OCR (A) Physics GCSE

Topic P8: Global Challenges

Summary Notes

(Content in bold is for Higher Tier only)

P8.1 Physics on the Move

Speeds

This table gives general speeds of common things:

Wind	5 - 7 m/s
Sound	340 m/s
Walking	5 km/h (~1.4 m/s)
Running	6 miles/hour (~3 m/s)
Cycling	15 km/h (~4m/s)
Bus	14 km/h
Train	125 miles/hour
Plane	900 km/h

Magnitudes of Accelerations

To estimate acceleration, think about the force applied and the mass of the object involved:

$$a = \frac{F}{m}$$

Converting Units

Convert the answer one unit at a time.

Example:

$$196kmph = \ ???ms^{-1}$$

$$196000\ metres\ per\ hour = \frac{196000}{60}\ metres\ per\ minute = \frac{196000}{60\times60}\ metres\ per\ second$$

$$= 54ms^{-1}$$

Human Reaction Time

There is a delay between a human observing an event and acting due to processing of the situation by the brain. The average human reaction is **0.25 seconds** $(250\ milliseconds)$.

Vehicle Stopping Distances

After seeing a hazard there are two component of stopping distance:

1. Before you react - during reaction time you travel X metres. This is called the thinking distance.
2. Then you react - braking causes the vehicle to slow down and stop over Y metres. This is called the braking distance.

Thinking distance is affected by:

- Speed
- Affected by reaction time
- Concentration
- Tiredness
- Distractions
- Influence of drugs/alcohol

Braking distance is affected by:

- Speed
- Poor road conditions (icy, wet)
- Bald tires (low friction)
- Worn brake pads
- Weight (more passengers)

Speed and Braking Distance (Physics Only)

The greater the speed, the greater the distance travelled during the same reaction time. Therefore the total braking distance will be greater.

Dangers

When braking hard, there is a large deceleration. Therefore, a large force is exerted on the passengers and the vehicle. This can be dangerous, as the force felt can cause injury (neck whiplash etc).

These impacts of dangers can be reduced through several safety measures:

- **Seatbelts**
  - Without these, when braking hard you will keep moving and not decelerate (momentum), causing you to fly through the windshield.
  - Seatbelts strap you in, but also **stretch slightly** under large forces. This stretching **increases the distance** moved for passengers to stop which decreases the magnitude of the acceleration, **reducing the force** experienced.
- **Crumple Zones**
  - Without these, the car acts as a **solid metal block**, which would immediately stop during a crash, transferring all of the momentum to people in the car.

- **Softer areas** at the front of the car, which crumple upon impact absorb energy to deform and compact. This **increases the time** taken for the car to stop, **reducing the acceleration** and force on passengers.

- **Air Bags**
  - Without these your head would whip forward during a crash, hitting the steering wheel or whipping back causing serious neck injuries.
  - Air bags inflate instantaneously upon a crash. Your head hits this and slows down. Therefore the time taken for the head to stop moving is increased, reducing the force on the neck.

P8.2 Energy on Earth

Main Energy Sources

Fossil Fuels	• Non-renewable source • Combustion produces thermal energy which heats water to create steam to turn turbines
Nuclear Fuels	• Non-renewable source • Fission releases thermal energy which is used to turn turbines
Biofuels	• Renewable source • Combustion for thermal energy to turn turbines
Wind	• Renewable source • Directly turns turbines which generate electricity
Hydroelectricity	• Renewable source • Water moving from a height with GPE directly turns turbines to generate electricity
Tidal	• Renewable source • Wave action directly turns turbines in tidal barrages
Solar	• Renewable source • Solar cells (photovoltaic cells) directly produce electricity from the sun's energy

Trends in the use of Energy Resources

Energy consumption was very low before 1850. In the late 1800s there was a sharp rise in coal use, due to the industrial revolution.

Extraction of fossil fuels and crude oil also saw a rise in petrol and natural gas from the early 1900s.

Nuclear power has risen since the late 1900s.

Only very recently has renewable energy been used, with hydroelectric and wind producing the most energy.

The National Grid

Electrical power is transferred at high voltages from power stations for domestic use via overhead power lines. These high voltages are reduced to safer lower voltages when reaching each settlement for domestic use.

Step-up transformers are used to increase the potential difference from power stations to power lines. **This reduces the current and therefore reduces the energy lost to heat in these lines.**

Step-down transformers are used to decrease the potential difference from power lines to domestic use. This increases the current to a usable level.

