

Please write clearly in block capitals.

Centre number

--	--	--	--	--

Candidate number

--	--	--	--

Surname

---

Forename(s)

---

Candidate signature

---

I declare this is my own work.

# GCSE PHYSICS

# H

Higher Tier Paper 2

Time allowed: 1 hour 45 minutes

## Materials

For this paper you must have:

- a ruler
- a scientific calculator
- a protractor
- the Physics Equations Sheet (enclosed).

## Instructions

- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided.
- Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- In all calculations, show clearly how you work out your answer.

## Information

- The maximum mark for this paper is 100.
- 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.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
<b>TOTAL</b>	



Answer **all** questions in the spaces provided.

Do not write  
outside the  
box

0 1

**Figure 1** shows an electric super-car.

**Figure 1**



0 1 . 1

The battery in an electric car needs to be recharged.

Suggest **two** factors that affect the **distance** an electric car can travel **before** the **battery needs to be recharged**.

[2 marks]

- 1 Capacity of the battery
- 2 Speed driven



Use the Physics Equations Sheet to answer questions **01.2** and **01.3**.

- 0 1 . 2** Write down the equation which links acceleration ( $a$ ), change in velocity ( $\Delta v$ ) and time taken ( $t$ ).

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

[1 mark]

---

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

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

- 0 1 . 3** The maximum acceleration of the car is  $20 \text{ m/s}^2$ .

Calculate the time taken for the speed of the car to change from  $0 \text{ m/s}$  to  $28 \text{ m/s}$  at its maximum acceleration.

$$a = 20 \text{ m/s}^2$$

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

[3 marks]

$$\Delta v = 28 - 0 \text{ m/s}$$

$$= 28 \text{ m/s}$$

$$t a = \Delta v$$

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

$$t = ?$$

Time taken = 1.4 s

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

Question 1 continues on the next page

$$t = \frac{28 \text{ m/s}}{20 \text{ m/s}^2}$$

$$t = 1.4 \text{ s}$$



0 1 . 4 In a trial run, the car accelerates at  $10 \text{ m/s}^2$  until it reaches its final velocity.

distance travelled by the car =  $605 \text{ m}$

initial velocity of the car =  $0 \text{ m/s}$

Calculate the final velocity of the car.

Use the Physics Equations Sheet.

(final velocity)<sup>2</sup> – (initial velocity)<sup>2</sup> = 2 × acceleration × distance

$v^2 - u^2 = 2 a s$  [3 marks]

$$v = ?$$

$$v^2 - u^2 = 2as$$

$$u = 0 \text{ m/s}$$

$$v^2 = 2as + u^2$$

$$a = 10 \text{ m/s}^2$$

$$v = \sqrt{2as + u^2}$$

$$s = 605 \text{ m}$$

Final velocity = 110 m/s

$$v = \sqrt{2as + u^2}$$

$$v = \sqrt{2 \times 10 \times 605 + 0^2}$$

$$v = \sqrt{12100}$$

$$v = 110 \text{ m/s}$$



Use the Physics Equations Sheet to answer questions **01.5** and **01.6**.

**0 1 . 5** Write down the equation which links distance ( $s$ ), force ( $F$ ) and work done ( $W$ ).

[1 mark]

$$W = Fs$$

work done = force  $\times$  distance (along the line of action of the force)

$$W = F s$$

**0 1 . 6** When travelling at its maximum speed the air resistance acting on the car is 4000 N.

Calculate the work done against air resistance when the car travels a distance of 7.5 km at its maximum speed.

[3 marks]

$$W = ?$$

$$W = F s$$

$$F = 4000 \text{ N}$$

$$W = 4000 \text{ N} \times 7.5 \times 10^3 \text{ m}$$

$$s = 7.5 \text{ km}$$

$$W = 3.0 \times 10^7 \text{ J}$$

$$= 7.5 \times 10^3 \text{ m}$$

Work done =  $3.0 \times 10^7$  J

13

Turn over for the next question

Turn over ►



0 2

A student used a ray box to shine a ray of light through air into a glass block.

The student investigated how the angle of refraction varied with the angle of incidence.

