Collins

AQA

GCSE

PHYSICS

H

SET B – Paper 1 Higher Tier

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Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:

- a ruler
- a calculator
- the Physics Equation Sheet (found at the end of the paper).

Instructions

- Answer **all** questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- There are 100 marks available on this paper.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.
- When answering questions 01.1, 02.1 and 08.1 you need to make sure that your answer:
  – is clear, logical, sensibly structured
  – fully meets the requirements of the question
  – shows that each separate point or step supports the overall answer.

Advice

- In all calculations, show clearly how you work out your answer.

Name: ....

01.1 Compare the motion and arrangement of particles when a substance is in its **solid** state, **liquid** state and **gas** state.

[4 marks]

01.2 What is meant by the **internal energy** of a material?

[3 marks]

01.3 Which **two** of the changes below would cause an **increase** in the internal energy of a volume of liquid water?

Tick **two** boxes.

The water temperature is increased ☐

The water is changed to ice at 0°C ☐

The water is changed to steam at 100°C ☐

The water temperature is decreased ☐ **[2 marks]**

02.1 A student wants to demonstrate to her class that:

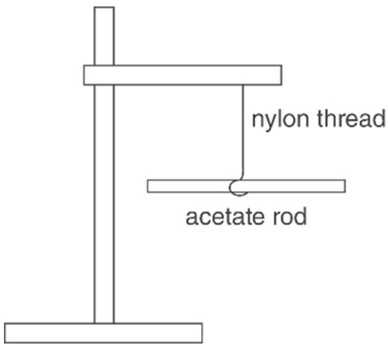
Two objects that carry the same type of charge repel

Two objects that carry different types of charge attract

The apparatus the student has is:

1. a piece of cloth
2. two acetate rods
3. two polythene rods
4. a way to suspend a rod so that it can move freely, as shown in **Figure 2.1**

Figure 2.1



Describe the demonstration that the student should do for the class.

Use this information:

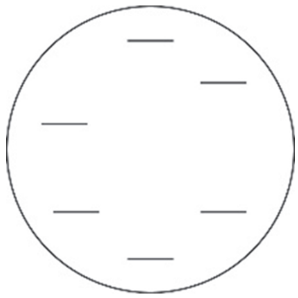
- polythene can gain a negative charge
- acetate can gain a positive charge.

[4 marks]

Question 2 continues on the next page

02.2 A polythene rod is used to give a negative charge to the surface of a small metal sphere shown in **Figure 2.2**

Figure 2.2



Draw **at least four** electric field lines on **Figure 2.2** to show the pattern of the electric field created by the charge on the sphere.

[2 marks]

02.3 The student gives another sphere a negative charge.

She moves the second sphere towards the first.

Which is the correct description of the force between the two charged spheres as they are moved closer together?

Tick **one** box.

An attractive force getting bigger ☐

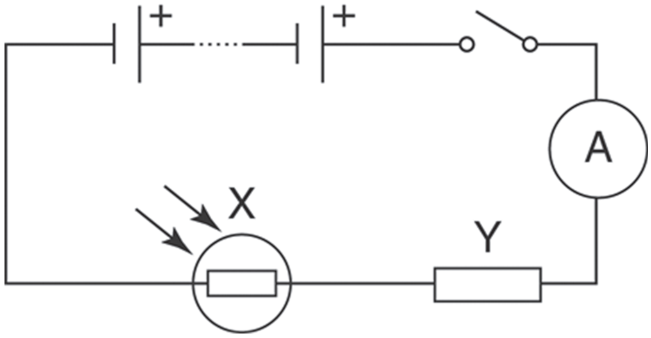
A repulsive force getting bigger ☐

An attractive force getting smaller ☐

A repulsive force getting smaller ☐ **[1 mark]**

03 **Figure 3.1** shows a circuit diagram containing components X and Y.

Figure 3.1



03.1 Give the name of component X.

.... **[1 mark]**

03.2 In daylight, X has a resistance of 40 Ω

Y has a resistance of 460 Ω

Determine the total resistance in the circuit.

Total resistance = ... Ω **[1 mark]**

03.3 Write down the equation linking potential difference, current and resistance.

.... **[1 mark]**

Question 3 continues on the next page

03.4 The battery supplies a potential difference of 12 V to the circuit.

Calculate the expected reading on the ammeter during daylight when the switch is closed.

