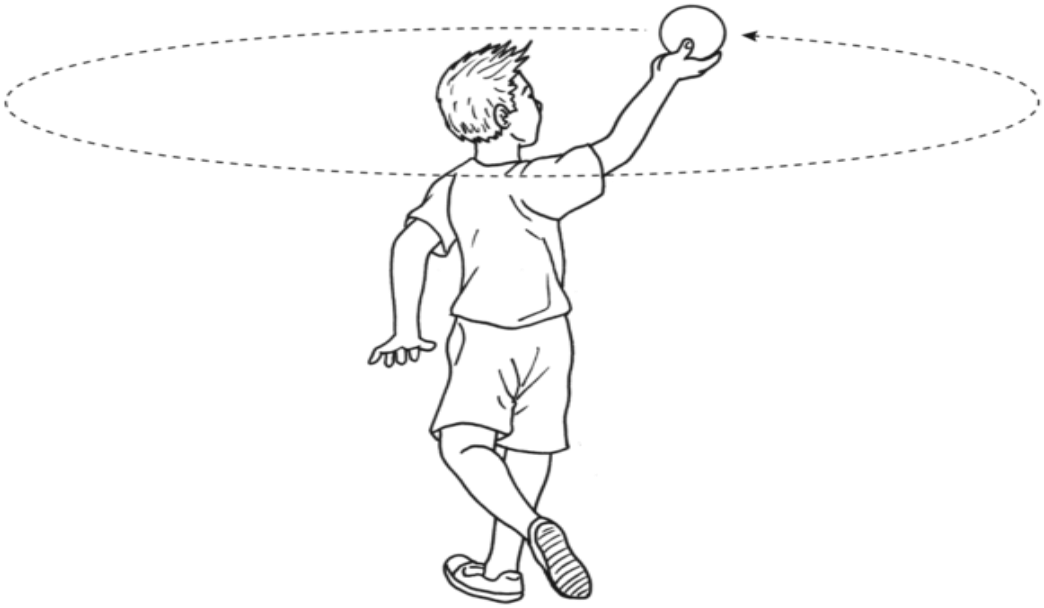
1. Use your body to make a model of the moon rotation.

MATERIALS:

- A white ball with a red mark on it
- a person who will swing the ball around like the learner in the picture
- another person who will watch the ball as it swings around

INSTRUCTIONS:

1. I Do as the learner in the picture is doing. Stretch out your arm and make the white ball revolve around your body by holding out your arm and moving on around on a spot.
2. As you are moving the ball around yourself, you only ever see one side of the ball. Do you agree?
3. Your partner must stand on one side of you as you swing the ball around. What does this person see? They will see different sides of the ball.
4. Take it in turns to be the one moving the ball around as you rotate and the one observing.



The learner swinging the ball will see the same side of the ball all the time, however the person standing and watching the ball will see it as rotating. The red mark on the ball will point to the **side** of the room, then to the **back** of the room, then to the **other side**, and then to the **front** of the room. The person watching will say that the ball has rotated, and also revolved.

Topic: The movement of the moon

Subtopic: Revolution (Moon)

The moon revolves around the Earth and the revolution takes about a month.

Notes:

The Moon also revolves around the earth in its orbit. Just like the moon rotate in its axis once in 28 days, it also takes 28 days to revolve around the earth. The moon rotates in an anti-clockwise direction. However, because it takes the same time to rotate and revolve, the same side of the moon always faces the earth.

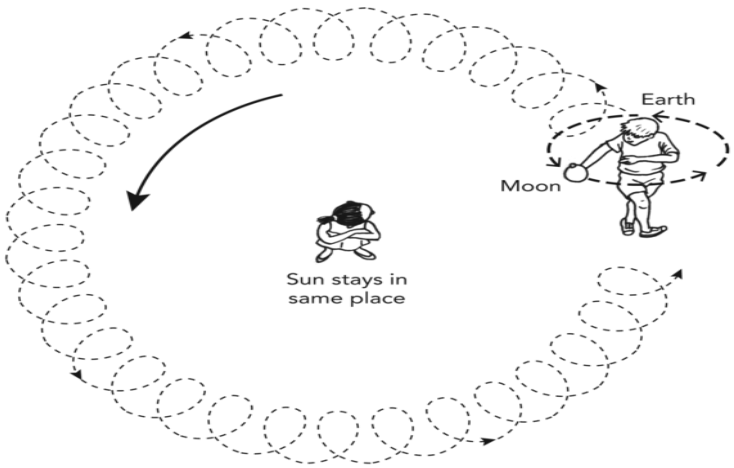
Activity2- Make a model of the Earth and Moon revolving around the Sun

MATERIALS:

- A white ball
- two people who have practised the model in the previous activity

INSTRUCTIONS:

1. You must use your bodies and the white ball to act out this model of the Earth and Moon revolving around the Sun.
2. Work together in small groups to decide how you are going to perform this model.
3. You must put together the movement of the Moon around the Earth from the last activity, and the movement of the Earth with its Moon, around the Sun.
4. Then perform the movements for the class.
5. The model you perform will be like the diagram shown.



Key Concepts

- The Moon travels in an orbit around the Earth in about 28 days.
- The Moon rotates on an axis which also takes about 28 days.
- We always see only one side of the Moon.
- Together, the Earth and Moon revolve around the Sun.

Topic: The movement of the moon

Subtopic: Together the Earth and the moon revolve around the sun.

The moon revolves around the earth and at the same time the earth revolves around the sun. While the earth revolves in its own orbit, the moon together with the earth revolve around the sun.

Activity3- Make a model to show the movement of the earth and the moon around the sun.

Materials:

1. Pair of scissors.
2. Three split pins.
3. Metal paper fasteners.
4. Cardboard (cereal box can be used).
5. Paper plate (yellow if possible or it can be coloured yellow).
6. Three round shapes of different sizes.
7. Crayons or makers.

Instructions.

1. Cut out three different sized circles from the cardboard. (small, medium and large. The large one can be cut from the yellow paper plate so that it represents the sun.
2. Colour the two remaining to represent the moon and the earth.
3. Cut out two strips of cardboard. One measuring 17 cm long and the other 7 cm long.
4. Connect one end of the short strip of cardboard to the centre of the back of the moon using a split pin.

5. Connect the other end of the same strip to the centre of the earth. (Don't close the second split pin as yet.
6. Connect one end of the long strip of cardboard to the centre of the back of the earth with the already open split pin.
7. Connect the other end of that same long strip to the centre of the sun.
8. Now you have a model of the sun, the earth, and the moon. Move the earth and the moon to observe their movements. See how the moon revolves around the sun with the earth.

Activity 4- Write and draw the about the movements of the moon and the earth.

Complete the sentences using all the words from the word box. write the sentences out in full on the lines below and number each sentence.

1. The Sun stays in
   _____
2. The Earth rotates on its own
   _____
3. The Moon revolves around the _____
4. The _____ revolve together in a big circle around the Sun.
5. We only ever see _____ of the Moon.