**Table 1** shows the results.

**Table 1**

Angle of incidence in degrees	Angle of refraction in degrees
10	5
20	10
30	14
40	19
50	23
60	26
70	28
80	29

0 2 . 1

**Describe a method** the student could have used to obtain the results in **Table 1**.

Your answer may include a labelled diagram.

**[6 marks]**

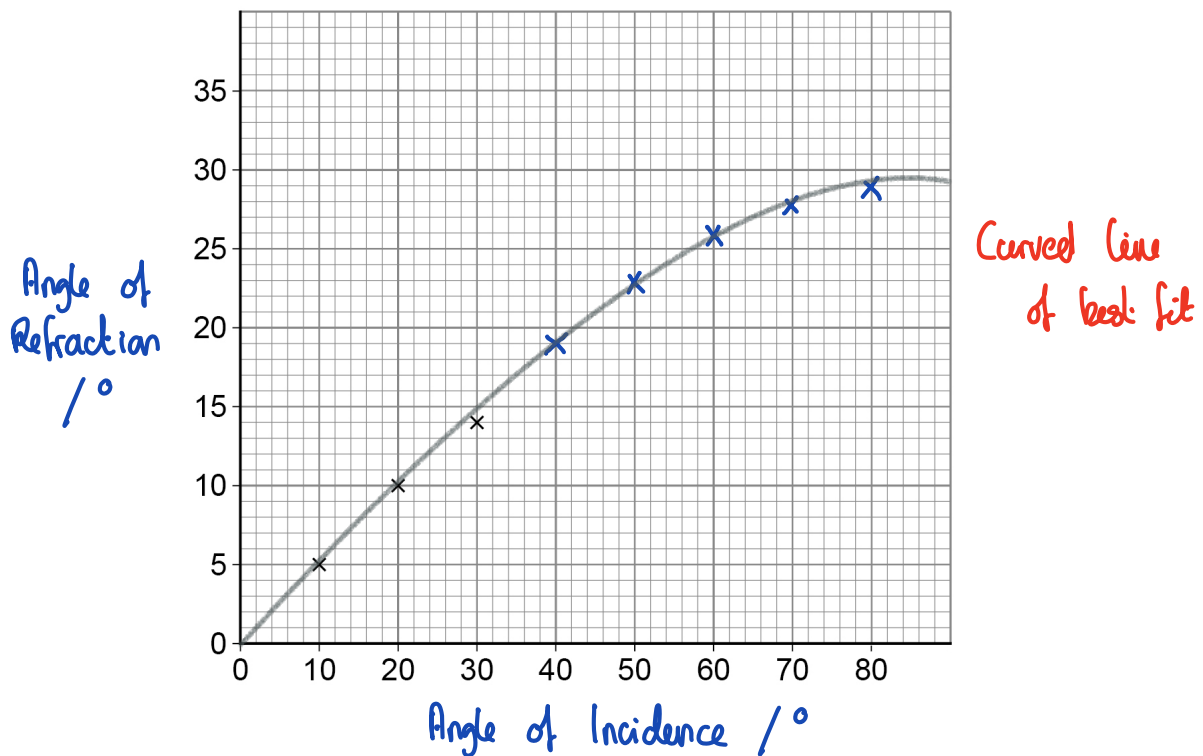
Place glass block on piece of paper  
 Draw around glass block  
 Use ray box to shine a ray of light through glass block  
 Mark the ray of light entering the glass block  
 Mark the ray of light emerging from the glass block  
 Join the points to show the path of the complete ray  
 through the block, and draw a normal line at  
 $90^\circ$  to the surface.



Use a protractor to measure the angle of incidence  
 Use a protractor to measure the angle of refraction  
 Use ray box to shine a ray of light at a range of  
 different angles of incidence, increasing in  $10^\circ$   
 intervals, from  $10^\circ$  to  $80^\circ$

0 2 . 2 Figure 2 is an incomplete graph of the results.

Figure 2



Complete **Figure 2** using data from **Table 1**.

- Label the axes.
- Plot the remaining data.
- Draw a line of best fit.

