Physics Paper 2 (F) Knowledge Recall Booklet

Paper Physics 2F   8464/P/2F

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
- 6.5.4.3   Forces and braking
- 6.6.2   Electromagnetic waves
- 6.7.1   Permanent and induced magnetism, magnetic forces and fields
- 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?
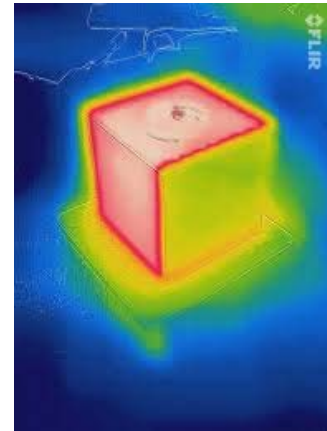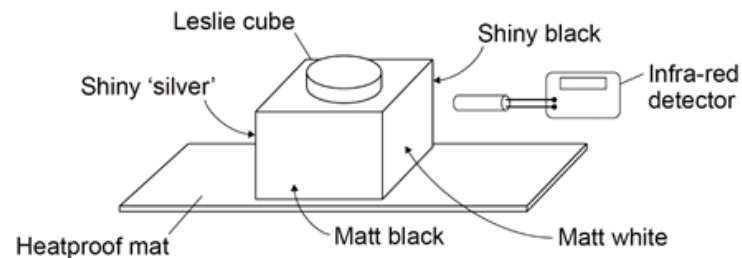
Recall it ...

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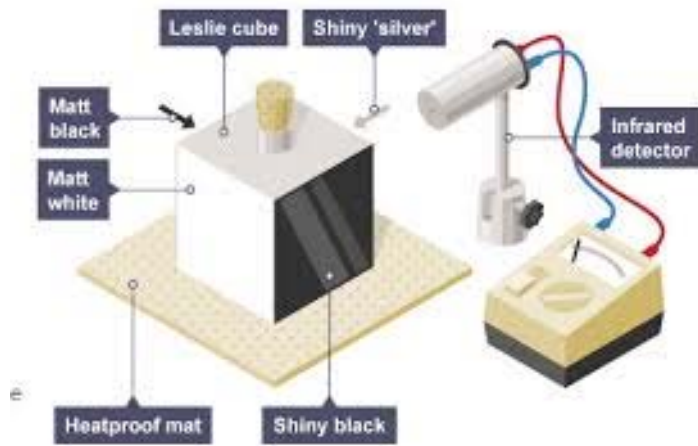
1. Place the Leslie cube on to a heat proof mat.

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.

best emitter ➡ worst emitter

Matt black surfaces are the best emitters of radiation.

Shiny surfaces are the worst emitters of radiation.

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.

214N

150N

100N

Figure 2
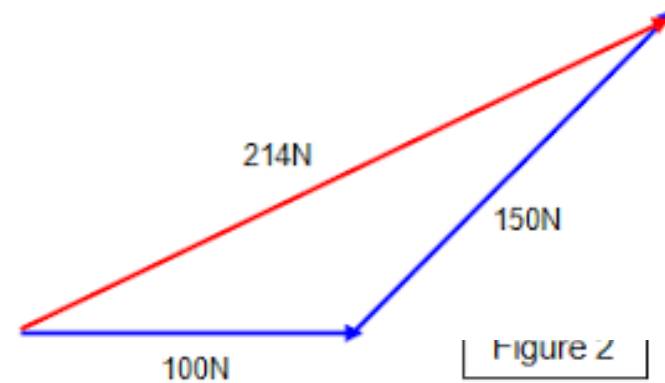
Contact and Non-contact Forces

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.

Pin

Thin, irregular sheet of material

90°

The centre of mass is where the lines cross
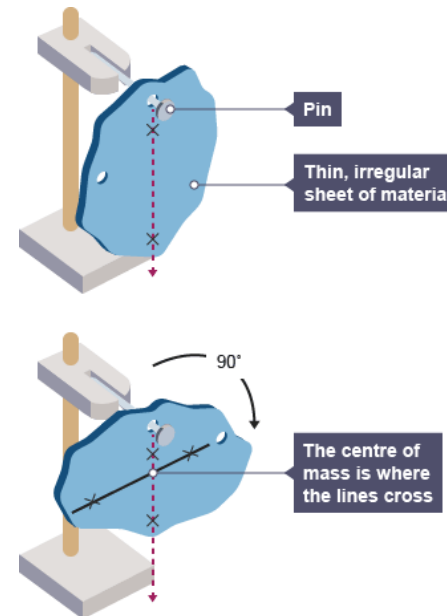
Recall it ...

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. What is the difference between distance and displacement? Which is a scalar quantity and which is vector? Why?
4. What is the difference between speed and velocity? Which is scalar and which is vector? Why?
5. How can the speed, distance, time formula can be re-arranged to make speed, distance and time the subject?
6. How fast is the speed of sound in air?
7. What is the difference between average speed and instantaneous speed?
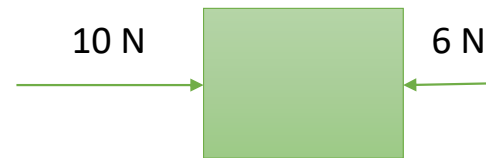
Resultant Forces

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.

