S2/3 BGE Physics Course 1

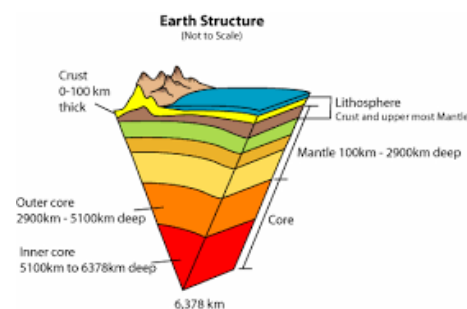# Unit 2 - Dynamics and Space

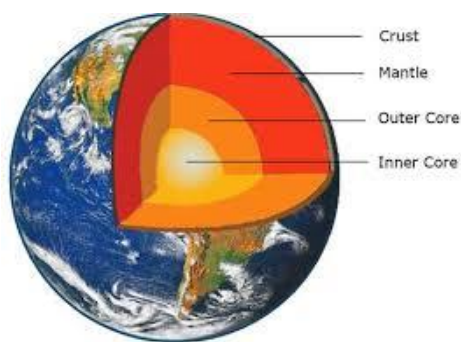
4. Earth and Space

Summary Notes

Topic 4 – Earth and Space

The Structure of the Earth

The structure of the Earth involves:

- the Crust – an outer solid layer
- the Mantle – a highly viscous layer
- the Outer Core – a liquid layer
- the Inner Core – a solid centre

The Earth is covered by oceans. This makes up 71% of the Earth's surface, with the remaining 29% made of land. Desserts account for 1/3 of the land surface.

Earthquakes

These occur when two tectonic plates are moving past each other with different speeds. Sometimes the plates crash together, pull apart or sideswipe each other. A sudden release of energy causes seismic waves which make the ground shake.
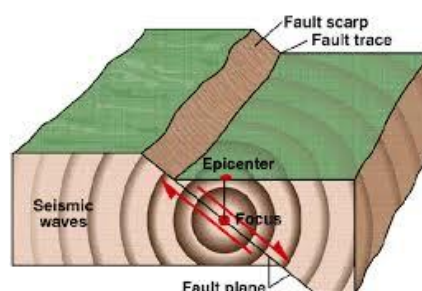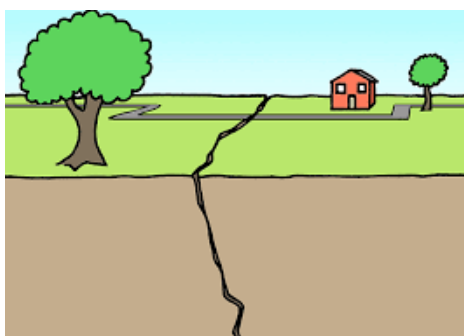
Volcanoes

These occur when material significantly warmer than its surroundings erupts on the surface of a planet or the Moon from its interior.

When this happens on Earth the erupted material is typically a liquid rock known as Lava. This liquid rock is known as Magma when it is underground.
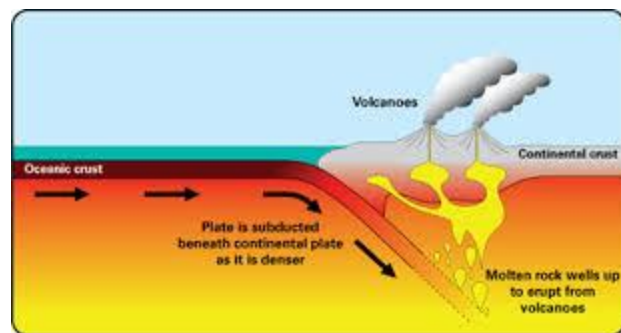

The most dangerous volcano in the world is Italy's Mount Vesuvius, which is buried in the ancient city of Pompeii. This is near the city of Naples (Napoli) in southern Italy and it has a 17,000 year history of explosive eruptions.

Day and Night

The change from day to night is due to the rotation of the Earth on its own axis. The Earth turns on its own axis once in 24 hours and during that time the Sun only shines on the half of the Earth that it is facing.

(The seasons on Earth happen due to the tilt of the Earth's axis. At different times of the year the Sun's rays hit different parts of the globe more directly.)
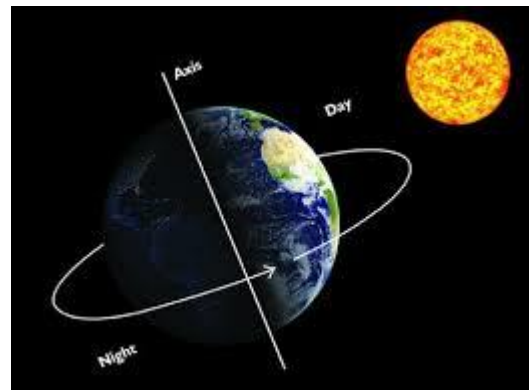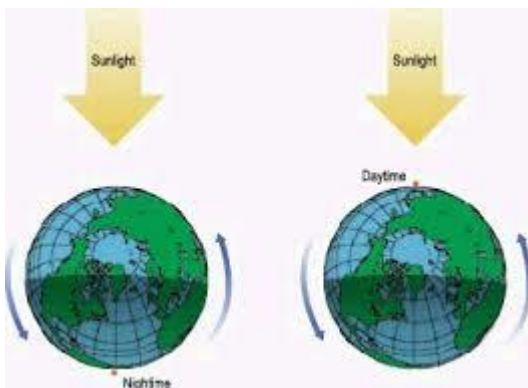
One Year