[4 marks]

Question 2 continues on the next page



0 2 3

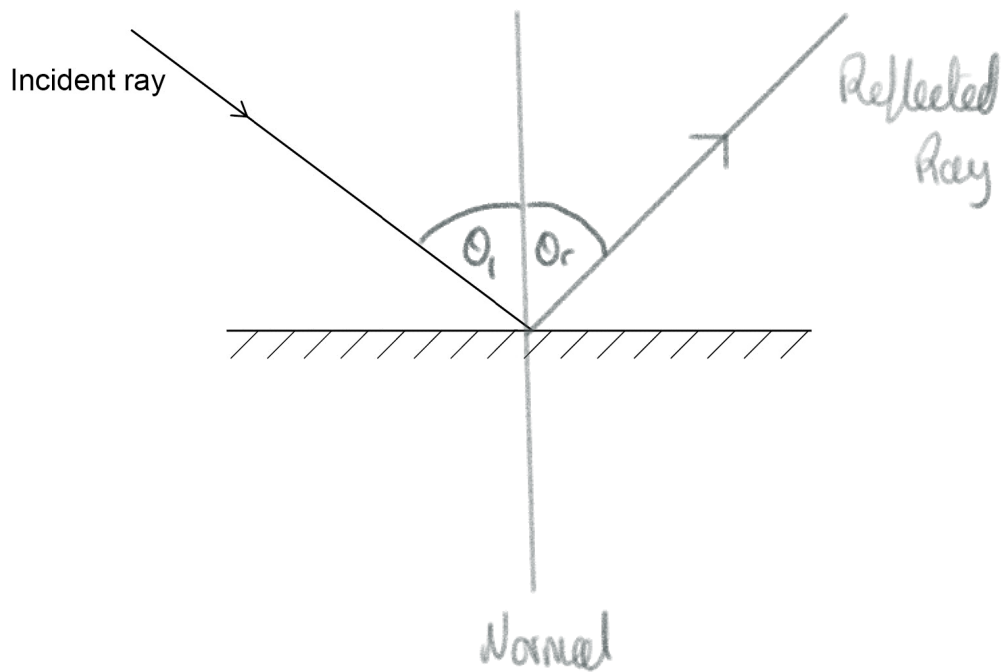
Complete the ray diagram in **Figure 3** to show the **reflection** of light from the surface of a plane mirror.

You should:

- draw the normal line
- draw the reflected ray.

[2 marks]

Figure 3

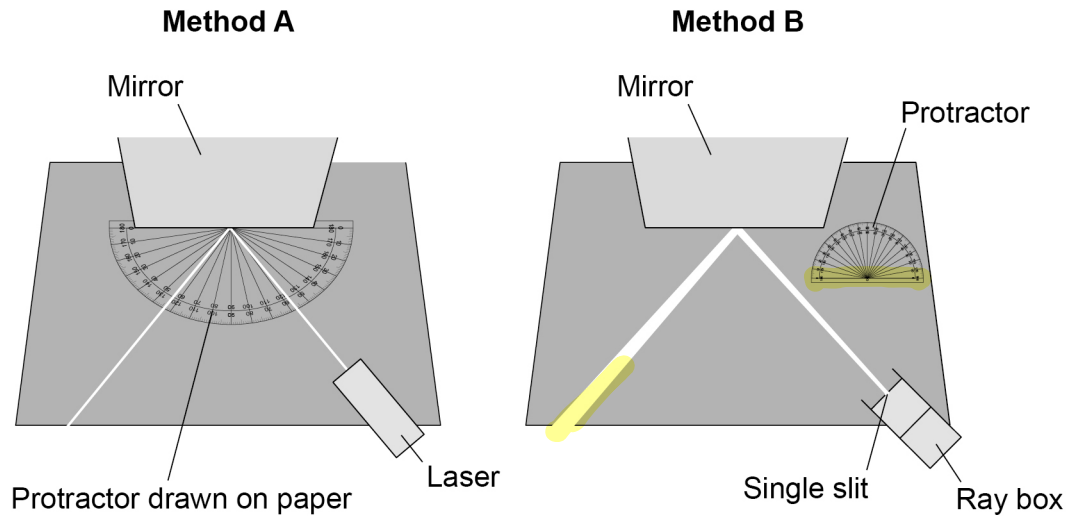


0 2 . 4

Two students investigated the reflection of light by a plane mirror.