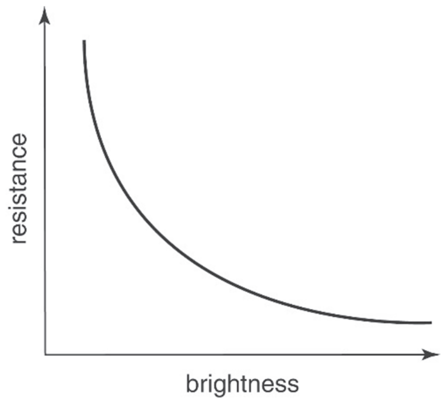
....

....

Ammeter reading = ... A **[3 marks]**

03.5 **Figure 3.2** is a sketch graph showing how the resistance of component X varies as the brightness of the light shining on it changes.

Figure 3.2



Use **Figure 3.2** to predict how the ammeter reading would change if the circuit was in darkness when the switch was closed.

Explain your answer.

....

....

.... **[2 marks]**

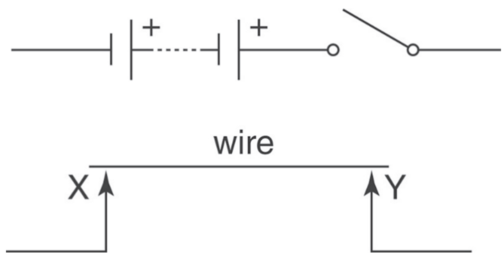
04.1 A student wants to find out if a length of wire behaves as an ohmic conductor.

She needs a circuit to measure the current through the wire for various values of potential difference across the wire.

She has crocodile clips, X and Y, to connect to the ends of the wire.

Complete the circuit diagram in **Figure 4.1** to enable her to take the measurements.

Figure 4.1

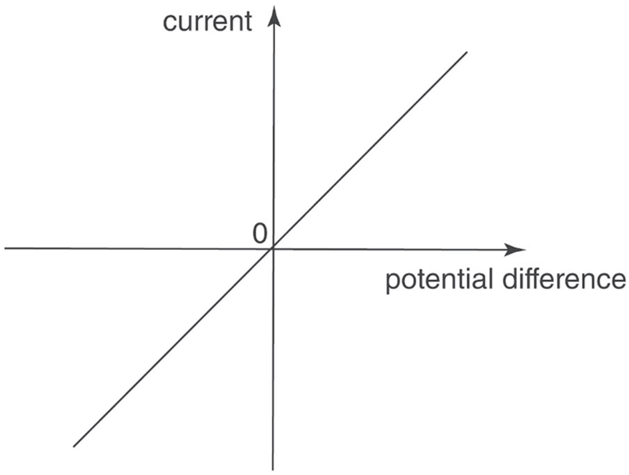


[3 marks]

Question 4 continues on the next page

04.2 **Figure 4.2** is a sketch graph of the student's current and potential difference data for the wire.

Figure 4.2



What can be concluded from **Figure 4.2** about the relationship between current and potential difference?

Is the wire an ohmic conductor?

....

....

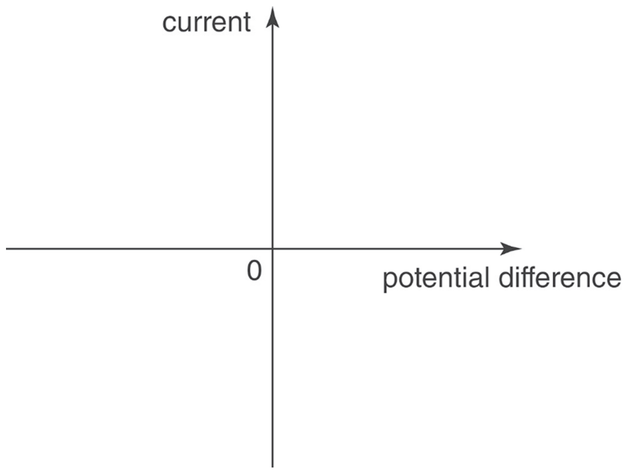
.... **[2 marks]**

04.3 The student replaced the wire between the crocodile clips with a filament bulb.

Sketch the graph of current against potential difference that the student would expect for the filament bulb.

Use the axes in **Figure 4.3**

Figure 4.3



[2 marks]

04.4 Explain why the resistance of a filament bulb changes as the current through it is increased.

....

....

....

.... **[2 marks]**

Turn over >

05.1 A radioactive tracer is put into a patient's body to investigate an organ that may not be functioning normally.

A detector is used to detect the radiation emitted by the tracer atoms.