(Physics Only)

The same power enters the transformer and leaves the transformer. As pd is increased in a step up transformer, current is decreased. Since power loss is due to:

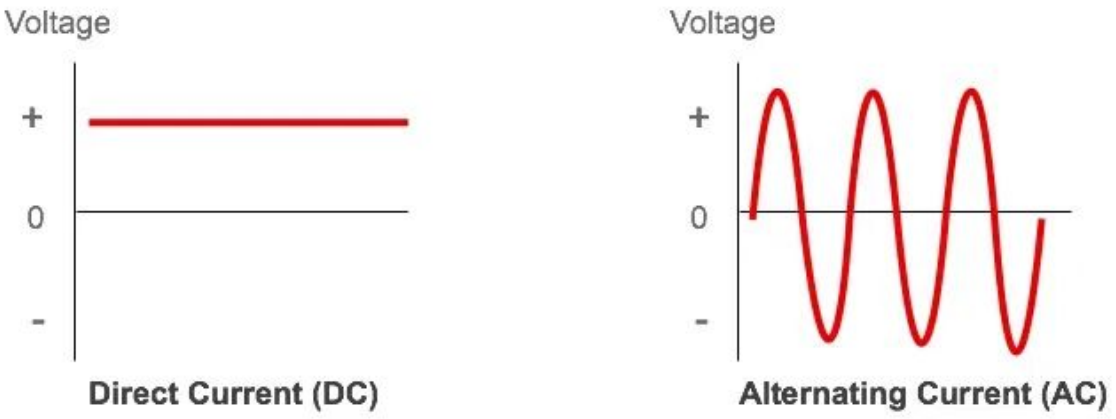
$$P = I^2R$$

reducing the current reduces the energy loss. Therefore transformers are effective at reducing the amount of power lost.

Domestic Electricity Supplies

Mains electricity is alternating (AC) at 50Hz and 230V. AC varies from a positive maximum to a negative minimum and constantly changes.

Direct electricity (DC) is at a constant fixed (positive) amount and is the type of supply provided by batteries and cells.

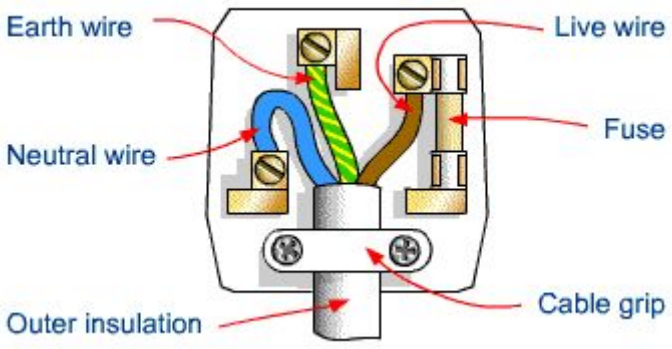


Types of voltage supply (freeingenergy.com)

Wirings

In a plug there are 3 wires:

- **Live Wire**
  - Brown in colour
  - Carries voltage from mains to appliance.
  - This may be dangerous even if the mains circuit is off, as current may still be flowing through it.
- **Neutral Wire**
  - Blue in colour
  - Completes the circuit
- **Earth Wire**
  - Green and yellow striped
  - Safety wire to stop the appliance becoming live.
  - It is connected to the earth and to the casing.
  - If the live wire touches the metal casing of the appliance, it will become live (you'll get a serious electric shock if you touch it, as current flows through you to the ground). The earth wire is connected to the metal casing, and its low resistance means the current will go from the casing through the earth wire and to the ground.



Internal structure of a plug (weebly.com).

P8.3 Beyond Earth (Physics Only)

Red Shift

Light appears 'red shifted' from galaxies which are **moving away from Earth.** The change with distance of each galaxy's speed 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. The **distance** between the galaxies also expands.

Therefore light from a galaxy has its wavelength "**red-shifted**" as it appears to move away from us as it has to travel further. The wavelength appears to get **larger** (more towards the red-end of the visible EM spectrum). Frequency also appears to decrease, as each time a wavelength is emitted, the source (galaxy) is further away.

Evidence for the Big Bang

There are two main forms of evidence for the Big Bang Theory:

- **Red Shift**
  - This shows the universe is expanding (see above).
  - So initially, it must have been formed from a single point.

- **CMBR**
  - **Cosmic Microwave Background Radiation**.
  - When the universe was very young, everything was very **hot**, and would have emitted lots of **short-wavelength** radiation.
  - As the universe expanded over time, the wavelength of this radiation would have been **stretched** to become microwaves.
  - This **background radiation** is present wherever you point a telescope in the sky, which proves that the hot young universe has cooled and expanded since.

Life Cycle of a Star

Dust and gas clouds are present in a galaxy. The **gravitational attraction** between the gas and dust particles draws them together so the cloud becomes denser, as the particles get closer.