10 N   6 N

10 N   6 N
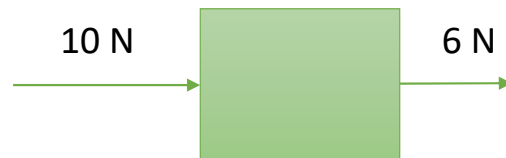
R = 16 N to the right

R = 4 N to the right

Calculating Resultant Force

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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.
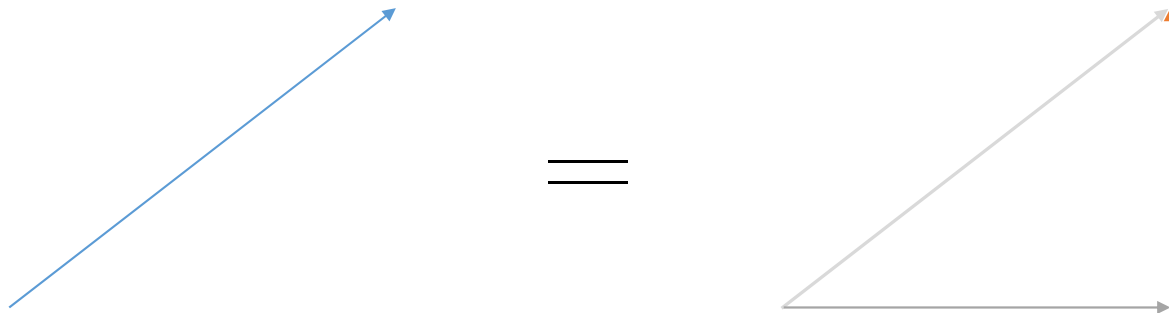
Addition of the forces gives:

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

</div>

120 N →   [box]   ← 30 N
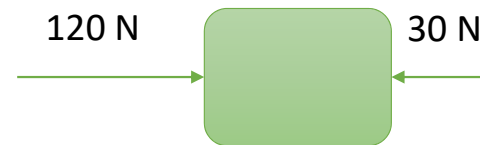
Calculating Resultant Force... continued

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.
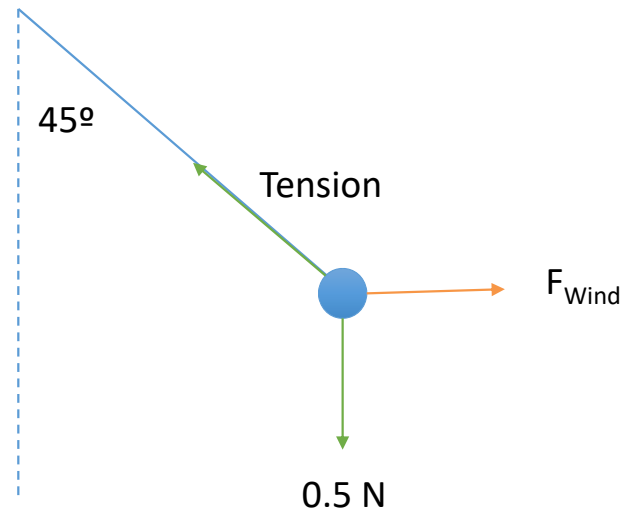
Example

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

45º

Tension

F_{Wind}

0.5 N

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:

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

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:

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

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.**

average speed = total distance travelled
                        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

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?
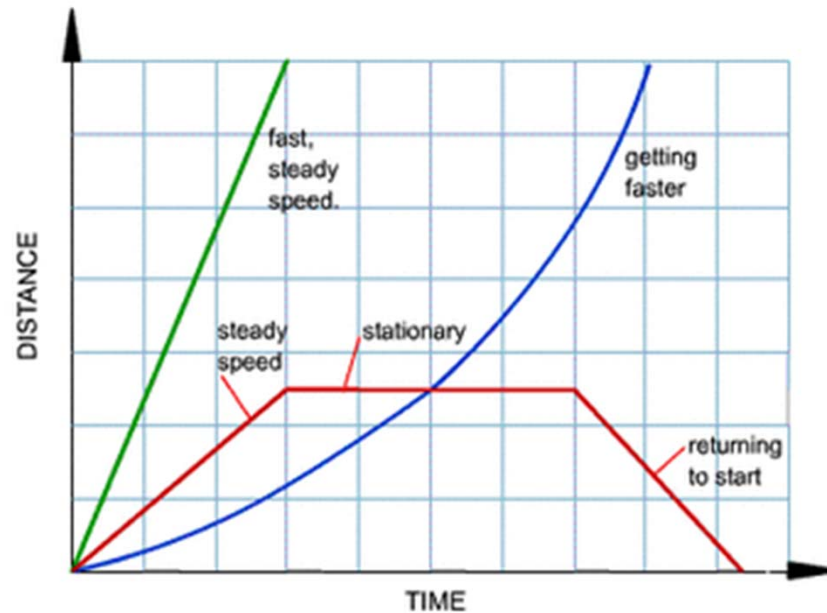
Distance-Time Graphs

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
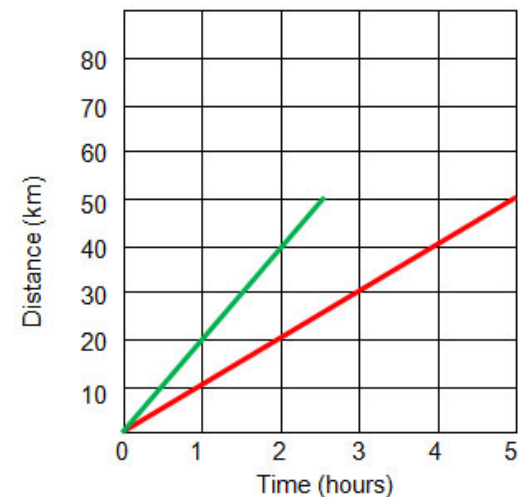
Acceleration

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:

Acceleration (m/s²) = change in velocity (m/s)
Time taken (s)