Explain why a radioactive isotope that emits alpha radiation is **not** suitable for use as a tracer.

....

....

....

.... **[2 marks]**

05.2 The most commonly used medical tracer is technetium-99

Technetium-99 has a half-life of 6 hours.

Explain why a half-life of 6 hours makes technetium-99 suitable for use as a tracer.

....

....

....

.... **[2 marks]**

05.3 The radioactive isotope iodine-131 is used to destroy cancerous cells in the thyroid gland.

The radioactive iodine is given to the patient in the form of a capsule which they eat.

Iodine-131 emits beta and gamma radiation.

It has a half-life of 8 days.

Explain why the patient would have to spend time in hospital isolated from other people.

....

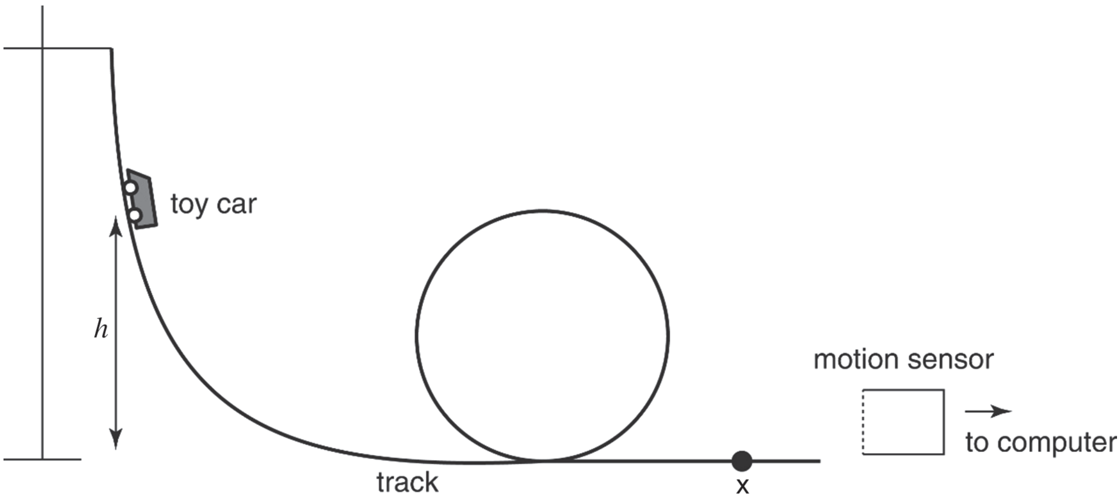
....

....

.... **[3 marks]**

06 A student is experimenting with a child's loop-the-loop track for toy cars, as shown in **Figure 6.1**

Figure 6.1



The student gradually increases the height (h) from which the toy car is released.

Eventually, the car has enough energy to complete the loop and travel along the track towards the motion sensor.

The motion sensor and computer record the speed of the car as it passes point X.

06.1 The student finds that if the car is released at a height of h = 42 cm, it stays on the track and reaches the motion sensor.

Calculate the gain in the car's gravitational potential energy store by lifting it to height h = 42 cm

The mass of the toy car is 0.050 kg

Take gravitational field strength = 10 N/kg

....

....

Gain in gravitational potential energy = ... J **[2 marks]**

Question 6 continues on the next page

06.2 At point X in **Figure 6.1**, the motion sensor records the car's speed as 2.0 m/s

Calculate the car's kinetic energy.

....

....

Kinetic energy = ... J **[2 marks]**

06.3 Give a reason why the kinetic energy value at **X** must be less than the gravitational potential energy value at height $h =$ 0.42 cm

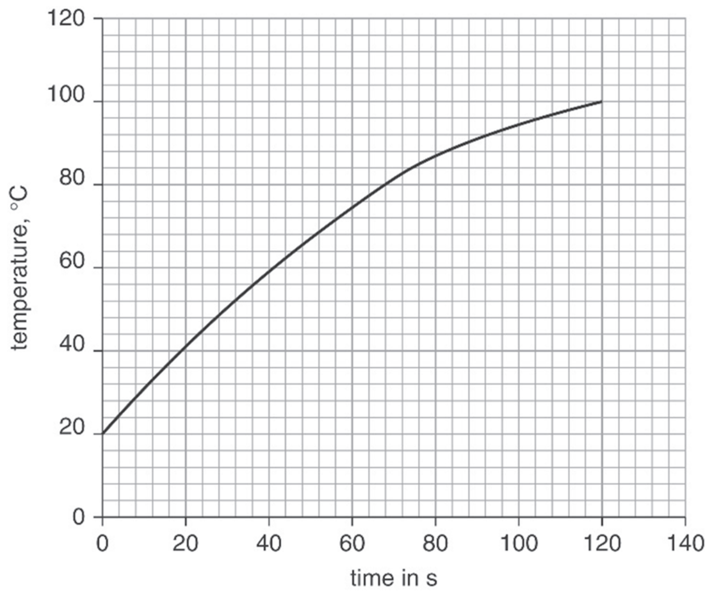
....