The **temperature and pressure of the cloud increases** as the particles gravitate together. Eventually the pressure gets so great that the particles can fuse together. **Fusion occurs** as the lighter nuclei (mainly hydrogen gas) fuse together to form helium nuclei, creating a large amount of energy.

This energy is released, **opposing the collapsing** of the cloud due to gravity. So eventually an **equilibrium** forms, where the energy released due to fusion balances the pull of gravitational collapse.

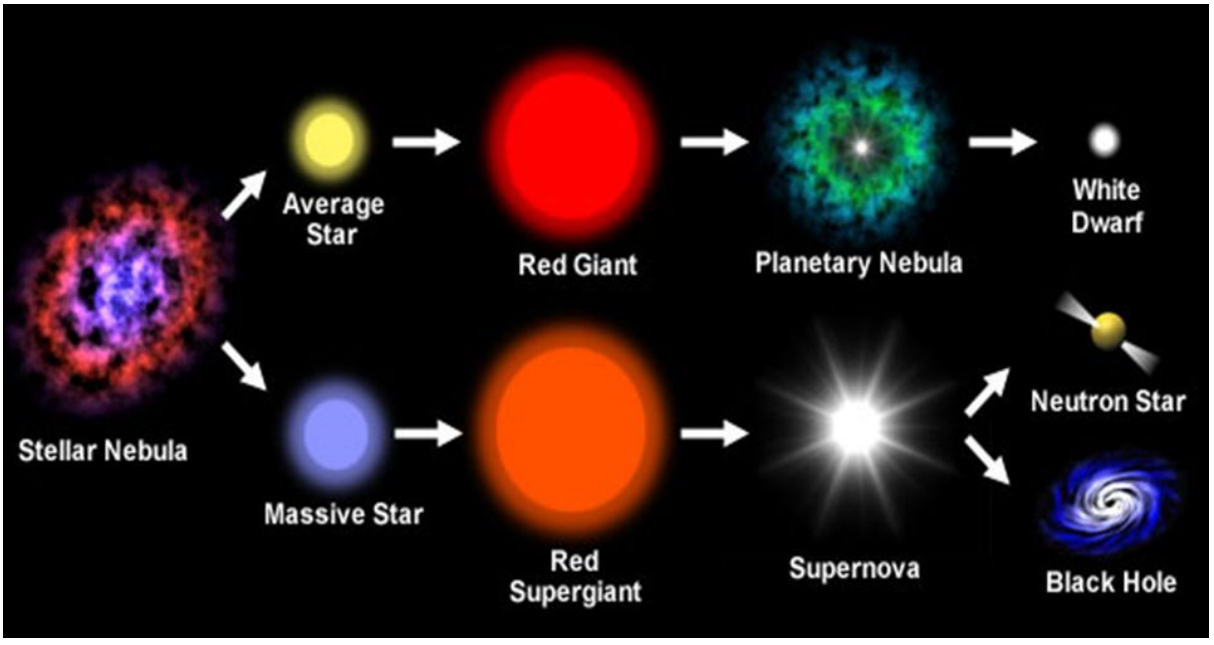
This balanced state means a **star** has now formed, and it will stay like this for billions of years.

Eventually the star **runs out** of gas to fuse any more nuclei. This means it is **no longer in equilibrium**, so it collapses.

If it is **'massive'** (much greater than the Sun), the star will collapse, increasing the pressure and temperature of the core, meaning heavier elements can fuse. Once all possible fusion of elements has occurred, the star is too massive to be stable. Therefore it collapses again and rebounds on its centre, producing a **supernova.**

Eventually, the supernova will become either a **neutron star or black hole.**

If the star is an average size (a similar size to the sun), the same process occurs however **less fusion** occurs as there is less fuel to fuse. The star collapses, and produces a **planetary nebula** before becoming a **white dwarf**.



The life cycle of stars (Hortense O'Brien).

Radiation Emission

All solar bodies emit **radiation**. The **intensity and wavelength** distribution of this radiation depends on the temperature of the body. Some wavelengths are emitted more than others in the EM spectrum.

The Solar System

The order of the planets in the solar system:

Mercury - Venus - Earth - Mars - Jupiter - Saturn - Uranus - Neptune - (Pluto)

The **smaller** planets (Mercury, Venus, Earth and Mars) are made of primarily **rock**. Whereas the larger planets (Jupiter, Saturn, Uranus and Neptune) are primarily **gas.**

All planets **orbit** the Sun on the same plane and all planets **rotate** on their own **axis** at different speeds. Some planets rotate in the opposite direction or on a skewed axis and this is thought to be due to past collisions throwing its axis off balance.

The solar system (cyberphysics.com).

