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CAMBRIDGE IGCSE®
PHYSICS
EXPLAINED

Kaleem Akbar

Contents

Additional support material

Friction

- ❑ The force of friction **opposes the motion** of an object.
  Air resistance (drag) is a form of friction.

- ❑ Friction causes heating, e.g. when one material is pushed across the surface of another.

- ❑ Friction can be useful in certain situations and not very useful in others.

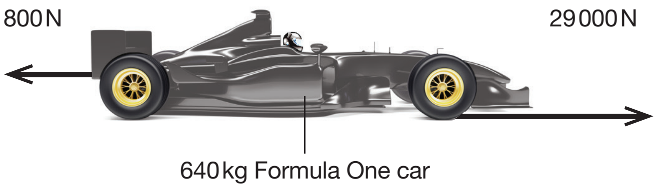
- ❑ Friction is **useful** in the following situations and can be **increased** by:
  - a skydiver opening a parachute allowing him/her to slow down quickly due to increased air resistance
  - pressing the brake pedals in a car, slowing it down quickly.

- ❑ Friction is **not useful** in the following situations and can be **decreased** by:
  - skiers putting wax on their skis to make them smooth
  - making objects **streamlined**, allowing them to travel faster by cutting through the air
  - oiling engines to allow the parts to move easily.

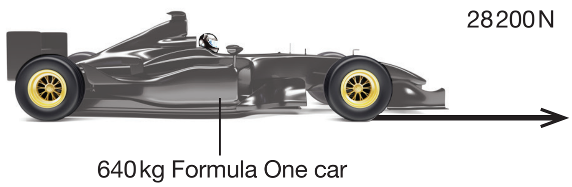
❍ ***Example***

A Formula One car has a mass of 640 kg (including the driver). When the engine exerts a driving force of 29 000 N, the opposing frictional force is 800 N. Calculate the acceleration.

Step 1 Draw a diagram showing the forces acting on the object and their directions.



Step 2 Calculate the **resultant** (**unbalanced**) force.



$\boldsymbol{F} = 29000 - 800 = 28200\text{ N}$

Step 3 List all the information in symbol form and change into appropriate and consistent SI units if required.

$\boldsymbol{F} = 28200\text{ N}$
$\boldsymbol{m} = 640\text{ kg}$
$\boldsymbol{a} = ?$

Step 4 Use and rearrange the correct formula.

$$\boldsymbol{F} = \boldsymbol{ma} \quad ⇨ \quad \boldsymbol{a} = \frac{\boldsymbol{F}}{\boldsymbol{m}}$$

Step 5 Calculate the answer by putting the numbers into the formula.

$$\boldsymbol{a} = \frac{\boldsymbol{F}}{\boldsymbol{m}} = \frac{28\,200}{640} = 44.06\text{ m/s}^2 = 44\text{ m/s}^2$$

ALWAYS REMEMBER TO STATE THE UNIT FOR CALCULATED QUANTITIES.

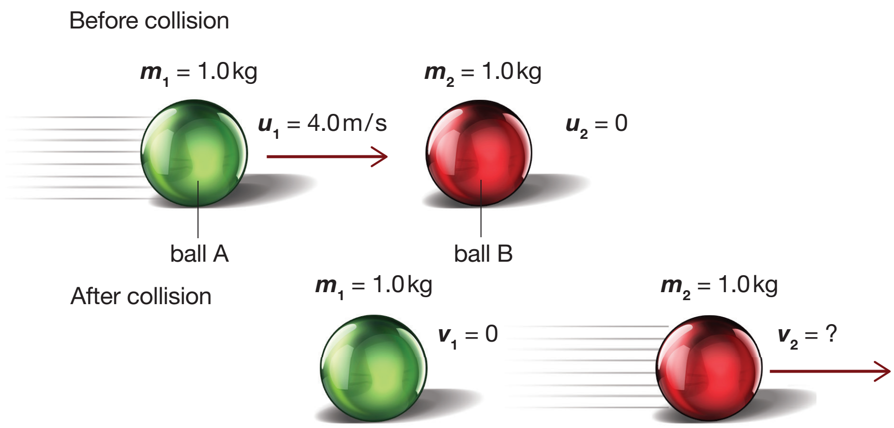
Elastic collision

❍ ***Example* 1**

A rubber ball A of mass 1.0 kg moving to the right at a velocity of 4.0 m/s collides with another rubber ball B of mass 1.0 kg, which is stationary.

(a) Ball A is stationary after the collision. Calculate the velocity of ball B.

(b) Show that the collision is elastic.



(a) **Step 1** List all the information in symbol form and change into appropriate and consistent SI units if required.

Before collision:	After collision:
$m_1 = 1.0\,\text{kg}$	$m_1 = 1.0\,\text{kg}$
$u_1 = +4.0\,\text{m/s}$	$v_1 = 0$
$m_2 = 1.0\,\text{kg}$	$m_2 = 1.0\,\text{kg}$
$u_2 = 0$	$v_2 = ?$

Step 2 Use the correct formula.

momentum before = momentum after

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

Step 3 Calculate the answer by putting the numbers into the formula.

momentum before:

$$m_1u_1 + m_2u_2 = (1.0 \times 4.0) + (1.0 \times 0) = 4.0\,\text{kgm/s}$$

momentum after:

$$m_1v_1 + m_2v_2 = (1.0 \times 0) + (1.0 \times v_2)$$

momentum before = momentum after

$4.0 = v_2$

Ball B moves to the right at 4.0 m/s.

ALWAYS REMEMBER TO STATE THE UNIT FOR CALCULATED QUANTITIES.

(b) **Step 1** List all the information in symbol form and change into appropriate and consistent SI units if required.

All values before and after collision are as (a) but

$v_2 = +4.0\,\text{m/s}$

Step 2 In an elastic collision, **k.e.** is conserved. Use the correct equation.
Total kinetic energy before collision:

$$\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2$$

Total kinetic energy after collision:

$$\frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$$

Step 3 Calculate the answer by putting the numbers into the equation.
Total kinetic energy before collision:

$$\frac{1}{2} \times 1.0 \times 4.0^2 + \frac{1}{2} \times 1.0 \times 0^2 = 8.0\,\text{J}$$

Total kinetic energy after collision:

$$\frac{1}{2} \times 1.0 \times 0^2 + \frac{1}{2} \times 1.0 \times 4.0^2 = 8.0\,\text{J}$$

There is no kinetic energy change in this collision, therefore the collision is elastic.