The revolution period of the Earth is 365 days = 1 year. This is the time that it takes to make one full revolution around the Sun.
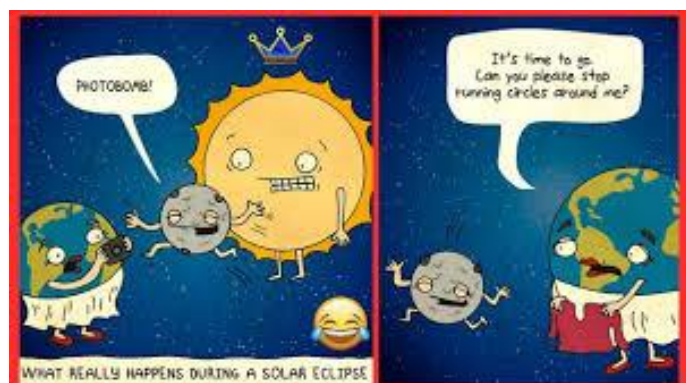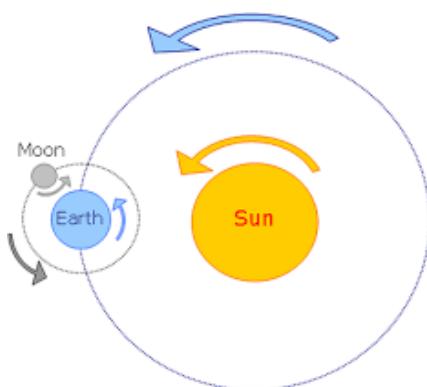
Tides

There are two different types of tide:

- high tide
- low tide

Tides are caused due to the gravitational pull of the Moon on the Earth. This generates a tidal force which causes the Earth and its water to bulge out on the side closest and farthest away from the Moon. These bulges are **high tides**.

Low tides occur when you are not in one of the bulges.
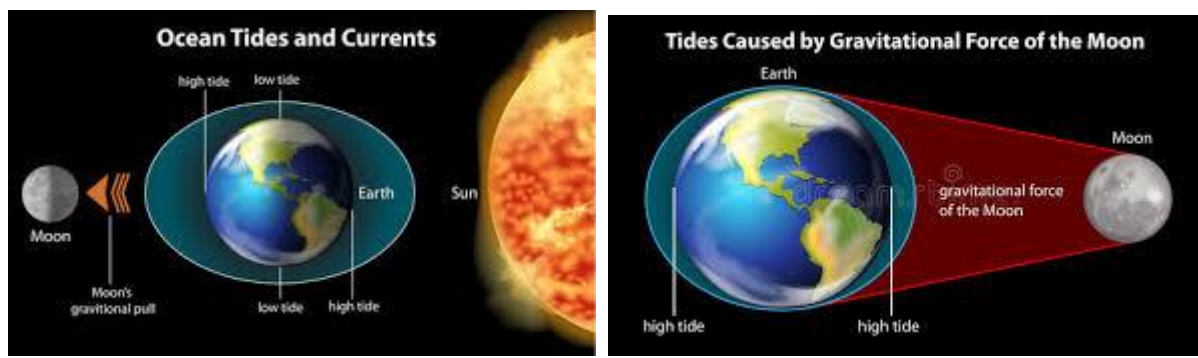
Why does the Moon light up?

The Moon lights up due to its surface reflecting light from the Sun. The Moon only reflects between 3% and 12% of the sunlight that hits it.
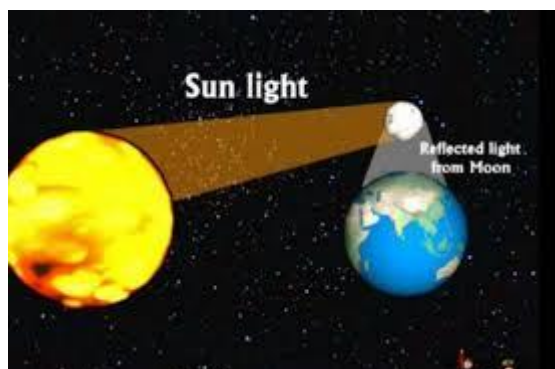
Cosmology Definitions

- **Comets** – Cosmic snowballs of frozen gases, rock and dust that orbit the Sun.

- **Meteors** – A particle broken off an asteroid or comet orbiting the Sun. It burns up as it enters the Earth's atmosphere causing the effect of a 'shooting star'.

