

## P8 Space Physics Knowledge Organiser – Separate Physics only

### 1. Our Solar system

Our solar system consists of 1 star (the Sun), 8 planets, several dwarf planets and natural satellites (Moons).

Planets orbit the Sun and natural satellites orbit planets. Gravity provides a force that keeps them in orbit.

Our solar system is part of the Milky Way galaxy.

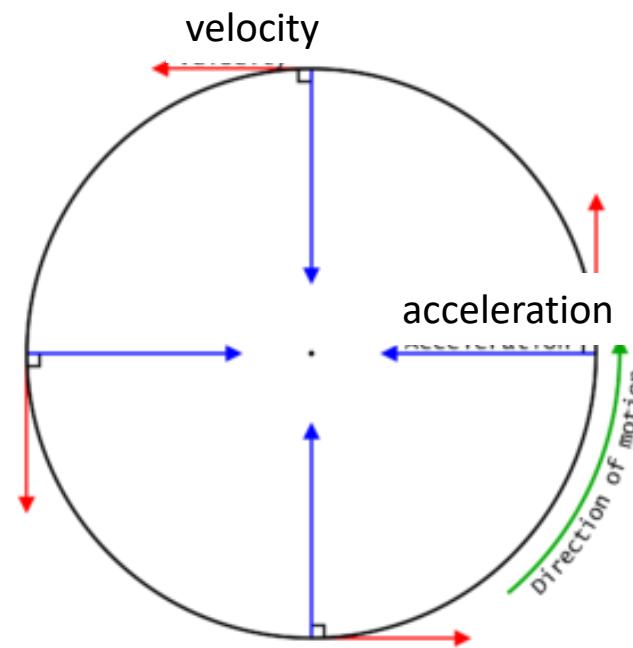
### 3. Circular motion HIGHER ONLY

Orbits are nearly circular (elliptical).

If an object is travelling in a circle it is constantly **changing direction**, therefore constantly **changing velocity**, therefore is constantly **accelerating** due to a **resultant force** caused by **gravity** to the **centre** of the circle/orbit.

However, it will be travelling at a constant speed.

Objects in orbits with small radius need to travel quickly because of the strong gravitational attraction and vice versa.



### 2. Definitions

Planets

Objects that orbit stars and are large enough to have cleared their orbit of matter other than their moons.

Dwarf planets

Objects that orbit stars but haven't cleared their orbit of matter.

Moons

Objects that are not man-made that orbit planets.

Artificial satellites

Man-made objects that orbit planets.

Galaxy

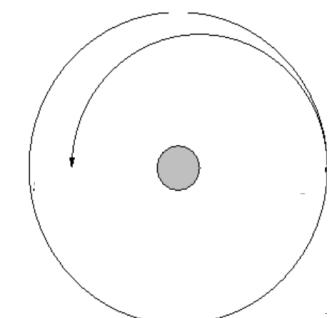
Collection of billions of stars that are held together by gravity.

### 4. Changing circular motion HIGHER ONLY

The radius of a stable orbit will change if the speed changes.

For example, if the moon started slowing down in its orbit then its orbit will become smaller in radius and it would start getting closer to the Earth, because it will not be able

to escape the gravitational attraction quick enough. To stay in the lower orbit it would need to move faster.



## 5. The life cycle of stars

All stars, including our Sun, undergo steps in a life cycle (see diagram to the right). Our Sun is currently in the main sequence stage.

Nebula – cloud of dust and gas (mainly hydrogen gas) pulled together by gravitational attraction, causing temperature to rise.

Protostar – as temperature rises in the nebula and density increases the nuclei in the star collide with each other. Eventually the temperature is high enough that the collisions cause the hydrogen nuclei to fuse into helium nuclei and release large amounts of energy.