ALWAYS REMEMBER TO STATE THE UNIT FOR CALCULATED QUANTITIES.

Section 2.3 Thermal processes

Heat transfer

❑ The three principal methods of heat transfer are:

1. conduction
2. convection
3. radiation.

❍ **Conduction** – Particles **gain energy** when heated. In a solid the particles cannot change positions but the particles vibrate, and this transfers the heat energy through the solid from particle to particle as they collide. In addition metals are particularly good conductors because they have **free-moving electrons**. The vibrating particles hit electrons and send them through the metal. This causes energy to be transferred quickly.

❑ **Convection** – A liquid or gas **expands** as it is heated and it becomes **less dense**; this causes the hot fluid to **rise** and the cooler fluid above it to **fall** in a circular fashion.The rising of the hot gas or liquid sets up a **convection current**.

Remember: It is **NOT** heat that rises; it is the molecules of hot liquid or gas that rise.

❑ **Radiation** – Energy in the form of **infra-red radiation** (part of the electromagnetic spectrum) travels in all directions from any **hot body**. This is how heat energy is transferred through a vacuum, such as from the Sun through space to Earth.

❍ The amount of heat radiated from a body depends on its temperature; a very hot body radiates more heat than a cool body. A body with a large surface area will radiate more than a body of small surface area at the same temperature.

❑ Because infra-red radiation is an electromagnetic wave it can be reflected. This means that a highly polished surface will reflect heat radiation away, e.g. a polished metal plate behind the element of an electric fire reflects the heat into the room.

Note

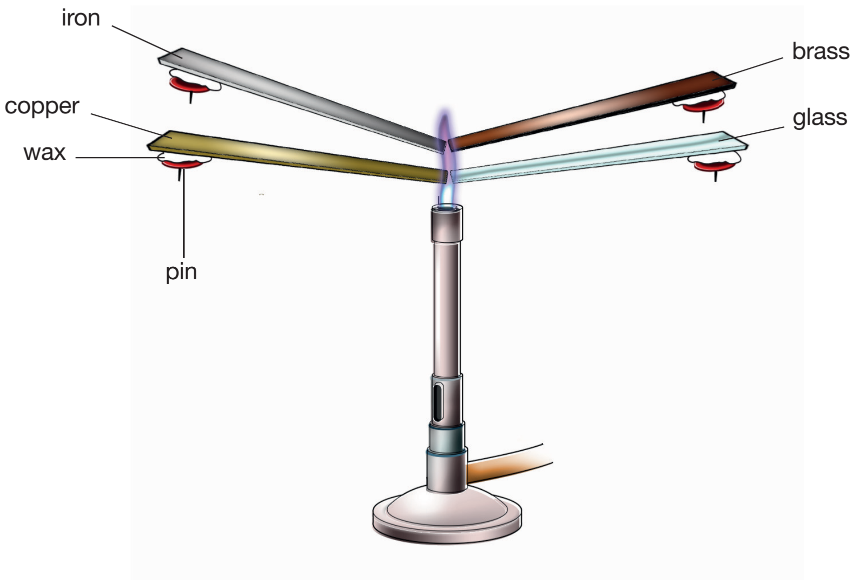
Conduction is the transfer of energy by vibrating particles in **solids.** Good conductors such as metals also have free-moving electrons to carry the energy.

Convection is the transfer of energy by **hot gas or liquid rising** and **cold gas or liquid falling.**

Radiation is the transfer of energy as an electromagnetic wave. Radiation is the only way thermal energy can travel through a vacuum.

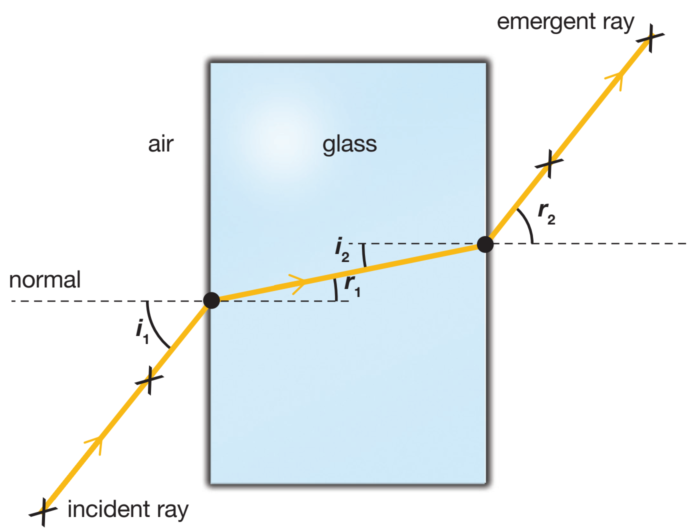
Experiments demonstrating heat transfer

❏ ***Conduction***



1. Select four strips of different material of equal length.
2. Attach a drawing pin to the end of each strip, using petroleum jelly or candle wax.
3. Heat the other ends of the strips equally.
4. The strip that allows the pin to drop first is the best conductor, and so on.
5. Glass is a bad conductor, so the drawing pin will stay attached.

Measuring angles of incidence and refraction

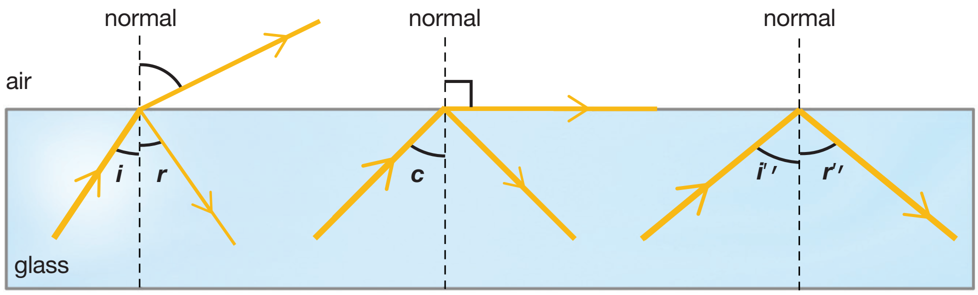


❑ The following experiment describes how to measure the angle of incidence and angle of refraction.

