EDEXCEL
GCSE Separate
Physics
Paper 2
Outcomes Revision

Outcomes	Physics key concepts
Ph1 *Recall and use the SI unit for physical quantities, as listed in the specification*	The SI units defined in the specification are:

Distance Metre (m)	Mass Kilogram (kg)	Time Second (s)
Current Ampere (A)	Temperature Kelvin (K)	Amount of a substance Mole (mol)
Frequency Hertz (Hz)	Force Newton (N)	Energy Joule (J)
Power Watt (W)	Pressure Pascal (Pa)	Electric charge Coulomb (C)
Electric potential difference Volt (V)	Electric resistance Ohm (Ω)	Magnetic flux density Tesla (T)

Ph2 *Recall and use multiples and sub-multiples of units, including giga (G), mega (M), kilo (k), centi (c), milli (m), micro (μ) and nano (n)*	Some numbers are very large or very small, to make these easier to handle we use prefixes. Prefixes tell you how much bigger or smaller a unit is than the base unit. For example, 1 kg is 1000 times bigger than a gram and 1 mm is 1000 times smaller than a metre. These numbers are called the conversion factors. So, to convert 4.5 kg into grams you do the following: 4.5 x 1000 = 4500 g. To convert 45 mm in meters: 45 x 0.001 = 0.045 m. (N.B. 45 x 0.001 is the same as 4.5 ÷ 1000). A table of common prefixes and their conversion factors is here:

Tera (T)	Giga (G)	Mega (M)	Kilo (k)	Milli (m)	Micro (μ)	Nano (n)
10^{12}	**10^{9}**	**10^{6}**	**1000**	**0.001**	**10^{-6}**	**10^{-9}**

In a question you might get given a value such as 5.6 GHz, the first thing you need to do is convert this to Hz (not GHz) 5.6 GHz = 5.6 x 10^{9} Hz. (5.6 x 1,000,000,000)
Or 2.3 μA, to convert this: 2.3 μA = 2.3 x 10^{-6} A. (2.3 x 0.000,001 or 2.3 ÷ 1,000,000)

Ph2a *Be able to convert between different units, including hours to seconds*	You may get given time in minutes, or even in hours, but we need time in seconds if we are using it in an equation. This is easy to convert as there are 60 seconds in a minute and 60 minutes in an hour. Convert 5 minutes into seconds: 5 x 60 = 300 s Convert 2 hours into seconds: 2 x 60 x 60 = 7200 s
Ph3 *Calculate mean averages, giving answer to appropriare number of significant figures*	To calculate a mean average, you must first find the sum of the individual values (add them all up and press equals). You then divide the sum by the number of values (often 3 or 5 for investigations). Find the average of 25, 28 and 25. 25 + 28 + 25 = 78 78 ÷ 3 = 26 Sometimes the average will not be a whole number, when presenting you average value you should never give your answer to more significant figures than were given in the original data. (See Ph4 for more information on significant figures.) Find the average of 5.6, 6.2 and 5.5 5.6 + 6.2 + 5.5 = 17.3 17.3 ÷ 3 = 5.766666, however the original data is only 2 significant figures so 5.8 should be written on the answer line.

Outcomes	Physics key concepts
Ph3a *Calculate mean averages, identifying and handling anomolus results*	To calculate a mean average, you must first find the sum of the individual values (add them all up and press equals). You then divide the sum by the number of values (often 3 or 5 for investigations). Find the average of 25, 28 and 25. 25 + 28 + 25 = 78 78 ÷ 3 = 26 Sometimes there is a result that clearly does not fit the pattern, this is called an anomaly, is usually due to an error. When calculating the average, we ignore this value and calculate the average of the remaining values. Find the average of 4.5, 8.2, 4.3 and 5 8.2 is clearly an anomaly so we ignore it: 4.5 + 4.3 + 5 = 13.8 13.8 ÷ 3 = 4.6
Ph4 *Use significant figures where appropriate*	The first significant figure (s.f.) of a number is the first digit that is not a zero. The second and third significant figures come straight after the first (even if they are zeros). *Remember that:* *If the number you are rounding is followed by 5, 6, 7, 8, or 9, round the number up. Example: 38 rounded to the nearest ten is 40* *If the number you are rounding is followed by 0, 1, 2, 3, or 4, round the number off. Example: 33 rounded to the nearest ten is 30* Examples: Round 0.005642 to 2 s.f. = **0.0056** Round 56.42 to 2 s.f. = **56** Round 5642 to 2 s.f. = **5600** Round 7.685 to 2 s.f. = **7.7** *N.B. it is good practice to give your final answer to the lowest number of significant figures given in a question.*
Ph4a *Use decimal places where appropriate*	Sometimes you will get asked to give an answer to a certain number of decimal places (d.p.) - these are the digits that come after a decimal place. *Remember that:* *If the number you are rounding is followed by 5, 6, 7, 8, or 9, round the number up. Example: 38 rounded to the nearest ten is 40* *If the number you are rounding is followed by 0, 1, 2, 3, or 4, round the number off. Example: 33 rounded to the nearest ten is 30* Examples: Round 0.005642 to 2 d.p. = **0.01** Round 5.642 to 2 d.p. = **5.6** Round 5642 to 2 d.p. = **5642.00** Round 7.685 to 2 d.p. = **7.69**

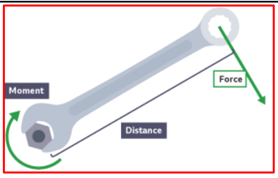
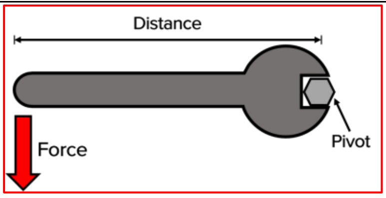
<table>
<tr><th>Outcomes</th><th>Physics key concepts</th></tr>
<tr><td>Ph4b
Use standard form where appropriate</td><td>Standard form, or standard index form, is a system of writing numbers which can be particularly useful for working with very large or very small numbers. It is based on using powers of 10 to express how big or small a number is.
Standard form uses the fact that the decimal place value system is based on powers of 10:
<table>
<tr><td>For larger numbers we use a positive power of 10</td><td>For smaller numbers we use a negative power of 10</td></tr>
<tr><td>$10^2 = 100$
$10^3 = 1000$
$10^4 = 10000$
$10^5 = 100000$
$10^6 = 1000000$</td><td>$10^{-2} = 0.01$
$10^{-3} = 0.001$
$10^{-4} = 0.0001$
$10^{-5} = 0.00001$
$10^{-6} = 0.000001$</td></tr>
<tr><td>Example
Write 50,000 in standard form.
50,000 can be written as: $5 \times 10,000$
$10,000 = 10 \times 10 \times 10 \times 10 = 10^4$
So: $50,000 = 5 \times 10^4$</td><td>Example
Write 0.0005 in standard form.
0.0005 can be written as 5×0.0001.
$0.0001 = 10^{-4}$
So $0.0005 = 5 \times 10^{-4}$</td></tr>
<tr><td>To input this into your calculator, press:

