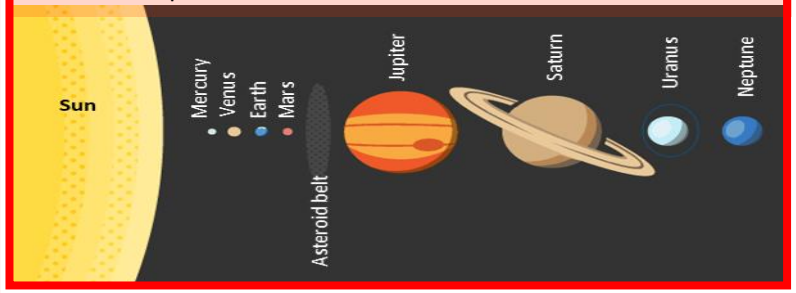
science physics

GCSE P8 – Space Physics SINGLE PHYSICS ONLY

1. The Solar System

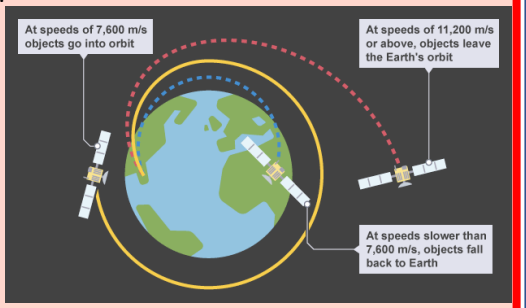
The Sun is the star at the centre of our solar system and its huge gravitational field holds all of the planets, dwarf planets (eg Pluto), asteroids and comets in orbit around it.
A comet is an object which orbits the sun in an elongated path and is made from rocky material, dust and ice.
As the distance from the Sun increases, the temperature of the planets decrease and the time for one complete orbit increases.
Our solar system exists in the Milky Way galaxy.
Gravitational forces between objects in space decrease with increased separation and decreased mass.



2. Satellites

Artificial satellites, used for weather and communications, are placed in **polar** or **geostationary** orbit around the Earth.
Natural satellites are held in orbit by the gravity of the larger mass. eg planets are satellites of stars, moons are satellites of planets.
The larger the circular orbit then the slower the speed of the satellite eg. Mercury moves with the greatest speed and Neptune the slowest. For a stable orbit, the radius must change (increase) if the speed changes (decreases).
When an object moves in a circle at a constant speed, its direction constantly changes and therefore it is **accelerating** even though its speed may be constant.

For an object moving in a circle, the resultant force is the **centripetal force** that acts towards the middle of the circle. Gravitational attraction provides the centripetal force needed to keep planets and all types of satellite in orbit.

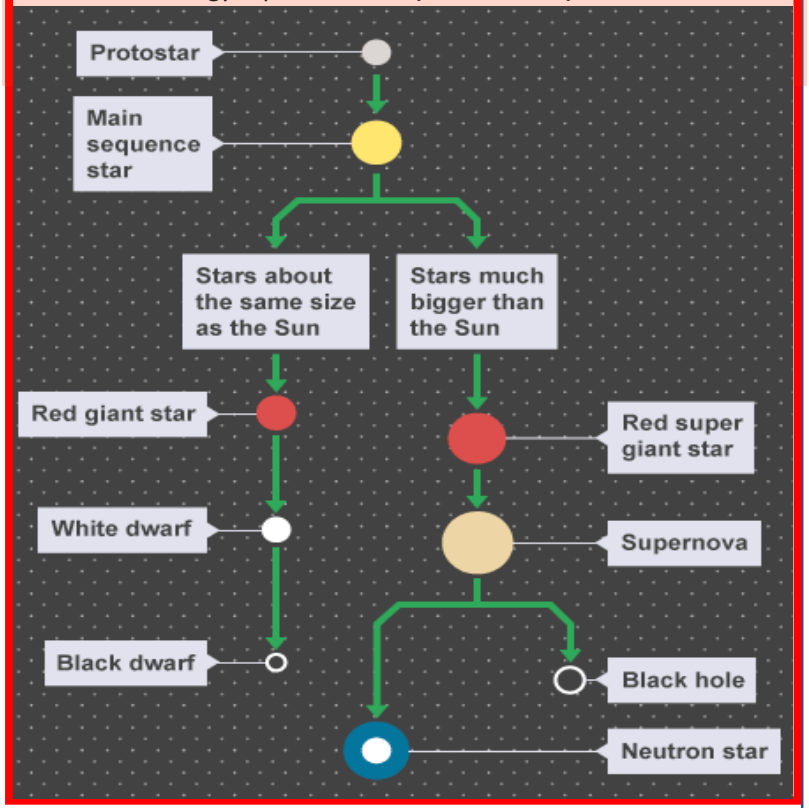


3. Life cycle of a star

Stars form from massive clouds of dust and gas in space (**NEBULA**):

Gravity pulls the dust and gas together → heat rises → fusion of Hydrogen nuclei into Helium **(PROTOSTAR)** → releases energy to maintain core temperature → the inward force of gravity holding is balanced by the outward force due to the radiation pressure from fusion reactions **(MAIN SEQUENCE STAR)** → all the hydrogen gets used up, larger nuclei begin to form and the star may expand **(RED GIANT)** → when all the nuclear reactions are over, a small star may begin to contract under the pull of gravity **(WHITE DWARF)**

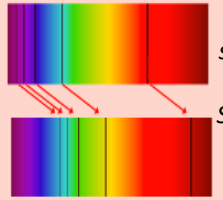
A larger star will continue with fusion and get hotter and more massive until it explodes **(SUPERNOVA)** → the collapsed core is left behind **(NEUTRON STAR)** or the remaining matter is squeezed into such a tiny space that the gravitational force is so great that all matter and energy is pulled into it **(BLACK HOLE)**



4. Red shift

Light from a star does not contain all wavelengths of the EM spectrum. Some emitted wavelengths are absorbed by elements in the star. This produces emission spectra with different patterns of dark lines for different stars.

When observing light from distant galaxies we see the spectra is shifted to the red end of the spectrum (**RED-SHIFT**) as if all of the wavelengths of light are being stretched. This is because the universe is **expanding**. This expansion **stretches** out the **light waves** during their journey to us, shifting them towards the **red end** of the spectrum.



Sun's spectra

Spectra from a distant galaxy

The **more red-shifted** the light from a galaxy is, the **faster** the galaxy is moving **away** from Earth.

5. The Expanding Universe

The **further away** the galaxies are, the **faster** they are moving away (receding) and the greater the red shift. This is similar to an explosion, where the bits moving fastest travel furthest from the explosion.This is evidence that the universe is expanding and supports the **Big Bang Theory**.

6. The Big Bang Theory

13.8 billion years ago the whole Universe was a very small, extremely hot and dense region. From this tiny point, the whole Universe expanded outwards to what exists today.
Astronomers have also discovered a cosmic microwave background radiation (CMBR): the remains of the thermal energy from the Big Bang, spread thinly across the whole Universe.

Prediction from Big Bang theory	Evidence observed
More distant galaxies should move away faster	More distant galaxies have greater red-shift
Initial Big Bang heat should now be thinly spread across the whole Universe	CMBR is everywhere at a temperature of about -270°C

7. Dark stuff

Only 5% of the Universe is currently understood. **Dark energy** is thought to cause the acceleration of the expansion of the Universe. **Dark matter** could account for the galaxies which seem to rotate too quickly for the mass of their stars.

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