1. Place a transparent block in the middle of a plain sheet of paper; trace around the block in pencil.
2. Position a raybox so that the light from it strikes the glass block at an angle. (**Remember**: If the light strikes the glass boundary at 90°, it will pass straight through undeviated.)
3. Mark the positions where the light meets the glass boundary and where it leaves the glass boundary with dots (see the diagram).
4. Mark two crosses (or place optical pins) on the paper along the incident ray and the emergent ray approximately 5 cm apart.
5. Remove the glass block and switch off the raybox.
6. Using a ruler, complete the lines between the dots and the crosses.
7. Draw in the normal at **90°** to where the light strikes the glass boundary.
8. Draw the second normal where the light leaves the glass boundary, again at **90°**.
9. Using a protractor, measure the angles of incidence and refraction as shown on the diagram above.

Notes

Total internal reflection



For small angles of incidence, the ray splits into a refracted ray and a weak internally reflected ray.

At the critical angle ***c***, most of the light is refracted at 90° along the glass surface; the internally reflected ray has become a little stronger.

For angles of incidence greater than the critical angle, **total internal reflection** occurs. No light is refracted.

- ❑ **Total internal reflection** occurs when **light is travelling from a more dense to a less dense material** and the angle of incidence is greater than the **critical angle** of the material.
- ❑ The **critical angle** is defined as the angle in the denser material above which total internal reflection occurs.
- ❑ Each material has its own critical angle. For example, the critical angle of glass is 42° and for water it is 49°.
- ❑ Consequently, light incident at angles greater than 42° for glass and greater than 49° for water will be completely reflected and none of it will be refracted – total internal reflection (see page 140).
- ❑ The inside surface of diamond, water or glass can act like a mirror depending on the angle at which light strikes it.
- ❍ The critical angle ***c*** is related to the refractive index ***n*** by the formula:

$$n = \frac{1}{\sin c}$$

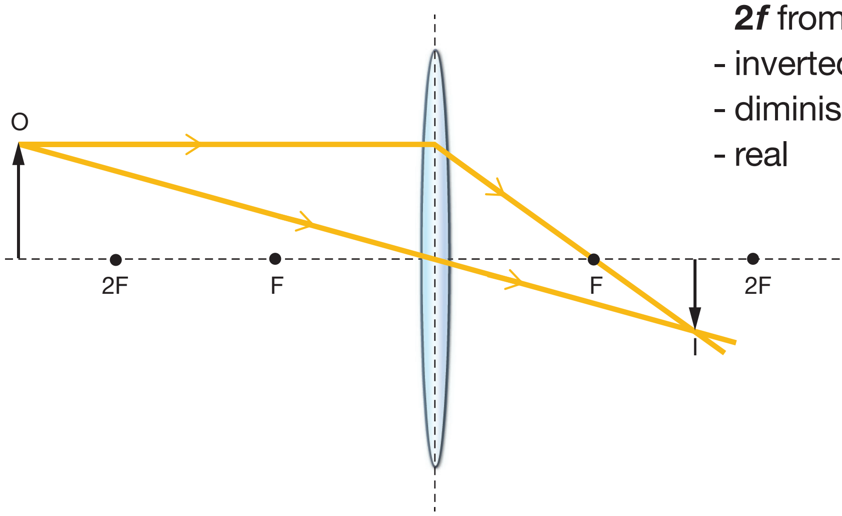
n = refractive index (no units)
c = critical angle (°)