Figure 4 shows the different equipment the students used.

Figure 4



Explain **two** ways that **Method A** is better than **Method B**.

[4 marks]

- 1 The protractor drawn on the paper means you do not have to move the mirror to measure the angles, so more likely to record the correct angle of incidence and reflection.
- 2 Light ray in method A does not diverge, making it easier to judge the centre position of the ray.

16

Turn over for the next question

Turn over ►



0 3

Speed limits on roads increase safety.

0 3 . 1

The braking distance of a car increases as the speed of the car increases.

Give two **other** factors that **increase** the braking distance of a car.

[2 marks]

- 1 Wet or icy road conditions
- 2 Poor condition of brakes

0 3 . 2

Explain why the driver's reaction time affects the thinking distance of a car.

[2 marks]

$$\text{distance} = \text{speed} \times \text{time}$$

So, larger reaction time = larger distance

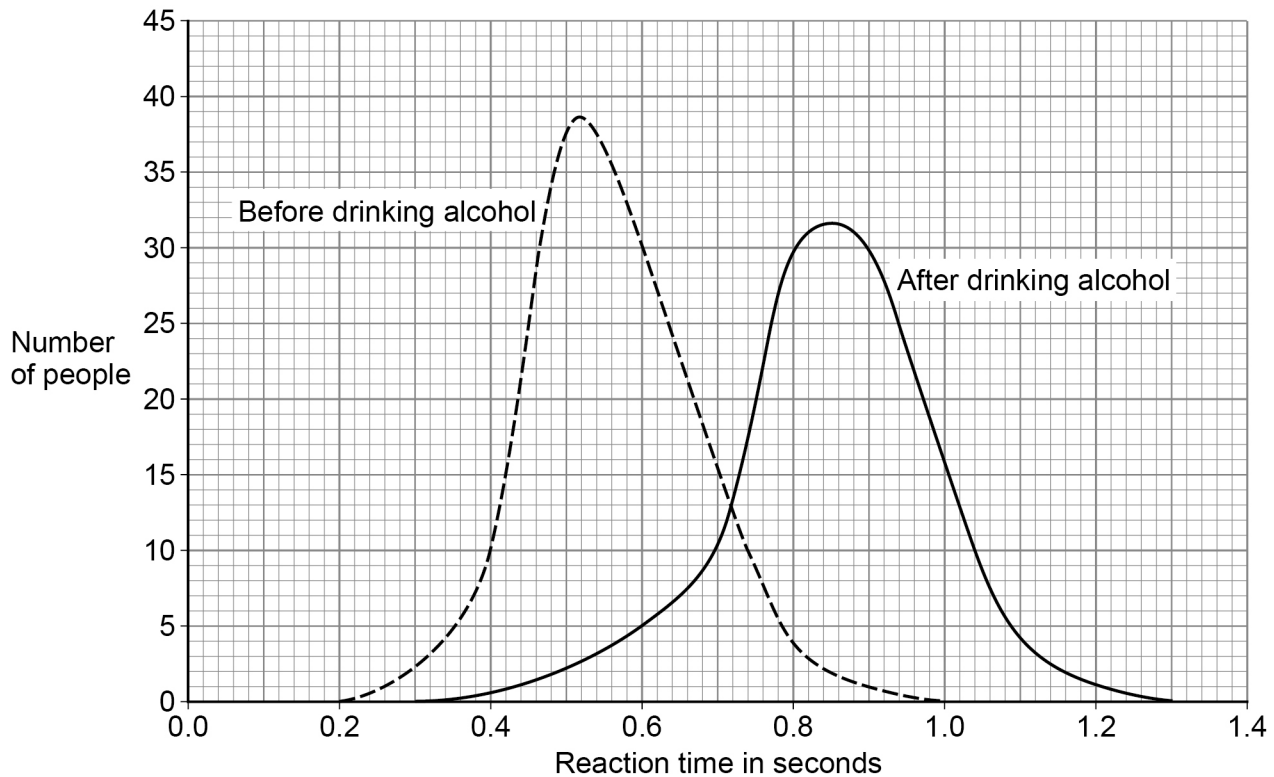


0 3 . 3

Scientists have investigated how drinking alcohol affects a person's reaction time.

