Physics 3 - Forces in Action

Section 1: Key terms

Scalar quantity	Have magnitude only.
Vector quantity	Have magnitude and direction.
Force	A push or a pull that acts on an object due to the interaction with another object (interaction pair).
Resultant force	A single force that has the same effect as all the original forces acting together.
Contact forces	forces between objects that are physically touching (friction, air resistance, tension, normal contact force).
Non-contact forces	Forces between objects that are physically separated (gravitational, electrostatic, magnetic force).
Mass	The quantity of matter in an object. Measured in kg.
Weight	The force acting on an object due to gravity. Measured in N.
Elastic object	An object is elastic when it returns to its original shape when the forces deforming it are removed. The increase of length from the original shape of this object is called extension.
Non-elastic object	An object that either cannot be deformed or cannot go back to its original shape when deformed.
Distance	How far an object moves. Scalar quantity. Doesn't involve direction.
Displacement	Includes both the distance an object moves and its direction. Vector quantity.
Centre of a mass	The point at which its mass can be thought of as being concentrated.

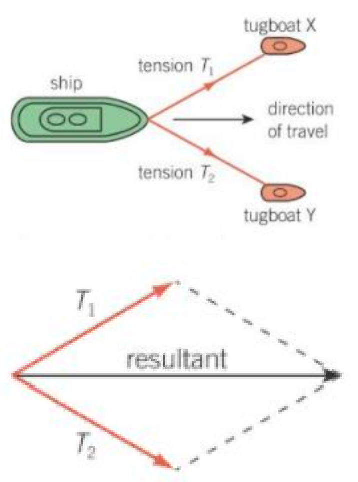
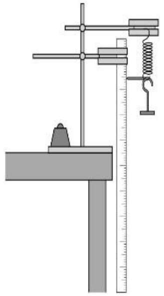


Figure 1. Combining forces.

Section 2: Forces and elasticity

Variable	Definition	Word equation	Symbol equation	Extra information
Weight	Force acting on an object due to gravity	Weight, N = mass, kg x gravitational field strength, N/kg	w=m x g	Measured using a Newtonmeter
Work done	When a force causes an object to move through a distance work is done on the object.	Work done, J= Force,N x distance, m	W=F x s	Work done against frictional forces acting on an object causes a rise in the temperature of the object
Hooke's Law	The extension of a spring is directly proportional to the force applied, as long as its limit of proportionality is not exceeded	Force applied, N = spring constant, N/m x extension, m	F= k x e	This is valid provided that the limit of proportionality is not exceeded
Elastic potential energy	Work done in stretching or compressing a spring (up to the limit of proportionality)	Elastic potential energy, J = 0.5 x spring constant, N/m x (extension)^2, m^2	E_P= 0.5 x k x e ^{2}	

Required Practical: Force and Extension



1. Attach the two clamps to the clamp stand using the bosses. The top clamp should be further out than the lower one.
2. Place the clamp stand near the edge of a bench. The ends of the clamps need to stick out beyond the bench.
3. Place a heavy weight on the base of the clamp stand to stop the clamp stand tipping over.
4. Hang the spring from the top clamp.
5. Attach the ruler to the bottom clamp with the zero on the scale at the top of the ruler. If there are two scales going in opposite directions you will have to remember to read the one that increases going down.
6. Adjust the ruler so that it is vertical. The zero on the scale needs to be at the same height as the top of the spring.
7. Attach the splint securely to the bottom of the spring. Make sure that the splint is horizontal and that it rests against the scale of the ruler.
8. Take a reading on the ruler – this is the length of the unstretched spring.
9. Carefully hook the base of the weight stack onto the bottom of the spring. This weighs 1.0 newton (1.0 N).
10. Take a reading on the ruler – this is the length of the spring when a force of 1.0 N is applied to it.
11. Add further weights. Measure the length of the spring each time.
12. Record your results in a table. You will need a third column for the extension. This is the amount the string has stretched. To calculate this you subtract the length of the unstretched spring from each of your length readings.
13. Do not put the apparatus away yet.
14. Plot a graph with: 'Extension of spring in cm' on the y-axis , 'Weight in N' on the x-axis.
15. Hang the unknown object on the spring. Measure the extension and use your graph to determine the object's weight. Check it with a newtonmeter.