</td><td>To input this into your calculator, press:

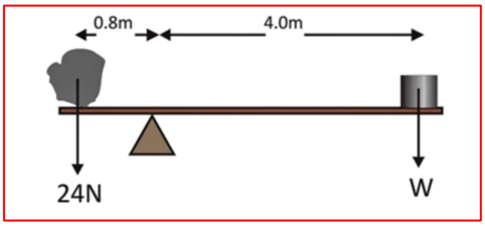
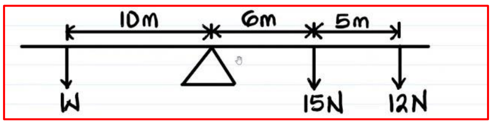
</td></tr>
</table></td></tr>
<tr><td>Ph5
Devise an investigation</td><td>You may be asked to describe how to carry out an investigation similar to one of the core practical tasks.
You should think about:

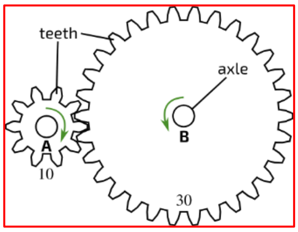
The measurements you need to make
The equipment you will use to make these measurements
How the equipment should be used
Any health and safety to consider?
Describe any equations that would be used to complete the investigation
Would you take repeats and find an average?
What range of results you would collect
</td></tr>
<tr><td>Ph5a
Can write, or comment on, a conclusion</td><td>In a conclusion you should say what your results show, and how this relates to any prediction given in the question.
e.g. As mass increased so did weight
In a conclusion we try to us evidence from our results to support our answer.
e.g. When mass was 3 kg, weight was 30 N and when mass 6 kg, weight was 60 N. When mass doubled so did weight.
For better marks we try to explain why we got those results
e.g. Mass and weight are linked by the equation ‘W = m x g’ so if the value of g does not change then mass and weight are directly proportional.
See Ph8a for more information on directly proportional relationships.</td></tr>
</table>

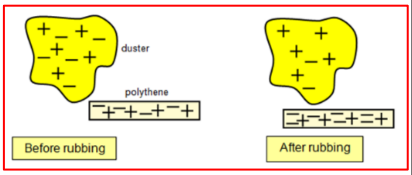
Outcomes	Physics key concepts
Ph6 *Apply a given equation*	Sometimes you get given an equation that you will never have seen before- don't let this throw you. Find the numbers that are reprinted in the equation and substitute the symbols with the numbers. Re-arrange the equation, if you need to. Resolve the equation- work out the answer.
Ph7 *Justify the use of equipment for an investigation*	Think about which equipment would be the best choice and why. For example, if you were measuring a small length or short distance you would use a ruler- but if you were measuring 300 m then you would use a trundle wheel or possibly a tape measure. When measuring time, we generally use a stopwatch however when recording short time intervals or timing things that move quickly then human riming error can become a problem and a digital timer may be a more accurate choice of equipment.
Ph8 *Interpret data from diagrams, tables and graphs*	These questions are about understanding information you are given in the question and will often be different to any question you may have seen before. **Diagrams** These could contain **values** that you need to **use in an equation** or **equipment** you may need to use in a **practical**. There is no set pattern to this- you will need to apply 'common sense' and think your way through what you are being asked. **Tables** For simple marks you are looking to **describe any relationships** you see- for example as mass increases so does weight. There may be **further patterns**- for example does weight keep going up by the same amount? Or **do the intervals getter smaller? Bigger?** Sometime you may need to use **values in an equation** to show a trend or relationship- for example a table could contain values for voltage and current- but you are asked about resistance. In this case you would need to calculate the resistance values. **Graphs** Is the graph **linear** (straight line) or **non-linear** (curved)? **What is the trend**? As the '**X axis values' increase**, what happens to the '**Y axis values'**, does it **increase or decrease**. Is there a **maximum** or a **minimum point**? Sometime you might have to **extract data** and 'do something with it' perhaps **use it in an equation** or work out a range.
Ph8a *Describe a directly proportional relastionship*	A directly proportional relationship is relationship between two variables that meets the following two rules: • If one value doubles, then the other value also doubles • If one value is zero, then the other value is also zero This type of relationship can be seen on a graph when: • You get a straight line of best fit • That passes through the origin (0,0)

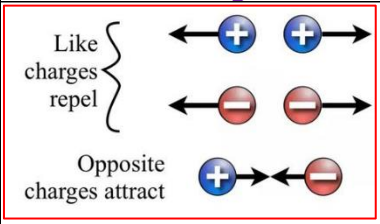
<table>
<tr><th>⌝</th><th colspan="2">Separate Forces and their effects</th></tr>
<tr><td>Ph280
Describe situations where forces can cause rotation</td><td colspan="2">A force, or more than one force, can cause objects to rotate. The turning effect of a force is called a moment.
The size of a moment is determined by the size of the force and the distance from the pivot (more correctly the perpendicular distance from the pivot).
We describe moments as clockwise ↻ or anticlockwise ↺.

</td></tr>
<tr><td rowspan="2">Ph281
Recall and use the equation: moment of a force = force × distance normal to the direction of the force</td><td colspan="2">We can calculate turning moments using this equation:
Moment (Nm) = force (N) x distance (perpendicular to the force) (m)
M = F x d</td></tr>
<tr><td>

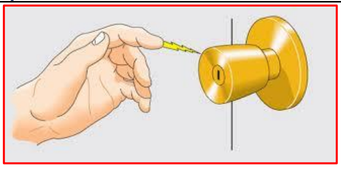
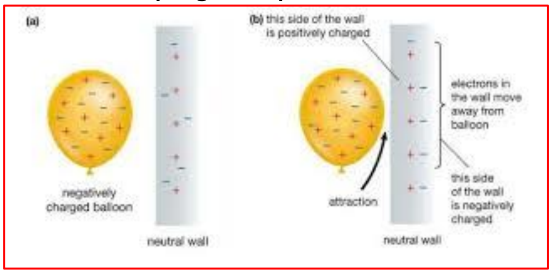
A force of 800 N is applied 50 cm away from the pivot.
Calculate the size of the moment</td><td>The distance must be in m NOT cm:
Distance = 50 ÷ 100
Distance = 0.5 m