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

An acceleration of 3 m/s² 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) <u>or</u> 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.
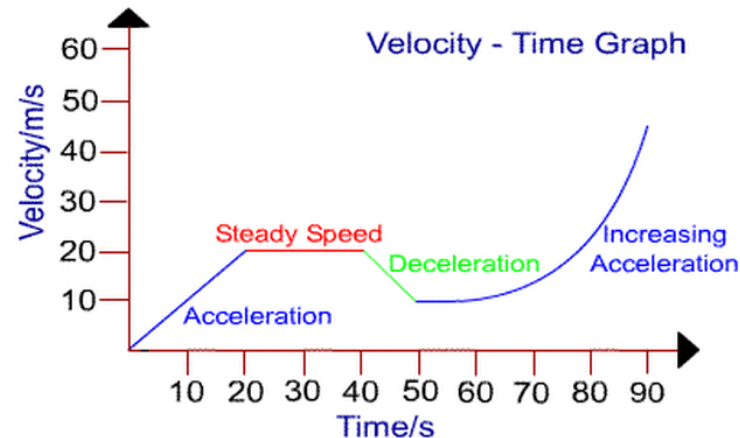
Velocity-Time Graph Calculations

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 <u>gradient</u> of the line on the velocity-time graph.**

The distance travelled: **The <u>area under the line</u> on a velocity-time graph is the distance travelled.**
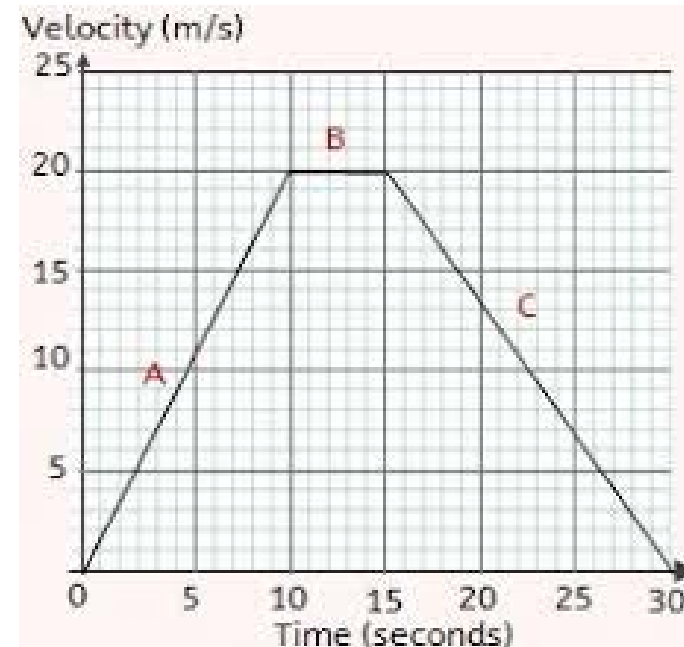
Interpreting Velocity-Time Graphs

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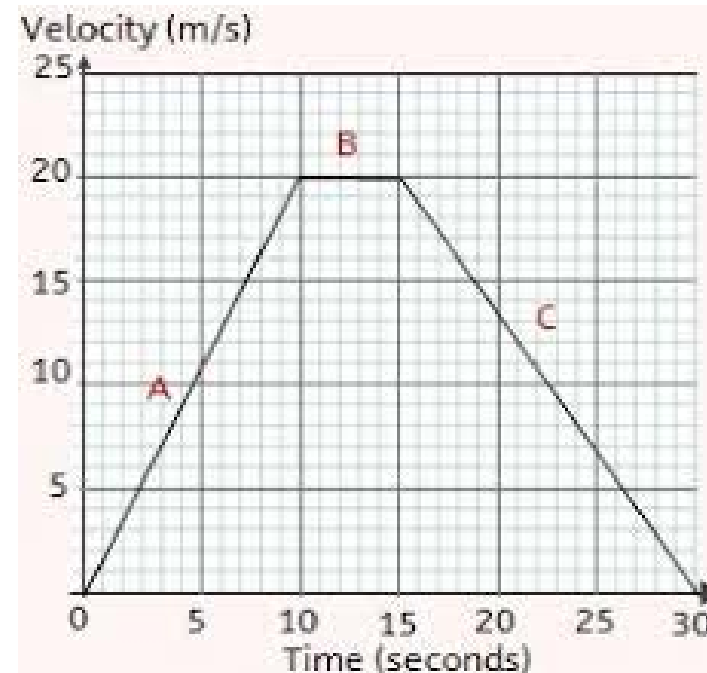
Solution:

From 0 to 10 s: Constant rate of acceleration of 2 m/s².
From 10 to 15 s: Constant speed of 20 m/s.
From 15 to 30 s: Constant rate of deceleration of 1.33 m/s².
**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.
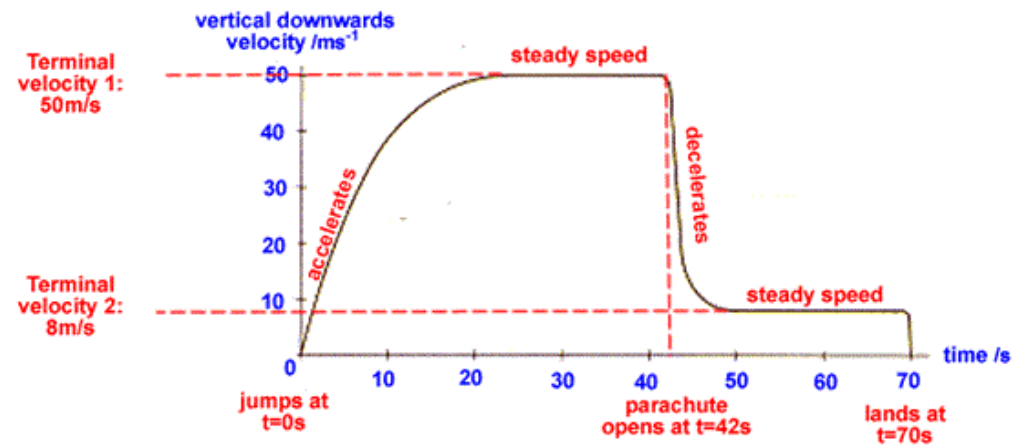
Forces acting on a Skydiver

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.