Section 3: Forces and motion

Variable	Definition	Word equation	Symbol equation
Speed	Scalar quantity. How far an object is moving at a certain amount of time. (Typical values: walking ~1.5m/s, running ~3m/s, cycling ~6m/s, speed of sound ~330m/s)	Speed, m/s = $\frac{\text{Distance travelled, m}}{\text{time, s}}$	V=s/t
Velocity	Vector quantity. Speed at a given direction.		
Acceleration	The acceleration of an object is its change of velocity per second	Acceleration, m/s²= $\frac{Change\ in\ velocity, m/s}{Time\ taken, s}$	$\alpha = \frac{\Delta v}{t}$
Uniform acceleration	Occurs when the speed of an object changes at a constant rate.	(final velocity)^2 -(initial velocity)^2 = 2 x acceleration x distance	$V^2 - u^2 = 2as$

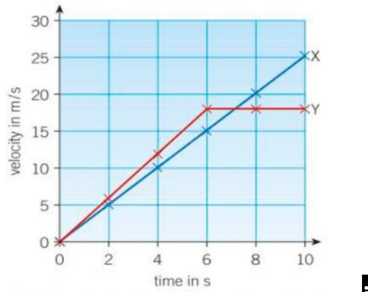


Figure 2. A velocity-time graph. The gradient of a line on a velocity-time graph represents acceleration.

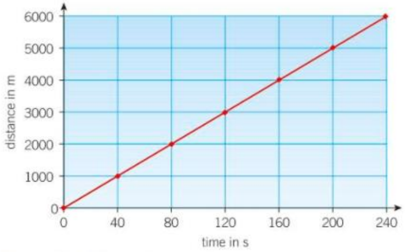


Figure 3. A distance-time graph. The gradient of a line on a distance-time graph represents speed.

Section 5: Forces and braking

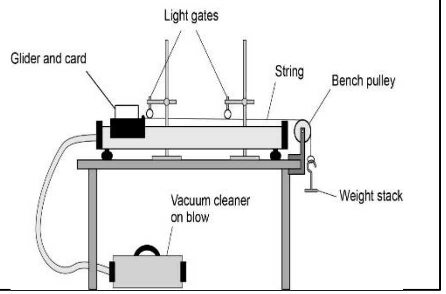
Stopping distance	• The sum of the distance the vehicle travels during the driver's reaction time (thinking distance) and the distance it travels under the braking force (braking distance). • The greater the speed of the vehicle, the greater the stopping distance.	**Stopping distance=thinking distance + braking distance**
Reaction time	It varies from person to person (typical values: 0.2-0.9s)	Can be affected by tiredness, drugs and alcohol.
Braking distance	The distance a vehicle travels under the braking force	Can be affected by wet or icy road conditions.

Section 4: Newton's Laws

Newton's First Law of motion	If the resultant force acting on an object is zero and: • The object is stationary, the object remains stationary. • The object is moving, the object continues to move at the same speed and in the same direction. So the object continues to move at the same velocity.	Apply to: explain motion of objects moving with a uniform velocity and objects where the speed and/or direction changes.
Newton's Second Law	The acceleration of an object is proportional to the resultant force acting on the object, and inversely proportional to the mass of the object	Equation: resultant force, N= mass, kg, x acceleration, m/s^2
Newton's Third Law	Whenever two objects interact, the forces they exert on each other are equal and opposite.	Apply to: Explain equilibrium.