WORD BOX

Moon and the Earth

around the Earth one side

axis

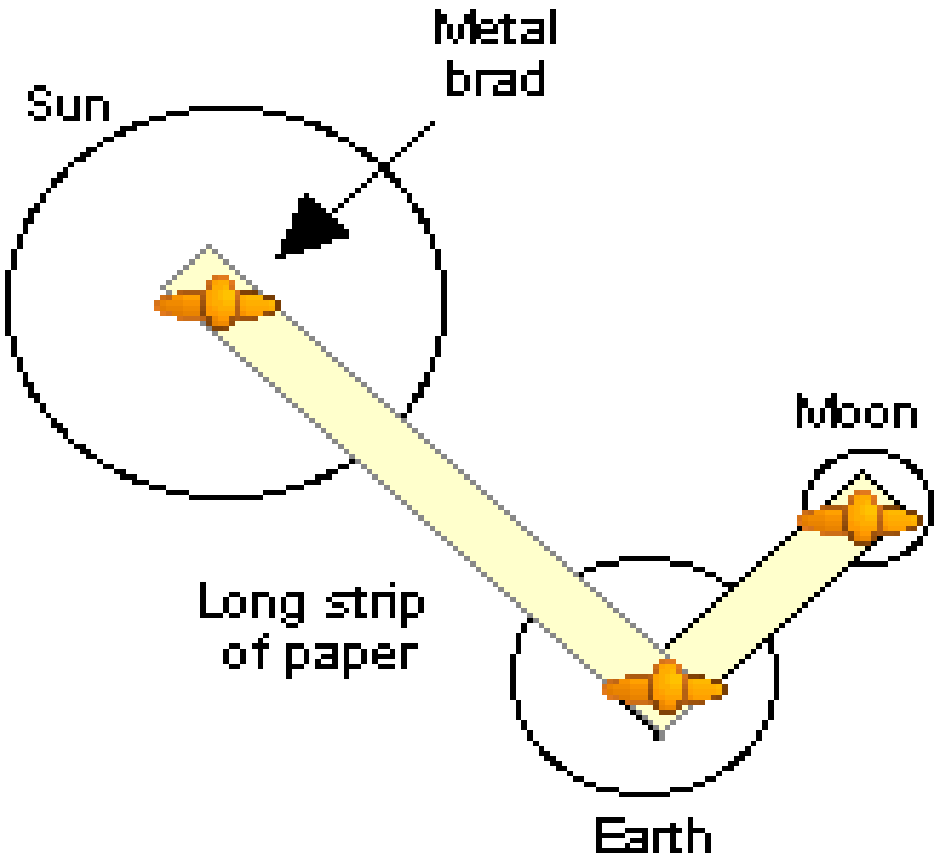
the same place

Activity 5: Compare the features of the Sun, Earth and the Moon.

Comparing the Sun, Earth and Moon, by complete the **GREEN BLOCKS** in the table below. Some answers have already been filled in for you, in the **BLUE BLOCKS**.

QUESTION	SUN	EARTH	MOON
What is the object classified as?			Moon
What is the shape?			
What is the size relative to the other objects being discussed here?	The Sun is the biggest.		
What is the movement in relation to other objects?		The Earth revolves around the Sun.	
What is the object made of?			rock
Can this object produce light?			No, the Moon reflects the Sun's rays.
Is the water present?			

Memo: Activity 3



Memo: Activity 4

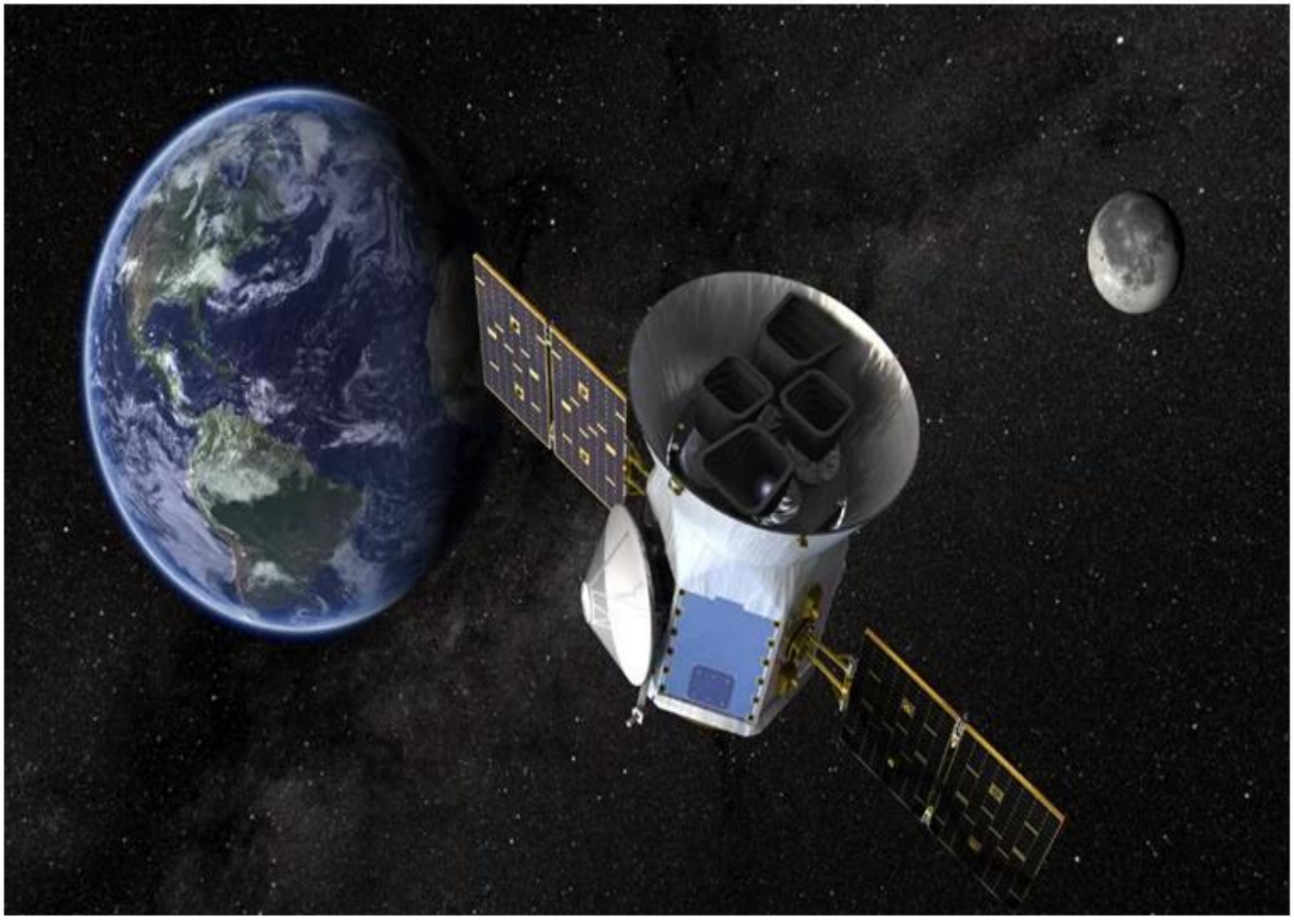
1. Same place
2. Axis
3. Earth
4. Moon and the Earth
5. One side

- The Sun stays in same place
- The Earth rotates on its own axis
- The Moon revolves the Earth
- The moon and the Earth revolve together in a big circle around the Sun.
- We only ever see one side of the Moon.