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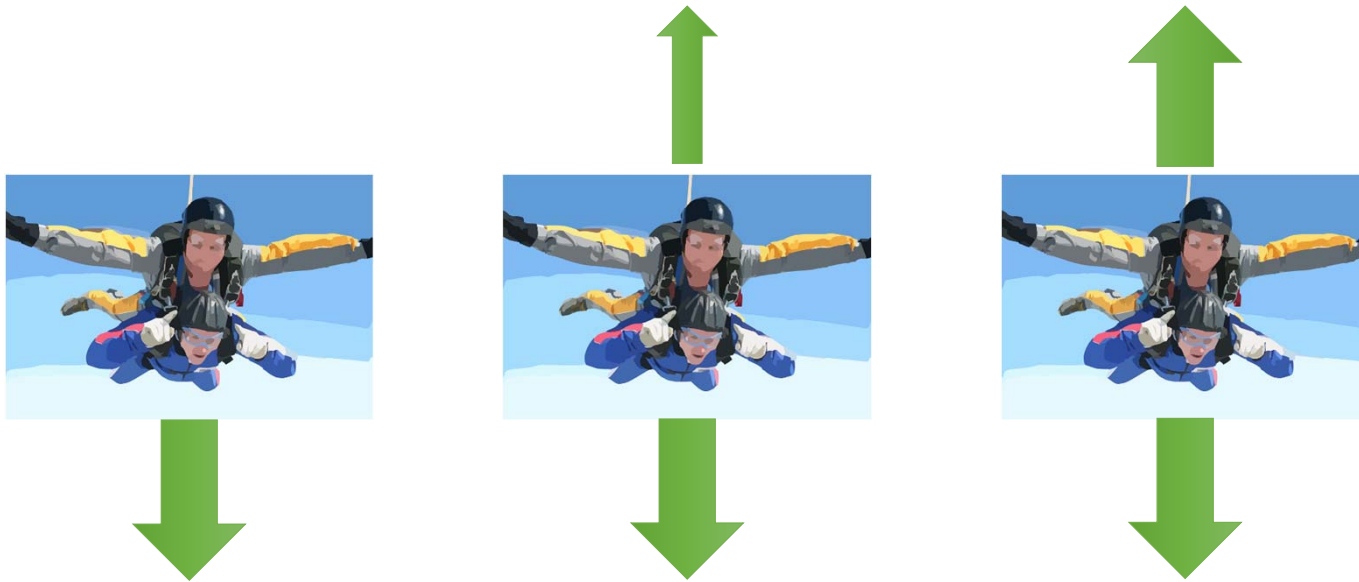
As the skydiver falls faster the amount of drag experienced increases, reducing the skydiver's acceleration, until weight and drag are equal in size. At this point the skydiver will be falling with terminal velocity.

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

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

Newton's Laws

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?

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).

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:

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

$$\text{acceleration} = 7.1 \text{ m/s}^2$$

Substituting gives

$$F = m\,a$$

$$4800 = m \times 7.1$$

$$m = 672 \text{ kg allow 676 kg if acceleration was rounded down}$$

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.

Stopping distances

Use the information in the following page(s) to answer these questions ...
1. What is thinking distance and braking distance?
2. What does the overall stopping distance depend upon?
3. How does speed affect stopping distance? How does speed affect thing distance and breaking distance? How does speed affect kinetic energy?
4. Name four factors that affect thinking distance / reaction time? How do they affect reaction time?
5. Describe how online tests and the ruler drop experiment can be used to measure reaction time?
6. Describe 6 factors that affect a drivers braking distance? How do they affect braking distance?
7. Describe what happens when the brakes are applied to a vehicle? What happens if they brake are applied at greater speeds?

Stopping Distance

Definitions

Thinking Distance: Thinking distance is the distance that you travel while reacting to a stimulus until you get your foot onto the brake pedal. Thinking distance depends on reaction time, but these are not the same thing.

Braking Distance: Braking distance is the distance you travel from pressing the brake pedal until you come to a stop.

Stopping Distance: Stopping distance is the sum of thinking distance and braking distance, usually shown as:

Stopping distance = Thinking distance + Braking distance

How Speed Affects Stopping Distance

Increasing the speed of a vehicle will increase its stopping distance.

The highway code shows the stopping distances for cars at various speeds...

	Braking distance
	Thinking distance

30mph 9m 14m 23m

40mph 12m 24m 36m

50mph 15m 38m 53m

60mph 18m 55m 73m

70mph 21m 75m 96m

Distance (metres)
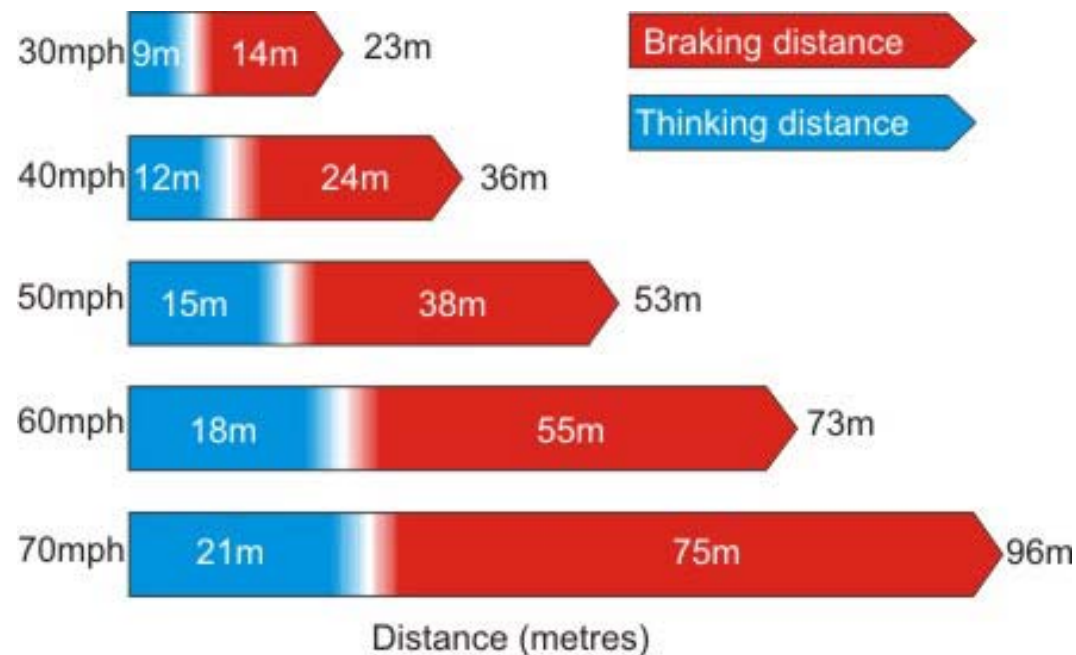
As you can see, when speed increases so does the overall stopping distance.