Formation of images by a converging lens

❑ **Object:** Further than **2*f*** from lens

Image:
- between ***f*** and **2*f*** from lens
- inverted
- diminished
- real

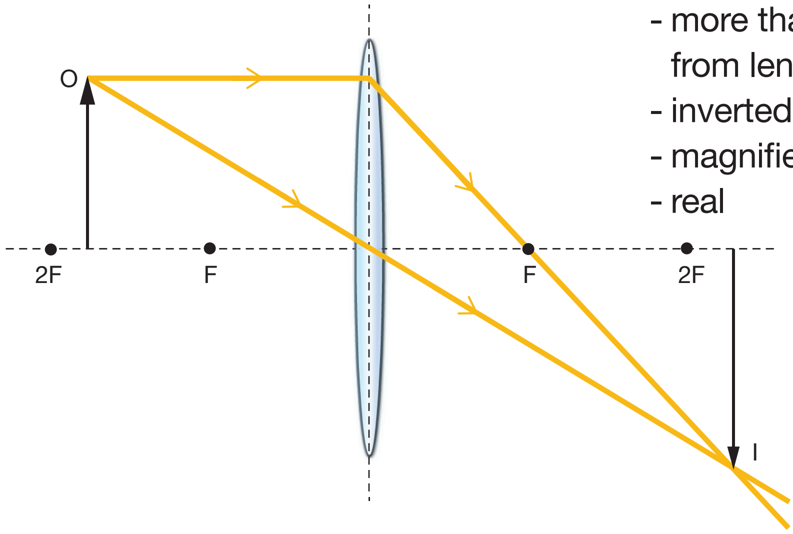
Uses: camera



❑ **Object:** Between ***f*** and **2*f*** from lens

Image:
- more than **2*f*** from lens
- inverted
- magnified
- real

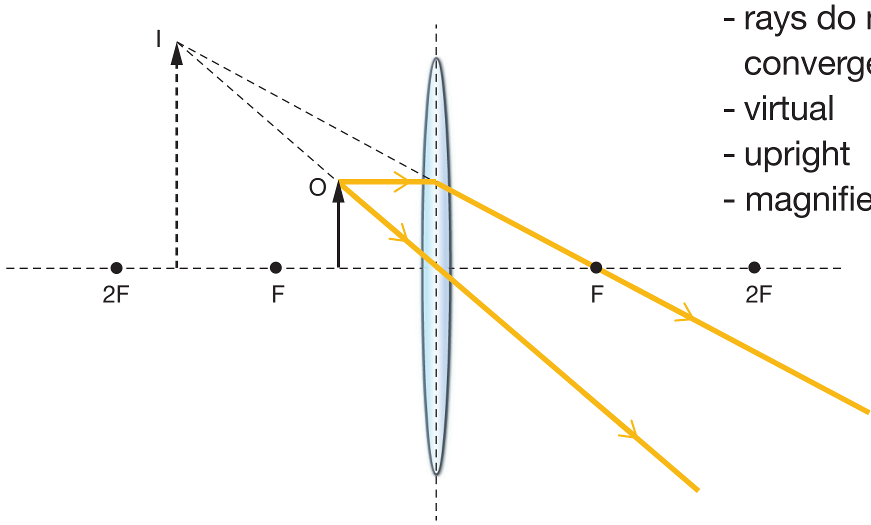
Uses: projector



❍ **Object:** Less than ***f*** from lens

Image:
- rays do not converge
- virtual
- upright
- magnified

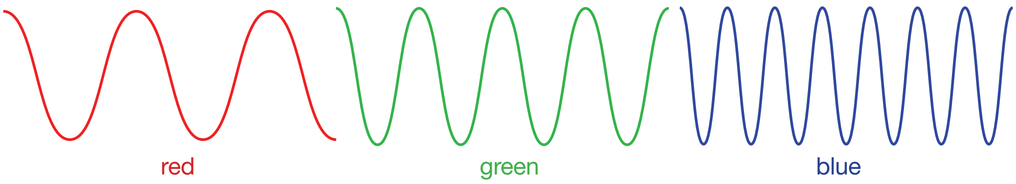
Uses: magnifying glass



Dispersion of light

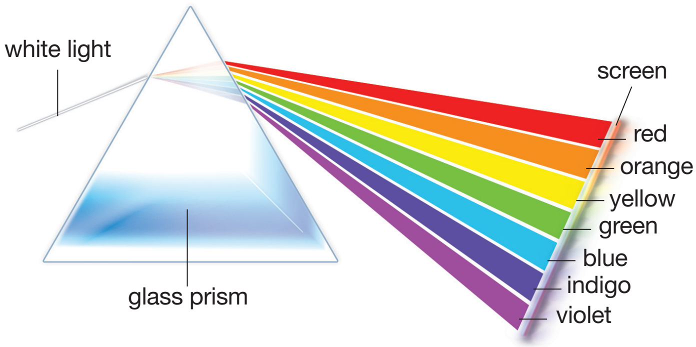
- ❑ Light of different colours has different wavelengths.

- ❑ Red light has a longer wavelength than green light, which has a longer wavelength than blue light.



- ❍ Light of a single wavelength and therefore a single frequency, is known as **monochromatic** light. **Lasers** produce monochromatic light.

- ❑ **White** light is said to be made up of **seven** different colours. The colours travel at the same speed in space (vacuum) but slow down when they enter a denser medium like glass. The different wavelengths slow down by different amounts and so refract by different angles in a prism. This is known as dispersion and a **spectrum** is produced.



- ❑ The colours of the **visible light spectrum** can be memorised using the mnemonic: **ROYGBIV**: Richard Of York Gave Battle In Vain.

Top Tip

Always describe white light **splitting up** into a **spectrum of light** and **not** ‘colours of the rainbow’.

- The **power** of an item of electrical equipment depends on **voltage** and **current**.

$$\boxed{P = IV}$$

P = power (W)
I = current (A)
V = voltage (V)

- ***Example***
  The current in a 240V electric cooker is 8.0A.
  Calculate the power of the cooker.

Step 1 List all the information in symbol form and change into appropriate and consistent SI units if required.

V = 240V
I = 8.0A
P = ?

Step 2 Use the correct formula.

$P = IV$

Step 3 Calculate the answer by putting the numbers into the formula.

$P = IV = 8.0 \times 240 = 1920\,\text{W}$

ALWAYS REMEMBER TO STATE THE UNIT FOR CALCULATED QUANTITIES.

- The **energy** transferred by an appliance is related to **power** and **time**:

$$\boxed{E = Pt}$$

E = energy (J)
P = power (W)
t = time (s)

- ***Example 1***
  Calculate how much energy is transferred by a 100W lamp in 2.0 minutes.

Step 1 List all the information in symbol form and change into appropriate and consistent SI units if required.

P = 100W
t = 2.0 minutes = 2×60 = 120s
E = ?

Step 2 Use the correct formula.

$E = Pt$

Step 3 Calculate the answer by putting the numbers into the formula.

$E = Pt = 100 \times 120 = 12\,000\,\text{J}$

ALWAYS REMEMBER TO STATE THE UNIT FOR CALCULATED QUANTITIES.

❍ ***Example 2***

A television set is connected to a 240V supply and the current is 0.33A. Calculate the energy transferred if the television is switched on for 1.0 hour.

Step 1 List all the information in symbol form and change into appropriate and consistent SI units if required.

$I = 0.33\,\text{A}$
$V = 240\,\text{V}$
$t = 1.0\,\text{h} = 3600\,\text{s}$
$E = ?$

Step 2 Choose the correct formulae.

$P = IV \qquad E = Pt$

Step 3 Calculate the answer by putting the numbers into the formulae.

$P = IV = 0.33 \times 240 = 79.2\,\text{W}$

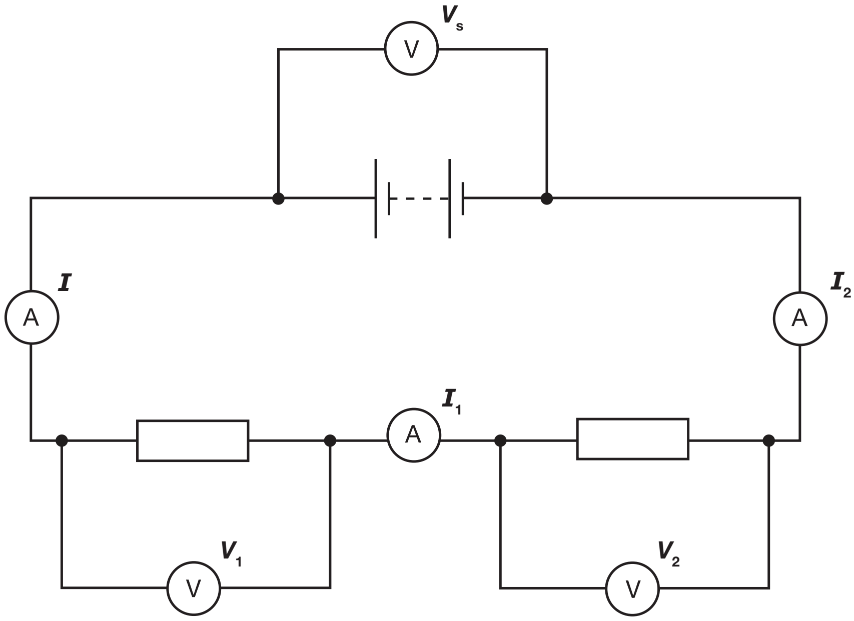
$E = Pt = 79.2 \times 3600 = 285\,120\,\text{J}$
$= 285\,000\,\text{J}$ (to 3 significant figures)
$= 285\,\text{kJ}$

ALWAYS REMEMBER TO STATE THE UNIT FOR CALCULATED QUANTITIES.

