Whitley Academy

Physics Paper 2 (H) Knowledge Recall Booklet

Paper Physics 2H   8464/P/2H

For this paper, the following list shows the major focus of the content of the exam:

- 6.5.1 Forces and their interactions
- 6.5.4.1 Describing motion along a line
- 6.5.4.2 Forces, accelerations and Newton's Laws of motion
- 6.5.5 Momentum
- 6.6.2 Electromagnetic waves
- 6.7.2 The motor effect

Required practical activity that **will be assessed**:

- Required practical activity 21: investigate how the amount of infrared radiation absorbed or radiated by a surface depends on the nature of that surface.

Your teacher will tell you specific topic areas to focus on …

Topic	RAG			Revision technique					Date completed	Teacher Signed
	R	A	G	Flashcards	Mindmap	Notes	Video Watched (With notes)	Frog resource		

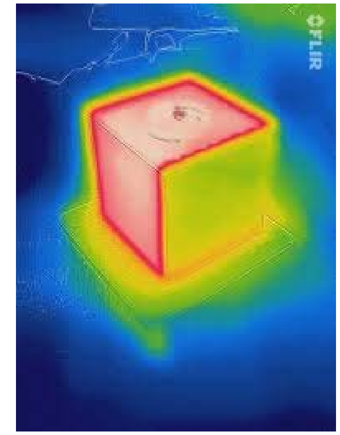
Required Practical – How does the amount of IR Radiation absorbed or reflected depend on the nature of the surface?

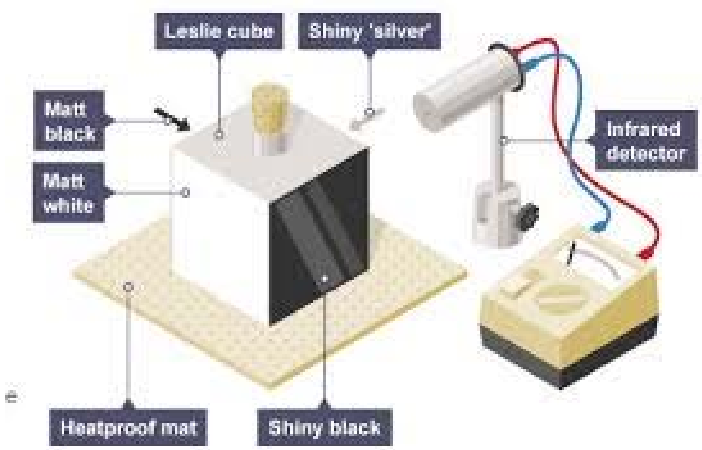
Recall it ...

Use the information in the following page(s) to answer these questions ...

1. What type of surfaces are the best emitters of IR radiation?
2. What type of surfaces are the worst emitters of IR radiation?
3. Describe the method of how a Leslie cube is used to show the effect of these surfaces?
4. Describe and explain what the results show?

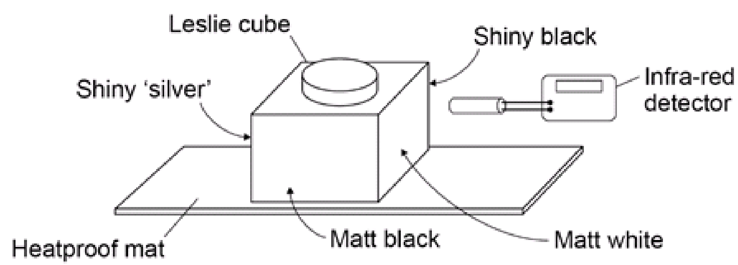
Required Practical – How does the amount of IR Radiation absorbed or reflected depend on the nature of the surface?





1. Place the Leslie cube on to a heat proof mat.

2. Fill the cube with very hot water and replace the lid of the cube.



3 Use the detector to measure the amount of infrared radiated from each surface.

Make sure that before a reading is taken the detector is the same distance from each surface.

Draw a bar chart to show the amount of infrared radiated against the type of surface.

Matt black surfaces are the best emitters of radiation.

Shiny surfaces are the worst emitters of radiation.

Recall it ...

Forces

Use the information in the following page(s) to answer these questions …

1. What is the difference between a scalar and vector quantity?
2. Give examples of scalar and vector quantities?
3. Why are arrows used to show vector quantities?
4. How can arrows be used to find the overall resultant force?
5. What is the difference between a contact and non-contact force?
6. Give examples of contact and non-contact forces?
7. What is weight? What does weight depend upon?
8. What is the formula for weight?
9. What is the gravitational strength field of the earth? What does gravitational strength field depend upon?
10. What is the relationship between weight and mass?
11. What is centre of mass? Describe how to find the centre of mass of an irregular shaped object?

Scalars and Vectors

Materials in a classroom can be grouped into two groups – metals and non-metals.

Things we measure can be put into two groups as well – scalars and vectors.

Scalars: Things that we measure that have a magnitude (size) only are scalars.

Vectors: Things that we measure that have both magnitude and direction are vectors.

Sometimes direction is really important. In a crash the direction, as well as the speed, of the vehicles will determine how much damage is caused.

Examples of Scalars and Vectors

Some examples of scalars and vectors are shown in the table below.

Scalars	Vectors
Time	Forces (including weight)
Mass	Displacement
Temperature	Velocity
Speed	Acceleration
Direction	Momentum

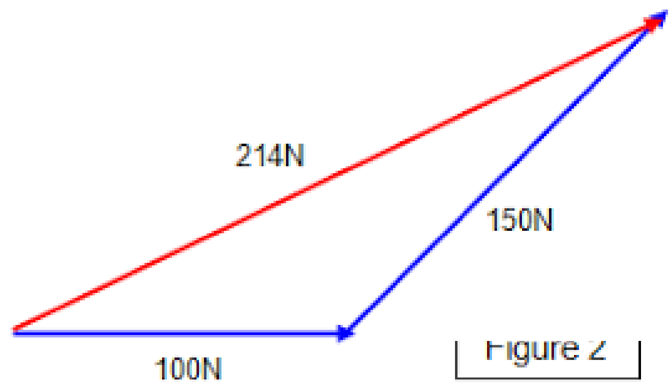
Representing Vectors

Vectors can be shown by arrows.

The length of the arrow shows the size, or magnitude, of the force.

The direction of the arrow shows the direction of the force.

The vector arrows can be added together to show the resultant of two of more vectors.



Contact and Non-contact Forces

Forces can be placed into two groups. There are forces that act on contact and there are forces that act at a distance.

Contact Forces	Non-Contact Forces
Air Resistance	Gravity
Friction	Magnetism
Tension	Electrical Force
Normal Force	Nuclear Force

Gravity

Gravity is a non-contact force.

Gravity is the force responsible for the formation of galaxies, stars and planets.

Weight is the force acting on an object due to gravity. The force of gravity close to the Earth is due to the gravitational field around the Earth.

The weight of an object depends on the gravitational field strength at the point where the object is.

Calculating Weight

The weight of an object can be calculated using the equation:

Weight (N) = Mass (kg) x Gravitational field strength (N/kg)

$$W = m\,g$$

It is useful to note that the gravitational field strength, g, on Earth is about 10 N/kg.
This means that a one kilogram mass would have a weight of 10 N. This can also be found using a calibrated spring balance (a newtonmeter).

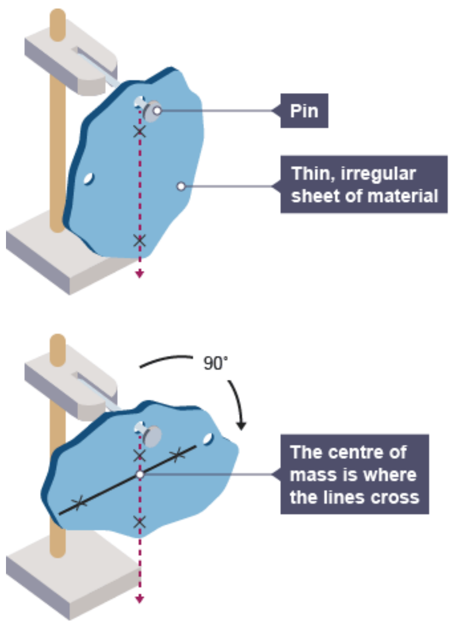
The value of the gravitational field strength will depend on where you are. Your weight on top of a mountain will differ slightly from your weight at sea level. On the Moon your weight will be approximately one sixth of your weight on Earth.

Weight and mass are directly proportional.

Centre of Mass

The weight of an object may be considered to act at a single point referred to as the object's 'centre of mass'.

The centre of mass of an irregularly shaped 2-D object can be found by using a pin, some string and a small mass. By pinning the 2-D object up on a board with the string hanging from the pin (with the small mass on the end) the string will go through the centre of mass – mark with a line. Rotate the object and re-hang on the board. Draw a line to show where the string hangs. Where the lines cross is the centre of mass of the shape.