.... **[1 mark]**

07 A temperature sensor inside an electric kettle measures the water temperature every 5.0 s as the water is heated.

Figure 7.1 shows the graph of the temperature data that was recorded.

Figure 7.1



07.1 Determine the gradient of the line in **Figure 7.1** at 80 s

Show on the graph how you obtained your answer.

....

....

....

Gradient = ... °C/s **[2 marks]**

Question 7 continues on the next page

07.2 The gradient of the line in **Figure 7.1** represents the water's **temperature rise per second**.

What can be concluded about how the water's temperature rise per second changes as the water gets hotter?

Use data from the graph to support your answer.

[2 marks]

07.3 What can be concluded about the **rate of dissipation** of thermal energy to the surroundings as the water temperature rises?

[1 mark]

07.4 **Table 7.1** shows the thermal conductivity of materials used for the outer casing of different kettles.

Table 7.1

Material	Thermal conductivity in W/(m K)
Steel	16
polyethylene	0.33
polypropylene	0.22

It is desirable to minimise the rate of energy transfer from the water through the outer casing of the kettle.

Which material from **Table 7.1** is most suitable?

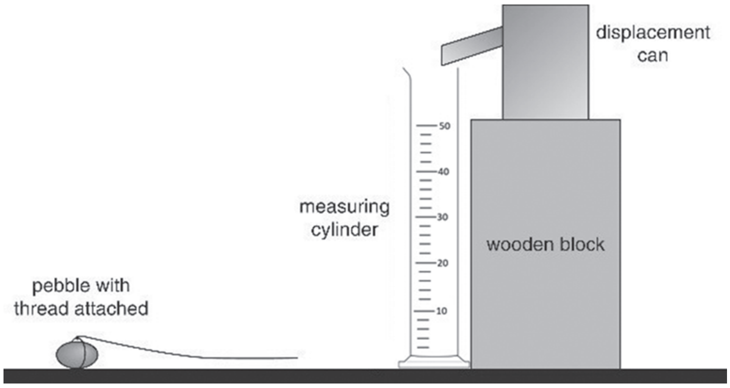
Explain your answer.

[2 marks]

08.1 **Figure 8.1** shows apparatus that can be used to measure the volume of a pebble, in order to determine the pebble's density.

The measuring cylinder measures up to 50 cm^3 and has 1 cm^3 graduations.

Figure 8.1



Write a series of instructions to determine the volume and density of the pebble.

State any additional laboratory apparatus that may be required.

Suggest how errors can be kept as small as possible.

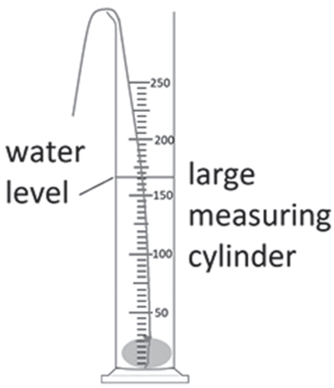
[6 marks]

Question 8 continues on the next page

08.2 A student suggests an alternative method to determine the volume of the **same** pebble.

He suggests lowering the pebble into a much larger measuring cylinder which already contains water **(Figure 8.2).**

Figure 8.2



Describe how this apparatus can be used to determine the **volume** of the pebble.

[3 marks]

08.3 Using the method in **Figure 8.2,** the student chooses a measuring cylinder that measures up to 250 cm^3 and has 5 cm^3 graduations.

Compare the accuracy of the volume measurement using this method with the accuracy using the method shown in **Figure 8.1**

[2 marks]

09.1 When a uranium nucleus undergoes fission, it splits into two daughter nuclei called **fission fragments**.

Typically, two to three free neutrons are also released.