Larger planets tend to have **rings**, as their gravitational field is so strong it attracts **debris** that then orbits the planet.

Moons

Venus and Mercury do not have moons but all other planets have at least one. The larger planets have more moons: Jupiter has 67 and Saturn ~60. Again, their **larger mass means greater gravitational pull.**

Moons are **natural satellites** (objects which orbit a planet). Moons were formed naturally. Our Moon was formed very early on in the solar system's lifetime. A large mars-sized object collided with the earth and they **fused together.** This ejected **debris** which then came together to form the moon.

Satellites

Satellites and space stations are artificial satellites as they were placed into orbit by humans on purpose. There are two different types of orbit that satellites can move on:

Polar Orbit

- These are typically used for **surveillance** and **weather forecasting.** They orbit over the poles at a low height, with a period of ~90mins.
- They cover the **entire earth quickly and many times in a day** so are good for scanning large areas for data which needs to be constantly updated.

Geostationary Orbit

- These are used for communications. They orbit over the equator, with a **period of 24hrs.**
- They appear fixed when viewed from Earth, because they have the same angular speed.
- This means satellite dishes on earth **do not need to move**, they can stay in a fixed position to communicate with the satellite, allowing for **uninterrupted data transfer.**

The rest is Physics Only

Planetary Orbits

As a planet orbits the sun, the gravitational force experienced causes the planet to change direction constantly as it moves in a circle around the sun. However the speed of the planet is constant. Therefore the velocity is always changing and the force on it causes the planet to accelerate without increasing its speed.

For a stable orbit, if the planet moves closer to the sun, (i.e. its orbital radius decreases), the gravitational attraction to the sun increases. The force increases, and so does acceleration. Therefore the orbital speed of the planet increases.

Temperature

Temperature of a body is due to the balance between the incoming radiation absorbed and the radiation emitted.

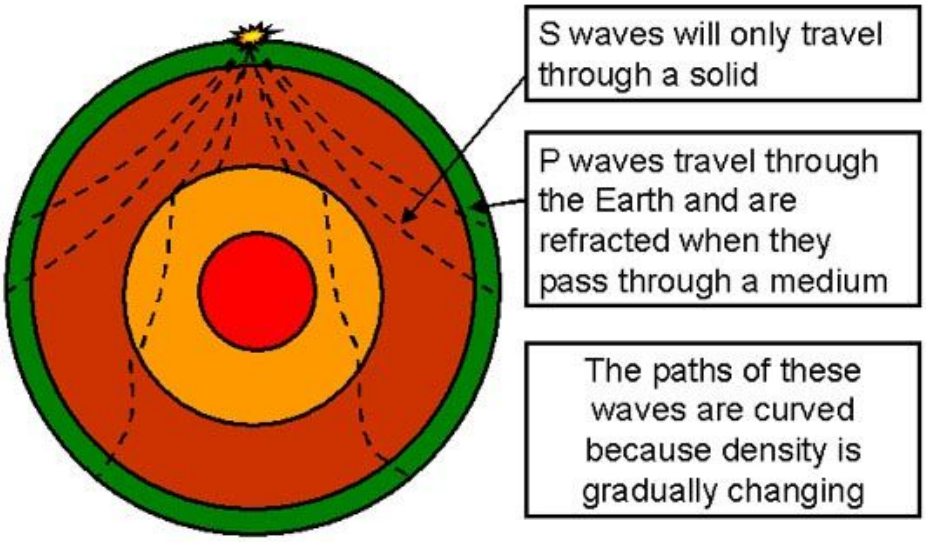
The temperature of the Earth is a result of the amount of EM radiation transmitted through the atmosphere, and the amount absorbed by the greenhouse gases in the atmosphere. This balance is constant over a long time period, so Earth is said to have a constant temperature.

As the amount of greenhouse gases in the atmosphere increases, more radiation is absorbed than emitted, causing Earth's temperature to rise. This is global warming.

Earth's Core

P and S waves are two different types of seismic wave produced by Earthquakes. P waves are longitudinal, travel quicker and can pass through solids and liquids. S waves are transverse and can only pass through solids.

Therefore P waves can be detected on the other side of the Earth to the quake. No S waves reach here, suggesting the Earth's core is liquid.



The internal structure of the Earth (getrevising.co.uk).

Deep Water

SONAR is used to map the ocean floor. Sound waves are sent down and the time taken for them to reflect back and be received can be used to calculate water depth.

Higher frequency waves reflect off more subtle differences in the ocean, including shoals of fish.
Lower frequency waves are more penetrating and reflect off different types of sediment under the sea floor. This is because the lower frequencies transfer less energy, so less energy is lost during transfers. Therefore they travel further and only reflect when there is a significant change.