Memo: Activity 5

QUESTION	SUN	EARTH	MOON
What is the object classified as?	Sun	Earth	Moon
What is the shape?	Round	Round	Round
What is the size relative to the other objects being discussed here?	The Sun is the biggest.	Bigger than the moon but smaller than the sun.	Smallest of the 3.
What is the movement in relation to other objects?	Stays in one place	The Earth revolves around the Sun.	Rotates the Earth
What is the object made of?	Ball of gas	Rocks, soil and water	Rock
Can this object produce light?	Yes	No	No, the Moon reflects the Sun's rays
Is the water present?	No	Yes, made from 75 percent water	No. Moon has no life

4. Systems for looking into space



WHAT IS A TELESCOPE?

A telescope is **a tool that astronomers use to see faraway objects**. Most telescopes, and all large telescopes, work by using curved mirrors to gather and focus light from the night sky. The first telescopes focused light by using pieces of curved, clear glass, called lenses.

TELESCOPES

1. A telescope makes far away objects look closer.
2. Astronomers use telescopes to study the Solar System and other objects that are far away.
3. Telescopes use large lenses and mirrors to make objects seem closer.
4. Modern telescopes are large and have built in cameras to take photographs.
5. Large telescopes are put inside a building called an **observatory**.
6. This is a round building with high walls.
7. The observatory has a dome shaped roof that can slide open to view the night sky.

1. Explain this to the learners as follows:

a. Humans have been studying the night sky since the beginning of time.
b. A telescope is like a very big magnifying glass so it makes far away things look bigger.
c. Observatories are placed in remote places so that the lights from cities and towns do not make the night sky too light.

2. Show learners VIDEOS/ PHOTOGRAPHS OF "An Observatory".

- ✓ Point out the dome-shaped roof that can slide open.
- ✓ Give learners some time to copy the information from the chalkboard into their workbooks
- ✓ The photo below is taken from the inside of the Johannesburg Planetarium build in 1956. The Johannesburg Planetarium is a highly entertaining and educational experience for kids.
- ✓ The Planetarium is a fantastic way for kids to learn about planets, galaxies, celestial bodies and our universe.

3. Ask the learners the following questions to check their understanding at this point.

a. What is an observatory?

A round building with high walls with a large telescope inside (the roof can open so that the night sky can be viewed).

b. What do telescopes use to make objects look closer? Lenses and mirrors

4. Read the following information to the learners

Since the invention of the telescope, our knowledge of Space has grown enormously. Galileo Galilei, an Italian, made his own telescope in 1610. He used this telescope to study the night sky. Galilei was the first person to see the moons of Jupiter. He could prove that the Sun was at the centre of the Solar System. Galilei was put in prison when he told the authorities that is was the Sun that was at the centre of the Universe and not the Earth.

Show learners the photo of 'Galileo Galilei showing his telescope' to scientists.

.

5. Activity: Lenses

Do the following activity with the learners to show them what a lens can do.

- ✓ Put learners into groups.
- ✓ Each group must have a lens (either a hand-lens or round empty bottles filled with water).

- ✓ One learner from each group must hold up the lens and look at something on the wall (some writing or a poster).
- ✓ When the learner stands at a distance from the poster, the poster will appear to be upside down when it is looked at through the lens or bottle.
- ✓ When the learner gets closer, the poster will be the right way up but it will look bigger than what it is. The lens is magnifying the poster.

6. Activity: Mirrors

Do the following activity with learners to show them the power of mirrors.

- ✓ Put learners into groups.
- ✓ Each group must have a mirror (either a small mirror or one that has been made with foil stuck to a piece of cardboard)
- ✓ Go outside into the sunshine.
- ✓ A learner from each group must use a mirror to reflect sunlight onto a spot. Find a spot in the shade but the learners must be in the sun to reflect the sun off their mirrors.
- ✓ All the learners with mirrors must reflect the light from the Sun onto the same spot.
- ✓ Show learners that this spot will become very bright.

Go back to the classroom and explain the following to the learners:

a. All the mirrors work together like one big mirror onto a spot in the shade.

b. They each collect a bit of light energy from the Sun and send it to the spot that is bright.

c. This is how a telescope works.

d. The mirror inside a telescope collects the light from a star.

e. This light is focused on a lens.

Ask the learners the following questions to check their understanding at this point:

a. Who was the Italian astronomer who made his own telescope in 1610?
Galileo Galilei

b. What word is used to mean 'to make something look bigger'? Magnify

In addition, further reading, listening or viewing activities related to this sub-topic are available through the following web links:

https://goo.gl/ebgCQV ------[How to make a telescope at home]

https://goo.gl/rLPjvh -------[South Africa's Meerkat Telescope]

https://goo.gl/x7jqu9 -------[South African SKA Telescope]

https://goo.gl/boSmnd -------[Square Kilometre Array Official Animation]

Read the following case study carefully and answer the questions that follow.

Southern Africa's Largest Telescope

The Southern African Largest Telescope (SALT) is a state of- the- art scientific instrument. SALT is situated near Sutherland in the Northern Cape. This site was chosen for its clear and dark skies and good weather conditions. SALT is amongst the largest optical telescope in the world. SALT can detect light as faint as candle flame on the moon as it appears to us. This is important to have dark skies with no city lights nearby.

The Southern African Large Telescope (SALT) in Sutherland

Square Kilometer Array Radio Telescope (or SKA)

It will consist of thousand of radio receiver dishes mostly in South Africa, but also in other parts of the world, in fact four different continents. The dishes will be linked together into one huge radio telescope system. They will be linked with high - speed data cables and data will be processed by some of the fastest computers available.

The dishes together will add up to the square kilometre of surface area. This huge size and spread across the continents will make the SKA at least 50 times more powerful, and 10 thousand times faster than any other radio telescope.

KAT -7 (**Karoo Array Telescope**) is part of the SKA and is already operating. It has 7 receiver dishes. MeerKat, also in the Karoo, will have 64 receiver dishes and will be completed in 2016.

Radio receiver dish

1. Explain the following abbreviations.

(i) SKA: _____

(ii) KAT: _____

(iii) SALT: _____

2. Explain why SALT was built near Sutherland.

_____

3. Decide whether the description matches an optical telescope or radio telescope.

(a) It picks up radio signals._____

(b) We look through this telescope._____

(c) They are best used in a group (an array) _____

(d) It usually can be recognized by its bowl shape. _____

(e) South Africa's biggest is called SALT. _____

4. State if the sentences below are true or false.

(a) We can see stars better with our eyes than with a telescope. _____

(b) We can see more stars with a telescope than with our eyes. _____

(c) Telescopes make stars bigger. _____

(d) It is better to use telescopes far away from towns. _____

5. Match column A with column B and write your answers in column C

Column A	Column B	Column C
(1) Array	A. Make bigger	
(2) Optical telescope	B. Telescope for collecting radio waves	
(3) Magnify	C. Gas around the Earth	
(4) Atmosphere	D. Telescope we look through	
(5) Radio telescope	E. A group of telescope	

Memorandum

1. (i) Square Kilometre Array✓

(ii) Karoo Array Telescope✓

(iii) Southern African Large Telescope✓

2. Because of its clear and dark skies and good weather conditions✓

3.(a) Radio telescope✓

(b) Optical telescope✓

(c) Radio telescope✓

(d) Radio telescope✓

(e) Optical telescope✓

4 (a) False✓ (b) True✓ (c) False✓ (d) True✓

5 (a) E✓ (b) D✓ (c) A✓ (d) C✓ (e) B✓

5. Systems to explore the Moon and Mars

For a long time, people had to be satisfied to consider space and wonder about it. Over time, as people developed new technologies, such as telescopes, they could start to see the 'heavenly bodies' in more detail.