Required Practical: Acceleration

- The first experiment will investigate how the acceleration depends upon the force. The force is provided by the weight stack.
- Attach the full weight stack (1 N) to the end of the string.
- Switch on the software. Make sure the glider is in position and switch on the vacuum cleaner.
- The glider should accelerate through the light gates towards the bench pulley.
- Record the acceleration. Repeat.
- If the two values are not similar, repeat again.
- Record your readings in a table such as the one below. Calculate the mean.
- Remove one weight (0.2 N) and attach that to the glider. This will keep the total mass constant. (The weight stack is being accelerated too.)
- Repeat the experiment for a force of: 0.8 N, 0.6 N, 0.4 N, 0.2 N. Remember to
- attach each weight to the glider as it is removed from the weight stack.
- Plot a graph with: 'Acceleration in m/s^2' on the y-axis , 'Force in N' on the x-axis.



Physics 6: Waves

Section 1: Transverse and Longitudinal Waves

1 Transverse Waves	Oscillations (vibrations) are perpendicular to the direction of travel and energy transfer.
2 Longitudinal Wave	Oscillations (vibrations) are parallel to the direction of travel and energy transfer.
3 Wave Speed	The speed at which energy is transferred.

4

$v = f \cdot \lambda$

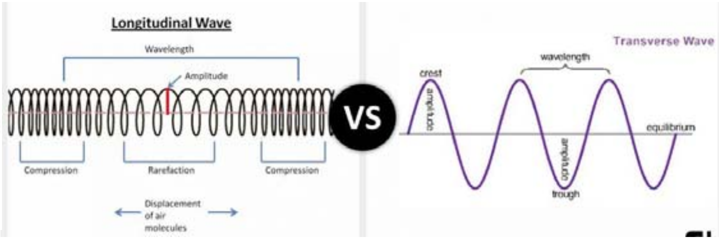
$f = v / \lambda$

$\lambda = v / f$

UNITS: λ = meters (m)

f = Hertz (Hz)

v = m/s



Section 2: Properties of waves

5 Amplitude	The wave height/ **maximum displacement** of the wave from its **undisturbed position**.
6 Wavelength	The distance between the same points on two adjacent waves e.g. trough to trough or peak to peak.
7 Frequency	The number of complete waves passing a fixed point every second. Measured in Hz (Hertz)
8 Hz (Hertz)	Number of waves per second (unit of frequency)

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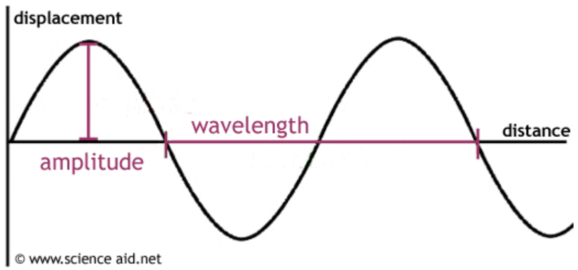

Section 3: Types of electromagnetic waves- The EM Spectrum

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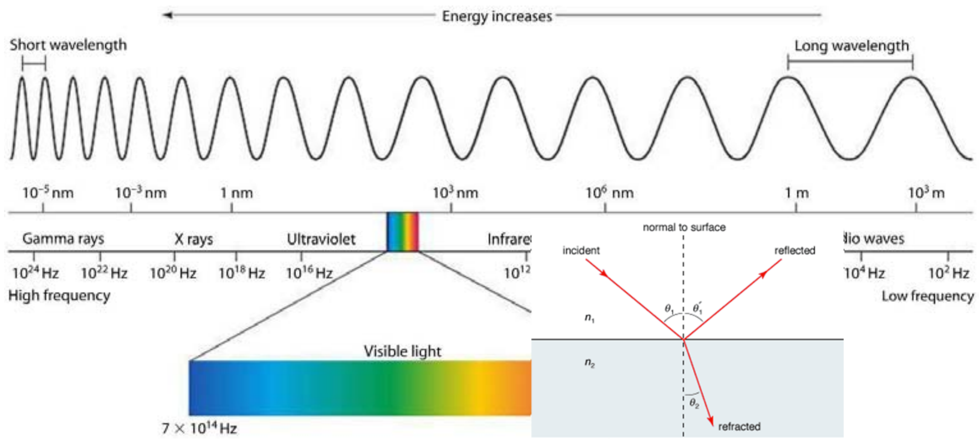

As wavelength increases, energy decreases. EM waves travel at the same speed through air or a vacuum. There are 7 basic types of wave which merge to form a continuous spectrum of waves.