**Figure 5** shows the results of the investigation.

**Figure 5**



Which of the following conclusions can be made using **Figure 5**?

[2 marks]

Tick (✓) **two** boxes.

Every person's reaction time increases after drinking alcohol.

Mean reaction time increases after drinking alcohol.

Some people's reaction time is not affected by drinking alcohol.

The change in reaction time is not the same for all people after drinking alcohol.

There is a smaller range of reaction times after drinking alcohol.

**Question 3 continues on the next page**

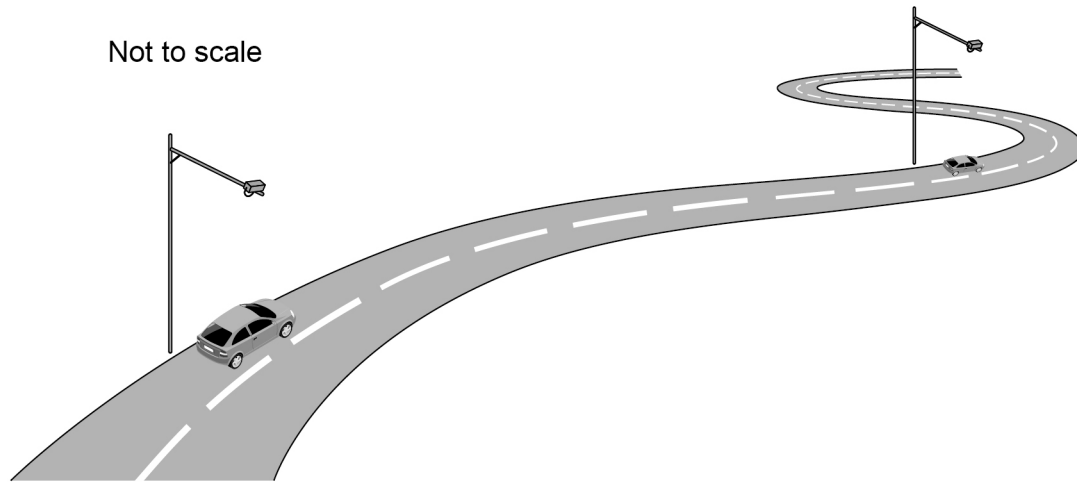
**Turn over ►**



**Figure 6** shows some speed cameras on a road.

The speed cameras determine the average speed of cars on the road.

**Figure 6**



**0 3 . 4** The speed limit on the road in **Figure 6** is  $20 \text{ m/s}$ .

The cameras in **Figure 6** are  $1.5 \text{ km}$  apart.

Calculate the minimum time it takes to travel  $1.5 \text{ km}$  without breaking the speed limit.

Use the Physics Equations Sheet.

distance travelled = speed  $\times$  time

$s = vt$  [4 marks]

$$s = 1.5 \text{ km}$$

$$s = vt$$

$$= 1.5 \times 10^3 \text{ m}$$

$$vt = s$$

$$v = 20 \text{ m/s}$$

$$t = \frac{s}{v}$$

$$t = ?$$

$$t = \frac{1.5 \times 10^3 \text{ m}}{20 \text{ m/s}}$$

Minimum time = 75 s

$$t = 75 \text{ s}$$



0 3 5

The **average speed** of a car between the cameras and the **average velocity** of the car between the cameras are **different**.

Explain **why**.

[3 marks]

Velocity is a vector and speed is a scalar

The road is not straight

Therefore direction changes so the velocity changes.

13

Turn over for the next question

Turn over ►



**There are no questions printed on this page**

*Do not write  
outside the  
box*

**DO NOT WRITE ON THIS PAGE  
ANSWER IN THE SPACES PROVIDED**



0 4

Hailstones are small balls of ice. Hailstones form in clouds and fall to the ground.