Eventually, technology made the human dream possible - to send people into space. The first time a space vehicle left the Earth's atmosphere* was in the 1950s.

A spacecraft is a vehicle that goes into space to explore space and to carry people and supplies to space stations. Before going into space, people need to know what it is like there, so that they, can be properly prepared.

SHOW PICTURES / VIDEOS OF SPACE CRAFT AND ITS PURPOSES

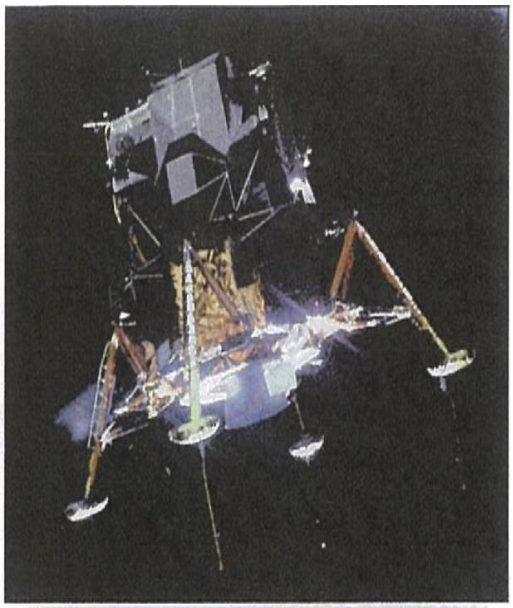
Activity 1

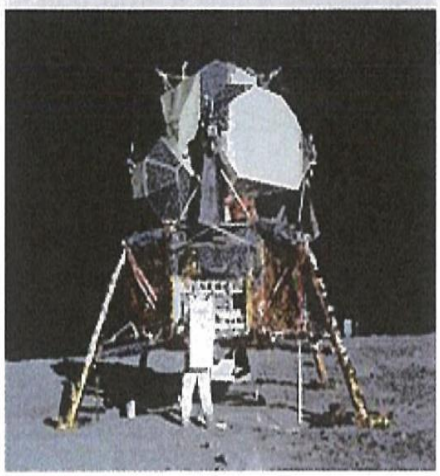
Copy this table and use it to compare the Moon and Mars.

FEATURES	MOON	MARS
Gravity	$^1/_6$ of Earth's gravity	$^1/_3$ of earth's gravity
Atmosphere	None	Much less than earth
Temperature	Very hot on the sunny side (more than 100° C)	Generally, very cold
Dust	Fine, sharp dust	Fine, red dust
Water	No evidence	Frozen water at the poles- possible underground water.
Distance from the Earth	380 000 km	Varies but an average of 225 $x10^6$ km

Vehicles that have visited and explored the Moon and Mars had to differ, because the surfaces of the Moon and Mars are different.

Vehicles used on the Moon





✓ Apollo11 was the spacecraft used for the first Moon landing. The spacecraft provided a shell structure to contain and protect the astronauts and their supplies of food and water.

✓ Apollo had special materials on the front of the spacecraft to stop it burning as it re-entered the Earth's atmosphere.

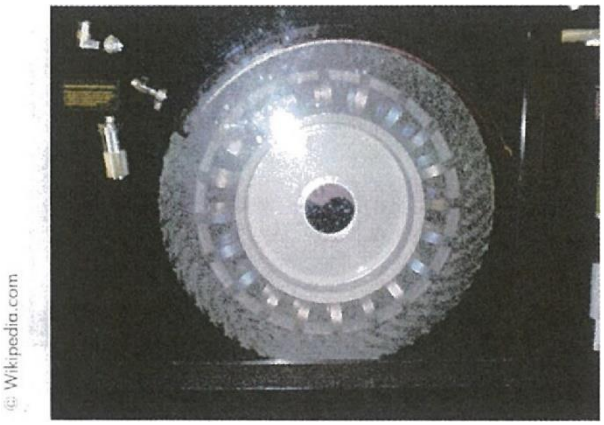
✓ These pictures show the lunar module of the Apollo spacecraft. It carried enough fuel to propel itself off the Moon's surface so that it could reconnect with the spacecraft for the return journey to Earth.

✓ A few people have visited the surface of the Moon and explored it. They used a vehicle called the Moon Rover, which can be seen in these pictures.

✓ The Moon Rover weighs 210kg. The frame is 3,1m long with a wheel base of 2,3m. The vehicle is low with a height of only 1,4m. It is only 36cm off the ground, that is just higher than the length of your ruler.

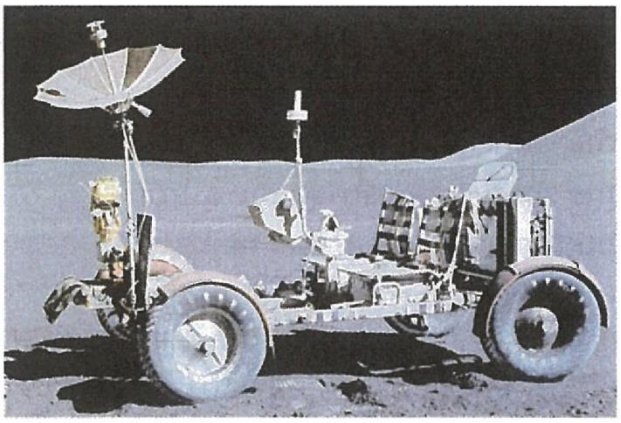
✓ The frame is made of tubing with a three-part chassis that can fold up when being transported from Earth. It also has two side-by-side seats and a Velcro seatbelt. A large mesh dish antenna is mounted on a mast on the vehicle so that it can communicate with the spacecraft and people on Earth. The wheels have an aluminium hub with a tyre made of zinc-coated woven steel attached to the rim

Photo A



Close- up of wheels showing chevron treads of Lunar Rover

Photo B



Photograph of Lunar Roving Vehicle

HOW TO OPERATE A MOON ROVER

- ✓ Dust guards above the wheels protect the Moon Rover from the dust on the Moon.
- ✓ The wheels have both front and back steering motors; therefore, it can move in any direction.
- ✓ The steering device is like that of an aircraft.
- ✓ A T-shaped hand controller is situated between the two seats.
- ✓ Moving the controller forward makes the Moon Rover go forward.
- ✓ Moving it to the left or right turns the vehicle left or right and pulling it backwards puts on the brakes.
- ✓ To put it into reverse, a switch must be put on before the controller is pulled backwards.
- ✓ When the Moon Rover is in space, it unfolds large wing-shaped structures that show panels to the Sun. The panels collect the Sun's energy so it can be stored and used later to power the equipment on the Moon Rover.