- **Meteorites** – A piece of comet or asteroid that falls into the Earth's atmosphere and survives to hit the surface.

- **Star** – A large ball of burning gas. The nearest star to the Earth is the Sun.

- **Planet** – They orbit a star.

- **Galaxy** – Made up of billions of stars.

- **Solar System** – The group of 8 planets that orbit the Sun. (**MVEMJSUN**)

- **Moon** – A natural satellite of the Earth.

- **Exoplanet** – This is the name of a planet that is not in our solar system.

- **Universe** – This is the name given to the whole of space that we can observe.

Light Year (Ly)

This is defined as the distance travelled by light in one year.

The distance between stars and galaxies are so large that we use light years as a special measurement of distance.
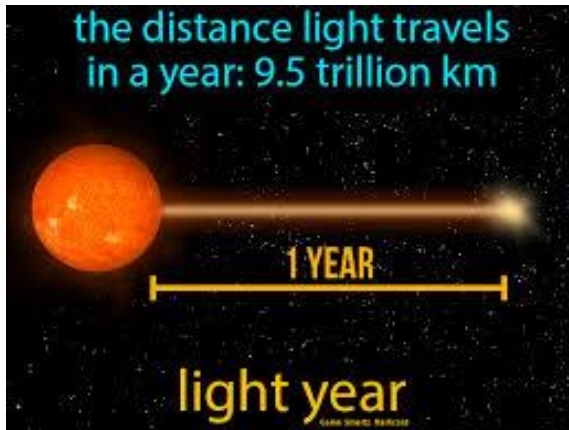
Extra !!!

Converting Light years into metres.

$d = ?$

$v = 300,000,000 ms^{-1}$

$t = 1$ year $= 365 \times 24 \times 60 \times 60 = 31,536,000s$

$d = v \times t = 300,000,000 \times 31,536,000$

d = 9,500,000,000,000,000m

It's a lot of metres!!!!!!!!!!!!!

Light Travelling from the Sun to Earth

It takes light approximately 8 minutes to travel from the Sun to Earth. This means that the light reaching Earth at this moment left the Sun approximately 8 minutes ago.

The distance from the Sun to Earth is 150 million kilometres. (150,000,000 km)

$$d = 150,000,000 \times 1000 = 150,000,000,000m$$
$$v = 300,000,000ms^{-1}$$
$$t = ?$$

$$t = \frac{d}{v} = \frac{150,000,000,000m}{300,000,000ms^{-1}} = \textbf{500 seconds}$$

500 seconds = 8 minutes 20 seconds

Light and heat energy travels from the Sun to all 8 planets in the Solar System.

Is Mercury the hottest planet?

Conditions for an Exoplanet to sustain life

There is a narrow range of distances around each star where a planet can orbit that has liquid water on its surface. This narrow range of distances is called the 'habitable zone' or more colloquially known as the 'Goldilocks Zone'.

This is after the children's story about 'Goldilocks and the three bears' with the porridge needing to be not too hot or not too cold, but just right.

If the Exoplanet is too close to the star the high temperatures will make the water heat up and turn to steam or water vapour.

If the Exoplanet is too far away from the star then the temperature will be too low and the water will freeze.

In summary liquid water on an Exoplanet surface is essential to sustain life.

Earth Knowledge gained due to Space Exploration

'' Man must rise above Earth to the top of the atmosphere and beyond, for only then will he fully understand the world in which he lives''.

 – Socrates (469-399BC) (Ancient Greek Philosopher)

This basically means that we can find and develop our knowledge about Earth by finding out more about the Universe.

The debate about Space Exploration has come up for many years and the costs that it entails.

''Why should we be spending billions of pounds exploring space when we should be spending it on ensuring a better life for all our citizens on Earth''?

This is not a question that is easily answered, but it could be looked at in terms of the positives and the negatives.

Looking down the road, space exploration and the benefits it yields - in medicine and information technology - should not be overlooked.

-Bob Barr

Spacecraft re-entering the Earth's Atmosphere

When a spacecraft re-enters the Earth's atmosphere it will reduce its speed, which means that its kinetic energy will reduce.

This reduction in kinetic energy will be converted into heat energy, which is due to frictional forces involving the air resistance in the Earth's atmosphere.

(This can be compared to a car reducing its speed by putting the brakes on with heat energy being created in the brakes.)


Thermal Protection Materials on Spacecraft

The thermal protection on a spacecraft is provided by a material called Silica.

- A coat of Silica on the top
- Flexible sheets of Silica on the sides
- Silica tiles everywhere else

This thermal protection known as the **heat shield** will allow the Silica to melt but will protect the spacecraft and the crew on board from the high temperatures.
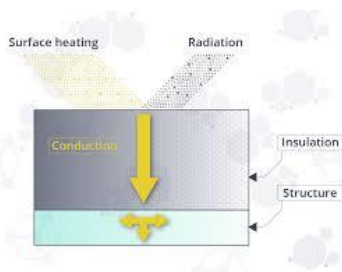
The Heat Shield material on a spacecraft.