Figure 7 shows different-sized hailstones.

Figure 7



A hailstone falls from a cloud and accelerates.

0 4 . 1

Why does the hailstone accelerate?

[1 mark]

Resultant force is acting,  
weight/gravity is greater than air resistance

0 4 . 2

The hailstone stops accelerating and reaches terminal velocity.

Explain why the hailstone reaches terminal velocity.

[3 marks]

As the velocity of the hailstone increases,  
air resistance increases.

Until air resistance becomes equal to the weight of  
the hailstone.

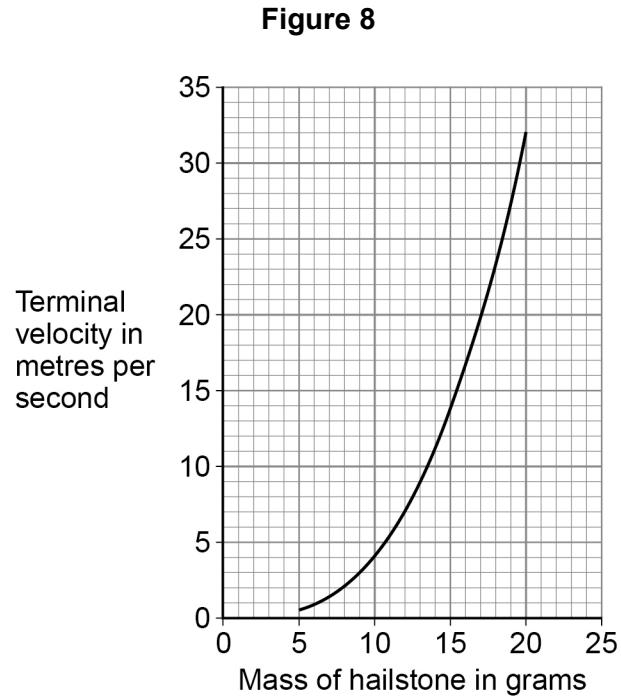
So the resultant force is equal to zero

Turn over ►



A scientist investigated how the mass of hailstones affects their terminal velocity.

**Figure 8** shows the results.



**0 4 . 3** Why does terminal velocity increase with mass?

**[1 mark]**

Tick (✓) **one** box.

As mass increases the cross-sectional surface area of a hailstone increases.

As mass increases the volume of a hailstone increases.

As mass increases the weight of a hailstone increases.

$$\text{weight} = mg$$



0 4 . 4

Explain the difference in the maximum kinetic energy of a hailstone with a mass of 10 g and a hailstone with a mass of 20 g.

[3 marks]

$$E_k = \frac{1}{2} mv^2$$

Kinetic energy depends on both mass and velocity  
As mass increases, so does the terminal velocity  
Kinetic energy  $\propto m$ , Kinetic energy  $\propto v^2$   
So as mass doubles Kinetic energy more than doubles

0 4 . 5

The kinetic energy of a hailstone is measured in joules.

Which of the following is the same as 1 joule?

[1 mark]

Tick (✓) **one** box.