Recall it ...

Resultant force, speed and velocity

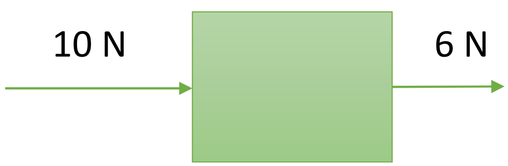
Use the information in the following page(s) to answer these questions …

1. What is resultant force?
2. How do you find the resultant force is forces are acting in the same direction and in opposite directions?
3. Sketch a free body diagram?
4. What is the difference between distance and displacement? Which is a scalar quantity and which is vector? Why?
5. What is the difference between speed and velocity? Which is scalar and which is vector? Why?
6. How can the speed, distance, time formula can be re-arranged to make speed, distance and time the subject?
7. How fast is the speed of sound in air?
8. What is the difference between average speed and instantaneous speed?

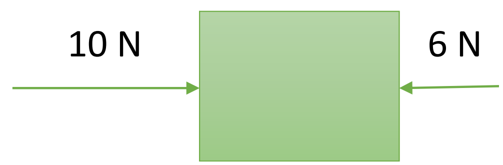
Resultant Forces

A number of forces acting on an object may be replaced by a single force that has the same effect as all the original forces acting together. This single force is called the resultant force.

When two forces act in a line the resultant force is the vector addition of the two vectors. Remember the direction is important.



R = 16 N to the right



R = 4 N to the right

Calculating Resultant Force

Example 1:

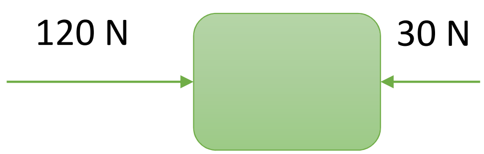
A box is pushed along the floor with a force of 120 N. There is a resistive force of 30 N. Work out the resultant force on the box.

Solution:

Resistive forces act in the opposing direction to motion.

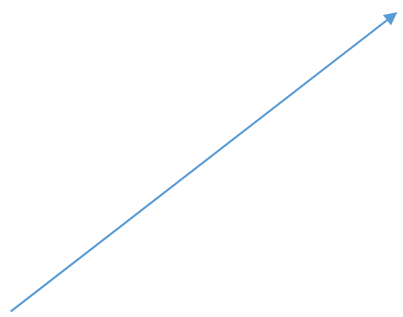
Addition of the forces gives:

120 N + -30 N = 90 N in direction of 120 N force



Calculating Resultant Force… continued

A single force can be resolved into two components acting at right angles to each other. The two component forces together have the same effect as the single force.



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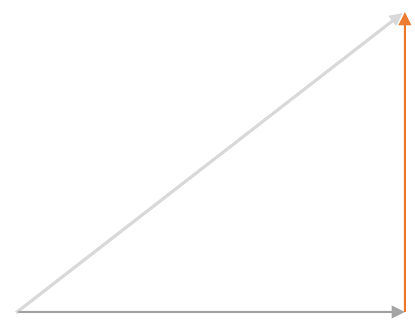


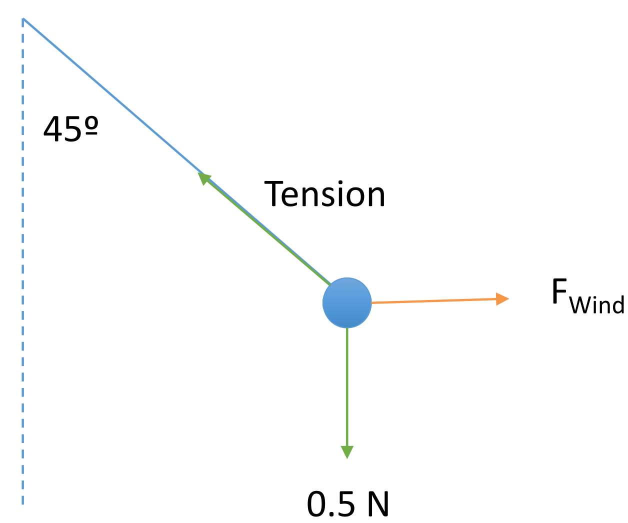
Example

A pendulum has a weight of 0.5 N.

On a windy day the pendulum is hung outside and the pendulum now hangs at an angle of 45º.

Assuming the wind hits the pendulum moving horizontally, draw a free body diagram to represent the forces acting.

Solution



Definitions

Distance: How far an object has travelled. Distance is a scalar quantity.

Displacement: How far an object has travelled in a straight line from the starting point to the finishing point and the direction of that line. Displacement is a vector quantity.

Examples:

A runner runs around a track. The track is 400 m long.

After completing one complete circuit of the track the runner has travelled a distance of 400 m. After the one complete circuit the runner ends up at their starting point. This means that their displacement is 0 m.

Calculations

For an object moving at a constant speed the distance travelled in a specific time can be calculated using the equation:

Distance travelled (m) = Speed (m/s) x time (s)

$$s = v\,t$$

Definitions

Speed is the rate of change of distance. This can be found using the equation:

$$\text{speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

Speed is a scalar quantity which means that it has magnitude but no direction.

Velocity is the rate of change of distance. Velocity is found using the equation:

$$\text{velocity} = \frac{\text{displacement}}{\text{time taken}}$$

Velocity is a vector quantity which means that is has magnitude and direction.

Speed Calculations

Example 1:

A bike travels 800 m in 160 seconds. Calculate the speed of the bike.

Solution 1:

Using the equation: **Speed = distance / time**
Speed = 800 / 160
Speed = 5 m/s

Example 2:

A car travels a distance of 300 miles at an average speed of 50 mph. Calculate how long it will take to complete the car journey.

Solution 2:

Rearranging the speed equation gives: **time = distance / speed**
time = 300 / 50 = 6 hours

Velocity Calculations

Example 1:

A track runner runs around a 400 m athletics track 4 times in 3 minutes and 10 seconds.

Work out:

a) **The speed of the track runner**
Speed = distance / time
Speed = 1600 / 190
Speed = 8.4 m/s

b) **The average velocity of track runner.**
As the displacement at the end of the run is 0 m (they end up where they started after four loops of the track) their average velocity is 0 m/s.

Typical Speeds

These are the typical speeds of everyday situations that you should know for your exam.

Situation	Typical Speed/ m/s
Walking	1.5
Running	3
Cycling	6

The speed of sound in air is 330 m/s (though this does changes with temperature and pressure).

Average and Instantaneous Speed

Average speed is the speed of an object over the entire journey. The average speed is found by using the total distance travelled divided by the total time taken.

$$\text{average speed} = \frac{\text{total distance travelled}}{\text{total time taken}}$$

Instantaneous speed is the speed of an object at a given moment in time. The speedometer in a car gives the instantaneous speed of the car.

Motion Graphs

Recall it ...

Use the information in the following page(s) to answer these questions …

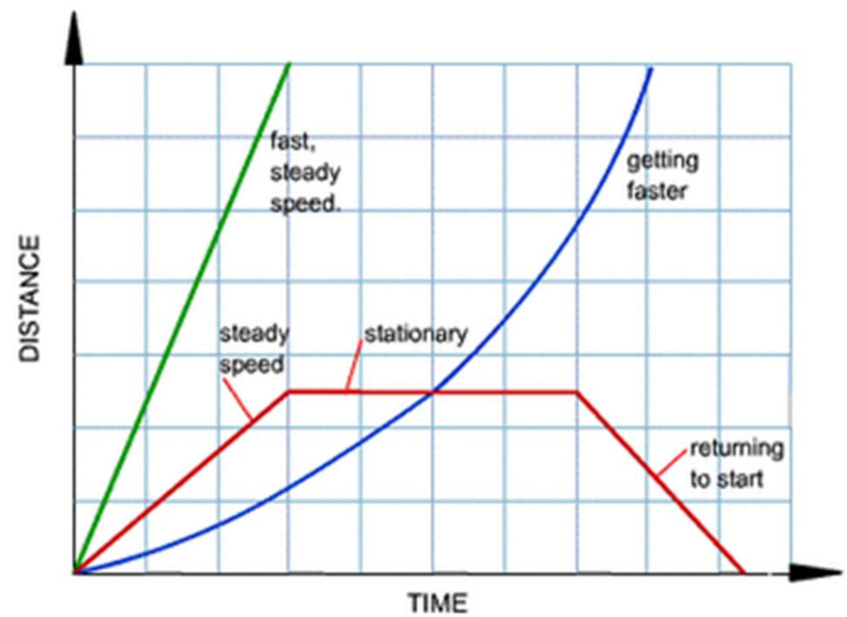
1. What does a upward slope, downward slope and straight line mean on a distance-time graph?
2. What does the steepness of the slope tell you in a distance-time graph?
3. How do you calculate speed from a distance-time graph?
4. What is acceleration? Is acceleration a scalar or vector quantity? Why?
5. How do you calculate acceleration? What are the units for acceleration?
6. Describe what is negative acceleration? Give two examples?
7. What does an upward slope, downwards slope and straight line mean of a velocity-time graph?
8. How can you calculate acceleration from a velocity-time graph?
9. How do you find distance travelled from a velocity-time graph?
10. What is terminal velocity? Describe what happens at terminal velocity?
11. Name the forces acting on a skydiver? How do these forces change as the skydiver reaches terminal velocity?
12. What is the formula for uniform acceleration? Give an example calculation for uniform acceleration?