Moment = force x distance
Moment = 800 x 0.5
Moment = <u>400 Nm</u></td></tr>
<tr><td rowspan="5">Ph282
Recall and use the principle of moments in situations where rotational forces are in equilibrium</td><td colspan="2">The principle of moments states that:
For an object that is in equilibrium
The <u>sum of</u> the clockwise moments is equal to the <u>sum of</u> the anticlockwise moments
This means that if a lever is in equilibrium (not rotating) then if we calculate all of the clockwise moments and add them together it will be the same size as all the anticlockwise moments added together.</td></tr>
<tr><td>
</td><td>24 x 0.8 = W x 4
19.2 = W x 4
19.2 ÷ 4 = W
W = <u>4.8 N</u></td></tr>
<tr><td colspan="2">Sometimes there will be more than one moment in a given rotation- we add these together.</td></tr>
<tr><td>
</td><td>W x 10 = (15 x 6) + (12 x 5)
W x 10 = 90 + 60
W x 10 = 150
W = 150 ÷ 10
W = <u>15 N</u></td></tr>
</table>

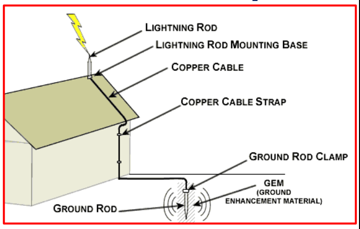
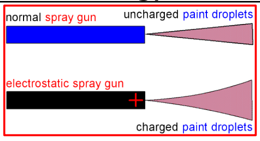
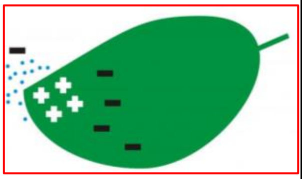
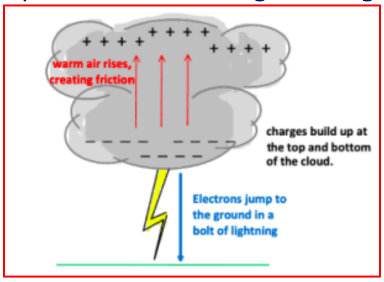
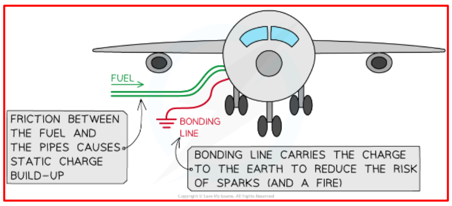
	Separate Forces and their effects
Ph283 *Explain how levers and gears transmit the rotational effects of forces*	**Levers** Levers transfer the turning effect of a force- levers make it easier to do work by increasing the distance between pivot and the force. The longer the lever the smaller the force required to give the same moment. **Gears**  Gears are cogs with interlocking teeth, they transmit the rotational effect of a force- **connected cogs turn in opposite directions**. Cog A is turning clockwise- so cog B is turning anticlockwise. A **larger cog** will **turn slower** than a smaller cog. A **larger cog** will **turn less times** than a smaller cog. A **larger cog** has a **larger radius** than a smaller cog. A **larger cog** will have a **larger turning moment** than a smaller cog (because the force is applied further away from the pivot). This is all about **ratios,** the ratio of teeth for A:B is 10:30 so **1:3.** **Cog A rotates 3 times faster** (cog B rotates 3 times slower. **Cog A rotates 3 times** to make **cog B turn once**. **Cog B has a radius 3 time larger** (cog A has a radius 3 time smaller). **Cog B has a turning moment that is 3 times bigger** (cog A has a turning moment that is 3 times smaller).

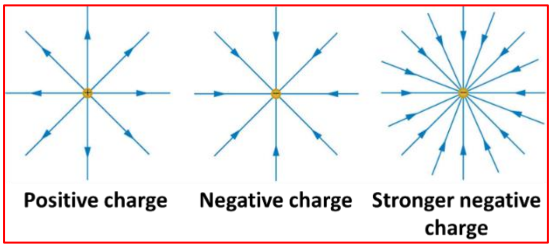
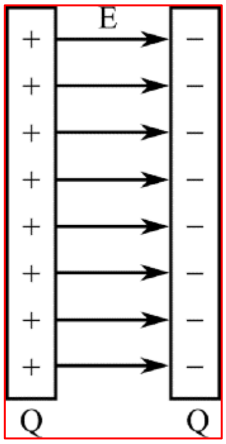
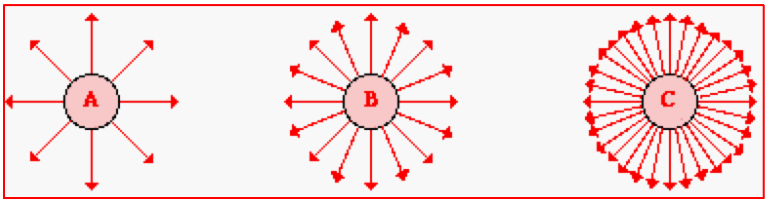
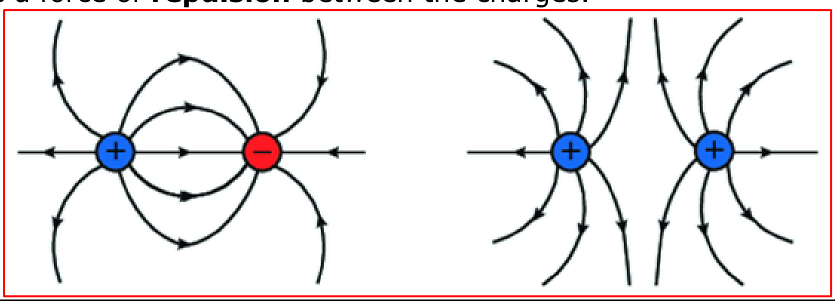
<table>
<tr><th>Outcomes</th><th>Separate Static electricity</th></tr>
<tr><td>Ph284
Explain how an insulator can be charged by friction, through the transfer of electrons</td><td>Static charge can build up on insulators. Usually there is no charge because the number of protons (positive charge) and electrons (negative charge) are equal, so they balance each other out.
Static charge is caused by the moment of electrons, through friction.
Friction transfers electrons from one material to another:
The material that loses electrons (negative) now has an excess of protons (positive), so will have a positive charge.
The material that gains electrons (negative) now has an excess of electrons, so will have a negative charge.</td></tr>
<tr><td>Ph285
Explain how insulating materials become charged due to the loss or gain of electrons</td><td>Static charge can build up on insulators. Usually there is no charge because the number of protons (positive charge) and electrons (negative charge) are equal, so they balance each other out.
Static charge is caused by the moment of electrons, through friction.
Electrons are negatively charged.
Friction transfers electrons from one material to another:
The material that loses electrons (negative) now has an excess of protons (positive), so will have a positive charge.
The material that gains electrons (negative) now has an excess of electrons, so will have a negative charge.