Section 4: Properties of electromagnetic waves

11 Refraction	Change in direction of a wave at a **boundary** due to a change in speed caused by density differences.
12 Boundary	The junction between two different mediums e.g. air and glass.
13 Reflection	The bouncing off of a wave from a barrier.
14 Law of reflection	The angle of incidence always equals the angle of the reflected ray (either side of the normal)

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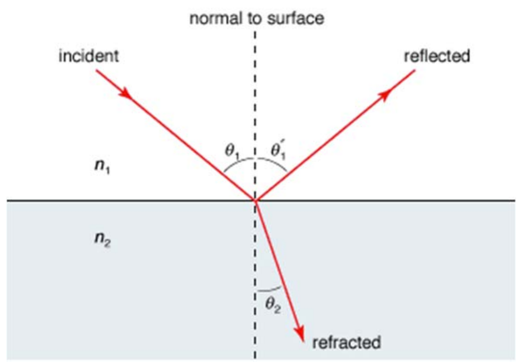
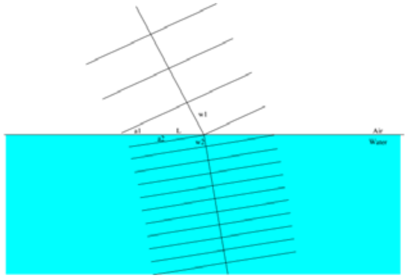


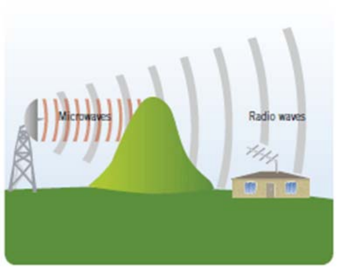
Section 5: Explaining Refraction

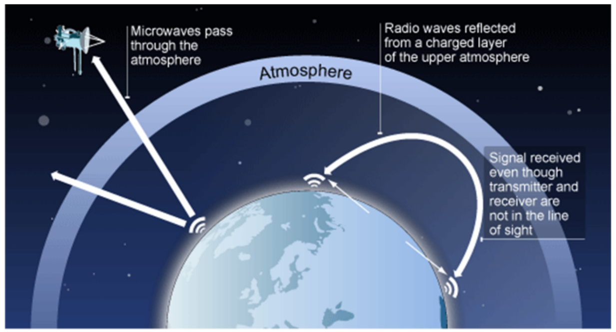
16	17
When a wave crosses a boundary at an angle, only part of the wave crosses the boundary first. If it is travelling into denser material, then that part travels slower than the rest of the wave front. The changing speed of the wave front as it crosses the boundary causes the wave to bend.	

Section 6: Radio Waves

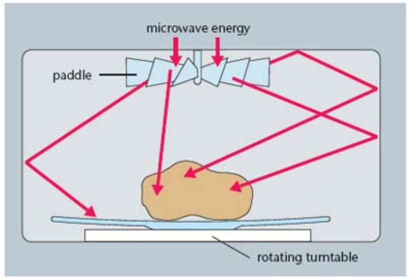
18 Radio waves can be produced by oscillations in electrical circuits.. When radio waves are absorbed they may create an alternating current with the same frequency as the radio wave itself, so radio waves can themselves induce oscillations in an electrical circuit.

19 Long wavelength radio waves do not need line of sight between the transmitter and receiver	Radio waves (long wave lengths) diffract (bend) around the Earth's surface making it possible for radio signals to be received even if the receiver is not in line of sight of the transmitter. Shorter wave radio signals are reflected by the ionosphere (electrically charged layer in the atmosphere).
20 Very short wavelength radio waves need line of sight between the transmitter and receiver	TV and FM radio signals have very short wavelengths. To get signal you must have direct sight of the transmitter (line of sight)
21 Line of sight	Transmitter is in direct sight of the receiver