Distance-Time Graphs

Distance-time graphs can be used to represent the motion of an object.

The different gradients (steepness) of line on the graphs show different motions of the object.

The shapes of line that you need to know are shown opposite.



Calculating Speed from a Distance-Time Graph

From the shapes of distance-time graphs it is possible to compare the speeds of different objects. The steeper the gradient of a line on a distance-time graph the faster the object is travelling.

The gradient of the line on a distance-time graph is the speed of the object.

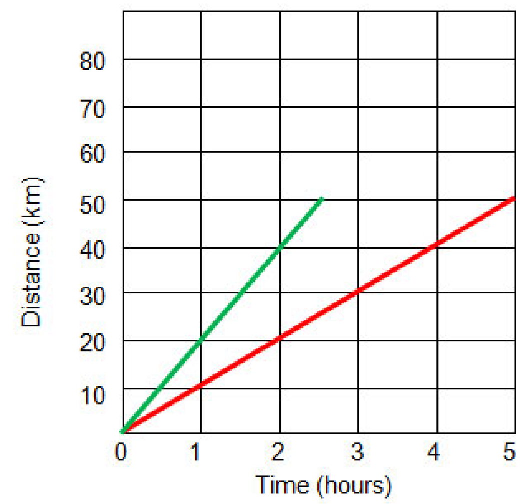
Example:

Work out the speed of the objects shown by the red and green line.

Solution:

Red = distance / time = 30 / 3 = 10 km/h

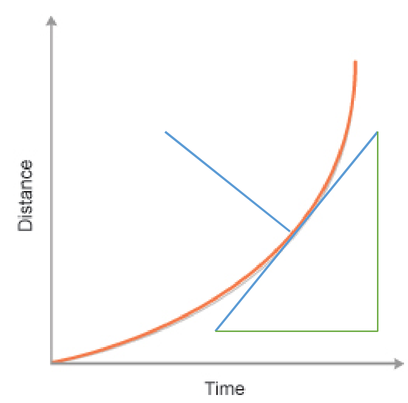
Green = distance / time = 40 /2 = 20 km/h



Calculating Instantaneous Speed

Higher Tier Only
When an object is accelerating the line on a distance-time graph is curved.
To find the instantaneous speed of the object at any point along the curve the tangent to the line must first be found – then the gradient of the tangent shows the speed.

To draw the tangent of a curve you should draw a line perpendicular to your curve to start with, then draw a straight line at right-angles to this across your curve – this is your tangent. The longer the line that you draw at this point the easier and more accurate your speed calculation will be.



Acceleration

When objects accelerate they can be changing speed or changing direction or changing both speed and direction.

Acceleration is the rate of change of velocity, and since velocity is a vector so is acceleration.

The average acceleration of an object is found using the equation:

$$\text{Acceleration (m/s}^2\text{)} = \frac{\text{change in velocity (m/s)}}{\text{Time taken (s)}}$$

$$a = \frac{\Delta v}{t}$$

An acceleration of 3 m/s^2 means that an object is getting 3 m/s faster every second.

Equivalent units for acceleration are: m/s/s and ms^{-2}.

Negative Acceleration

As acceleration is a vector the direction is important.

When a moving object has a negative acceleration it can either be slowing down (often just called decelerating) or it could be increasing speed in the opposite direction.

If a car is moving along a straight motorway at 70 mph and then has a negative acceleration the car will slow down.

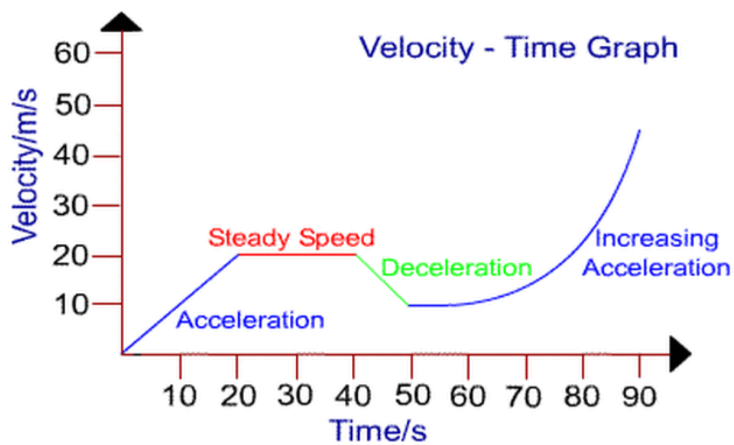
On the on the other hand if the positive direction is chosen to be upwards then a ball that is dropped will have a negative acceleration (as it is in the opposite direction) and will continue to speed up (accelerate) in the opposite direction.

Velocity-Time Graphs

A velocity-time graph gives more information than a distance-time graph. As well as speed, distance travelled and time, a velocity-time graph will give the acceleration of the object.

Although the line shapes look the same as a distance-time graph, as the axes are different the line meanings are different.

Below are the line shapes for velocity-time graphs.



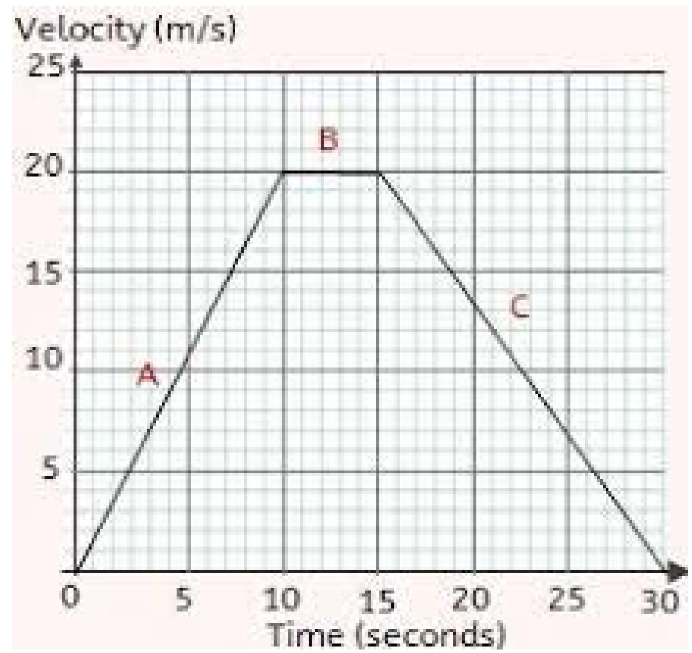
Velocity-Time Graph Calculations

The following information can be gathered from a velocity time graph:

The velocity: **From reading off the axes on the graph.**

The acceleration: **Found from the gradient of the line on the velocity-time graph.**

The distance travelled: **The area under the line on a velocity-time graph is the distance travelled.**

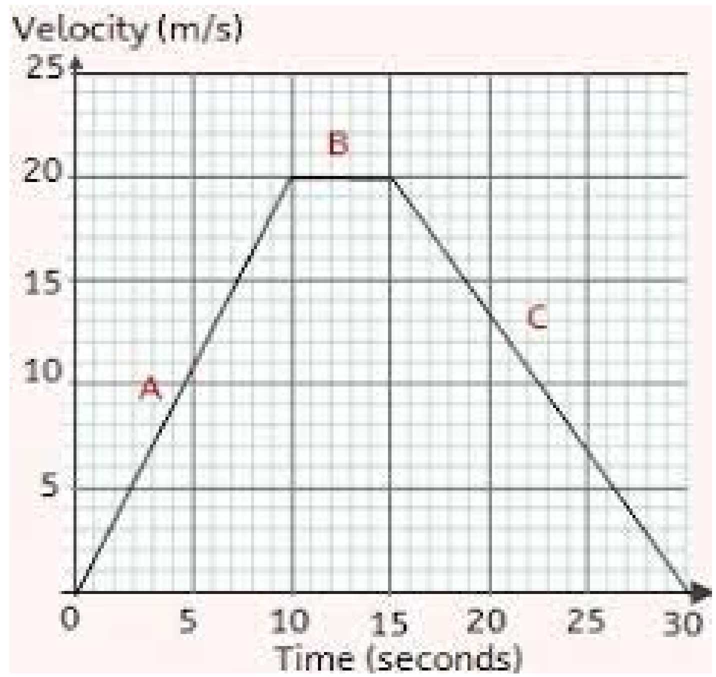


Interpreting Velocity-Time Graphs

Example:
Describe fully the motion shown in the velocity-time graph.