Also, it is both parts of the overall stopping distance – thinking and braking distance – that increases.

Speed and Thinking Distance

From the highway code it is possible to see patterns in the data.

When you double your speed your thinking distance will also double. This is shown by the thinking distance being 9 m at 30 mph and 18 m at 60 mph. The reason this happens is because your reaction time does not change but you will now travel further while you react:

If you take 0.5 seconds to react then at a speed of 10 m/s you would travel 5 m while reacting to a stimulus. If the speed doubled to 20 m/s then you would now travel 10 m while reacting to the stimulus – the thinking distance has doubled when the speed has doubled.

Speed and Braking Distance

Doubling your speed will more than double your braking distance**. In fact** doubling the speed **of a vehicle will cause the** braking distance to quadruple**.**

At 30 mph the braking distance is 14 m and at 60 mph the braking distance is 55 m (according to the highway code) which is approximately four times greater: The difference of 1 m is accounted for by rounding.

When the speed of a vehicle doubles the kinetic energy **of the vehicle is four times greater. This happens because kinetic energy is found using the equation:**

kinetic energy = ½ x mass x (velocity)^2

As there is four times the kinetic energy it takes four times longer to stop at a given braking force**.**

Reaction Time

A typical person's reaction time varies from 0.2 to 0.9 seconds.

There are a number of factors that will affect your reaction time, and in turn thinking distance.

These factors include:

Factor	Affect on Reaction Time
Alcohol	Increases
Caffeine	Decreases
Tiredness	Increases
Distractions	Increases

Drugs can either increase or decrease reaction times as some drugs are stimulants and some are depressants.

Measuring Reaction Time

A person's reaction time is very short. Trying to measure this reaction time is going to be difficult but there are ways of measuring it.

1. **There are online tests that display a stimulus and measures the time taken to respond to the stimulus – often by clicking a mouse button.**

2. **Ruler drop. This is where a ruler is dropped through your hand. As soon as you see the ruler move you close your hand. The distance that the ruler moves through your hand corresponds to a given reaction time - these can be found online at:**

   http://www.topendsports.com/testing/tests/reaction-stick.htm

Factors Affecting Braking Distance

There are a number of factors that affect the braking distance of a vehicle. Some of these are shown in the table below:

Factor Affecting Braking Distance	How this factor affects braking distance
Speed	Increasing speed increases braking distance
Weight of Vehicle	Increasing weight of vehicle increases braking distance
Icy Roads	Braking distance increases due to reduced friction between tyre and road
Wet Roads	Braking distance increases due to reduced friction between tyre and road
Poor Brake Condition	Braking distance increases
Bald Tyres	Braking distance increases when wet.

Braking Force

When a force is applied to the brakes of a vehicle, work done by the frictional forces between the brake pads and the brake disc reduces the kinetic energy of the vehicle and the temperature of the brakes increases.

The greater the speed of a vehicle the greater the braking force needed to stop the vehicle in a certain distance.

The greater the braking force the greater the deceleration of the vehicle. Large decelerations may lead to brakes overheating and/or loss of control.

Electromagnetic Waves

Recall it …

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. How does light behave when it enters a substance with high density?
6. How does light behave when it enters a substance with low density?
7. What happens when waves hit the nucleus of atoms?
8. What does the hazard of high energy radiation depend upon? What are the units of dose?
9. What are the risks of UV waves?
10. What are the risks of X-rays and gamma waves?
11. Give uses of each electromagnetic wave?

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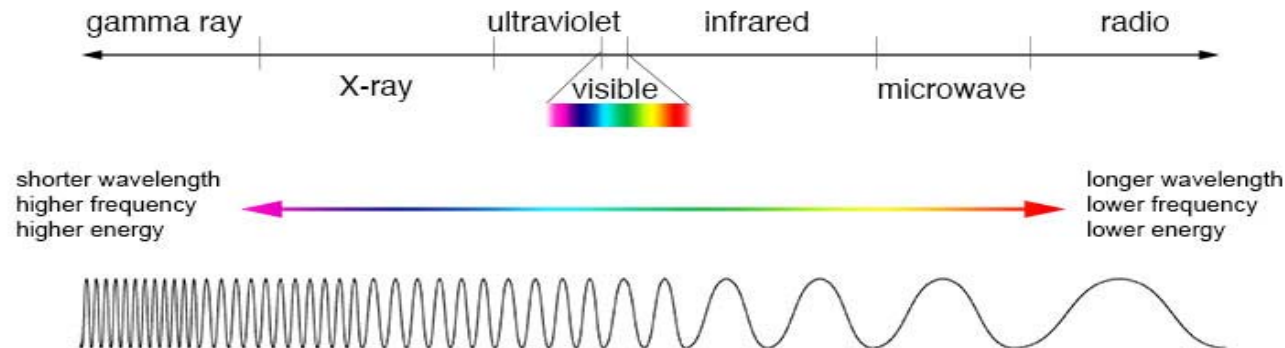
Our eyes are only able to detect a small range of these waves shown as the visible range above. Some animals can see in ultra violet and some can detect infra red.