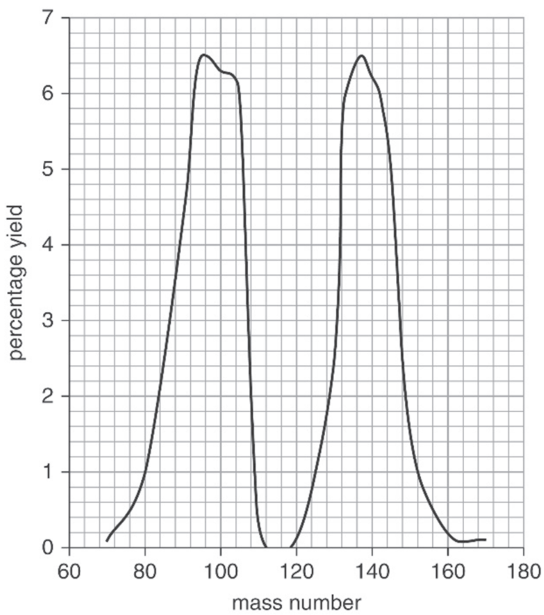
Describe what must happen for a chain reaction to become established in a sample of uranium.

[3 marks]

09.2 When a chain reaction occurs in uranium, the mass numbers of the fission fragments produced vary between 70 and 170

The graph in **Figure 9.1** shows the typical distribution of the fission fragment mass numbers for the fission of uranium.

Figure 9.1



Determine the **two most probable** mass numbers of the fission fragments produced in the fission of uranium.

Use the data shown in **Figure 9.1**

[2 marks]

Question 9 continues on the next page

09.3 Fission fragment nuclei are unstable.

One example of a fission fragment is strontium, $^{90}_{38}Sr$

Give the numbers of the different subatomic particles present in a strontium nucleus.

....

.... **[2 marks]**

09.4 Strontium-90 decays by beta emission to form an isotope of yttrium.

Complete the decay equation for strontium-90

$$^{90}_{38}Sr \longrightarrow {}^{\cdots}_{\cdots}Y + {}^{\cdots}_{\cdots}e$$

[2 marks]

09.5 Strontium-90 has a half-life of 30 years.

What fraction of a sample of strontium-90 remains after 120 years have passed?

....

Fraction = ... **[1 mark]**

09.6 The uranium fuel used at a nuclear power station is an alpha emitter.

The fission fragments produced in the power station are mostly beta emitters.

Explain why the fission fragments create a greater hazard to the workers at the power station than the uranium fuel.

....

.... **[2 marks]**

09.7 Material containing fission fragments forms some of the nuclear waste produced by a nuclear power station.

Table 9.1 lists some of the fission fragment isotopes, and gives their half-life values.

Table 9.1

Fission fragment	Half-life
Barium-140	12 days
Caesium-137	30 years
Caesium-139	9 minutes
Iodine-131	8 days
Krypton-85	11 years
Xenon-140	14 s

Name **two** fission fragments from **Table 9.1** that will require long-term safe storage.

....

.... **[2 marks]**

Turn over >

10.1 A change of state of a substance is described as a physical change.

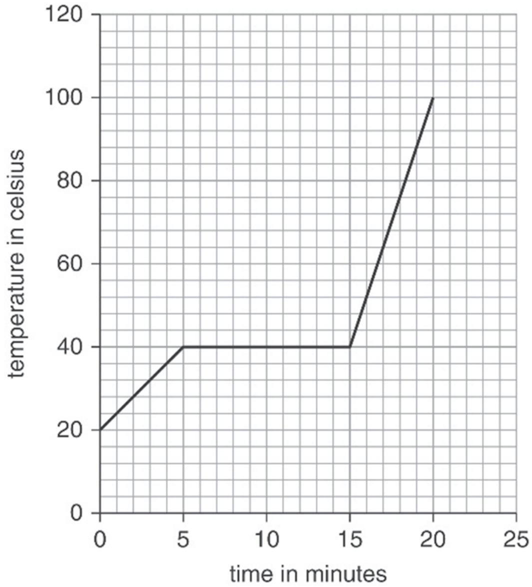
Explain what is meant by a **physical change**.

....

.... **[1 mark]**

10.2 **Figure 10.1** shows the heating graph for a substance being heated at a constant rate.

Figure 10.1



Determine the melting point of the substance.

Melting point = ... °C **[1 mark]**

10.3 Use **Figure 10.1** to determine the time taken for the substance to change entirely from its solid state to its liquid state.