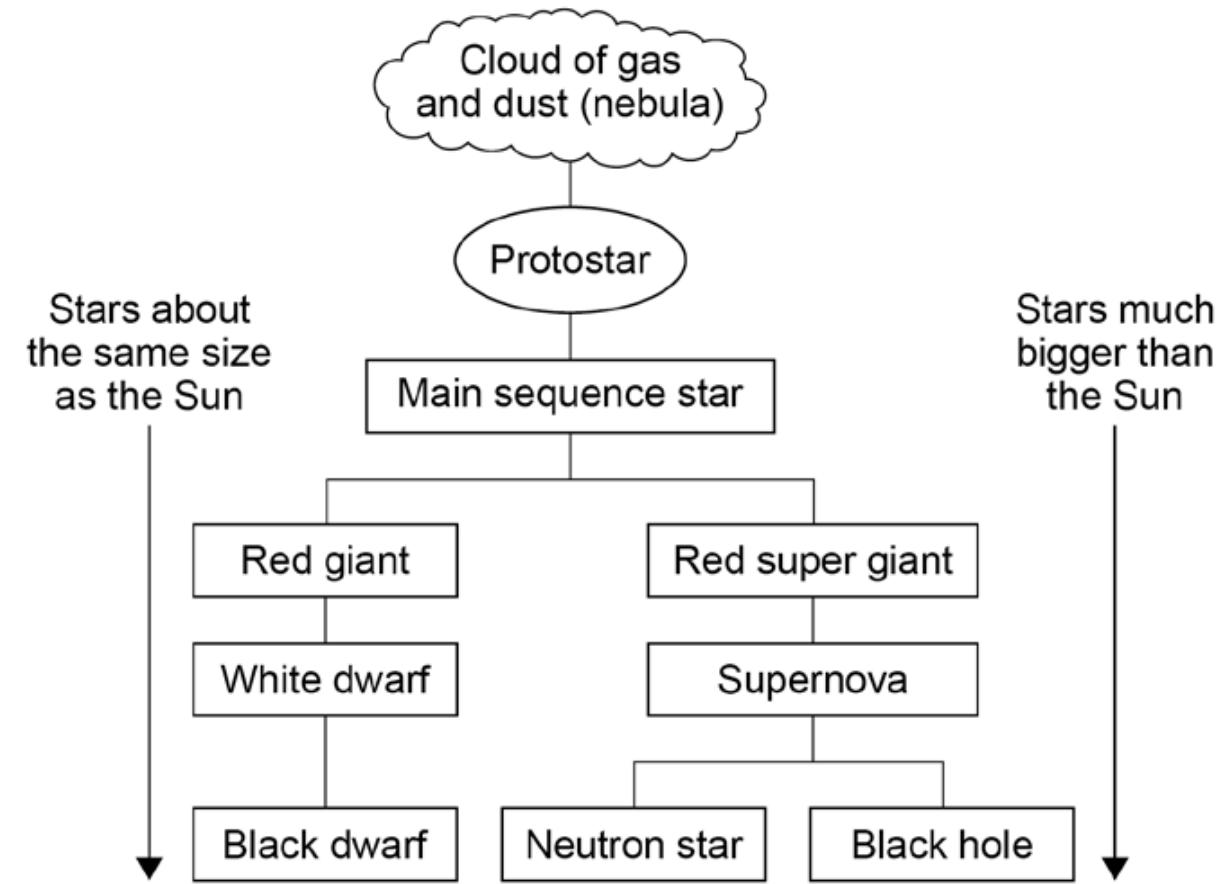
Main sequence – outward pressure from nuclear fusion balances the force of gravity inwards. Typically lasts billions of years but shorter for more massive stars.

Red Giant – eventually the hydrogen nuclei run out and the star swells. It becomes red because the surface cools. In the core helium nuclei are fused and then heavier elements, up to the production of iron.

White dwarf – the outer layer of the red giant drifts into space leaving behind a hot, dense solid core called a white dwarf.

Black dwarf – the white dwarf cools down and emits less energy until it emits hardly any and becomes a black dwarf.