Types of electromagnetic waves

Examples of transfer of energy by electromagnetic waves

Heater

Infra red waves
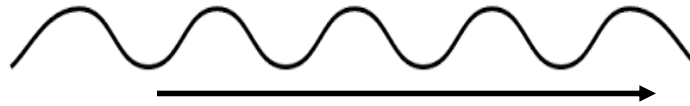
Detected by heat sensors in the hand

Torch

Visible light waves
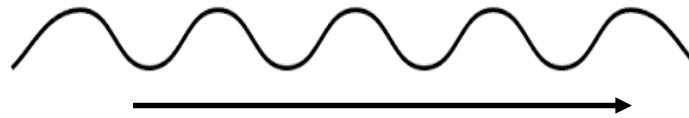
Detected by cells in the retina

Radio transmitter

Radio waves
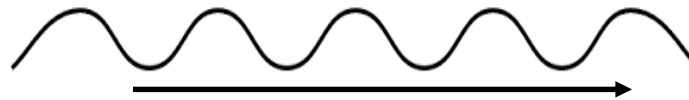
Detected by the aerial in the radio

Properties of electromagnetic waves 1

Refraction of waves at a boundary– ray diagrams
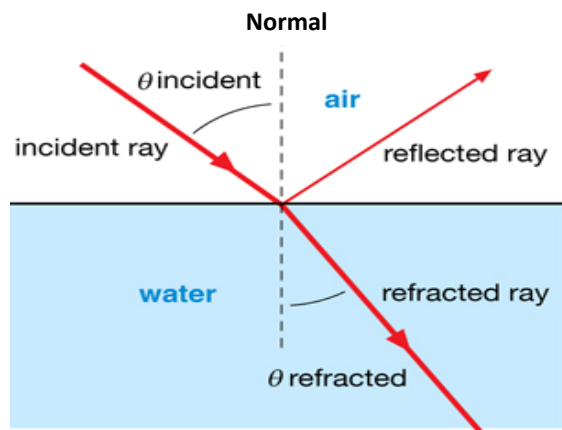
When light strikes a transparent material, some of the light may be reflected but some will also be **refracted**.

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 2

Atoms and electromagnetic waves
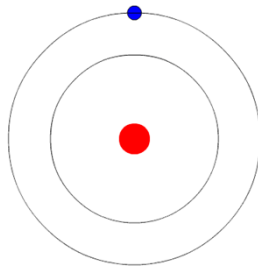
Input energy could be:
light, heat, electricity, X rays etc

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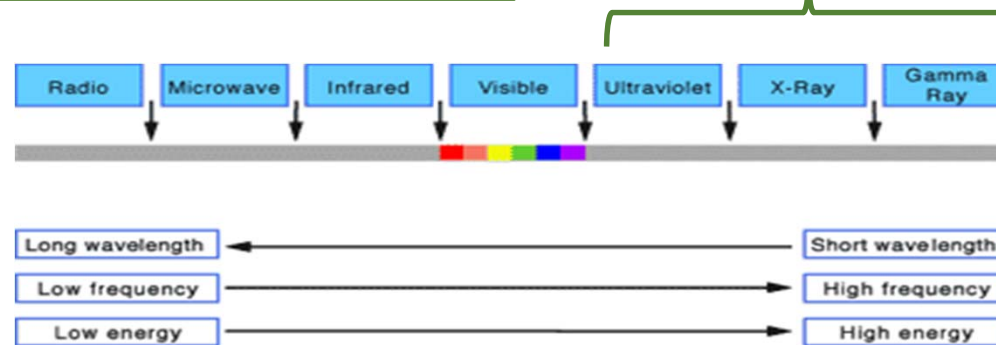
The hazard from high energy radiations also depends on the **dose**.
Radiation dose is a measure of the risk when exposed to these radiations.
Radiation dose is **measured in Sieverts**.
Ultra violet waves can cause sunburn, ageing of the skin and skin cancer.
X rays and gamma rays are ionising radiations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

Uses and applications of electromagnetic waves 2

	Type	Application
Low frequency low wavelength	Radio	Television and radio
	Microwave	Satellite communications. Cooking food
	Infrared	Electrical heaters, cooking food, infrared cameras
	Visible	Fibre optic communications
	Ultraviolet	Energy efficient lamps, sun tanning
	X-rays	Medical imaging and treatment
High frequency short wavelength	Gamma rays	Medical imaging and treatment

Magnetism

Use the information in the following page(s) to answer these questions ...
1. What are the poles of a magnet? What is the difference between a permanent and induced magnet?
2. What are the rules for attraction and repulsion?
3. Name the four magnetic materials?
4. Sketch a field pattern around a magnet? Describe the direction of the magnetic field and arrows?
5. Describe how to draw the magnetic field pattern around a magnet?
6. How do compasses work? Why is the earth magnetic?
7. 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?
8. Describe what is a solenoid? Describe the factors that make a solenoid stronger? What is an electromagnet?

Poles of a Magnet

Object	Definition
Poles	Places where the magnetic forces are strongest.
Permanent Magnets	Produce their own magnetic fields. Permanent magnets can attract and repel.
Induced Magnets	Material that becomes magnetic when placed in a magnetic field. Induced magnets can only attract. When the magnetic field is removed an induced magnet will lose most/all of its magnetism quickly.

When two magnets are brought together they exert a force on each other. Two like poles repel each other, two unlike poles attract each other.

Attraction and repulsion are examples of non-contact force.