Time = ... minutes **[1 mark]**

10.4 The power of the electrical heater used to heat the substance was 50 W

The substance had a mass of 0.10 kg

Calculate the specific latent heat of fusion of the substance.

....

....

....

....

....

Specific latent heat of fusion = ... J/kg **[5 marks]**

10.5 Look again at the graph in **Figure 10.1**

Determine whether the **specific heat capacity** of the substance in its solid state is **larger** or **smaller** than its specific heat capacity in its liquid state.

Explain your answer.

....

....

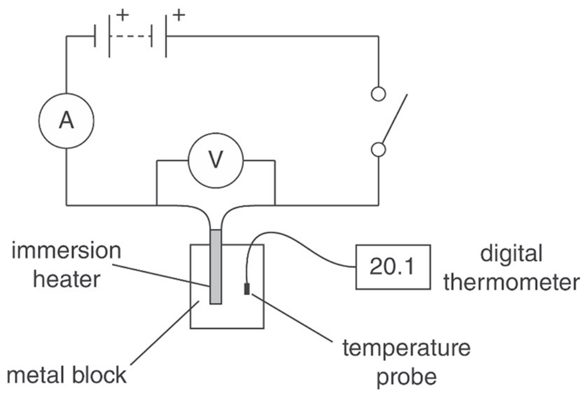
....

.... **[2 marks]**

Turn over >

11 A student uses the apparatus in the circuit shown in **Figure 11.1** to measure the specific heat capacity of a metal block.

Figure 11.1



11.1 The battery supplies approximately 9 V of potential difference.

The resistance of the immersion heater is approximately 15 Ω

Calculate an approximate value for the current drawn from the battery by the immersion heater.

....

....

Current ≈ .... A **[3 marks]**

11.2 The student has three different ammeters to choose from for the experiment.

Details of the three ammeters, X, Y and Z, are shown in **Table 11.1**

Table 11.1

Ammeter	Maximum current reading, in A	Value of the smallest division, in A
X	2	0.1
Y	1	0.05
Z	0.5	0.02

Which would be the most suitable ammeter to measure the current in the circuit?

Explain your answer.

....

....

.... **[3 marks]**

11.3 The student closes the switch in the circuit (**Figure 11.1**).

The heater raises the temperature of the metal block.

The student's measurements are shown in **Table 11.2**

Table 11.2

Quantity	Measurement
Mass of block	0.50 kg
Initial temperature	20.1°C
Final temperature	30.1 °C
Current	0.55 A
Potential difference	8.0 V
Heating time	500 s

Use the student's measurements to calculate the energy supplied by the heater.

....

....

Energy supplied = ... J **[3 marks]**

11.4 Use your answer to question 11.3 and the student's data in **Table 11.2** to calculate the specific heat capacity of the metal block.

Give the correct unit with your answer.

....

....

....

....

Specific heat capacity = ...

Unit: .... **[4 marks]**

END OF QUESTIONS

Physics Equation Sheet

Equation Number	Word Equation	Symbol Equation
1	pressure due to a column of liquid = height of column × density of liquid × gravitational field strength	$p = h \rho g$
2	(final velocity)^2 – (initial velocity)^2 = 2 × acceleration × distance	$v^2 - u^2 = 2 a s$
3	force = $\frac{\text{change in momentum}}{\text{time taken}}$	$F = \frac{m\Delta v}{\Delta t}$
4	elastic potential energy = 0.5 × spring constant × (extension)^2	$E_e = \frac{1}{2} ke^2$
5	change in thermal energy = mass × specific heat capacity × temperature change	$\Delta E = m c \Delta\theta$
6	period = $\frac{1}{\text{frequency}}$	
7	magnification = $\frac{\text{image height}}{\text{object height}}$	
8	force on a conductor (at right-angles to a magnetic field) carrying a current = magnetic flux density × current × length	$F = B I l$
9	thermal energy for a change of state = mass × specific latent heat	$E = m L$
10	$\frac{\text{potential difference across primary coil}}{\text{potential difference across secondary coil}} = \frac{\text{number of turns in primary coil}}{\text{number of turns in seconday coil}}$	$\frac{V_p}{V_s} = \frac{n_p}{n_s}$
11	potential difference across primary coil × current in primary coil = potential difference across secondary coil × current in secondary coil	$V_p I_p = V_s I_s$
12	For gases: pressure × volume = constant	pV = constant