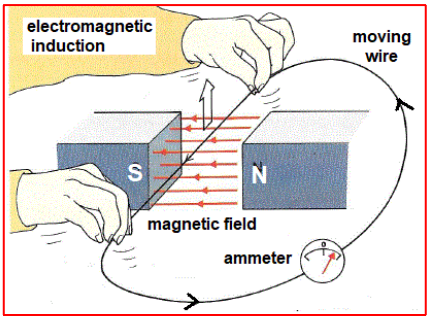
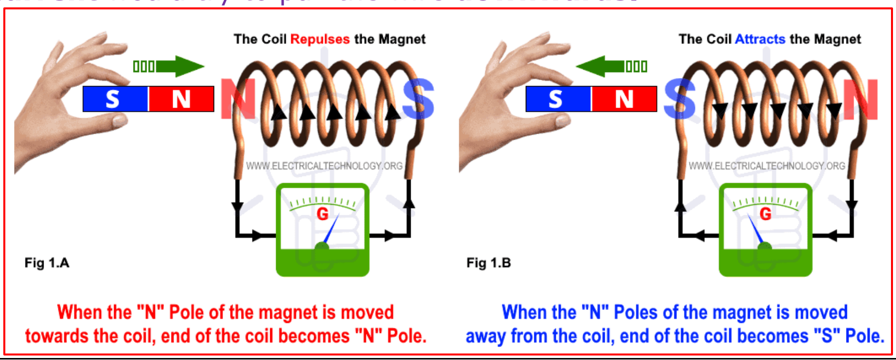
The diagram shows friction has transferred electrons moving from the cloth to the polythene rod. The cloth is positive because it has lost electrons and has an excess of protons and the rod is negative because it has gained electrons.</td></tr>
<tr><td>Ph286
Describe the interactions between like charges and unlike charges</td><td>

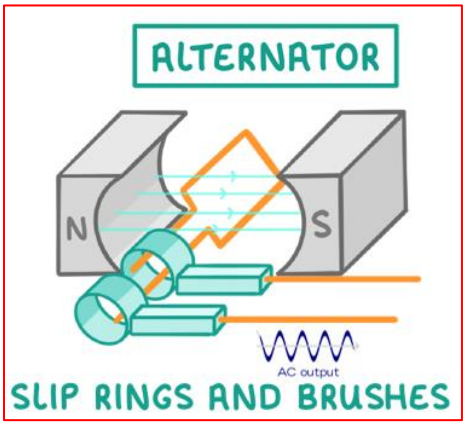
A charged object is surrounding by an electrostatic field.
When an electrically charged objects is inside the electrostatic field of another object, they will both experience a force.
Like charge swill repel.
Opposite charges will attract.
These forces get weaker as the objects move away from each other.</td></tr>
<tr><td>Ph287
Explain common electrostatic phenomena for movement of electrons, inc: shocks from objects, lightning & attraction by induction</td><td>Sparks and shocks

Friction between insulators can cause an unbalanced charge to build up- a negative charge if electrons are gained or a positive charge if electrons are lost.
If this charged object come close enough to a conductor (e.g. a metal door handle) then they can be a spark and potentially an electric shock.
Electrons will flow to balance the charge and the object will be discharged (or earthed).
Induction
A charged object can affect the distribution of electrons within an uncharged object, this is called an induced charge because no charges are actually transferred.
If a negatively charged balloon is moved close to a wall, then the electrons (negative) within the wall will be repelled, leaving only protons (which can't move) on the surface of the wall- an induced positive charge.


The negative balloon will now attract to the positive wall because opposite charges attract.
When the balloon is removed it is still negatively charged but the wall will return to being uncharged.</td></tr>
</table>

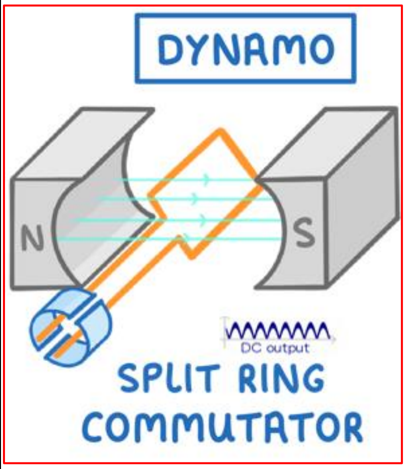
Outcomes	Separate Static electricity
Ph288 *Explain how earthing removes excess charge*	One way to discharge a charged object is to **connect it**, through low resistance wires, **to earth/ground**. This is called **earthing or grounding** the object. This provides an easy route for electron to flow (towards or away from the charge object) and **rebalance the charges**. If an object has a **negative charge** the **electrons will flow away from the objec**t, towards the earth/ground. If an object has a **positive charge** the **electrons will flow towards the object**, from the earth/ground. Some objects are connected to the earth/ground in order to prevent dangerous charges building up or to direct charges away from buildings (for example a lightning rod on top of a tall building). 
Ph289 *Explain some of the uses of electrostatic charges in everyday situations*	Static electricity can be used to help when spraying liquids.  The liquid is charged as it passes out of the nozzle, the **droplets** now all have **the same charge** so **repel** each other so **spread out** and form a **fine mist**. The droplets will be **attracted to the object** being sprayed **through induction**. If the d**roplets** are **negatively charged** then as they approach the object they will **repel the electrons**, **leaving a positive**, **induced charge**. The droplets and the leaf now have **opposite charges** so the **droplets are attracted to the leaf**.  This reduces the amount of insecticide needed **as less falls on the ground**, and **even the underside of the leaves gets covered**. This same method can be used when paint spraying, the **object being painted is given the opposite charge** to the **paint droplets** so that **these attract and waste less paint.**
Ph290 *Describe some of the dangers of sparking in everyday situations*	**Lightning** Friction between particles inside clouds can cause static charge to build up. When the charge is large enough, **electrons will flow to balance the charge.** This cause **lightning** (and thunder).  The charge on the bottom of the cloud can induce the opposite charge in the ground and any tall objects (buildings and trees). **To discharge clouds safely** tall buildings, have a '**lightning rod'** placed on top of them, **connected to the ground** by thick cables. This provides a **safe route** for the electrons rather than striking the buildings and causing fires. See Ph288 for more detail. **Refuelling** When refuelling aircraft or large fuel tankers **sparks can be dangerous** because the fuel vapours are very flammable and **easy to ignite**- this could cause an **explosion**. The fuel is pumped at high speed and friction can cause a static charge to build up. To **reduce the risk of a spark** a '**bonding line'** is used. This **connects the vehicle to the earth** so that any **charge is immediately earthed**. 