Solution:

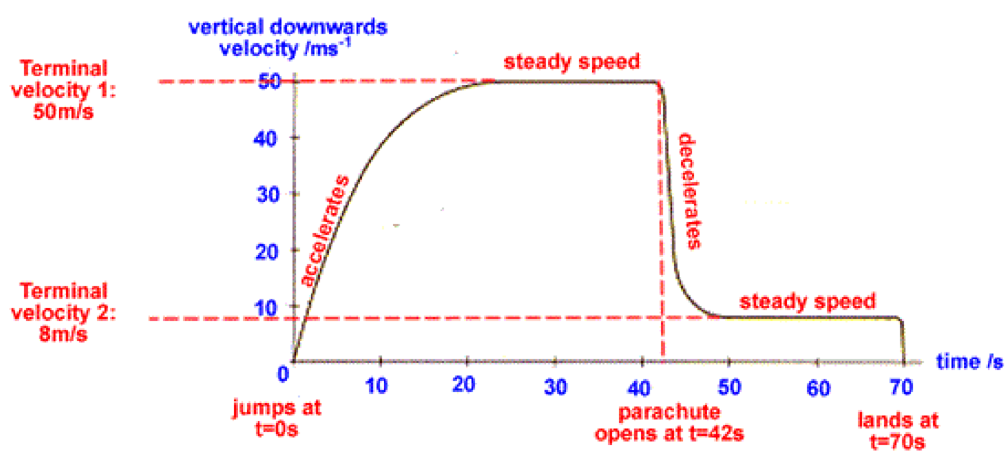
From 0 to 10 s: Constant rate of acceleration of 2 m/s^2.
From 10 to 15 s: Constant speed of 20 m/s.
From 15 to 30 s: Constant rate of deceleration of 1.33 m/s^2.
Distance-travelled is the area under the line = 100 m + 100 m + 150 m = 350 m



Terminal Velocity of Falling Objects

When a skydiver jumps out of a plane they may reach terminal velocity.

At terminal velocity the pull of gravity (the skydiver's weight) is equal in size and opposite in direction to the air resistance on the skydiver. As there is no resultant force there is no acceleration and the skydiver will fall at a steady speed.



Acceleration

Forces acting on a Skydiver

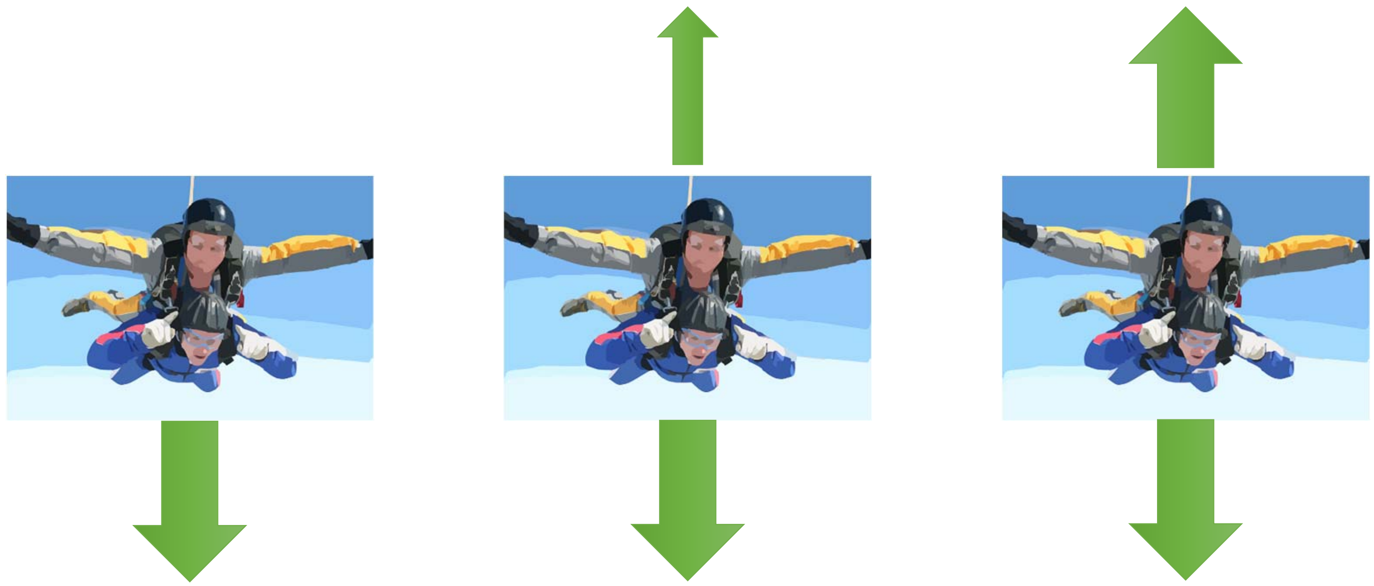
During the course of a skydive the weight of a skydiver will not change. As a result of this the skydiver will have a constant pull downwards caused by the gravitational attraction of the Earth.

Also acting on the skydiver is air resistance, or drag. As the skydiver moves through the air faster the skydiver will experience more drag.

Drag reduces the acceleration the skydiver experiences, from 10 m/s^2 when they have just jumped out of the plane to 0 m/s^2 when they reach terminal speed.

Acceleration

More Forces acting on a Skydiver



As the skydiver falls faster the amount of drag experienced increases, reducing the skydiver's acceleration, until weight and drag are equal in size. At this point the skydiver will be falling with terminal velocity.

Uniform Acceleration

The equation for uniform acceleration is:

(Final velocity)^2 – (Initial velocity)^2 = 2 x Acceleration x Distance
(m/s) (m/s) (m/s^2) (m)

$$v^2 - u^2 = 2\,a\,s$$

This equation is often used when an object is falling under gravity and assumes the acceleration due to gravity to be constant (so ignoring air resistance).

The acceleration of an object due to gravity is taken to be about 9.8 m/s^2. This is often rounded up to 10 m/s^2.

Uniform Acceleration Calculations

Example:

A stone is dropped off a 30 m high cliff.
The stone falls under gravity ($g = 9.8\ m/s^2$).
Work out the speed of the stone as it hits the floor.

Solution:

As the stone is dropped the initial speed is 0 m/s.
Using

$$v^2 - u^2 = 2\ a\ s$$
$$v^2 = 2\ a\ s + u^2$$
$$v^2 = 2 \times 9.8 \times 30 + 0^2$$
$$v^2 = 588$$
$$v = \sqrt{588} = 24.2\ m/s$$

Newton's Laws

Recall it ...

Use the information in the following page(s) to answer these questions …

1. Newton's first Law – What two things happen in the resultant force is zero?
2. What happens if the resultant force is not zero?
3. What is Newton's second Law of Motion? Give the formula that summarises Newton's second Law? Give example calculations?
4. What is Newton's third Law? Give an example of Newton's third law?
5. What is momentum? What is the equation for momentum? Is momentum a scalar or vector quantity?
6. Momentum is a conserved quantity – what does this mean?
7. What is an explosive event? Give an example of an explosive event?

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.**

The velocity of a vehicle will only change if there is a resultant force acting upon it. If the driving and resistive forces are balanced (there is no resultant force) then the vehicle will continue with a steady velocity (speed and direction).

Inertia – Higher Tier Only

Inertia is a property of matter. It is the resistance of the object to change its motion (speed and/or direction).

Mass is a measure of the amount of inertia an object has. The more inertia (or mass) an object has the harder it is to get that object to change its motion.

To find out which of two objects has the most inertia:

- **Apply an equal force to both of them when they are at rest.**
- **The one that has the greatest acceleration has the lowest inertia – it was easier to get it to change its motion.**

Newton’s Second Law of motion

The acceleration of an object is proportional to the resultant force acting on the object, and inversely proportional to the mass of the object.

In equation form, Newton’s Second Law is written as:

Force (N) = Mass (kg) x Acceleration (m/s^2)

$$F = m\,a$$

Inertial mass is the ratio of force divided by acceleration.

Using F = m a

Example 1:

A motorcycle has a mass of 240 kg and accelerates at a rate of 4 m/s^2.
Work out the driving force of the motorcycle.

Solution:

Using

$$F = m\,a$$
$$F = 240 \times 4$$
$$F = 960\ N$$

Using F = m a

Example 2:

A car brakes sharply from a velocity of 30 m/s to rest in 4.2 s.
The braking force applied by the brakes was 4800 N.
Work out the mass of the car.

Solution:

Finding the acceleration of the car:

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

acceleration = 7.1 m/s^2

Substituting gives

F = m a

4800= m x 7.1

m = 672 kg allow 676 kg if acceleration was rounded down

Newton's Third Law of motion

Whenever two objects interact, the forces they exert on each other are equal in size and opposite in direction.