Activity 2

Read the information about Moon Rovers and write down your answers to these questions.

1. How much does the Moon Rover weigh?

The Moon Rover weighs 210 kg.

2. Why did the designer use tubing for the chassis?

So that it is not too heavy. Solid parts would be very heavy.

3. It is 3m long, so how did it fit into the spacecraft carrying it to the Moon?

The chassis consist of three parts that can fold up when it is being transported.

4. How are the wheels suited to travel on the surface of the Moon?

The wheels have front and back steering motors; therefore, it can be moved in any direction.

5. Explain how the steering of the Moon Rover works.

A T-shaped hand controller between the seats is:

- ✓ Pushed forward for foreword movement.
- ✓ Pushed left or right for left/ right turning.
- ✓ Pulled backwards for braking.
- ✓ A switch is put on for reversing.

READ THE INFORMATION BELOW AND ANSWER THE QUESTIONS THAT FOLLOW:

The moon is the only world that humans have landed on outside our own world. As Earth's companion in space, the moon has aroused our interest for centuries and has been the most likely target for manned space travel. Between 1969 and 1972, six Apollo missions successfully landed on the moon.

When the craft arrives on the moon, they either work on the spot where they have landed, or they drove around. Stationary craft can only investigate their immediate areas. During early investigations, astronauts found that their spacesuits restricted their movements and limited their ability to collect samples and complete their missions. Movement on the moon was not easy. Astronauts found it easier to hop rather than walk.

Moon rovers, on the other hand, could drive over long stretches of land, stopping from time to time to take photographs and make on-the-spot investigations. Apollo 15 was the first mission to use a ***lunar roving vehicle*** **(LRV).**

The **LRV** is popularly known as a **moon rover or moon buggy**. This vehicle was designed to be light, carry two astronauts plus scientific equipment, tools and communication gear. The LRV was carried to the moon folded up in the storage bay of the lunar module.

David Scott and James Irwin drove the light-weight -battery, operated LRV for about 30 kilometres over the surface of the moon. The vehicle had a top speed of 17 kilometres an hour!

Information on LRVs used by Apollo 15, 16 and 17 on their probes to the Moon.

Mission	Total distance travelled	Total time of driving	Longest single journey	Maximum km ranges from 'walk back limit'
Apollo 15 (LRV 001)	27,76 km	3 hrs. 2 min	12,47 km	5,0 km
Apollo 16	26,55 km	3 hrs.	11,5q km	4,5 km
Apollo 17	35, sq. km	4 hrs.	20,1 2 km	7,6 km
Note: NASA LRV's are left behind on the moon.				

Photo A: The LRV is like an open jeep used for moon probes

Photo B The LRV parked outside the LEM (lunar Excursion Module)

The LRV is like an open jeep used for moon probes.

It includes:

- ✓ Hand control---This controls the four drive motors, two steering motors and brakes. Moving the control forward powers, the LRV. Turning it left and right turns the LRV left and right, and pulling it backwards activates the brakes. Activating a switch on the handle before pulling back will put the LRV into reverse.

- ✓ television control unit
- ✓ seats for two astronauts with Velcro seatbelts
- ✓ laser reflector
- ✓ radio aerials
- ✓ communications antenna
- ✓ camera, television cables and film magazines
- ✓ power pack
- ✓ room for equipment and samples, tools, bagged rock, and dust samples
- ✓ large wheels to cope with moon's uneven surface
- ✓ colour TV camera
- ✓ lunar hand tools
- ✓ control display which shows the speed, power and temperature levels of the LRV
- ✓ life support system.

Activity 3: Roving around the moon

1. What is an LRV?
Lunar roving vehicle (Moon Rover or Moon Buggy)

2. Explain how the LRV assisted astronauts with their scientific discoveries.
Moon Rovers could drive over long stretches of land, able to stop to take photographs and make on-the-spot investigations.

3.Take a close look at the tyres of the LRV. Suggest why they look so different to the tyres we use.
To keep the wheels from sinking into the soft soil of the Moon.

4. Why is there a "walk back limit "?
The LRV's movement is a limited distance. Therefore, in case of something going wrong, astronauts must be close enough to be able to walk back to base.

5. Explain how you would get the LRV into reverse. By activating a switch on the hand control before pulling the control back will put the LRV into reverse.

Vehicles used on Mars

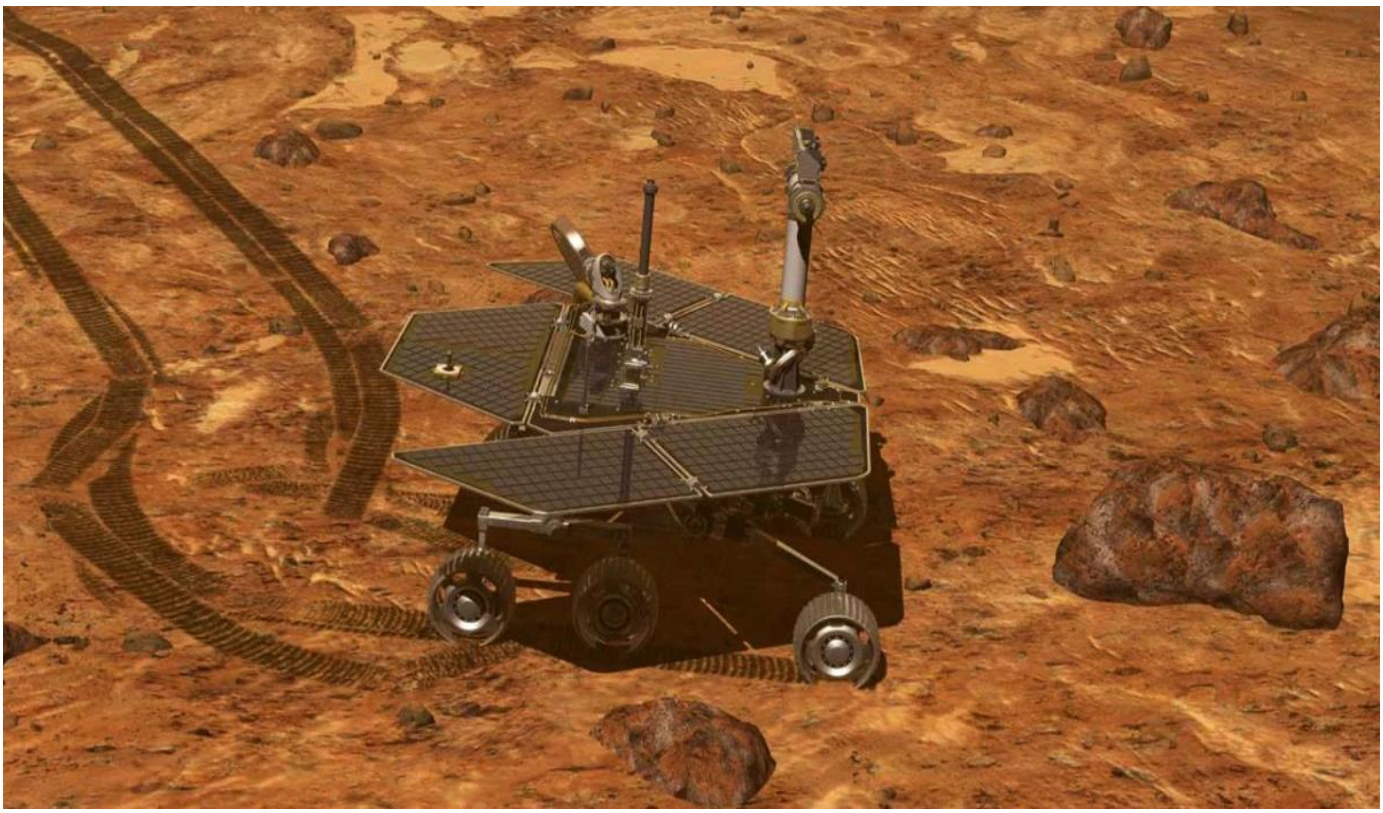
Opportunity, reported as one of the most successful rovers, landed on Mars in 2004. It touched down on Meridian Planum, a low-lying crater plain, which it is still exploring. The rover looks across the plain using cameras on its mast. Instruments on a jointed arm at the front of its body investigate the surface.