1 Nm

1 N/m

1 N/m<sup>2</sup>

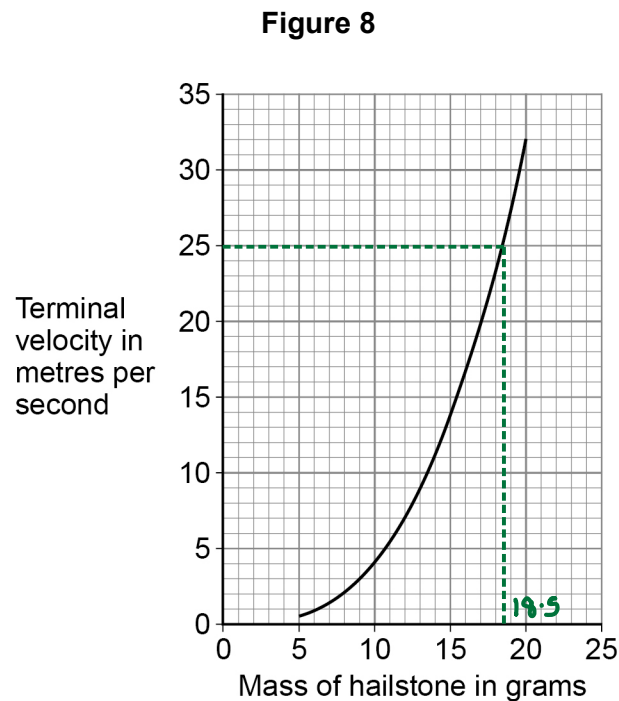
1 Nm<sup>2</sup>


Question 4 continues on the next page

Turn over ►



Figure 8 is repeated below.



$$\Delta v = 25 - 0 = 25 \text{ m/s}$$

**0 4 . 6** A hailstone hit the ground at its terminal velocity of 25 m/s.

The hailstone took  $0.060 \text{ s}$  to stop moving.

Determine the average force  $F$  on the hailstone as it hit the ground.

Use information from **Figure 8**.

Use the Physics Equations Sheet.

$$\text{force} = \frac{\text{change in momentum}}{\text{time taken}}$$

$$F = \frac{m \Delta v}{\Delta t} \quad [3 \text{ marks}]$$

$m = \text{mass of hailstone, from graph,}$

at term. vel = 25 m/s, mass = 18.5g

$$= \frac{18.5}{1000} \text{ kg} = 0.0185 \text{ kg}$$

$$F = \frac{0.0185 \times 25}{0.06}$$

Average force = 7.708 N

$$F = 7.708 \text{ N}$$

12



**Turn over for the next question**

*Do not write  
outside the  
box*

**DO NOT WRITE ON THIS PAGE  
ANSWER IN THE SPACES PROVIDED**

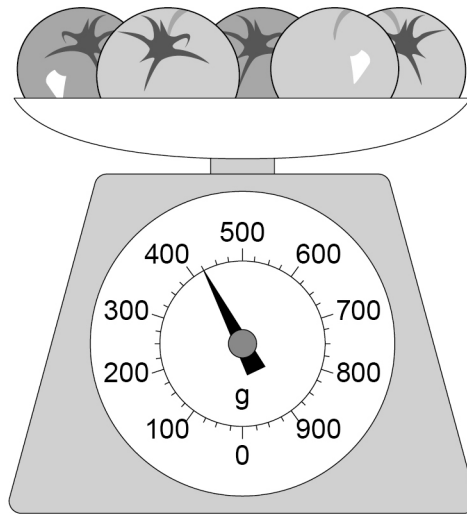
**Turn over ►**



0 5

Figure 9 shows a balance used to measure the mass of five tomatoes.

Figure 9



0 5 . 1

What is meant by 'centre of mass'?

[1 mark]

The point from which weight may be considered to act.

0 5 . 2

Calculate the mean weight of a tomato in Figure 9.

Use the Physics Equations Sheet.

gravitational field strength = 9.8 N/kg

weight = mass  $\times$  gravitational field strength

$$W = mg$$

[3 marks]