Section 4.3 Electric circuits

Series and parallel circuits

❑ There is **only one path** for the current in a **series circuit**.



(The various meters are assumed not to be part of the circuit as they are simply there to measure values and have no effect on the circuit.)

❑ The **current** is the **same** at all points in a **series** circuit:

$$\boxed{I = I_1 = I_2}$$

I = supply current as measured by an ammeter.

❍ The **supply voltage V_s**, also known as the **electromotive force (e.m.f.)**, is equal to the sum of the voltages (potential differences) across each **individual component** in a series circuit:

$$\boxed{V_s = V_1 + V_2}$$

V_s = supply voltage (e.m.f.)

Note

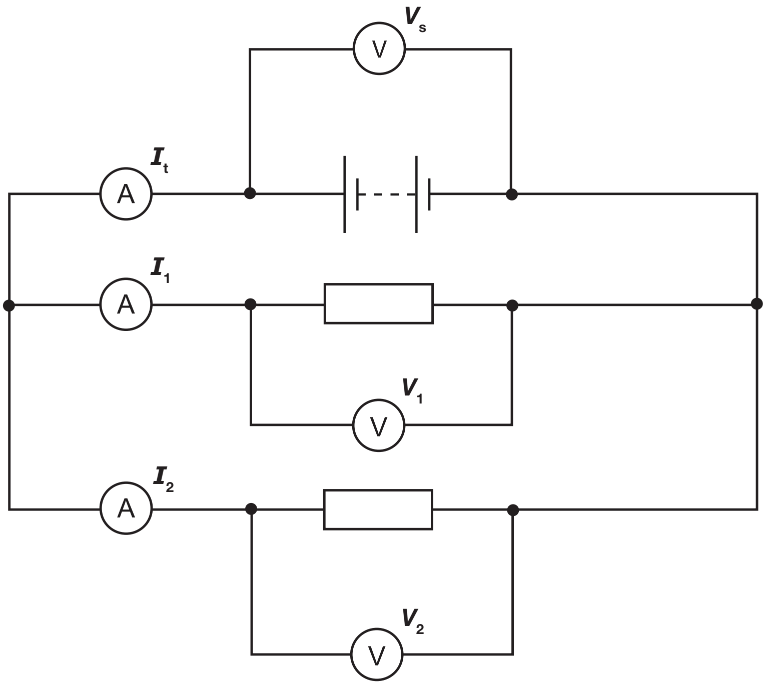
Current is the same at all points in a series circuit.

The supply voltage (e.m.f.) is shared between components within the circuit.

Notes

❍ Sometimes the supply voltage (e.m.f.) is provided by several sources in series. In this case the total e.m.f. is the sum of the individual **e.m.f.s.** For example, if six 1.5V cells are connected in series, the total e.m.f. is 9.0V.

❑ There is **more than one path** for the current in a **parallel circuit**.



(The various meters are assumed not to be part of the circuit as they are simply there to measure values and have no effect on the circuit.)

❑ The **voltage** (p.d) **across individual** components in a **parallel** circuit is **equal to the supply voltage**:

$$\boxed{V_s = V_1 = V_2}$$

V_s = supply voltage (e.m.f.)
V_1 and V_2 = **p.d.** across resistors

❑ The **current** in a parallel circuit is larger in the branch containing the battery than in the other branches.

❍ The **sum** of the **currents** in the individual parallel branches is **equal to the current drawn from the supply I_t**:

$$\boxed{I_t = I_1 + I_2}$$

I_t = total supply current as measured by the ammeter in series with the battery

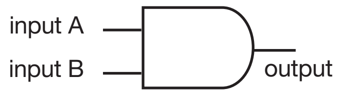
Logic gates

❍ DVD recorders, security lamps, alarm systems and washing machines are just some of the appliances controlled by **logic gates**.

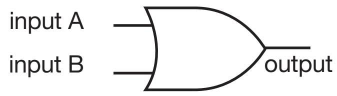
❍ Logic gates are made up of many electronic components. They are essentially **switches**.

❍ A logic gate has one or two input terminals, to which a high or low input voltage is connected, and an output terminal whose voltage is determined by the input to the gate.

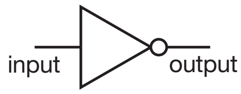
❍ The three basic logic gates are the **AND** gate, the **OR** gate and the **NOT** gate:



AND



OR



NOT

❍ Logic gates make use of two logic numbers:

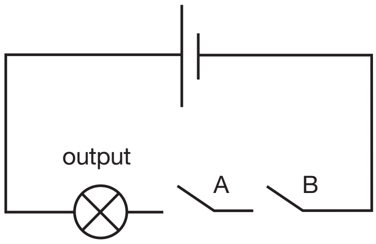
high voltage = **logic '1'** (**ON**)
low voltage = **logic '0'** (**OFF**)

❍ **Truth tables** show the outputs for all possible combinations of input.

- ***AND gate***

  An AND gate can be represented by a simple **series** circuit. The circuit below shows you how an AND gate works. Both switches must be closed for there to be a current in the circuit. The circuit itself is **not** an AND gate.

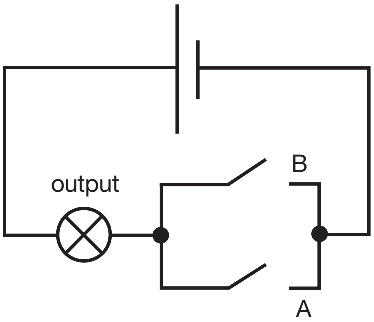
input A	input B	output
0	0	0
1	0	0
0	1	0
1	1	1



- ***OR gate***

  An OR gate can be represented by a simple **parallel** circuit. The circuit below shows you how an OR gate works. There is a current in the circuit if either or both of the switches are closed. The circuit itself is **not** an OR gate.