FEATURES OF THE ROVER CALLED OPPORTUNITY

- ✓ Each of the six wheels are about 26 centimetres in diameter and have their own motor. The wheels rotate very easily, almost in a full circle.
  The wheel surface can grip both in soft sand and on hard rock.
- ✓ The antenna is used for communications between Mars and Earth.
- ✓ It receives commands and software updates and returns information to Earth from the camera and other instruments.
- ✓ The equipment deck has solar panels on its upper surface, which provide power. Without power, the rover cannot move or communicate with Earth.
- ✓ Severe dust storms often covered 90% of the solar panels away from the sun, which proved challenging to the production of power.
- ✓ Opportunity also had battery packs as a back-up.
- ✓ The deck also protects the box-shaped body underneath, which contains a computer, radio and batteries.

The rock tool rotates and can move rocks to analyse what is underneath.

- ✓ When Opportunity travels, its arms are tucked. When it stops near a rock for examination, it unfolds like a human's, bending and moving at the shoulder, elbow and wrist joints.
- ✓ At the end are tools that can grind, take photos and analyse the rock, sending information back to us on Earth



On 6 August 2012, Curiosity, a robot called a Mars Rover, landed on Mars after an eight-month journey through space. The journey was about 225 million kilometre's as Mars is much further away from the Earth than the Moon.

The purpose of the Mars Rover

To investigate the possibility of people living on Mars in the future, to find out if water is present, to study its climate and **geology** and to collect information for a human mission to Mars.

Case study

Scientist's interest to explore Mars further has resulted in "building Curiosity. Curiosity is twice as long and five times as heavy, more sophisticated and advanced than Opportunity. After an eight-and-a-half-month journey into space, Curiosity Successfully landed on Mars on 5 August, 2012 and has already sent data to Earth.

Curiosity's two-year mission on Mars is to answer age-old questions about whether life ever existed or if this planet can sustain life, specifically inside the Gale Crater where there is evidence of water in the past.

The Mars Rover was carried through space by the Mars Science Laboratory.

- ✓ Information was sent to mission control by two antennae.
- ✓ Insulating blankets kept sensitive science instruments warm.
- ✓ There were two identical rover computers on board.
- ✓ These regulate the temperature, take pictures, control the driving and operate the instruments.
- ✓ The Mars Rover's wheels are much larger than those of earlier rovers.
- ✓ There are six wheels instead of four.

- ✓ They have wedges to prevent slipping and each wheel is geared.
- ✓ This allows it to climb in soft sand and scramble over rocks.
- ✓ The four corner wheels can be independently steered so the robot can turn in one place.
- ✓ The robot can be tilted to 50° in any direction without overturning.
- ✓ The Mars Rover has a lot of equipment.
- ✓ I t has seventeen cameras.
- ✓ It can **vaporise*** a small portion of rock with an infrared laser.
- ✓ It can use a long mechanical arm to swing over a microscope to take a closer look at something.
- ✓ It can even drill a boulder and deliver a powdered sample to the laboratory.
- ✓ Although some previous spacecraft have used airbags to cushion their landing, the Mars Rover is too heavy for this.
- ✓ It has a **supersonic parachute** that allows for a guided accurate landing.
- ✓ Once the parachute starts braking, the Mars Rover is lowered by the sky crane system, a 7,6m tether called a spider web.
- ✓ Then it has a soft landing on its wheels on the surface of Mars.

ACTIVITY 4

Write down your answers to these questions:

1. What were the names of the two Mars Rovers mentioned in this exercise?
Opportunity and Curiosity.

2. Why did it take so long to reach Mars?
Mars is 225 million km away from Earth.

3. Name two functions of the rover computers.
It regulates temperature, take pictures, control the driving and operate the instruments.

4. Explain two ways in which the designers allowed for climbing over soft sand or scrambling over rocks.
The wheels have wedges to prevent slipping and each wheel is geared.

5. Explain how Curiosity had a soft landing even though it is heavy.

It has a supersonic parachute. Once the parachute starts braking, the rover is lowered by a sky crane system. Then it has a soft landing on its wheels.

ACTIVITY 5

Collect pictures and information of different Moon Rovers and Mars Rovers. Use the Internet or any other sources and prepare a poster. Use this information to find out about important features and purposes of the Moon Rovers and Mars Rovers.

CHECKLIST FOR POSTER: YOU CAN ALSO ALLOCATE MARKS TO THE CHECKLIST.

FEATURES	YES	NO
1. In poster format		
2. Sufficient pictures of Moon Rovers		
3. Sufficient pictures of Mars Rovers		
4. Sufficient information on features of Moon Rovers		
5. Sufficient information on features of the Mars Rovers		

ACTIVITY 6

- ✓ Read the text below very carefully.
- ✓ Look at the pictures closely.
- ✓ Use an A4 page to write your explanation.

Imagine you are a Martian living in the Gale Crater where there is evidence of water in the past. A strange object descends in your crater and seems to be moving around, prodding and drilling. You feel the need to report this to the Martian community. Explain the following when the object arrived:

Name of object	Curiosity
Date of arrival	6 August 2012
List its features	Features: 2 antennae Insulating blankets to keep sensitive instruments warm 2 computers Six wheels 17 cameras Infra-red lasers

	Long mechanical arm with microscope Supersonic parachute for accurate landing
Explain your fascination with the wheels of this object (the number of wheels, their size and how they move.)	6 wheels, very large wheels, having wedges to prevent slipping. Each wheel has its own gears. Can be steered independently, therefore it can turn in one place. Wheels can be tilted to 50° without overturning.
Suggest why you think this object is on Mars.	To investigate if life has existed / can Mars sustain life / is there still water present on the planet.
Suggest how long you think it may be around.	About two years.
Suggest who may have sent it and from where.	NASA –Washington DC in the USA.