Examples:

When a car crashes into a crash barrier, the force acting on the car and the force acting on the barrier are equal and opposite.

A pen falling will be pulled down by the Earth, and the Earth will be pulled up by the pen.

Momentum

Momentum is a vector quantity.

The momentum of an object only depends on it's mass and it's velocity.

The equation linking momentum, mass and velocity is:

Momentum (kg m/s) = Mass (kg) x Velocity (m/s)

$$p = m\,v$$

From this equation we can see that if an object is not moving (it has a velocity of 0 m/s) then it has no momentum.

Conservation of Momentum: Crashes

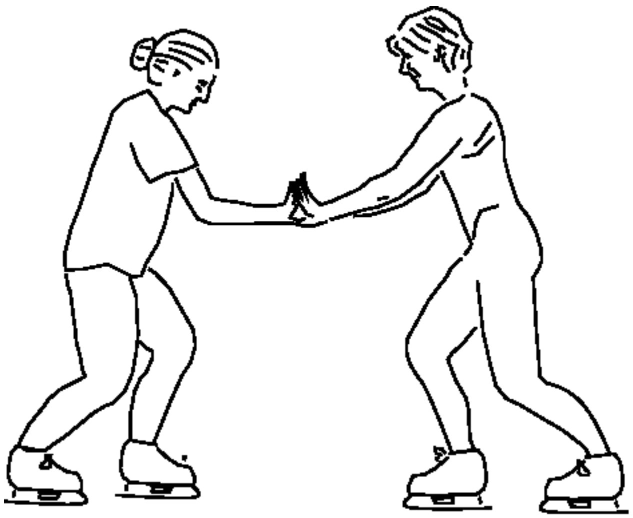
Momentum is a conserved quantity. The momentum of a system remains the same before and after an event.

e.g. In a car crash the momentum of the vehicles before the crash equals the momentum of the vehicles after the crash.

Conservation of Momentum: Explosive Events

In an explosion the momentum of the system is also conserved. This may seem strange as everything is stationary to begin with, but after the explosion parts are moving to the left and right and these cancel – since velocity is a vector and depends on direction.

An example of an explosive event is two ice skaters pushing themselves apart, where the momentum of each ice skater is equal in size and opposite in direction to the other. This then adds to be 0 kgm/s, which is what it was at the start.



Recall it …

Electromagnetic Waves

Use the information in the following page(s) to answer these questions …

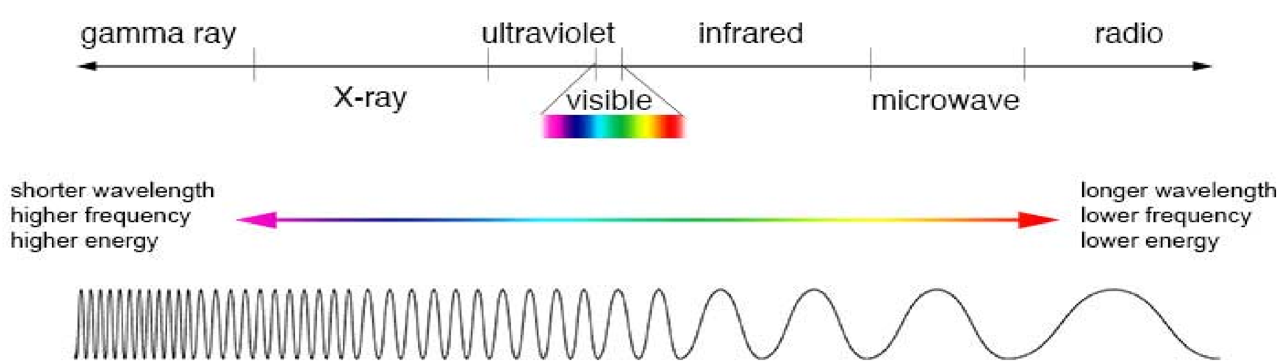
1. What do electromagnetic waves travel through? How fast are electromagnetic waves?
2. List the order of the electromagnetic waves starting with the most frequent?
3. How short are gamma waves? How long are radio waves?
4. How are heat, light and radio waves detected?
5. Give examples of how light is absorbed, transmitted and reflected?
6. What is refraction? How does optical density affect waves speed?
7. Why do we see a spectrum of colour through a prism?
8. How does light behave when it enters a substance with high density?
9. How does light behave when it enters a substance with low density?
10. Explain refraction using a wave front diagram?
11. What is the difference between black matt surfaces and shiny silver surfaces in terms of absorbance and transmittance?
12. Explain how radio signals are produced? How are radio signals transmitted? What happens when a radio signal reaches an antenna?
13. What happens when waves hit the nucleus of atoms?
14. What does the hazard of high energy radiation depend upon? What are the units of dose?
15. What are the risks of UV waves?
16. What are the risks of X-rays and gamma waves?
17. Give uses of each electromagnetic wave and describe their suitability?

Types of electromagnetic waves

Electromagnetic waves are transverse waves that transfer energy from the wave source to an absorber.

Electromagnetic waves form a **continuous spectrum** from the shortest gamma waves (< 10^{-11}m wavelength) to radio waves (> 100km wavelength). **Shorter wavelengths** have a **higher frequency** and **higher energy**.

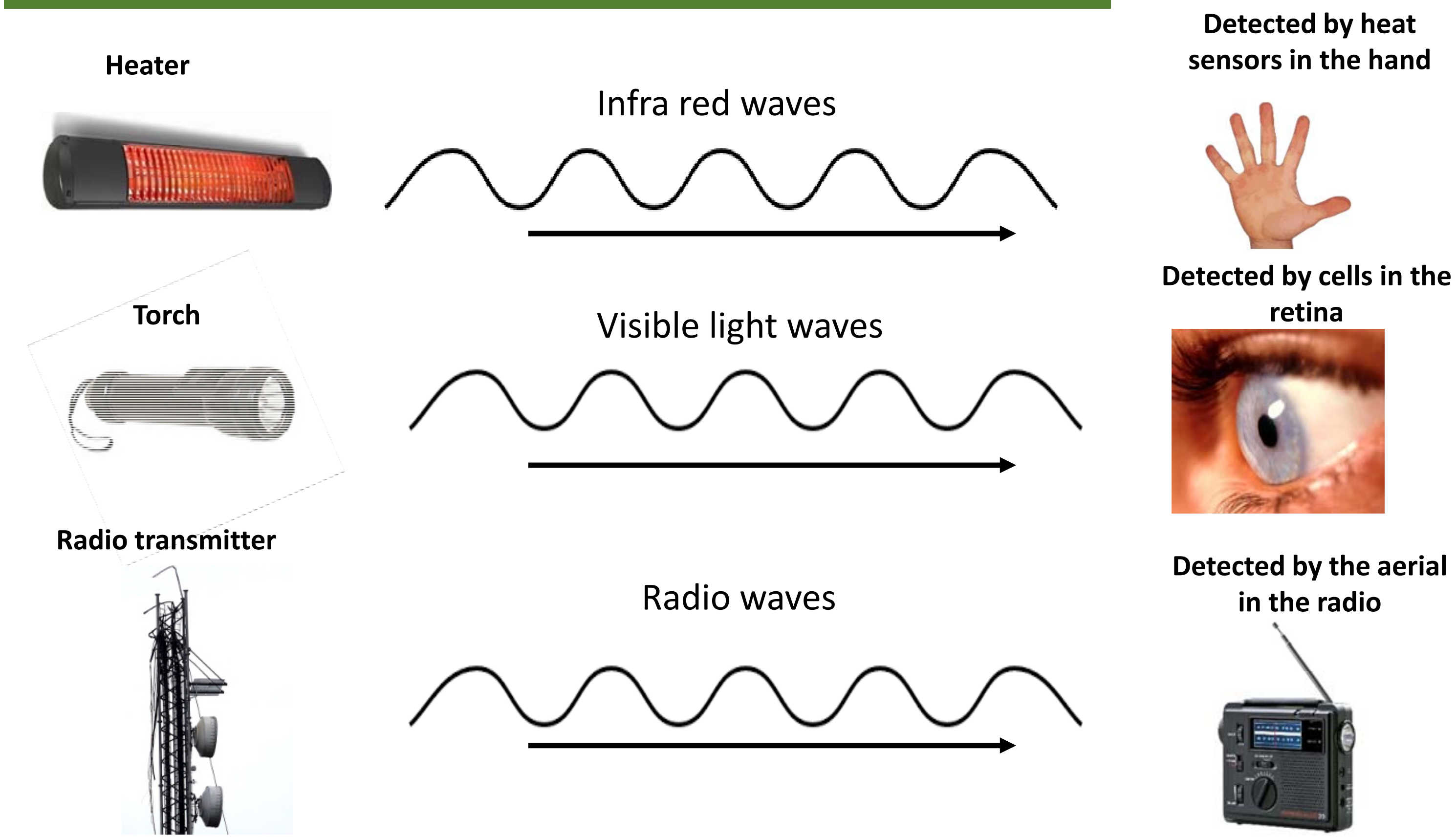
All electromagnetic waves travel at the same velocity in a vacuum: 300 000 000m/s.