Outcomes	Separate Static electricity
Ph291 *Define what an electric field is*	A force field is the volume of **space around an object** in which **another object** will **experience a force**. (See Ph292 for more information on the shape of fields.) An **electric field** is the **space around a charged object** where **other charged objects** will **experience a force** (attract or repel, see Ph286 for more details here.)
Ph292 *Describe the shape and direction of the electric field around a point charge and between parallel plates*	**Point charges** The electric field around a point charge are straight, radial lines (see the diagram). The **lines never cross**, they are **evenly spaced** and they always **point away from a positive** charge and **towards a negative** charge. The closer the field lines are to each other, the stronger the field.   **Parallel plates** The field lined between parallel charge plates are **straight lines**, **evenly spaced** and point **away from positive towards negative**. The field between two parallel plates is uniform- this means that it is the same strength and the same direction every within the fields.
Ph293 *Relate the electrical strength of the field to the concentration of lines*	The strength of an electric field can be seen by looking at the field lines- the **more densely packed** the **field lines** are, the **stronger the electric field** is. In the diagram below, field B is stronger than field A and field C is stronger than field B.  In all three examples **the field gets weaker** as you **move further away** from the charge- you can see this because the **field lines get further away from each other**, they are **less densely packed**.
Ph294 *Explain how the concept of an electric field helps to explain the phenomena of static electricity*	When you look at the field lines surrounding point charges you can see why opposite charges attract or repel. For **opposite charges** the **field lines** are acting in the **same direction** and create a force of **attraction** between the charges. For **like charges** the **field lines** are acting in **opposite direction** and create a force of **repulsion** between the charges. 

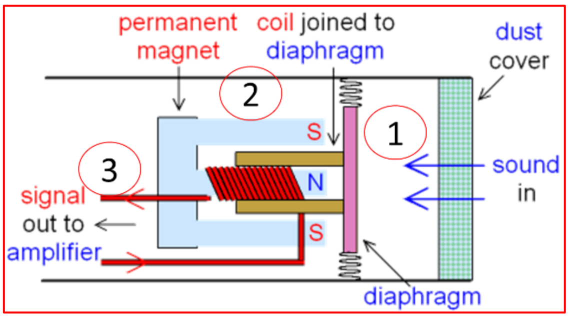
Outcomes	Separate Electromagnetic induction
Ph295 *HT: Explain how to produce an electric current by the relative movement of a magnet and a conductor in the lab & on a large-scale*	A **changing magnetic field** can **induce a potential difference (voltage)** in a wire, this will cause a **current to flow** if the wire is part of a **complete circuit**. (Induce means the potential difference is only there whilst the magnetic field is changing- it's not permanent.) This is called **electromagnetic induction**.  The magnetic field could be changing or the wire could be moving through the magnetic field. This can be done by **passing a length of wire through a magnetic field**, or by **coiling the wire** up and **rotating it inside the field**, or even by rotating a magnet inside a coil of wire. This is how power stations work- a turbine is made to spin and the turbine turns a generator making a magnet rotate within a coil of wire and inducing a voltage
Ph296 *HT: Recall the factors that affect the size and direction of an induced potential difference*	See Ph295 to understand how a potential difference (voltage) can be induced. To increase the size of the induced voltage: ➢ **Increase** the **strength** of the **magnetic field** ➢ **Move** the **wire faster** ➢ **Increase** the **number of coils/turns** in the wire To change the direction of the induced voltage ➢ **Swap the polarity** of the magnetic field (switch the poles of the magnet around) ➢ **Change the direction of the movement**
Ph297 *HT: Describe how the magnetic field produced opposes the original change*	This fairly tricky- think about it in three sections: 1- When a **wire is moved** through a **magnetic field** a **voltage is induced** that **causes a current to flow** through the wire. (See Ph295 for more detail.) 2- As **current flows** through the wire it **creates a magnetic** field around the wire (an electromagnet). 3- The **magnetic field around the wire** will **always work to oppose the movement that is creating it.** If you were to move a wire **upwards** through a permanent magnetic field then the **magnetic field created by the induced current** would try to pull the wire **downwards.** 

<table>
<tr><th>Outcomes</th><th>Separate Electromagnetic induction</th></tr>
<tr><td>Ph298
HT: Explain how electromagnetic induction is used in alternators to generate alternating current (a.c.)</td><td>A generator has a coil of wire that is made to rotate within a magnetic field (in a power station it is a magnet that is made to rotate within a coil of wire).


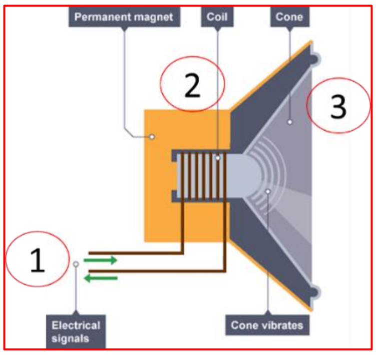
The rotating coil induces a potential difference (voltage), which causes a current to flow through a complete circuit.

An alternator is a generator that produces an alternating current.
Copper brushes maintain contact between the slip rings and the external circuit.
Each side of the coil stays connected to the same terminal of the circuit.</td></tr>
<tr><td>Ph299
HT: Explain how electromagnetic induction is used in dynamos to generate direct current (d.c.)</td><td>A generator has a coil of wire that is made to rotate within a magnetic field (in a power station it is a magnet that is made to rotate within a coil of wire).


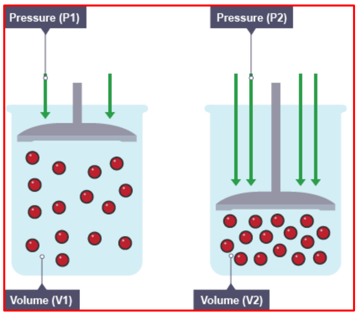
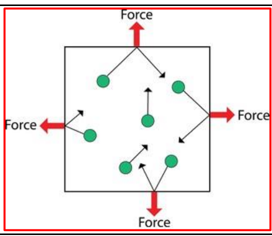
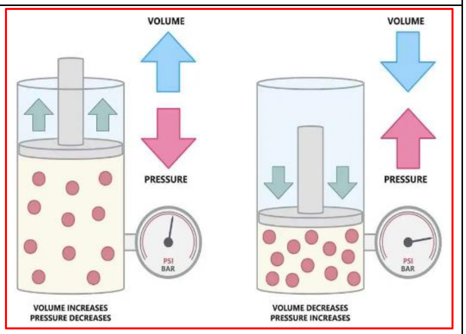
The rotating coil induces a potential difference (voltage), which causes a current to flow through a complete circuit.