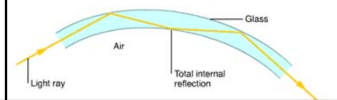
Section 7: Microwaves

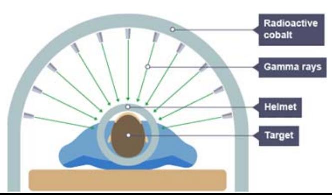
23 Microwaves	**Shorter wavelength** than radio waves. Used for Satellite **communications** (long distance). Shorter wavelength means they are **not reflected** by the **ionosphere**.
24 Cooking with microwaves **Quick!**	**Microwaves** penetrate a few centimetres into food before being absorbed. **Energy** is **transferred** to water molecules and fat causing them to heat up. Energy is transferred to the rest of the molecules in the food by **conduction** (heating). (microwave oven)
25	

Section 8: Infrared

26 Infrared (IR)	**Electromagnetic** radiation given out by all objects. The **hotter** the object the **more IR radiation** given out.
27 Cooking with IR **Slow!**	IR **does not penetrate** food, and is **absorbed** by the surface of food. Energy is **transferred** to the rest of the food by **conduction**. (conventional oven)

Section 9: Other Uses of EM Waves

28 Optic Cables	• **Optic cables** carry data over **long distances** and use **light**. • Unlike in wires, **energy is not lost due to heating** effect so signals can be used for long distance communication. • Relies on total internal reflection
29 Total internal reflection	Energy is not easily scattered or absorbed. 
30 UV Radiation (ultraviolet)	• UV is produced by the sun and fluorescent lighting. Exposure to UV is what gives people a suntan. • Overexposure is dangerous (skin cancer/ DNA mutation) • Uses: fluorescent lighting and security pens
31 X Rays and Gamma Rays	• X rays are used by radiographers in hospitals. They pass easily through flesh but not bone so can be used to form images. • High doses are harmful- can cause cancer/ DNA mutations • Gamma rays used for medical tracers and radiotherapy (cancer treatment

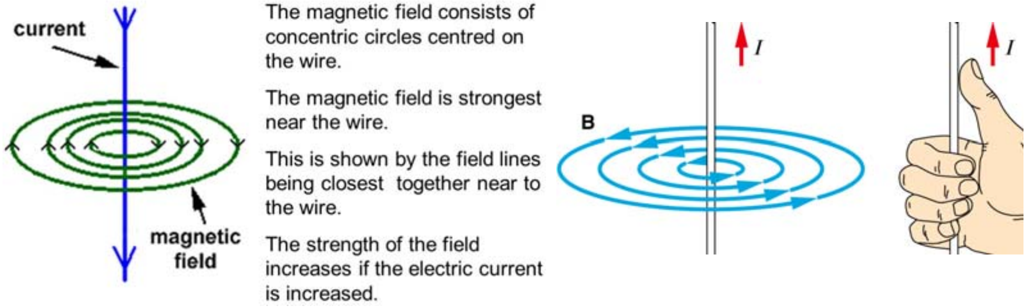


P7: MAGNETISM

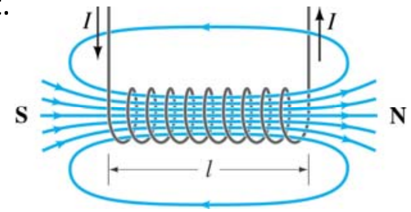
Section 1: Magnetism and electromagnetism Key Terms	
1 Pole	The **places** on a magnet where the **magnetic forces** are **strongest**.
2 Magnetic Field	The **area** around a magnet where a **force acts** on another magnet or magnetic material.
2 Repel	Occurs when two **like poles** are brought close together. The magnets **push apart**.
3 Attract	Occurs when two **opposite poles** are brought close together. The magnets **move together**.
4 Permanent magnet	A magnet that produces its **own magnetic field**.
5 Induced magnet	A magnetic material that **becomes a magnet** when it is placed in a **magnetic field**. When **removed** from the **field** it **quickly loses its magnetism**.
6 Magnetic material	There are four magnetic materials: **iron**, **steel**, **cobalt** and **nickel**.
7 Compass	Compasses contain small bar magnets which **points** to the **north pole** of the **Earth's magnetic field**.
10 Solenoid	A **coil of wire** that will create a **magnetic field** when **current** is passed through it. The magnetic field **inside** the solenoid is **strong** and **uniform**. It acts in the same way as a bar magnet.
11 Electromagnet	A **solenoid containing an iron core** which increases its strength.
12 Motor effect (HT)	When a **conductor carrying a current is placed in a magnetic field, the magnet producing the field and the conductor exert a force on each other**. This can be used to create a motor.
14 Fleming's Left Hand Rule (HT)	A rule that shows the **relative direction** of the **current**, **force** and **magnetic field** in the motor effect.