Our eyes are only able to detect a small range of these waves shown as the visible range above. Some animals can see in ultra violet and some can detect infra red.

Types of electromagnetic waves

Examples of transfer of energy by electromagnetic waves

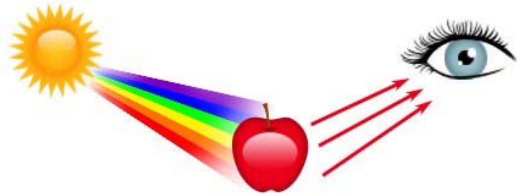


Properties of electromagnetic waves 1 (HT)

Absorption, transmission and reflection of different wavelengths of light

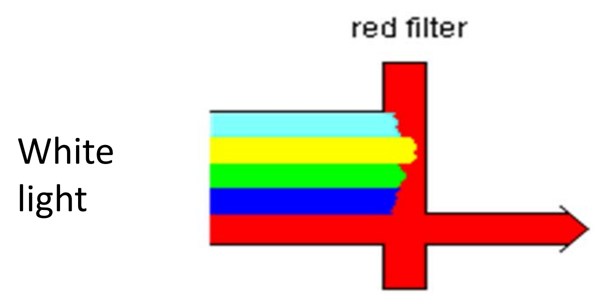
Most materials absorb some of the light falling on it. A white or shiny surface reflects most of the incident light whereas a black surface absorbs most wavelengths of light.

Absorbed light is changed into a **heat** energy store so is not re-radiated as light.



White light/sunlight is made from all the wavelengths of light in the spectrum.
A red object appears red in white light because it only **reflects** the red wavelengths of light, all other colours are absorbed.

If light **transmits** through a coloured object, the colour passing through is the colour we see. As with reflected light, all other wavelengths of light are absorbed by the transparent or translucent material.



Properties of electromagnetic waves 1 (HT)

Refraction of different wavelengths of light in different materials

Refraction of electromagnetic waves occurs because the **wave changes speed** when it enters a substance of different **optical density**.
The light wave will only refract if one side of the wave strikes the new material before the other side.
The amount of refraction is different for materials of different optical density as seen in Figure 1 opposite.

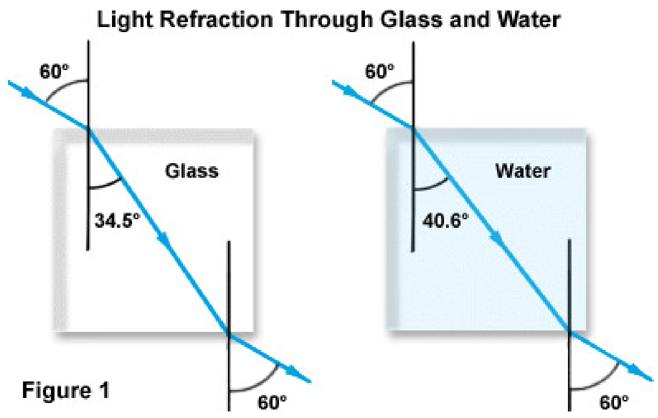
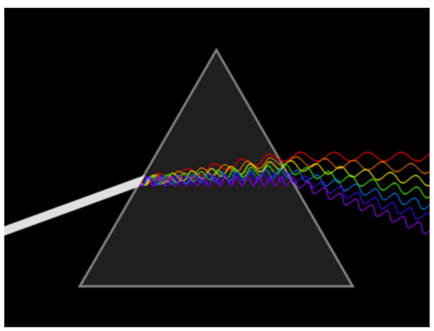


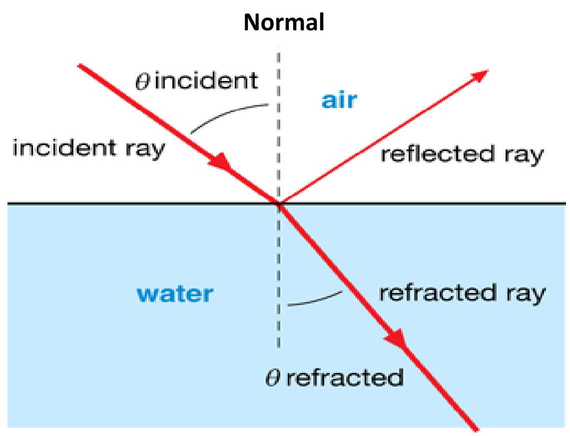
Figure 1



Different wavelengths of light are **diffracted by different amounts**, resulting in a spectrum of colour being produced when white light is refracted (dispersed) by a prism.

Properties of electromagnetic waves 1

Refraction of waves at a boundary– ray diagrams



When light strikes a transparent material, some of the light may be reflected but some will also be **refracted**.

When light enters a substance of greater density, it will be bent (refracted) **towards the normal line.**

Angle of incidence > angle of refraction

When light enters a substance of lower density, it will be bent (refracted) **away from the normal line.**

Angle of incidence < angle of refraction

Properties of electromagnetic waves 1 (HT)

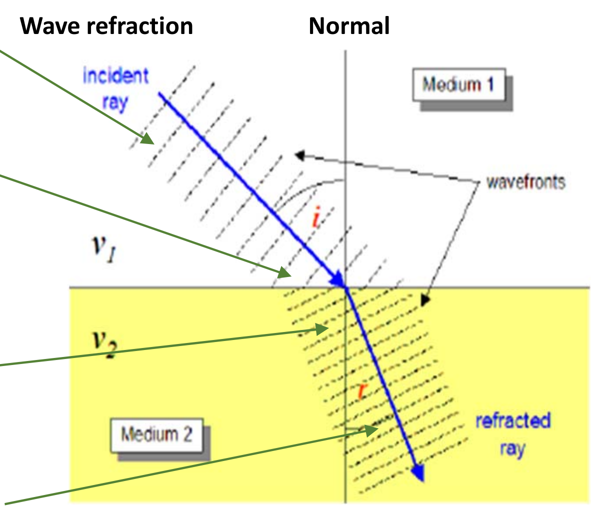
Explaining refraction using wave front diagrams

- The incident ray is shown as wave fronts where all the waves are in phase with each other. This is drawn as a wave line at right angles to the direction in which the wave is travelling.

- The incident ray strikes the denser medium 2 at an angle.

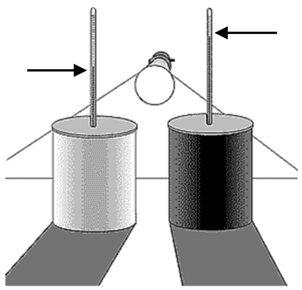
- When the wave front hits a denser material it slows down. One side of the wave front hits before the other side, so slows down first.

- This causes the wave front to bend towards the normal line. Wave fronts will be closer together as the velocity is decreased. Frequency is unchanged.



Properties of electromagnetic waves 1 (HT)

Absorption and radiation of infra red waves (required practical)



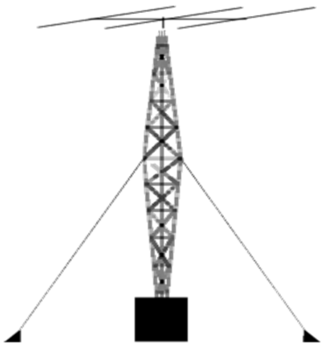
Black surfaces absorb infrared waves better than white or shiny surfaces.

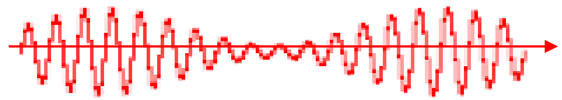
Black surfaces also emit infrared radiation quicker than light coloured surfaces

This is the reason black cars and black curtains get hot in sunshine.
Petrol storage tankers are painted white or polished to reflect the suns IR heat waves.
A black kettle would radiate IR heat quicker than a shiny silver kettle and so would cool down faster. Car radiators are painted black to help them emit IR heat quickly.

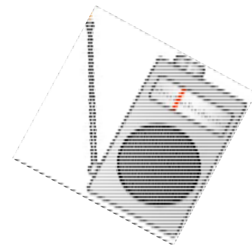
Properties of electromagnetic waves 2 (HT)

Radio waves





A radio wave is transmitted at the same frequency as the a.c. current which produced it.

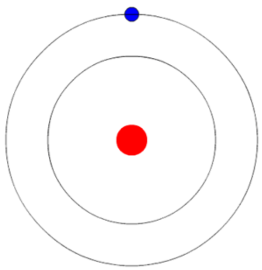


Radio signals are produced when an **alternating current** is passed through a wire in a radio transmitter. The **oscillating (vibrating) particles** in the wire produce a **radio wave** which is modulated and boosted so it can carry the signal over a great distance.