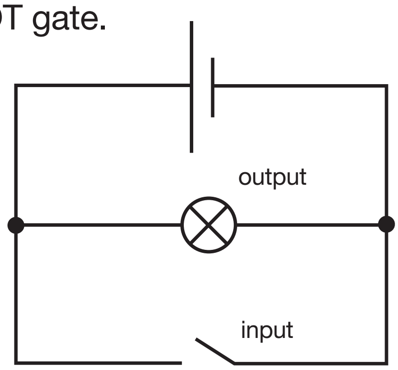
input A	input B	output
0	0	0
1	0	1
0	1	1
1	1	1



- ***NOT gate***

  A NOT gate can be represented by a **simple** circuit with a **short-circuiting switch**. The below circuit shows you how a NOT gate works. There is a current in the lamp when the switch is open. The circuit itself is **not** a NOT gate.

input	output
0	1
1	0



- In β-decay a **neutron changes** into a **proton** and an **electron**. The **atomic number** of the nucleus therefore increases by **one** and the **mass number** stays the **same**. The new proton stays in the nucleus but the electron is expelled as a β-particle. For example, using nuclide notation:

  $$^{131}_{53}I \rightarrow {}^{131}_{54}Xe + {}^{0}_{-1}\beta$$

  Again the mass numbers and proton numbers balance on both sides of the equation.

- A β-particle is a high-energy (high-speed) **electron** emitted from the nucleus.

- γ-rays are emitted when a nucleus decays but is still in a slightly unstable state after emission of particles. γ-emission causes **no change** in atomic or mass number.

Half-life

- The **activity** of any radioactive source is measured in a unit called the **becquerel** (Bq).

- An activity of **1 Bq** is **one nucleus decaying per second**. If a source has an activity of 100 Bq, it follows that 100 radioactive nuclei are decaying per second.

- The activity of radioactive sources **decreases with time**.

- Some radioactive sources are **more unstable** than others and decay at a **faster rate**.

- **Remember:** 'Decay' does not mean that radioactive material disappears. The unstable nuclei of the material change to stable nuclei of a different element.

- The bigger the mass of a given source, the greater the activity.

- Radioactive decay is **not affected** by temperature or pressure; it is spontaneous.

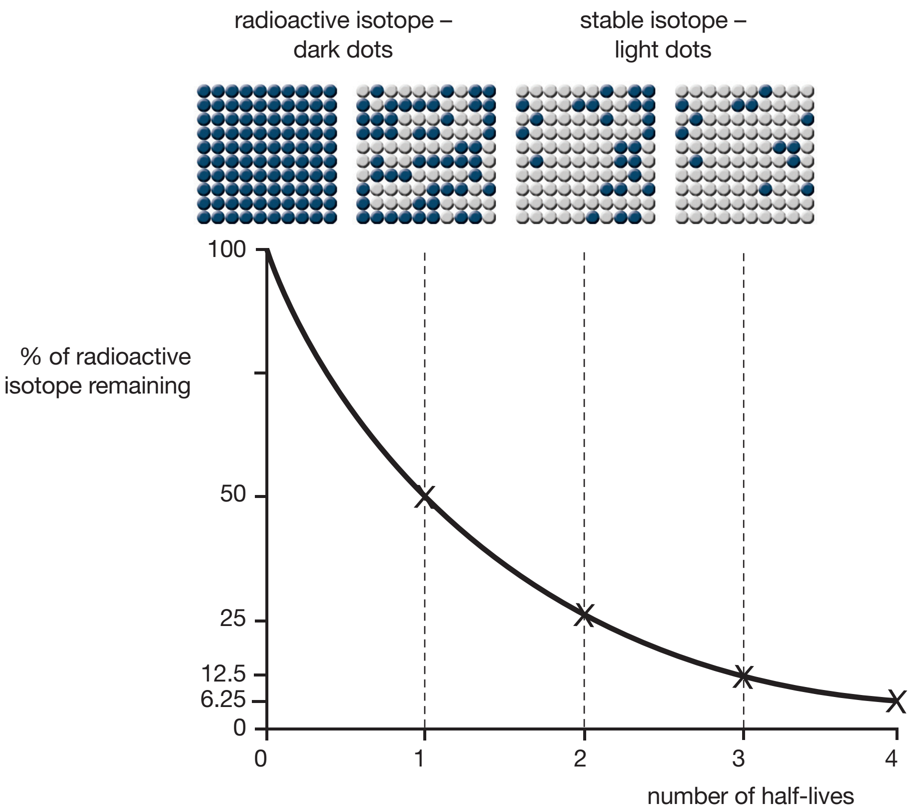
- ❑ Radioactive decay is a **random** process. There is no way to predict which nucleus in a radioactive substance will be the next to decay.

- ❑ However, the average time taken for **half** of the unstable nuclei in a sample of a particular radioactive isotope to decay is **always the same**. This time is known as the **half-life**.

- ❑ The half-life is the time taken for the **activity** of a radioactive isotope to **drop by half** of its original value.

- ❑ When calculating the half-life, the **count rate** must be corrected to account for **background radiation**. You must subtract the background count rate from the measured count rate before you start.

- ❑ The graph below shows a typical example of a radioactive isotope decaying over a period of time.

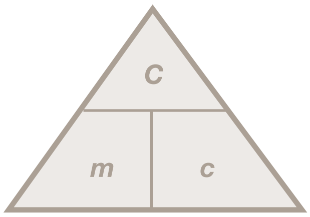


- ❑ Since the decay of an isotope is random, the curve is actually a curve of **best fit**.