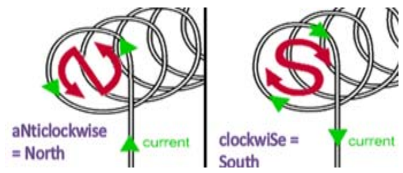
Section 3: Electromagnets

Magnetic field around a single wire. The direction of the magnetic field can be found from the **right hand grip rule.** Thumb in the direction of current and fingers point in the direction of magnetic field.



When a current moves through a wire, a magnetic field is produced. If you increase the current you increase the strength of the field. The closer an object is to the wire the greater the field strength. Rolling the wire into a **solenoid** increases the field strength. The field is strong and uniform within the solenoid. The field shape outside a solenoid is similar to that of a bar magnet.

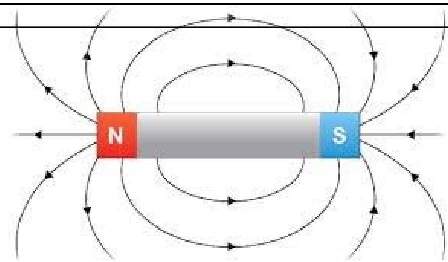




Section 2: Poles of a Magnet

The **poles** of a magnet are where the magnetic forces are the strongest. When magnets are brought together they exert a force on each other: like poles repel, opposites attract. **Attraction** and **repulsion** are examples of non-contact forces.

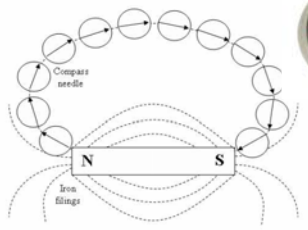
A permanent magnet makes its own magnetic field whereas an induced magnet is a material that only becomes magnetic when placed in a magnetic field. **Induced magnetism** always causes a force of attraction. Induced magnets lose their magnetism when taken out of a magnetic field.



Section 4: Magnetic field

The region around a magnet where a force acts on another magnet or a magnetic material is called the magnetic field. The force between a magnetic material and a magnet is always of attraction. The force is greater the nearer it is to the magnet and is strongest nearest to the poles. The direction of a magnetic field line is always from the north (seeking) pole to the south seeking pole.

A magnetic **compass** contains a small bar magnet. The compass needle points in the direction of the Earth's magnetic field. You can use a compass to plot the magnetic field pattern of a magnet. The core of the earth must be magnetic due to the effect it has on the magnet in a compass



Section 5: Motor effect

Motor effect: When a **conductor** is placed in a magnetic field the magnet produce the field and the conductor exert a force on each other

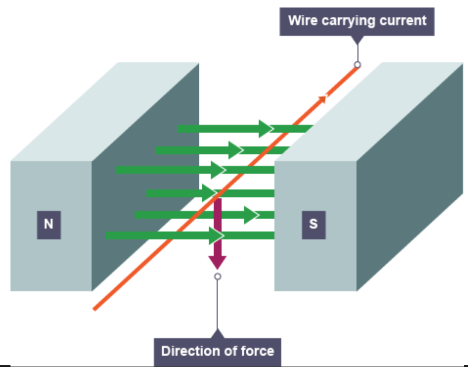
The size of the force can increased by:

- Increasing the currer
- Using a stronger mo

Size of the force depends on the angle between the wire and magnetic field line:

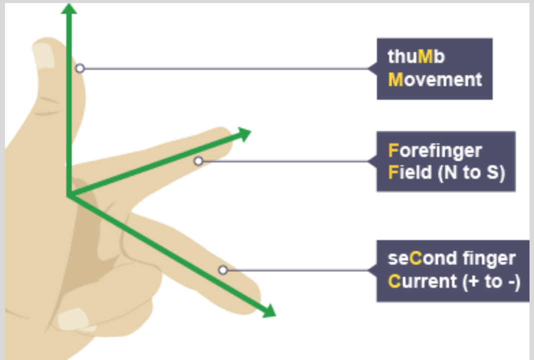
- Greatest when perpendicular (right angles) to magnetic field.
- 0 when parallel.

Direction is always at right angles to the wire and the field lines.



Section 6: left hand rule

Use Fleming's left-hand rule to remember the direction of motion in an electric motor



Align fingers to the field and the direction of the current to work out the way the wire moves.

Force = Magnetic Flux Density x Current x Length

(N) (T) (A) (m)

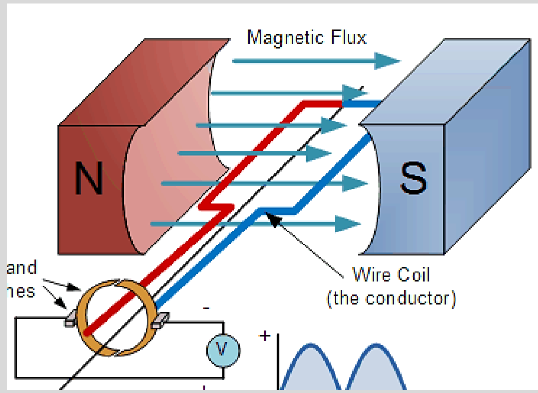
(You will be given this equation in the exam)

Section 7: Electric Motors (HT only)

A coil of wire carrying a current in a magnetic field has a tendency to rotate. This is how motors work. The force on a conductor in a magnetic field makes the coil spin in an electric motor.

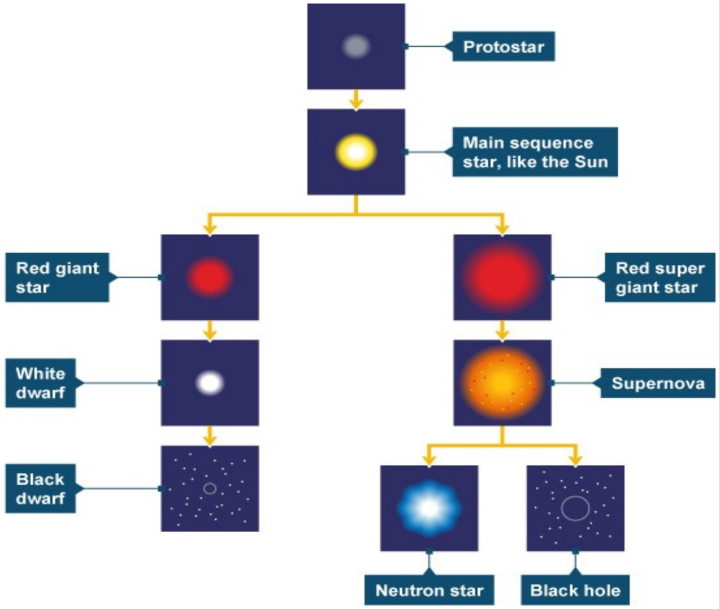
If the direction of the current is reversed the motor will spin in the opposite direction. The same occurs if the direction of the magnetic field is reversed.

The higher the current the faster the motor will spin. The higher the magnetic field strength the faster it will spin. The more coils in the motor the faster it will spin.