Magnetic Forces

When two poles of two magnets are placed near each other they can either attract or repel each other. The combination of north and south poles determines whether they attract or repel.
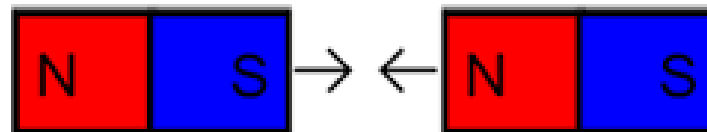

Opposite poles **attract**
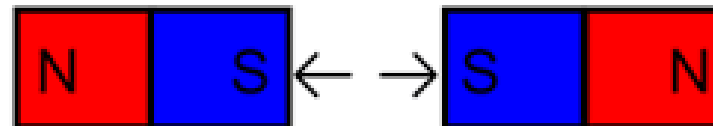
Same poles **repel**

Magnetic Fields

There are four main magnetic materials that you need to know: **iron**, **steel** (because it is made from iron), **nickel** and **cobalt**. There is always a force of **attraction** between magnets and magnetic materials.

Magnetic field = The region around a magnet where a force acts on another magnet (or magnetic material).

The **strength** of a magnetic field depends on the **distance from the magnet**. The field is **strongest at the poles**.
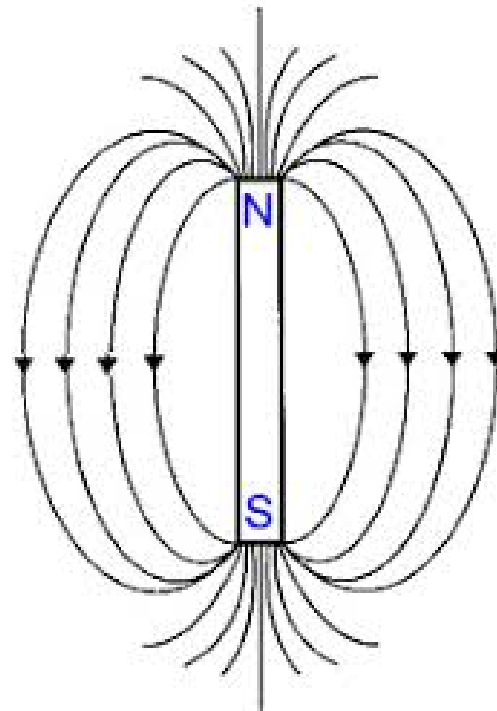
Direction of a Magnetic Field

The direction of the magnetic field at any point is given by the direction of the force that would act on another north pole placed at that point.

The direction of a magnetic field line is always from north (seeking) pole to south (seeking) pole.
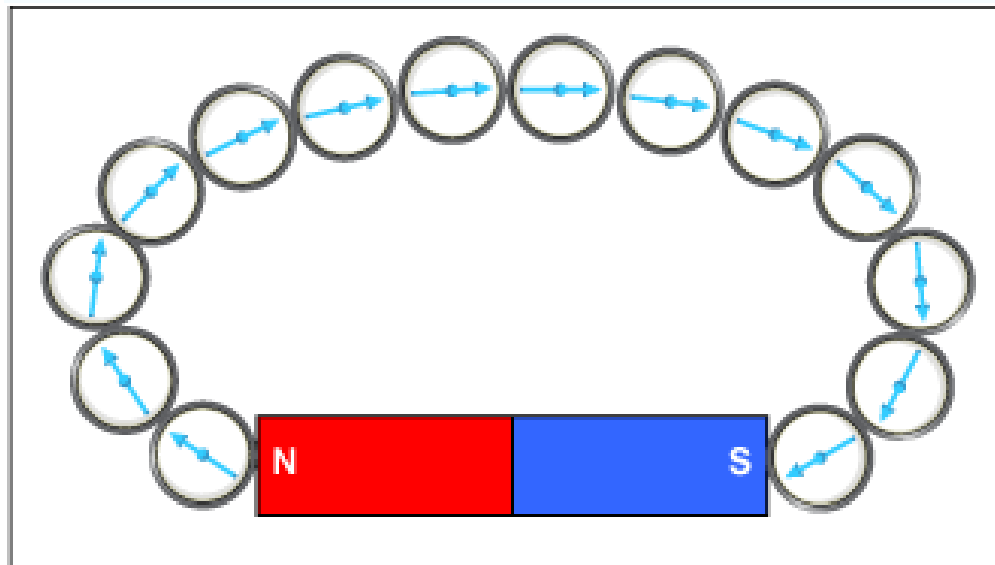
Magnetic Field Shapes

To find the direction of the magnetic field of a bar magnet there are two main techniques.

1. Place the bar magnet under a piece of paper and sprinkle **iron filings** over the paper. Tapping the paper will produce the magnetic field pattern of the bar magnet.
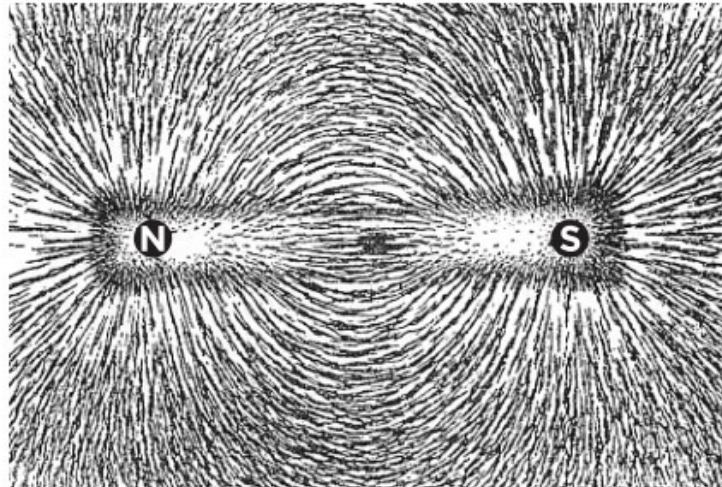
Magnetic Field Shapes...continued

2. Placing a **magnetic compass** (which contains a small bar magnet) in the magnetic field of a bar magnet causes the compass needle to point in the direction of the magnetic field.