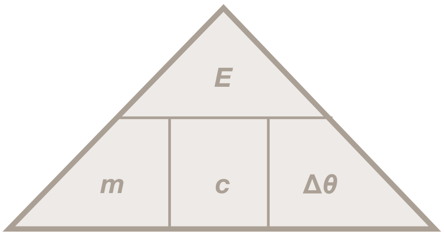
Thermal physics

- Boyle's Law:
  pressure × volume = constant
  pV = constant
  $p_1V_1 = p_2V_2$

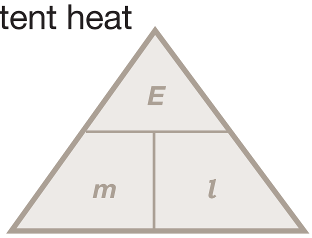
- thermal capacity = mass × specific heat capacity
  $C = mc$



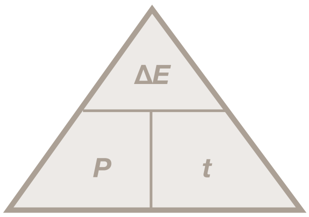
- change in energy = mass × specific heat capacity × change in temperature
  $E = mc\Delta\theta$



- energy transferred = mass × specific latent heat
  $E = ml$

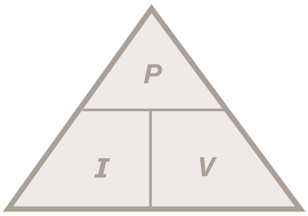


- energy transferred = power × time
  $\Delta E = Pt$



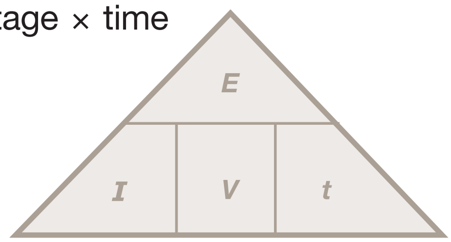
❍ power = current × voltage

$P = IV$



❍ energy transferred = current × voltage × time

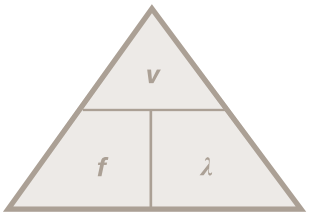
$E = IVt$



Properties of waves, including light and sound

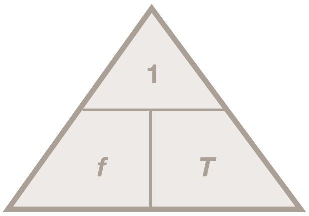
❍ velocity = frequency × wavelength

$v = f\lambda$



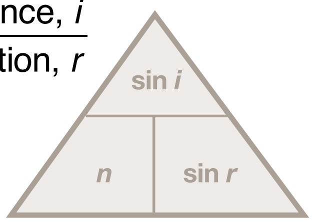
❑ frequency = $\dfrac{1}{\text{period}}$

$f = \dfrac{1}{T}$



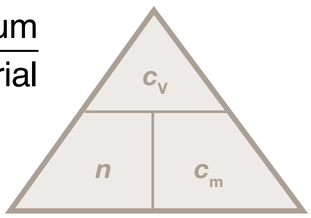
❍ refractive index = $\dfrac{\text{sine of angle of incidence, } i}{\text{sine of angle of refraction, } r}$

$n = \dfrac{\sin i}{\sin r}$



❍ refractive index = $\dfrac{\text{speed of light in vacuum}}{\text{speed of light in material}}$

$n = \dfrac{c_v}{c_m}$



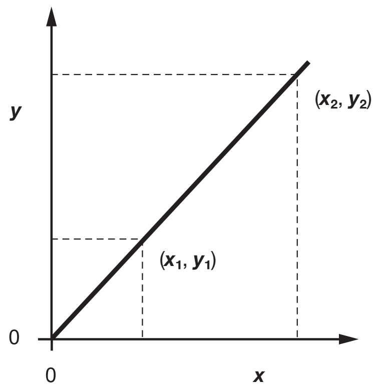
- The y-axis will usually represent the experimental results – the **dependent variable**. This will give rise to a straight line or a curve.
- Label the axes clearly with both variable and units.

❑ **Drawing the graph**

- The graph you draw (i.e. the points you plot) should cover as much of the graph paper as possible – three-quarters of the page is a good guide.
- Plot crosses (x) or encircled dots (⊙) rather than dots (·) on your graph. Re-check any points that do not appear to fit the pattern.
- Draw a smooth continuous line that will not necessarily pass through all the points, known as a **line of best fit**. If the graph looks like a straight line, then use a ruler.

❍ **Finding the gradient of a line**

- Use $m = \frac{\Delta y}{\Delta x}$ to find the gradient of a line. Make sure you pick two points that are **on the line**. It is helpful to show the values you choose by drawing dotted lines from the axes (see below). Choose values as **far apart** as possible to give a more accurate gradient.



Example

Let (x_1, y_1) be (5.0, 50) and (x_2, y_2) be (10, 100).

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{100 - 50}{10 - 5.0} = 10$$

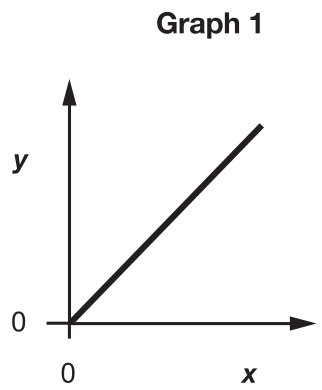
In many cases the gradient will have units. For example, if y is distance measured in metres and x is time measured in seconds, the gradient calculated above will be 10 m/s.

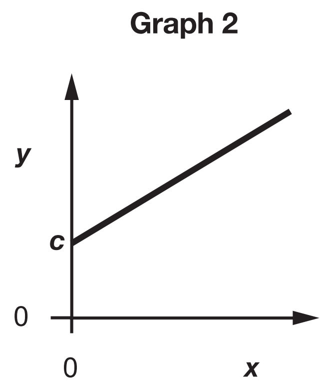
Understanding the graph you have plotted

❑ **Proportionality and linearity**

Many quantities in Physics are **directly proportional** to each other. Many formulae are derived from **straight-line** (**linear**) relationships.

The formula of a straight line on a graph is made up of a y term, an x term, and sometimes a number, and is written in the form of $y = mx + c$.