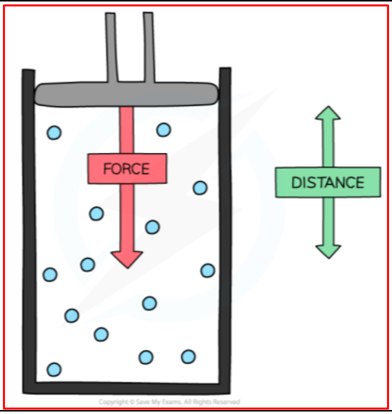
A dynamo is a generator that produces a direct current.
Copper brushes maintain contact between the commutator and the external circuit.
The commutator switches over the connections every half term- so the current always flows through the external circuit in the same direction.</td></tr>
<tr><td>Ph300
HT: Explain the action of the microphone in converting sound waves into variations in current</td><td>A microphone works by acting just like a generator (see Ph295 for more information on electromagnetic induction).
The microphone uses the movement of sound waves to oscillate (vibrate) a magnet through a coil of wire and induce a voltage, causing current to flow through a complete circuit.
See the diagram and steps below:


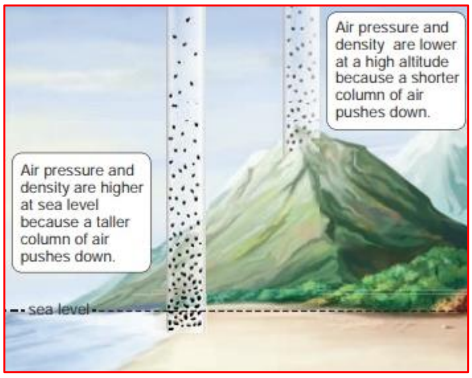
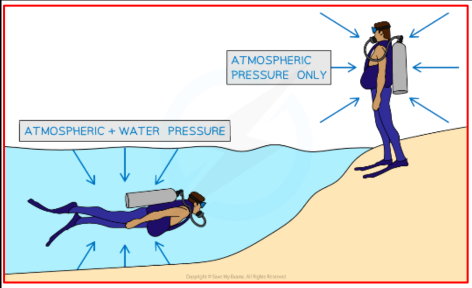
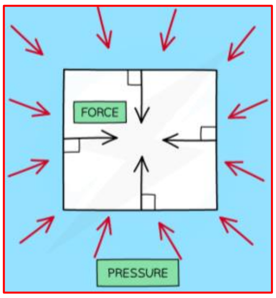
1- Sound waves cause the diaphragm to vibrate back and forth.
2- The vibrating diaphragm is connected to a magnet so the magnet moves back and forth through the coil of wire.
3- This movement induces a voltage and causes an alternating current to flow through a complete circuit.
4- The frequency of the alternating current matches the frequency of the sound waves.</td></tr>
</table>

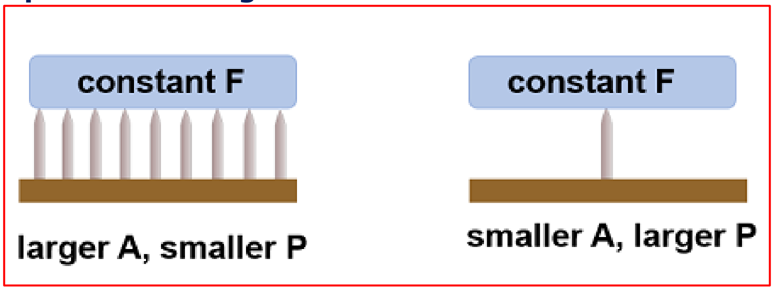
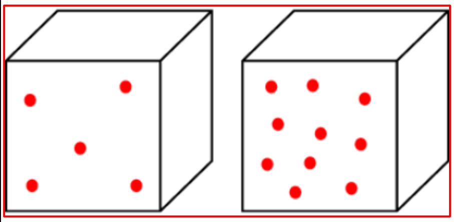
<table>
<tr><th>Outcomes</th><th colspan="2">Separate Electromagnetic induction</th></tr>
<tr><td>Ph301
HT: Explain the action of loudspeakers and headphones in converting current into sound waves</td><td colspan="2">Loudspeakers and headphones make use of the motor effect.
A recap of the motor effect: A current flowing through a wire causes a magnetic field to surround the wire.
When a current carrying wire is placed inside a magnetic field, the two magnetic fields interact and the wire feels a force acting on it- this is called the motor effect.
An alternating current through a coil of wire continuously changes the direction for the magnetic field around the coil- this changes the direction of the force due to the motor effect. This changing force cause a diaphragm to oscillate (vibrate) and produces sound waves.
See the diagram and steps below:


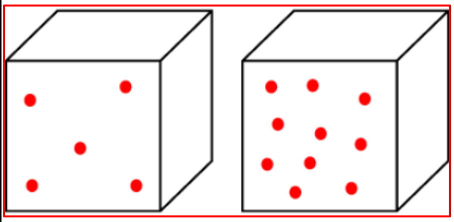
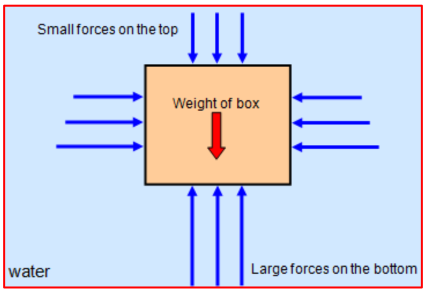
1- An alternating current (a.c.) flows through the coil, creating a changing magnetic field.
2- The changing magnetic field interacts with the permanent magnetic field and the coil of wire vibrates back and forth.
3- The moving wire causes the attached cone to vibrate back and forth and produce sound waves.
4- The frequency of the sound waves matches the frequency of the alternating current.</td></tr>
<tr><td rowspan="2">Ph303
HT: Use the turns ratio equation for transformers to calculate either voltage or number of turns:
$V_P / V_S = N_P / N_S$</td><td colspan="2">The ratio of turns between a primary and secondary coil is the same as the ratio of the voltages- if the number of turns doubles, then so does the voltage.
The relationship can be written as:
$\mathbf{voltage_{primary} / voltage_{secondary} = number_{primary} / number_{secondary}}$
$\mathbf{V_P / V_S = N_P / N_S}$
Voltage = potential difference and number = the number of turns.
You will be given three numbers- in the text or on the diagram.
Substitute in all of the numbers, resolve the side that has two numbers and then re-arrange to find the missing value.</td></tr>
<tr><td>A transformer has 40 turns on the primary coil and 200 turns on the secondary coil.
A potential difference of 25 V is applied across the primary coil.
Calculate the potential difference across the secondary coil.</td><td>$V_P / V_S = N_P / N_S$
$25 / V_S = 40 / 200$
$25 / V_S = 0.2$
$25 = 0.2 \times V_S$
$V_S = 25 / 0.2$
$V_S =$ <u>125 V</u></td></tr>
<tr><td>Ph304
HT: Explain the advantages of power transmission in high voltage cables, using the equations from the spec</td><td colspan="2">There are five different equations that this point refers to:
$\mathbf{V_P / V_S = N_P / N_S}$
$\mathbf{V_P \times I_P = V_S \times I_S}$
$\mathbf{P = E \div t}$
$\mathbf{P = I \times V}$
$\mathbf{P = I^2 \times R}$
➢ The first and second equations tell us about how the voltage and current changes- you can use these equations to show that in a step-up transformer the voltage is increased and the current is decreased. You can support that a higher voltage provides a lower current.
➢ The third and fourth equations can be used to calculate how much energy is transferred every second through cables in the national grid- the power transmission.
➢ The fifth equation is used to work out how much power is lost from the cable. The power loss tells us how much energy is lost every second due to the heating effect of the current.
So, less current means less power lost, this links us back to the first two equations and explains why we want higher voltages.</td></tr>
</table>

