

# Edexcel GCSE Physics

## Topic 7: Astronomy

### Notes

(Content in bold is for Higher Tier only)

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## Weight (Physics Only)

- $W = mg$
- $W = mg$ , Weight (Newtons, N) = mass (kilograms, kg) x acceleration due to gravity (metres per second, m/s)
- The greater the value of  $g$ , the greater the weight of the object.
- The greater the mass of the planet, the greater value of  $g$  on that planet.
  - This is because more mass = stronger gravitational pull = higher value of gravitational acceleration = higher value of  $g$ .

## Solar System (Physics Only)

- Our Solar System consists of:
  - The Sun, which lies at the centre (heliocentric)
  - Eight planets that orbit the sun
    - Natural satellites orbit the planets (e.g. the Moon for Earth)
  - Dwarf planets orbit the sun (including Pluto, Ceres)
  - Asteroids and comets

## Our Solar System (Physics Only)

- Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune
  - o *My Very Early Morning Jam Sandwich Usually Nauseates*
- Smaller planets are made of primarily **rock**, then the larger planets are primarily **gas**
- All planets orbit the Sun on the same plane
- All planets rotate, just at different speeds
  - o Some planets rotate in the opposite direction or on a skewed axis to the other planets, and this may be due to past collisions throwing its axis off balance
- Larger planets have rings, as their **gravitational field is so strong it attracts debris**

## Solar System Model (Physics Only)

- The initial model suggested, Earth was at the centre, the planets, our moon, and the sun, orbited the Earth
  - o "Geocentric" model
  - o Everything orbited in perfect circles
  - o With a fixed background of stars
- Then 600 years later, the heliocentric model was formed, with the sun at the centre
  - o The main evidence being Mars' "retrograde motion"
    - Earth orbits the sun faster than mars, so we undertake it, so it appears to reverse its direction in the sky
  - o Galileo observing moons orbiting Jupiter showed not everything orbited the Earth
  - o Kepler showed that the planets orbited in ellipses, and not circles



## Planetary Orbits (Physics Only)

- As the planet orbits the sun
  - o The gravitational force causes the planet to **change direction constantly** (it moves in a circle around the sun)
  - o But the speed of the planet is constant
  - o This means the **velocity is always changing**
    - Hence the force causes the planet to **accelerate without increasing its speed**

## Relationships (Physics Only)

- For a stable orbit:
  - o If the planet moves closer to the sun, (i.e. its orbital radius decreases)
  - o The **gravitational attraction to the sun increases**
    - (Force increases, and so does acceleration, which causes an increase in velocity)
  - o So, the **orbital speed of the planet increases**

## Red Shift (Physics Only)

- Light appears red shifted from galaxies which are **moving away from Earth**.
- The emission spectrum shows the different wavelengths emitted from a star, with black absorption lines showing absorbed wavelengths. The spectra from distant galaxies show the black lines in the emission spectra shifted towards the red end of the emission spectrum, showing a red shift.
- The red shift increases as the distance away from the earth increases which is evidence of an expanding universe
- Imagine the start of the big bang as an un-stretched balloon, with galaxies on the surface of the balloon, and as the universe expands, the balloon expands
  - o The distance between galaxies also expands
  - o So light from a galaxy has its wavelength "red-shifted" as it appears to move away from us
  - o As wavelength **appears to get larger** (more in the red-end of the visible spectrum)
  - o Frequency appears to decrease, as each time a wavelength is emitted, the source (galaxy) is further away.

## Evidence for the Big Bang (Physics Only)

- Red Shift
  - o This shows universe is expanding.
  - o So initially, it must have been formed from a single point.
- CMB
  - o Cosmic Microwave Background radiation.
  - o When the universe was very young, everything, the first stars and rock, would be very hot, and should have emitted lots of short-wavelength radiation.
  - o This radiation, as the universe expanded over time, would have been stretched to become microwaves.
  - o This **background radiation is present wherever you point a telescope in the sky**.
  - o Which proves that the hot young universe has cooled and expanded since.
- As the big bang accounts for all the experimental evidence, it is the most accepted model currently.