When this radio signal reaches another antenna (e.g. aerial on a radio) the **radio waves cause oscillations in the wire**. This produces an alternating current of the **same frequency as the radio signal.**

Properties of electromagnetic waves 2

Atoms and electromagnetic waves



Input energy could be:
light, heat, electricity, X rays etc

Energy out will be a type of electromagnetic radiation i.e.
X ray, ultra violet, visible,
infra red, microwave or radio waves.

Changes within the nucleus of an atom can result in the emission of gamma waves. This occurs during the radioactive decay of some unstable atoms.

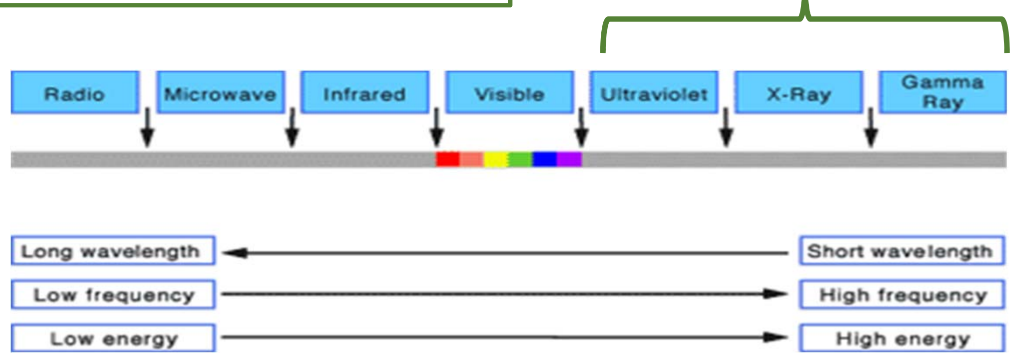
Atoms can receive energy from external sources.
This energy can cause electrons to “jump” to a **higher energy level**.
When the electron falls back to its original energy level it will release the stored energy in the form of a **photon of electromagnetic radiation.**

Properties of electromagnetic waves 2

Health risks of high energy electromagnetic radiations

High frequency radiations have **high energy**. They can have a **hazardous** effect on **human tissue**.

UV, X ray and gamma waves are high energy radiations.



The hazard from high energy radiations also depends on the **dose**.
Radiation dose is a measure of the risk when exposed to these radiations.
Radiation dose is **measured in Sieverts**.
Ultra violet waves can cause sunburn, ageing of the skin and skin cancer.
X rays and gamma rays are ionising radiations that can cause mutations of genes which could result in cancer.

Uses and applications of electromagnetic waves 2

	Type	Application	Suitability (HT)
Low frequency low wavelength	Radio	Television and radio	Travel through atmosphere for long distances
	Microwave	Satellite communications. Cooking food	Travel through atmosphere; agitates water molecules causing them to heat food
	Infrared	Electrical heaters, cooking food, infrared cameras	Heat energy transfer; detection of heat waves
	Visible	Fibre optic communications	Retina can detect light waves; light can travel through optic fibres and carry information
	Ultraviolet	Energy efficient lamps, sun tanning	Some materials can absorb UV and re-emit as visible, energy efficient, skin reacts to UV light causing tanning
	X-rays	Medical imaging and treatment	Pass through soft tissue, penetrate materials to different extents so can produce image
High frequency short wavelength	Gamma rays	Medical imaging and treatment	Kill tissue ; tracers can produce images of internal organs.

Recall it …

Magnetism

Use the information in the following page(s) to answer these questions …

1. Sketch the magnetic field pattern around a wire? What is the right hand grip rule? What can be changed to increase/decrease the magnetic field around a wire?
2. Describe what is a solenoid? Describe the factors that make a solenoid stronger? What is an electromagnet?
3. What is the motor effect?
4. What is Flemings left hand rule?
5. How can Fleming left hand rule be used to determine the direction of the force of a motor?
6. How do you calculate the force on a conductor?
7. Describe what is an electric motor and explain how it works?
8. What is a loud speaker? Explain how it works?
9. Explain how headphones work?

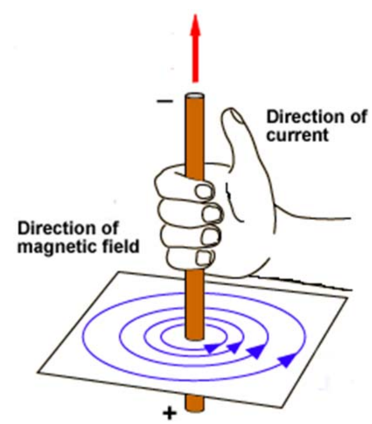
Electromagnetism

When a current flows through a conducting wire a magnetic field is produced around the wire.

The strength of the magnetic field depends on the current through the wire and the distance from the wire.

Increasing the current through the wire increases the strength of the magnetic field.

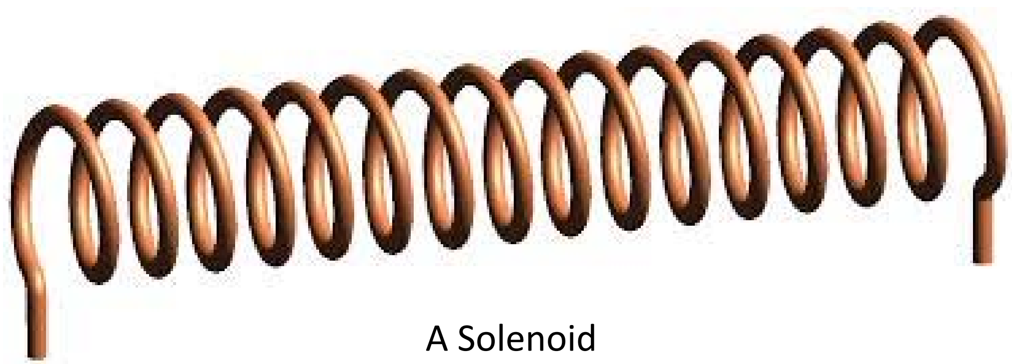
Increasing the distance from the wire decreases the strength of the magnetic field.



Solenoids

A solenoid is a **coil of wire** used to produce a **magnetic field**.

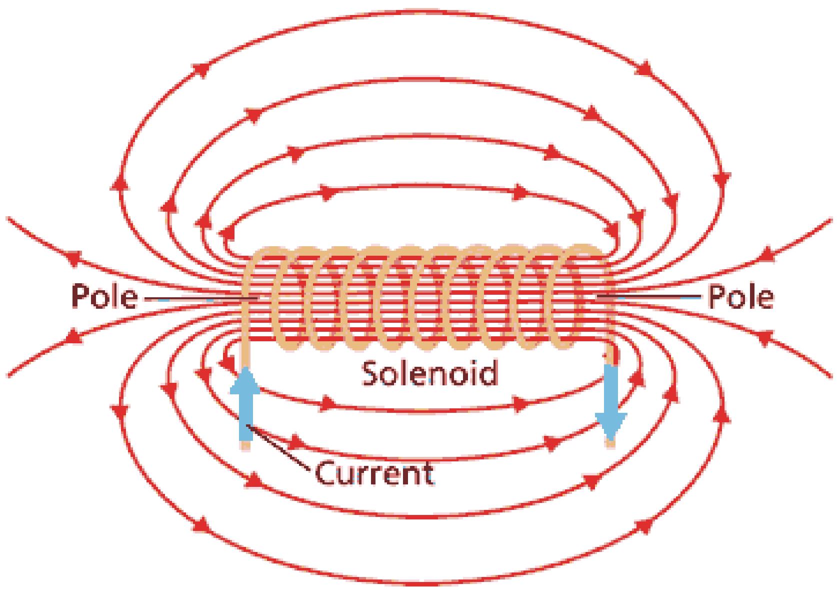
Shaping a wire to make a solenoid **increases the strength** of the magnetic field created by the current through the wire.



A Solenoid

Solenoids… continued

The magnetic field of a solenoid has a **similar shape to that of a bar magnet** – though the magnetic field extends inside the solenoid and is **strong and uniform**.



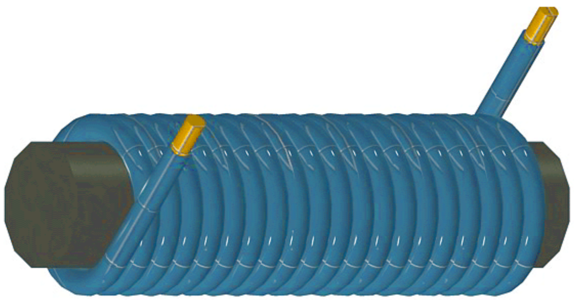
Making the Magnetic Field of a Solenoid Stronger

It is possible to increase the strength of a solenoid's magnetic field by…

1. Adding **an iron core** to a solenoid.

2. **Increasing the current** though the solenoid.