❑ ***Graph 1 – directly proportional***

As x increases, y increases. The graph is a straight line and passes through the origin. Importantly the ratio of x:y is always the same. The graph formula is $y = mx$, where m is the steepness of the line, also known as the gradient:

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

❑ ***Graph 2 – straight line with y-intercept***

As x increases, so does y as before. The difference is when $x = 0$, as this time y is not zero. The graph formula is $y = mx + c$, where m is the gradient. The y-intercept (the value of y when $x = 0$) is c.

resultant force the net force acting on a body when two or more forces are unbalanced; effectively the replacement of all forces acting on an object with one equivalent force

ripple a small, uniform wave on the surface of water

scalar quantity a quantity with magnitude (size) only

scintillations flashes of light

second (**s**) the base unit of time

secondary coil the output coil of a transformer

sensitivity response to change; a sensitive instrument gives a large reading for a small change in the quantity being measured

series circuit a circuit in which current has one path

short circuit a low-resistance connection between two points, causing a large current to flow

SI an internationally agreed system of units based on the metric system

slip rings used to allow the passage of current to and from a coil in an a.c. generator

Snell's Law the ratio of sin i to sin r is a constant and is equal to the refractive index of the second medium with respect to the first

soft magnetic materials materials that, once magnetised, can easily be demagnetised

solenoid a coil of wire that becomes magnetised when a current is present in the coil

sound wave a longitudinal wave that carries sound energy from place to place

specific heat capacity (**s.h.c.**) the energy needed to raise the temperature of one kilogram of a substance by one degree Celsius

specific latent heat the energy needed to melt or boil one kilogram of a substance without a change in temperature

spectrum colours of light separated out in the order of their wavelengths

speed the distance travelled by an object per second

speed of light in a vacuum is 3×10^8 m/s

split ring used to allow the passage of current to and from a coil in a d.c. motor; also reverses the direction of the current every half turn

static electricity electric charge held by a charged insulator

sterilise to kill bacteria and clean

sterility the inability to have children

streamlined smoothed and somewhat rounded in order to reduce air resistance

temperature a measure of how hot a body is

terminal velocity the maximum velocity reached by an object moving through a fluid such as air; reached when the force due to its weight is equal to the force due to air resistance

thermal energy the internal energy a body has because of the motion of its particles

thermal expansion the expansion of a material due to a rise in temperature

thermistor a component whose resistance decreases with an increase in temperature and vice versa

thermocouple a thermometer made from two metal wires joined at the ends to form junctions

total internal reflection all light is reflected back from a surface between materials; this happens as a result of the angle of incidence being greater than the critical angle

transducer any device or component that converts one form of energy into another

transformer a device used to change the voltage of an a.c. electricity supply

transmission lines power cables used to carry electricity from power stations to consumers

transverse wave a wave in which the vibrations or oscillations are at right angles to the direction of travel

truth table a summary table of the action of logic gate(s)

turbine a machine similar to a fan with blades that rotate when air, steam or water passes through; often used to generate electricity

ultrasound sound waves with frequencies greater than 20 000 Hz, which cannot be heard by the human ear

ultraviolet radiation the portion of the electromagnetic spectrum between visible light and X-rays, which can cause tanning of the skin

uniform constant

variable resistor a component whose resistance can be manually altered

vector a quantity with both magnitude (size) and direction

velocity the speed of an object in a particular direction

virtual image an image that cannot be formed on a screen

voltage a measure of the energy converted per unit charge passing through a component; also a measure of the amount of energy transferred to electrical form per unit charge by an electrical power supply, like a battery; measured in volts (V)

voltmeter a meter used for measuring the voltage (p.d) between two points

wavefront the set of points connected in space by a wave or vibration at the same instant; wavefronts generally form a continuous line or surface; for example, the lines formed by ripples on a pond

wavelength the distance between two adjacent identical points on a wave

weight the downward force due to gravity acting on an object's mass

work done the product of force and distance in the direction of the force

Glossary for examination terminology

This glossary (which is relevant only to science subjects) will prove helpful to candidates as a guide, but it is neither exhaustive nor definitive. Candidates should appreciate that the meaning of a term must depend, in part, on its context.

Define (the term(s) …) is intended literally, only a formal statement or equivalent paraphrase being required.

What do you understand by/What is meant by (the term(s) …) normally implies that a definition should be given, together with some relevant comment on the significance or context of the term(s) concerned, especially where two or more terms are included in the question. The amount of supplementary comment intended should be interpreted in the light of the indicated mark value.

State implies a concise answer with little or no supporting argument (e.g. a numerical answer that can readily be obtained 'by inspection').

List requires a number of points, generally each of one word, with no elaboration. Where a given number of points is specified this should not be exceeded.

Explain may imply reasoning or some reference to theory, depending on the context. It is another way of asking candidates to give reasons. The candidate needs to leave the examiner in no doubt why something happens.

Give a reason/Give reasons is another way of asking candidates to explain why something happens.

Describe requires the candidate to state in words (using diagrams where appropriate) the main points.

Describe and **explain** may be coupled, as may **state** and **explain**.

Discuss requires the candidate to give a critical account of the points involved.

Outline implies brevity (i.e. restricting the answer to giving essentials).

Predict implies that the candidate is expected to make a prediction not by recall but by making a logical connection between other pieces of information.

Deduce implies that the candidate is not expected to produce the required answer by recall but by making a logical connection between other pieces of information.

Suggest is used in two main contexts, i.e. either to imply that there is no unique answer (e.g. in physics there are several examples of energy resources from which electricity, or other useful forms of energy, may be obtained), or to imply that candidates are expected to apply their general knowledge of the subject to a 'novel' situation, one that may be formally 'not in the syllabus' – many data response and problem solving questions are of this type.

Find is a general term that may variously be interpreted as **calculate**, **measure**, **determine**, etc.

Calculate is used when a numerical answer is required. In general, working should be shown, especially where two or more steps are involved.

Measure implies that the quantity concerned can be directly obtained from a suitable measuring instrument (e.g. length using a rule, or mass using a balance).

Determine often implies that the quantity concerned cannot be measured directly but is obtained from a graph or by calculation.

Estimate implies a reasoned order of magnitude statement or calculation of the quantity concerned, making such simplifying assumptions as may be necessary about points of principle and about the values of quantities not otherwise included in the question.

Sketch, when applied to graph work, implies that the shape and/or position of the curve need only be qualitatively correct, but candidates should be aware that, depending on the context, some quantitative aspects may be looked for (e.g. passing through the origin, having an intercept).
In diagrams, **sketch** implies that simple, freehand drawing is acceptable; nevertheless, care should be taken over proportions and the clear exposition of important details.

- Are you aiming to improve your understanding of Cambridge IGCSE Physics?
- Do you want the core syllabus and supplement content clearly identified?
- Do you want a book that contains all the essential information, clearly laid out and written in a lively style that is easy to follow?
- Do you want clear diagrams and illustrations to aid your understanding?
- Do you want a formula summary and a book that guides you through calculations step by step?
- Do you want an alphabetical list of terms that are unfamiliar to you with helpful definitions to aid your understanding?
- Above all do you want Cambridge IGCSE Physics explained?

THEN THIS IS THE BOOK FOR YOU!