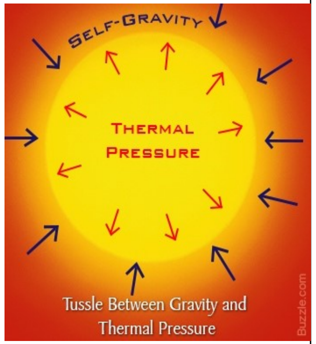
AQA GCSE Physics (9-1) Topic 8 - Space - Knowledge Organiser

Life Cycle of Stars:



Nebula—Cloud of dust and gas from which stars are made

Gravity and **Thermal Pressure**—the two forces that determine whether a star is stable (balanced), shrinking or growing.



Nuclear Fusion—The process of nuclei combining that releases energy in a star (in the main sequence **Hydrogen fuses to make Helium**). This requires huge pressure from gravity.

All elements **up to Iron** are made in stars during their lifetime. Elements heavier than iron are only made during a **supernova.**

Which path a star evolves along depends on **mass.** Stars like **our sun** become **Red Giants. More Massive** stars become **Red Super Giants.**

The Solar System and Orbits:

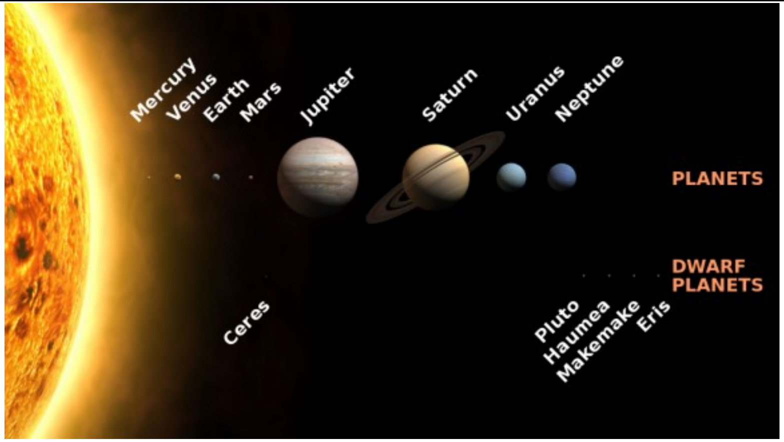
Dwarf Planet—too small to be a planet

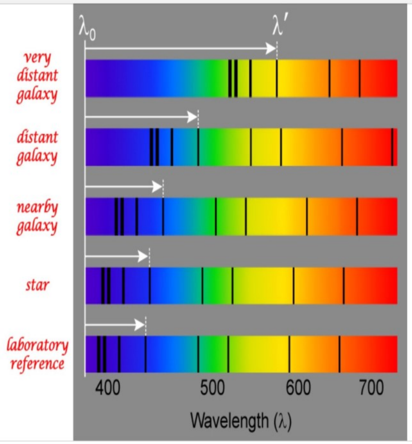
Orbit—a path of one object around another

Satellite—any object which orbits another

Planetary orbits are approximately **circular** and occur because of **gravity**

Gravity acts on an object <u>towards the centre of the more massive object</u>





Doppler Effect— The apparent increase in wavelength (decrease in frequency) of a wave when the emitter and receiver are moving away from each other

Redshift— The increase in wavelength of light from distant galaxies.

The **further away** the galaxy, the **more redshift**—the **faster away** it is moving

CMBR—**Cosmic Microwave Background Radiation**—Left over EM radiation from the high energy (very hot!) beginning of the universe

Big Bang—A **theory** that the universe began as a very small, very hot **singularity.**

Dark Matter and **Dark Energy—**Theoretical ideas that scientists use in models of the evolution of the universe. They are not fully understood or explained.

Links to other topics:

Circular motion—Gravity as the **centripetal force** for objects in orbit (including artificial satellites). The centripetal force always acts **towards the centre** of the circle. The **further away** from the centre of orbit, the **slower the speed** of the orbit.

Circular motion—As the object moves in a circle it **changes direction**, therefore **changing its velocity** (a **vector**), a changing velocity is an **acceleration**. So all orbiting objects have an acceleration directed **toward the orbit centre**.

Scientific Theories—The big bang theory is the latest theory for the evolution of the universe. There are others. Scientists **update their models** when there is **new evidence** which **cannot be explained by the old model**.