3. **Increasing the number of turns of wire** on the solenoid.

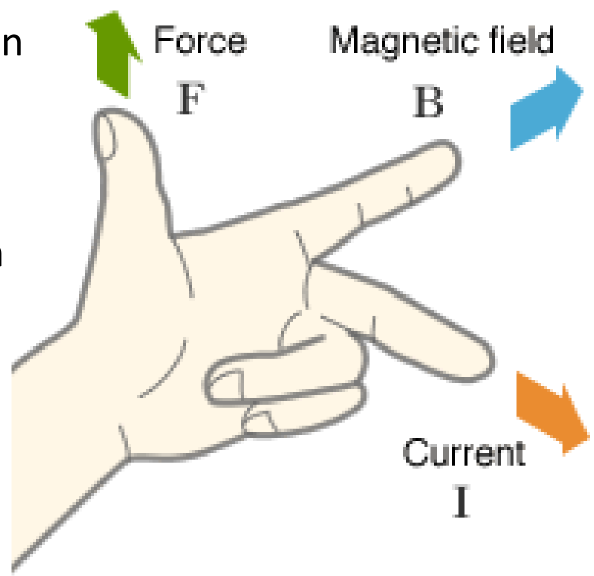


A **solenoid** with an **iron core** is an **electromagnet.**

Fleming's Left-Hand Rule

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 is called the **motor effect**.

The direction of the force can be found if the direction of the current flow and the direction of the magnetic field are known.



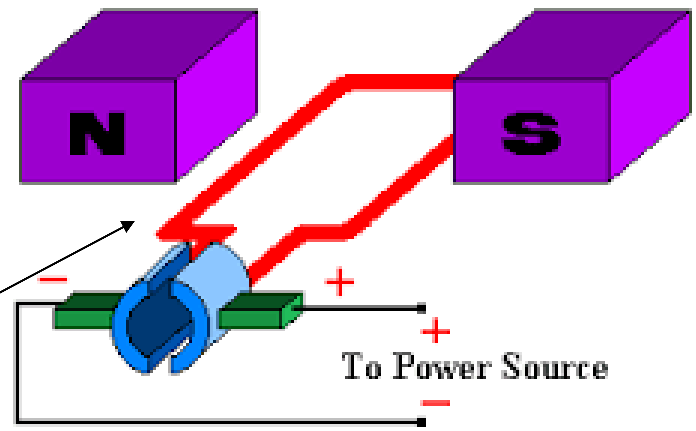
In the diagram the thumb, first finger and second finger are held at right angles to each other.

First Finger	– Field (magnetic N to S)
Second Finger	– Direction of current flow
Thumb	– Direction of Force (motion)

Motors

Example:

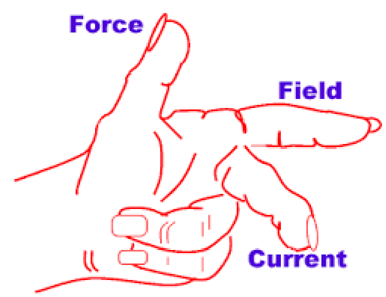
Determine the direction that the motor will spin using Fleming's Left-Hand Rule.



Solution:

Looking at the wire **next to the North seeking pole** of the magnet…

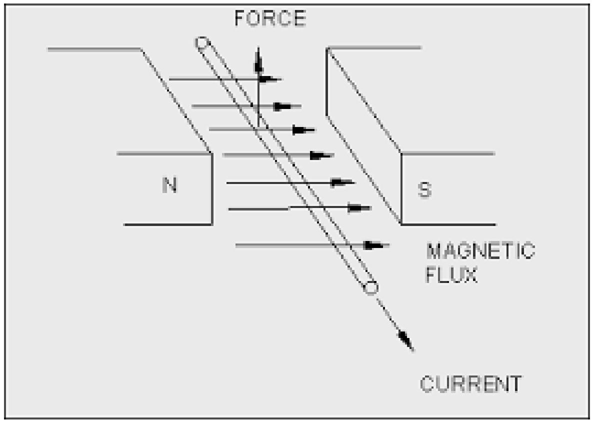
- **Magnetic field** (first finger) is pointing to the **right** (North to south).
- **Current flow** (second finger) is pointing **towards you**.
- (Remember, conventional flow is + to -)
- **Force/Motion** of the wire will be **upwards** (so the motor will spin clockwise.



Force on a Conductor

The factors that affect the force on a conductor are:

- **Magnetic Flux Density (B) in tesla**
- **Current (I) in amperes**
- **Length of Conductor (l) in metres**



These quantities are linked by the equation:

Force (N) = Magnetic flux density (T) x Current (A) x Length (m)

$$F = BIl$$

Force on a Conductor… continued

Example:

A 6 cm wire placed in a magnetic field carries a current of 50 mA.

Work out the force on the current carrying wire if the magnetic field strength of the magnetic field is 0.25 T.

Solution:
First step is convert the units: 6 cm = 0.06 m and 50 mA = 0.05 A

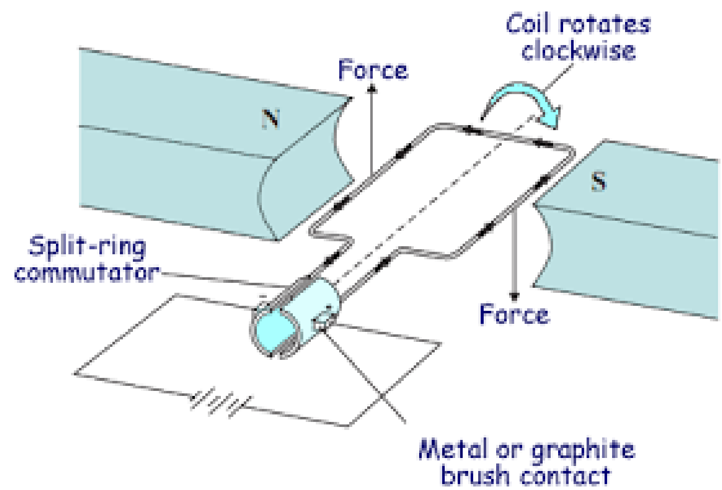
Then:

$$\boldsymbol{F = BI\ell}$$
$$F = 0.25 \times 0.05 \times 0.06$$
$$F = 7.5 \times 10^{-4}\ N$$

Electric Motors

A **coil of wire carrying a current in a magnetic field** tends to **rotate**. This is the basis of an **electric motor**.

As the coil of wire carrying a current is in a magnetic field, the coil will experience a **force** (the direction of which can be found from **Fleming's left-hand rule**).
The coil of wire shown will experience an **upwards force on the left-hand side** of the coil and a **downwards force on the right-hand side of the coil**.
As the coil will be **fixed** to an axle the coil of wire will **rotate in a clockwise direction**.

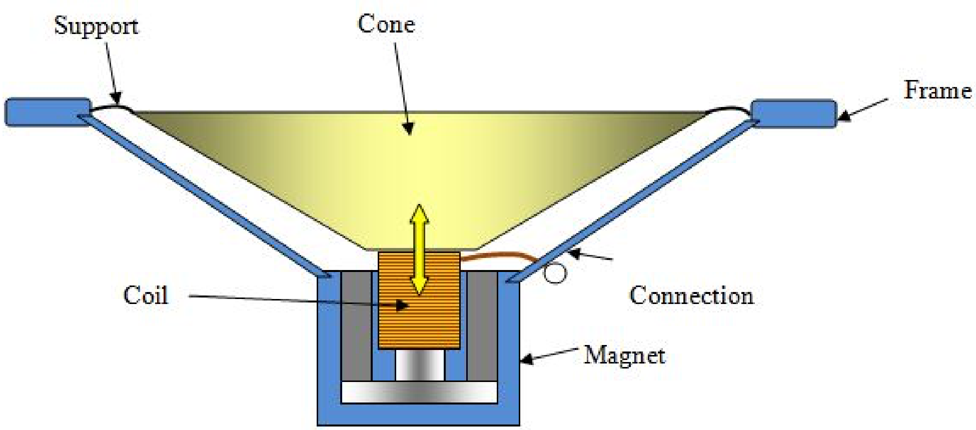


Loudspeakers

Loudspeakers and headphones use the **motor effect** to convert **variations in current** in electrical circuits to the **pressure variations in sound waves**.

Modern loudspeakers can be wired or wireless.

Loudspeakers… continued



- A **fluctuating electric current** flows through the **coil of wire**. The coil of wire then becomes an **electromagnet of variable strength**.
- The **electromagnet is then attracted or repelled** away from the **permanent magnet**.
- This **causes the cone to move** – producing a sound.

Headphones

Headphones are **miniature loudspeakers**. As the headphones only have to move the air inside the ear canal they can be a lot smaller than typical loudspeakers.