Earth's Magnetic Field

A **magnetic compass** contains a small **bar magnet**. The Earth has a magnetic field. The compass points in the **direction of the Earth's magnetic field**.

The magnetic field pattern produced by compass needles leads us to conclude that the **Earth's core is magnetic**. The origin of the Earth's magnetic field is thought to be the movement of **molten iron** in the core.
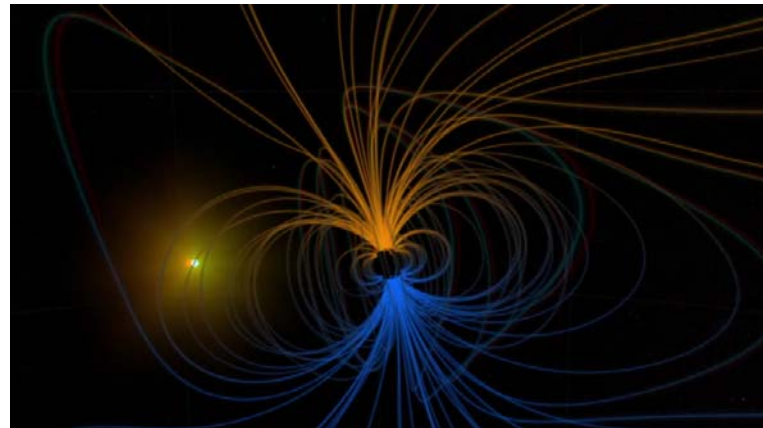
Electromagnetism

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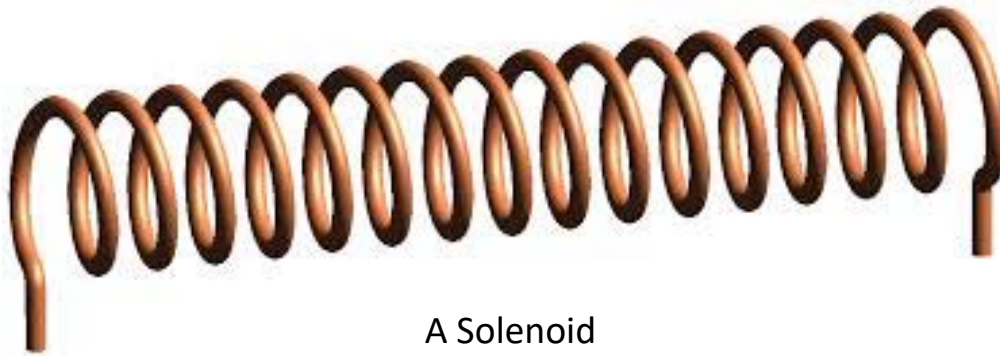
Increasing the distance from the wire decreases the strength of the magnetic field.
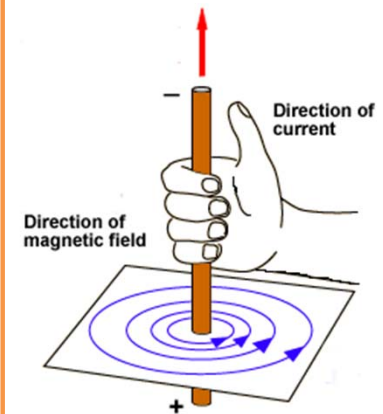
Solenoids

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.
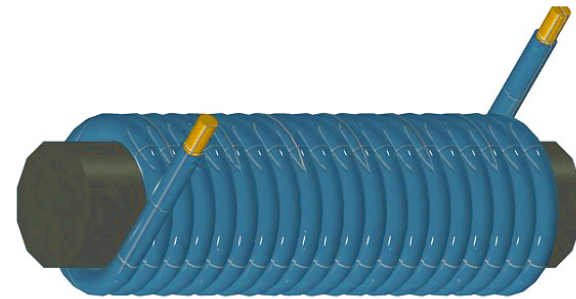

A Solenoid

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**.
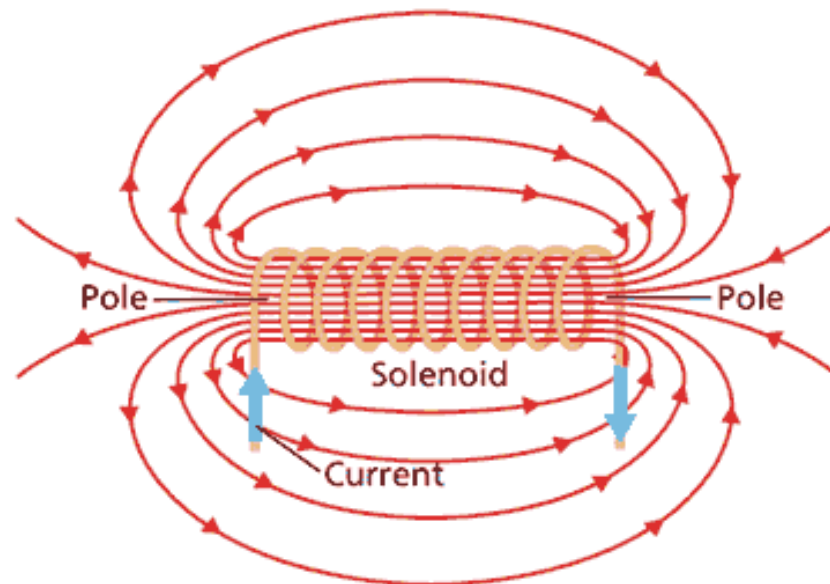
Making the Magnetic Field of a Solenoid Stronger

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.**