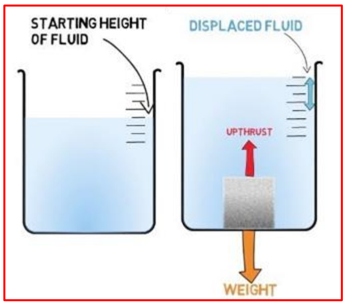
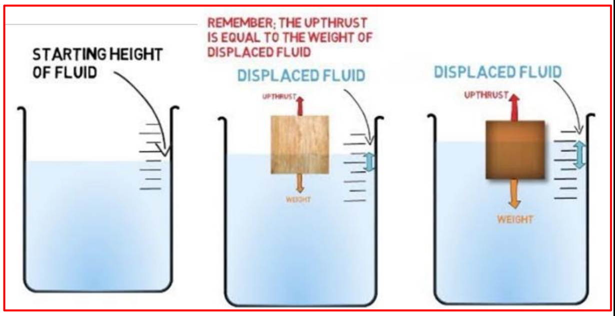
Outcomes	**Separate Particle model**
Ph305 *Explain that gases can be compressed or expanded by pressure changes*	Gas inside a flexible container, such as a balloon, will apply a force outward onto the surface, there will also be a force inward from the air outside. If these pressures are even then the volume will stay the same. If the **pressure** of the **air inside** the balloon **increases**, then the **volume** of the balloon (and the air inside it) will also **increase**. There will be **more force pushing outwards than inwards**. If the **pressure** of the **air inside** the balloon **decreases**, then the **volume** of the balloon (and the air inside it) will also **decrease**. There will be **less force pushing outwards than inwards**. The volume of the gas can **also be changed by increasing or decreasing the external pressure**. If the **external pressure** is **increased** then the **volume** of the gas will **decrease** and vice-verse. 
Ph306 *Explain that the pressure of a gas produces a net force at right angles to any surface*	 **Gas particles collide** with the **surface** of a container and **exert a force**. The collisions happen in random directions and so do the forces. These forces all add up to produce a **single net force at right angles to the surface**.
Ph307 *Explain the effect of changing the volume of a gas on the rate at which its particles collide with the walls of its container and therefore pressure*	Look at the diagram in the right- in both cases there are the same number of particles. The first diagram shows that the **volume has increased**. The **particles** will **collide with the surface less often**- the **collisions per second** (**rate of collisions**) will **be less**. A **lower rate of collisions** means the **pressure will be less**. The second diagram shows that the **volume has decreased**, the **rate of collisions** will **increase** and the **pressure will increase**. 
Ph308 *Use the equation:* $P_1 \times V_1 = P_2 \times V_2$	The volume and pressure of a fixed mass of gas at a constant temperature are related by the equation shown below. *Don't worry about 'fixed mass' and 'constant temperature', this just means that it's the same amount of gas and the temperature hasn't changed.* The SI units of **pressure** is the **Pascal (Pa)** and for **volume** its **metres cubed (m^3).** *For this formula you can use any units given in the question as long as they are the same on both sides of the equation.* Remember we only square or cube a value if the equation tells us to- if it's the units are squared or cubed such as '5 m^3' then we do not need to do anything extra to the value- we use '5' in the equation, not '125'. **$Pressure_{before}$ x $Volume_{before}$ = $Pressure_{after}$ x $Volume_{after}$** **$P_1 \times V_1 = P_2 \times V_2$**
	45g of gas is stored at a pressure of 500,000 Pa and has a volume of 0.4 m^3. The gas is compressed to a volume of 0.05 m^3. Calculate the new pressure of the gas.
	The mass of gas is not important here- so we just ignore it. $P_1 \times V_1 = P_2 \times V_2$ $500{,}000 \times 0.4 = P_2 \times 0.05$ $200{,}000 = P_2 \times 0.05$ $P_2 = 200{,}000 / 0.05$ $P_2 =$ **4,000,000 Pa**

Outcomes	Separate Particle model	
Ph309 *HT ONLY: Explain why doing work on a gas can increase its temperature, including a bicycle pump*	When you use a bike pump the bike pump and the object being inflated can feel warm. This is because you are doing work on the gas, the pump applies a force over a distance and therefore is **doing work- transferring energy to the gas molecules**. The gas molecules have **more kinetic energy** and so are **moving faster**- this **increases the temperature** of the gas.	

Outcomes	Separate Forces and matter
Ph310 *Explain why atmospheric pressure varies with height above the Earth's surface with reference to Earth's atmosphere*	Atmospheric pressure is caused by air molecules colliding with us, at sea level atmosphere pressure is around 100,000 Pa. **Air pressure** (and the pressure cause by all fluids) **always act 'normal'** (at right angles) to the **surface**. The **pressure from any fluid** depends on the **depth of the fluid**. When you standing at sea level, you at the bottom of the atmosphere and the **weight of all the molecules above you is pushing down on you**. If you **climb a mountain** then you are moving up through the atmosphere and there is **less weight of air above you** pushing down on you- **atmospheric pressure is less**.  The same effect is seen if you move deeper into a body of water, there is more weight of water above you and the pressure increases.
Ph311 *Describe the pressure in a fluid as being due to the fluid and atmospheric pressure*	 When an object is submerged into a liquid (for example into water) it experiences **fluid pressure due to the weight of water above it** pushing down on it. It **also experiences the air pressure from the weight of air above it** pushing down onto the water. So, a **diver experiencing 200,000 Pa of water pressure** from diving into the sea will **also experience 100,000** Pa of air pressure, **a total of 300,000 Pa.**
Ph312 *Recall that the pressure in fluids causes a force normal to any surface*	**Pressure** cause by **fluids** (any liquids or gases) **exert a force** '**norma**l' (at **right angles**) to **any surface.** We tend to **represent the total (or net) force** on any surface as a **single force arrow**. 