Super red giant – same as a red giant but bigger



Supernova – more massive stars, after going through the super red giant phase expand and contract several time and undergo more nuclear fusion, up to iron. Eventually they explode in a supernova, and undergo fusion of iron into heavier elements, which go on to become new stars or planets.

Neutron star/black hole – the centre of the supernova becomes a very dense neutron star. If it is a massive enough star this core left behind will become a black hole instead.

## 6. Red Shift

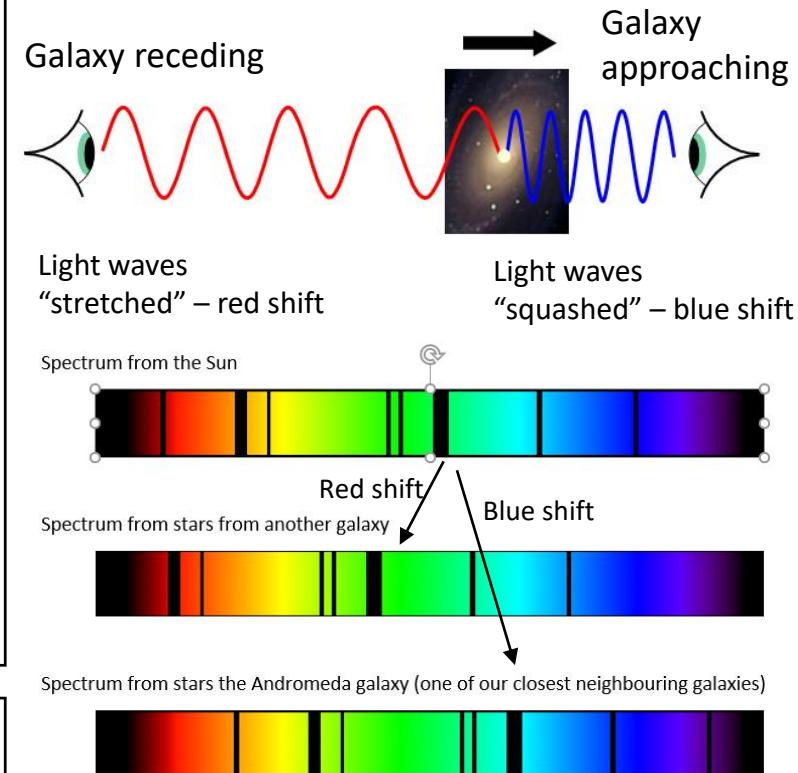
Red shift is an observed **increase in the wavelength** of light from most distant **galaxies**. This results in a **decrease in frequency** but **no change in speed**.

The reason this is called red-shift is because the colour red has the longest wavelength of all the colours of the spectrum.

Additionally, when it is observed in spectra the black absorption lines move towards the red end of the spectrum.

Galaxies that are **further away** show **larger red-shifts** and this tells us that they are moving away from our galaxy **faster**.

This tells us that the Universe is **expanding** and provides evidence for the Big Bang theory because if the galaxies are moving away from us, further back in time they must have been closer to one another, probably at a single point at the centre of the Universe.



## 7. Big bang theory

The Big Bang is a **theory** because it is the **best way to explain the evidence that we have**. It is not a fact. It is not proven. The theory/model may change if we get further evidence that cannot be explained by our current version.

## 8. Dark matter and dark energy

Since 1998 further evidence from observing supernovae suggests that **the expansion of the Universes is speeding up**. Scientists believe this is caused by **dark energy** which is believed to exist in the "empty" parts of space.

Other relatively new evidence suggests that the Universe contains a large amount of **dark matter**. This is invisible and we have no means of detecting it directly. We believe it is there because of gravitational lensing, the fact that the galaxies do not contain enough normal matter to have enough gravity to hold them together, together with unexpected orbital speeds of stars around the centre of galaxies.