ACTIVITY 7

What do you know?

1. How many wheels does the Moon Rover have? A Moon Rover has 4 wheels

2. How many wheels does the Mars Rover have? The Mars rover has 6 wheels

3. Compare the wheels of the Moon Rover with that of the Mars Rover.

MOON ROVER	MARS ROVER
Has 4 wheels - an aluminium hub with a tyre made of zinc-coated woven steel attached to the rim. Dust guards are mounted above the wheels to protect the Rover from moon dust. Wheels have both front and back steering motors and can therefore be moved in any direction.	Has 6 very large wheels, having wedges to prevent slipping and its own gears. Each wheel can be steered independently, can be tilted to 50° without overturning.

4. Why could the Mars Rover not have airbags for landing?

It is too heavy to be able to land accurately with airbags.

LOOKING BACK AT THIS UNIT

What did you learn?

- A few people have visited the surface of the Moon and explored it using a vehicle called a Moon Rover.
- Moon Rovers have special features that enable them to move on the Moon.
- Robots called Mars Rovers have been used to visit and explore the surface of Mars.
- Mars Rovers have special equipment that they use to investigate the surface of Mars.
- They also have special features that enable them to land and move on Mars.
- No person has ever set foot on Mars yet.

ACKNOWLEDGEMENTS

All information as well as pictures were taken from the following textbooks:

1. Shuters Top Class Natural Science and Technology grade 6 Learner's Book

Free Promotional Copy ISBN 978-0-7960-4559-1 Jill Cadle, Tom Campbell et al

2. Spot On Natural Sciences and Technology grade 6 Learner's Book

ISBN 978—796-23441-4 PEARSON

3. https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcTmBHhd1C-W_epa--nASYEi9Ym31d_QtFMA-w&usqp=CAU

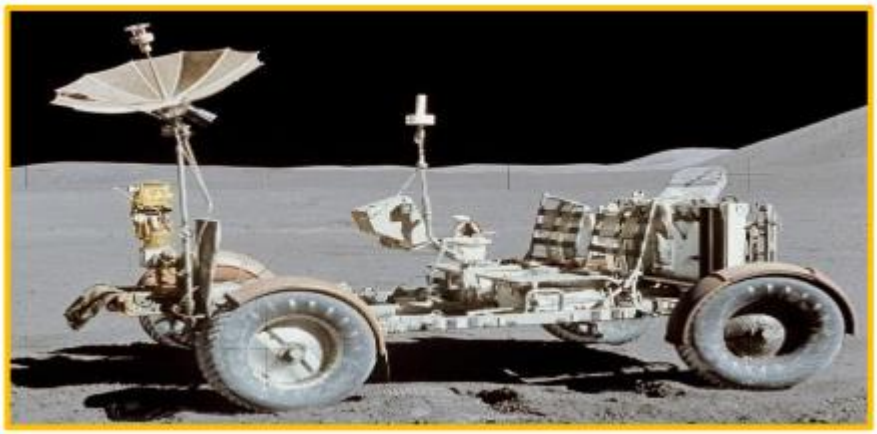
Technology project

Design, make and evaluate a model vehicle

Identifying the design (A model of a space rover vehicle)

Case study

The need for a model of a space rover vehicle



The school library has recently been given a lot new books. Many of these books are about space, exploring space and travelling in space. The librarian has decided to set a space display to encourage the learners to read the new space books. She has asked your class to help. You have decided that a model of a Moon rover or one of the rovers used to explore Mars will spark learner's interest in space exploration and encourage them to read the books.

You are required to use the Technological design process to build a model of one of these vehicles.

You model should:

- Be made out of recycled materials such as bottle caps, round tins, or cardboard, straws.
- Look similar to your chosen space rover
- Have wheels and axles that:
- Allow it to move
- Are joined well to the model of the space rover
- Turn smoothly and do not wobble.

1. Identifying (Investigation)

To understand the problem and identity the need set out in the case study, it helps to ask a few questions, such as

- What is it that I have to design and make?

- What is it for?
- Who will be using it?
- How big does it need to be?
- What will it be made out of?

2. Developing the a design brief

Use the above list of questions to help make a list of all the specifications needed to make your wheels and axle.

Make a list of your constraints for our design

_____

_____

_____

_____

_____

_____

Plan and write your design brief for your rover model.

Example

Design and make a model of a _____that _____, _____.

It will be made out _____. It must _____.

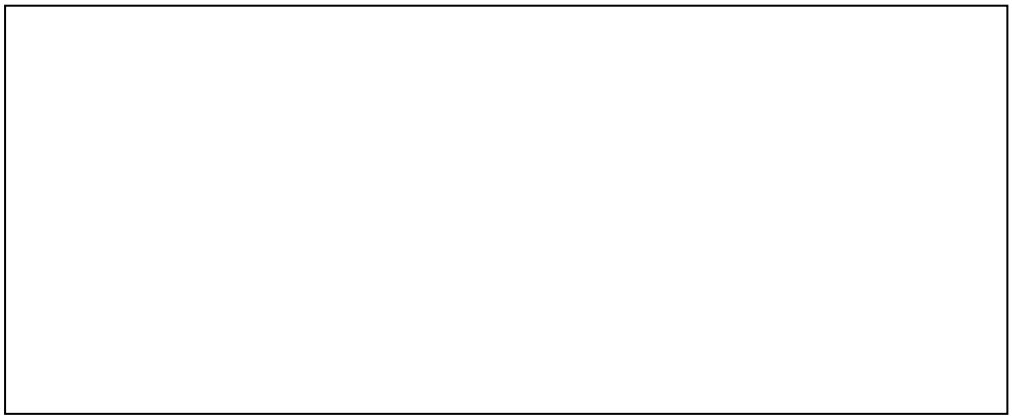
Designing

Making design sketches

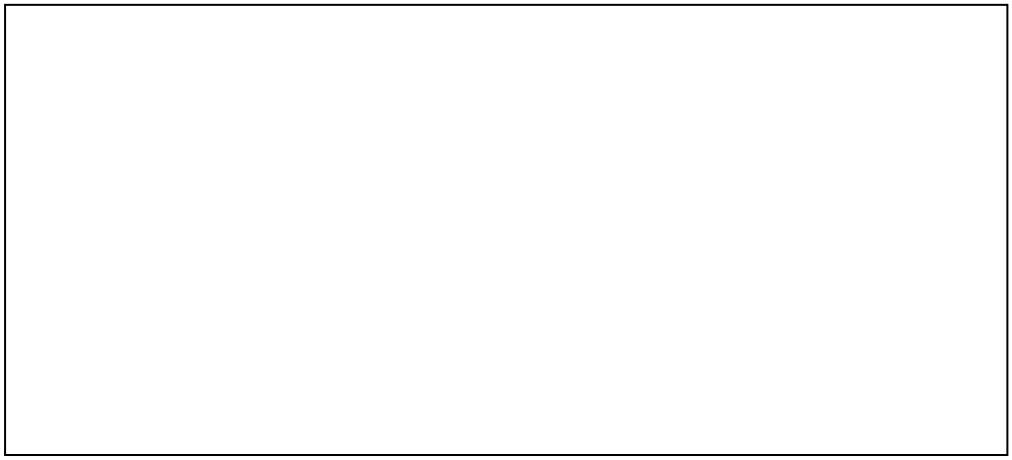
Draw two or three ideas of how you think your model should look. Think about what you will use to make it and how you will make it. Label the sketches.