Outcomes	**Separate Forces and matter**
Ph313 *Explain how pressure is related to force and area, using appropriate examples*	**Pressure** can be thought of as **how concentrated** a **force** is- it depends on the size of the force and the surface area that the force is applied over. If the size of the **force is increased** then the **pressure will** also **increase**- that's pretty obvious (hopefully). If the **surface area is increased** then the **pressure will decrease**- because the **force is spread over a larger area**. If **area decreases** then **pressure increases.** Think about the image below, in both diagrams the force (the wight) is the same. ➢ In the first diagram the **surface area is larger**, so the **pressure is smaller**. ➢ In the second diagram the **surface area is smaller**, so the **pressure is larger.** 
Ph314 *Recall and use the equation: P = F/A*	The **pressure exerted** by a force can be calculated using **the size of the force** and **the surface area**. The equation is given below. *The SI unit of pressure is the pascal (Pa), 1 Pa is equal to 1 N/m^2. In exam questions they will sometime use N/cm^2- this is OK, you just need to check which units they are using and be consistent in your calculation.* *If the area is in cm^2 then the pressure will be N/cm^2, if the area is in m^2, then the area will be in N/m^2.* Remember we only square or cube a value if the equation tells us to- if it's the units are squared or cubed such as '5 m^2' then we do not need to do anything extra to the value- we use '5' in the equation, not '25'. **Pressure = force ÷ surface area** **P = F ÷ A**
	A man's foot has a surface are of 0.02 m^2 and he exerts a pressure of 21,250 Pa when standing on both feet. Assume his feet both have the same surface area. Calculate the man's weight. *The man's weight is the force he applies on the ground.* P = F ÷ A 21,250 = F ÷ (0.02 x 2) 21,250 = F ÷ 0.04 F = 21,250 x 0.04 F = **850 N**
Ph315 *Describe how pressure in fluids increases with depth and density*	**Pressure increases** as **depth increases**. The greater the weight of particles above an object, the greater the pressure it feels. **Density** is a measure of **how concentrated particles are**- the greater the density the more closely packed the particles are. These two boxes have the same volume but the particles are more closely packed in the second box- the density is greater in the second box.  **Pressure increases** as the **density of a fluid increases**. The weight of the particles above an object will be greater if the particles are more closely packed.

Outcomes	Separate Forces and matter
Ph316 *HT: Explain why the pressure in liquids varies with density and depth*	**Pressure increases** as **depth increases**. The **greater the weight of particles** above an object, the **greater the pressure** it feels. These two boxes have the same volume but the **particles are**  **more closely packed** in the second box- the **density is greater** in the second box. **Pressure increases** as the **density of a fluid increases**. If the **density of the fluid is greater** then **there are more particles** in the column of air above an object **because the particles are more closely packed**. This means that the **weight of the particles above an object will be greater** therefore the **pressure will be greater.**
Ph317 *HT: Use the equation to calculate the magnitude of pressure in liquids & differences at different depths: P = h × ρ × g*	The **pressure** at any point **within a fluid** depends on three values. The **height of the column of fluid above an object**, the **density of the fluid** and the **gravitational field strength** (which on Earth is 10 N/kg). The height of the column of fluid is just the depth the object is within that fluid. **Pressure (due to a column of fluid) = height of the column x density of the fluid x gravitational field strength** **$P = h \times \rho \times g$** The density of sea water is 1030 kg/m^3 and shark is swimming 3000 m below the surface. Remember that, on Earth, gravitational field strength 'g' is 10 N/kg. Calculate the water pressure on the shark. $P = h \times \rho \times g$ $P = 3000 \times 1030 \times 10$ P = **<u>30,900,000 Pa</u>** Or **<u>31 MPa</u>** Calculate the depth of the shark if the pressure is 12,360,000 Pa. $P = h \times \rho \times g$ $12{,}360{,}000 = h \times 1030 \times 10$ $12{,}360{,}000 = h \times 10{,}300$ $h = 12{,}360{,}000 \div 10{,}300$ h = **<u>1200 m</u>**
Ph318 *HT: Explain why an object in a fluid is subject to an upwards force (upthrust)*	An **object inside a fluid** (gas or liquid) can feel lighter than it actually is (think about putting a football under the water in a pool), this is due to a force called **upthrust.** The **upthrust** an object feels due to being inside a fluid is caused by the **difference in pressure above and below** an object- it sounds complicated but its actually pretty straight forward. We know from Ph317 that **pressure increases with depth**- this means that the **pressure at the bottom** of an object, **pushing upwards** is **greater than** the **pressure at the top** of the object **pushing downwards**. The **difference between these two pressures** creates an **upwards force called upthrust**.  The **upthrust** is always **equal** to the **weight** of fluid that has been **displaced** by the object. If the **upthrust is greater** than the **weight of an object**, then the **object will float**. If not, it will feel lighter, but still sink.

Outcomes	Separate Forces and matter
Ph319 *HT: Relate upthrust to examples including objects that are fully immersed in a fluid (liquid or gas)*	See Ph318 for more details on why objects experience upthrust. A quick summary for you though. **Pressure** from a **fluid increases** with **depth**, the **bottom of an object is deeper** than the top so there is more **pressure pushing upwards**, an **overall force acts upwards**- this is called **upthrust**. The **upthrust force** is **equal to the weight of the fluid that has been displaced** (moved out of the way)- this depends on the volume (size) of the object and the density of the fluid.  If the **upthrust is smaller** than the **objects weight** then the object will still **sink**. It would '**feel lighter'** due to upthrust but would still sink. The **resultant force** pulling the object down **is smaller than it would be without the upthrust**- the object 'feels' heavier if we take it out of the fluid.
Ph320 *HT: Relate upthrust to examples including objects that are partially immersed in a liquid*	See Ph318 for more details on why objects experience upthrust. A quick summary for you though. **Pressure** from a **fluid increases** with **depth**, the **bottom of an object is deeper** than the top so there is more **pressure pushing upwards**, an **overall force acts upwards**- this is called **upthrust**. The **upthrust force** is **equal to the weight of the fluid that has been displaced** (moved out of the way)- this depends on the volume (size) of the object and the density of the fluid.  If the **upthrust is equal** than the **objects weight** then the object will still **float**. If the **upthrust is greater** than the **objects weight** then the object will still **rise up within the fluid** (think about holding a football under water and letting go of it). The **resultant force** acting on the object **is zero**- the **upthrust** is **equal** to the **weight**. Some objects that float have to sit deeper in the water- they need to displace more fluid to make the upthrust (weight of fluid displaced) equal to the weight of the object. *If the density of the fluid is greater then less fluid needs to be displaced before the upthrust (weight of fluid displaced) is equal to the weight of the object.*
Ph321 *HT: Recall that the upthrust is equal to the weight of fluid displaced*	**Upthrust force** is **equal to the weight of the fluid that has been displaced** (moved out of the way)- this depends on the volume (size) of the object and the density of the fluid. A **larger object** will obviously **displace more fluid**- a **greater weight** of fluid means **more upthrust**. Water has a greater density than air. An **object in air** experiences an **upthrust due to the weight** of air displaced- this will be **relatively small**. The same **object placed in water**, **displaces the same volume** of water, but this will have **a much greater weight** so the **upthrust will be much greater**.

Outcomes	Separate Forces and matter
Ph322 *HT: Explain the factors that influence whether an object will float or sink*	An object placed **into a fluid** will **experience upthrust** due to the **weight of the fluid it displaces** (this depends on the volume of the object and the density of the fluid). If **upthrust is equal to weight**, the **object will float**. If **upthrust is less than weight**, the **object will sink**. If **upthrust is greater than weight**, the **object will rise** out of the water and **displace less water until upthrust and weight are balanced**- it will then float.