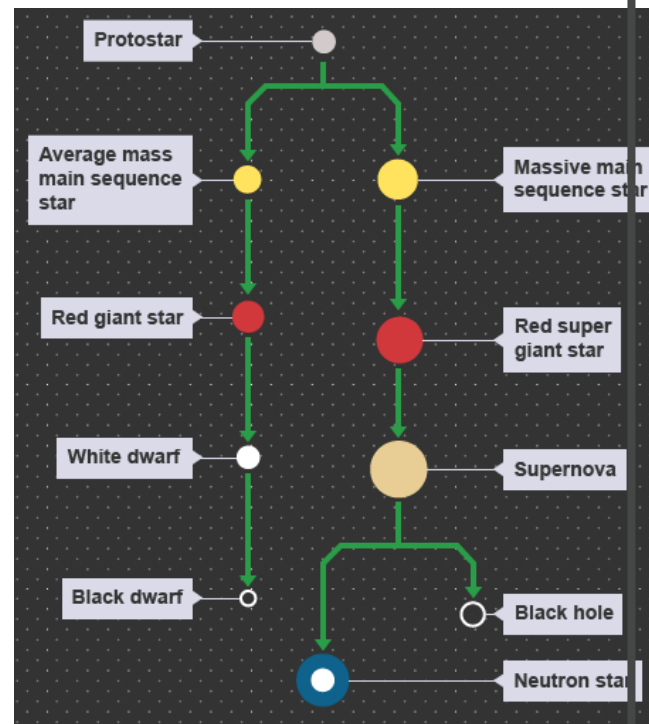


## Steady State Theory (Physics Only)

- As universe expands, matter is constantly being created so there is a constant density of matter in the universe.
- The red shift supports this theory
- This suggests that the observable universe is the same at any time and any place.
- However, showing that different stars were present at different eras of the universe shows that the universe has evolved and not stayed the same, so this cannot be correct.
- Also, the theory does not account for CMB.

## Life Cycle of Star (Physics Only)

- Dust and gas cloud is present in a galaxy
- Interstellar matter clump together to form clouds called **nebulae**. It is in these clouds/nebulae that stars are formed.
- The **gravitational attraction** between the gas/dust particles draws them together
- The cloud becomes more concentrated, as the particles get closer
- The **temperature and pressure of the cloud increases** as the particles get pushed so close together
- Eventually the pressure gets so great that the gas /dust particles are able to fuse together
  - o **Fusion occurs** as the light (mainly hydrogen gas) nuclei fuse together to form helium nuclei
  - o This creates a large amount of energy
  - o This release **opposes the collapsing** of the cloud due to gravity
  - o So eventually an **equilibrium** forms, where the energy released due to fusion balances the pressure of gravitational collapse
    - This means a star has now formed, and it will stay like this for billions of years
  
- Eventually the star **runs out** of gas to fuse
  - o This means it is **not in equilibrium**, so it collapses
  - o If the star is massive
    - The star will collapse, increasing the pressure + temperature of the core, meaning heavier elements can fuse. Once all the fusion has happened, it is too massive to be stable, so the star collapses, rebounds on its centre and produces a **supernova**
    - What remains is either a **neutron star or black hole**
  - o If the star is normal-sized
    - The same process happens, **less fusion** occurs however (less fuel to fuse)
    - The star swells to produce a **red giant star** fusing heavier elements
    - Once all reactions are over the star contracts and cools into a **white dwarf**.



<http://www.bbc.co.uk/schools/gcsebitesiz1>



## Observing the Universe (Physics Only)

- Observations can use any wavelength in the EM spectrum
- To measure X rays, Gamma, UV, these telescopes need to be outside of the atmosphere, as the atmosphere does not allow these to reach the ground
- More methods have developed over time
  - o Early refracting telescopes evolved to reflecting telescopes, which could be made larger and cheaper (as refracting lenses are expensive and heavy)
  - o Technological advances allowed other parts of the EM spectrum to also be measured and collected