1st Sketch

2nd Sketch

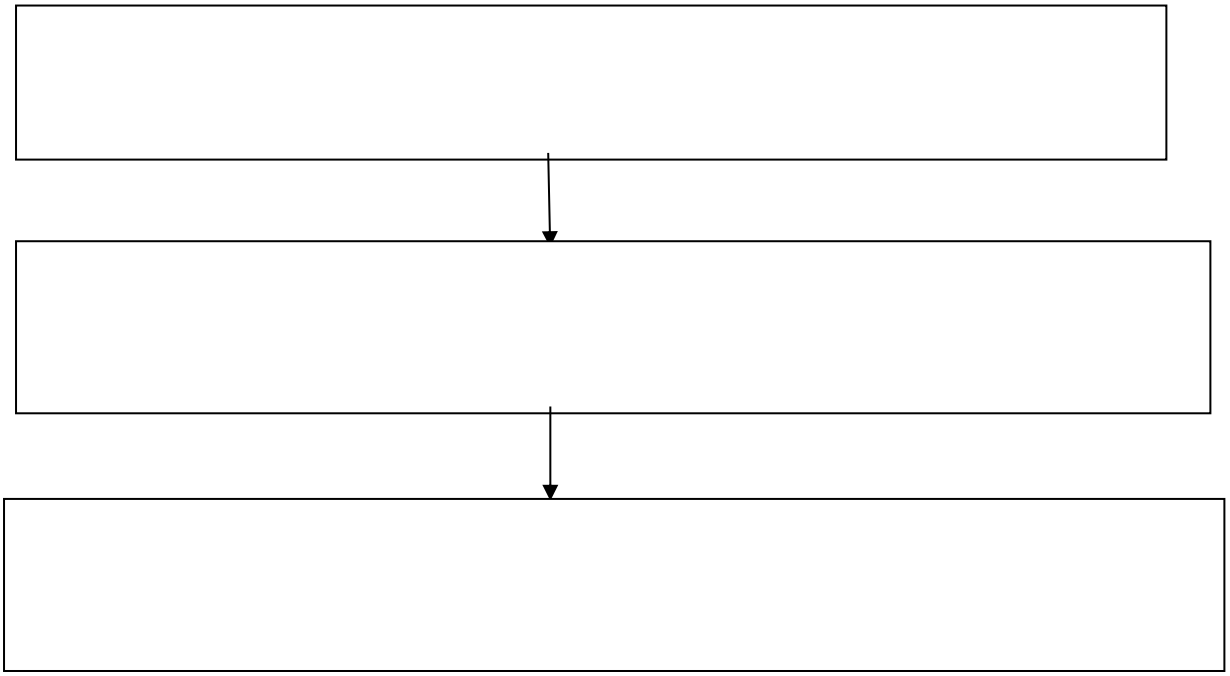


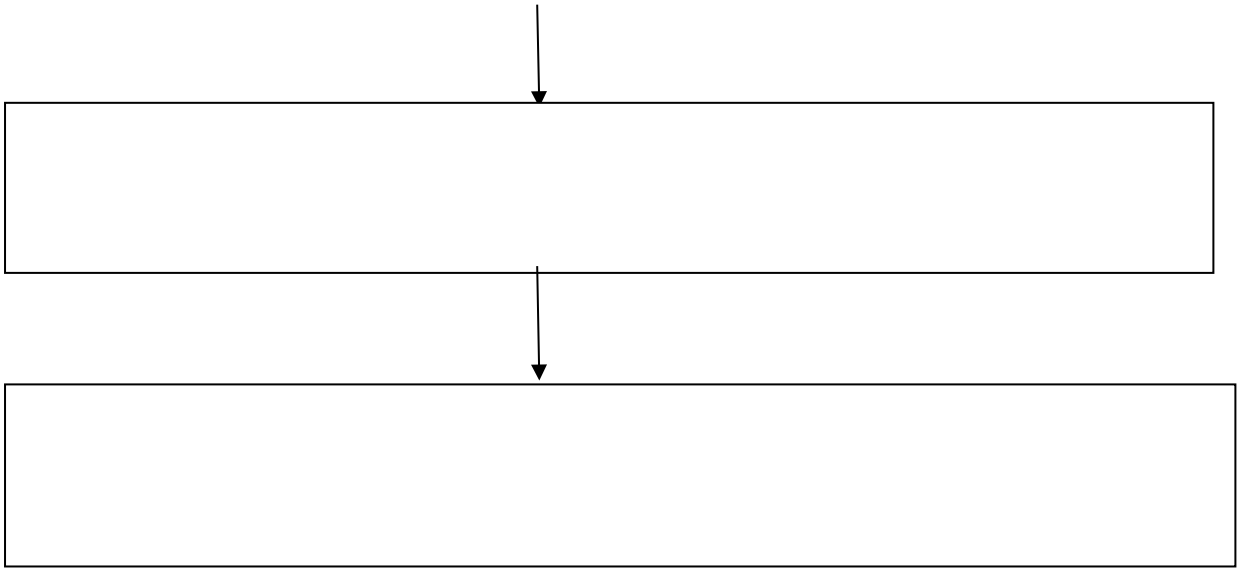
3rd Sketch



3. Making

Flow chart





4. Evaluate

Once you have completed making the model you need to test it or evaluate it. Evaluate your spacer rover vehicle in the following way.

Make a simple ramp, using a book to support the one side and a piece of hard cardboard or wood.

The cardboard or wood needs to be marked in centimetres, until

100 cm.

Take note of how far down the ramp they can run with the wheels.

- ✓ Turning smoothly
- ✓ Not wobbling
- ✓ Not coming loose

Record the distance travelled by each space rover

Use the information to draw a bar graph

Give reasons to explain the results

5. Communicate

_____

_____

_____

Memorandum

Suggested Assessment tool for this Technology task

Understanding the problem

How well did u develop a list of specifications	**1✓**
How well did u write a design brief	**1✓**

Investigation

How well did u access information about vehicles that moves in space?	**1✓**

Designing

How well did u sketch two possible ideas of what your model will look?	**1✓**
How well did u draw your final drawing of the model vehicle?	**1✓**

Making

Did you mention all the tools and materials you will use?	**1✓**
Does your model look like a space rover?	**1✓**
How well made it is?	**1✓**
Do the wheel and axles allow it to move?	**1✓**
Do wheels and axles turn smoothly and not wobble?	**1✓**
Does it have wheels and axles made out of available materials?	**1✓**

Are the wheels and axles joined well to the model of the space rover?	1✓
Did you build it on your own in class?	1✓

Evaluate

How well was your structure evaluated?	1✓
How well did you evaluate yourself?	1✓