$$g = 9.8 \text{ N/kg}$$

$$W = ?$$

$$m = 425 \text{ g for 5 tomatoes,}$$

$$= \frac{425}{5} \text{ " 1 tomato}$$

$$= 85 \text{ g}$$

$$= \frac{85}{1000} = 0.085 \text{ kg}$$

$$W = mg$$

$$W = 0.085 \text{ kg} \times 9.8 \text{ N/kg}$$

$$W = 0.833 \text{ N}$$

Weight = 0.833 N

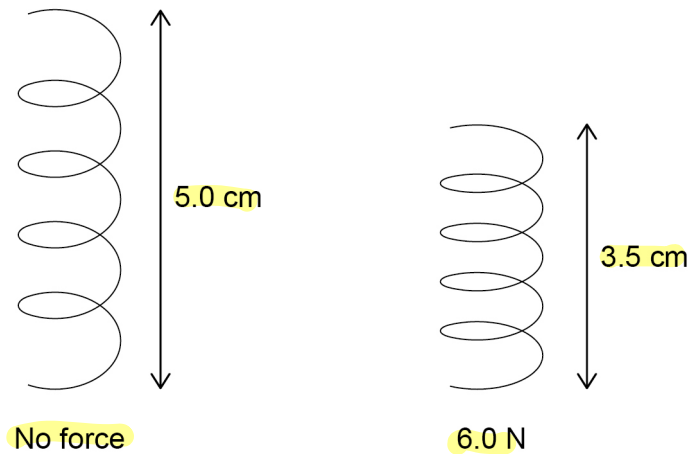


0 5 . 3

The balance in **Figure 9** contains a spring that compresses when the tomatoes are placed on the balance.

**Figure 10** shows the spring with no force acting and with a 6.0 N force acting.

Figure 10



Determine the spring constant of the spring.

Use the Physics Equations Sheet.

force = spring constant  $\times$  extension

$$F = ke \quad [3 \text{ marks}]$$

$$\text{Extension, } e = 5.0 - 3.5 \text{ cm} = 1.5 \text{ cm}$$

$$= \frac{1.5}{100} \text{ m} = 0.015 \text{ m}$$

$$F = 6.0 \text{ N}$$

$$k = ?$$

$$F = ke$$

$$ke = F$$

$$k = \frac{F}{e}$$

$$k = \frac{F}{e} = \frac{6.0 \text{ N}}{0.015 \text{ m}}$$

$$= 400 \text{ N/m}$$

$$\text{Spring constant} = \underline{400} \text{ N/m}$$

0 5 . 4

Explain **one** property of the spring that makes it **suitable** for use in the balance.

[2 marks]

The spring deforms elastically, so will return to its original length after force is removed.



0 6

Galaxies contain billions of stars.

0 6 . 1

Compare the formation and life cycles of stars with a similar mass to the Sun to stars with a much greater mass than the Sun.

[6 marks]

### All Stars:

- Form in a cloud of dust (nebula) by gravity.
- Forms a protostar which is mostly hydrogen
- Compression by gravity increases temp. until fusion occurs
- Fusion of small nuclei into larger nuclei  $H \rightarrow He$
- Main Sequence Star - stable period where gravitational forces (inwards) balance forces (outwards) due to fusion processes.

### Comparisons:

Stars same size as Sun:

Expand to form a Red Giant  $\rightarrow$  White dwarf which cools to Black dwarf

Stars much bigger than Sun:

Expand to form Red Super Giant  $\rightarrow$  Explodes in supernova

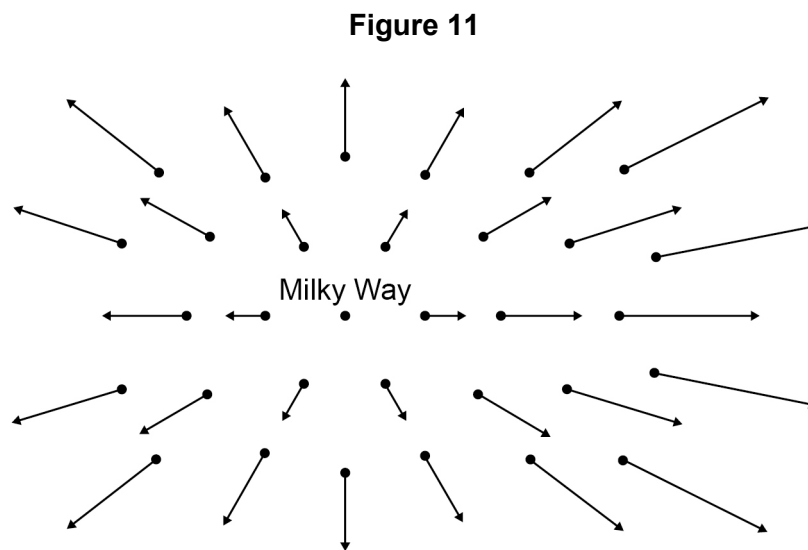
Becomes either Neutron Star or Black Hole

Sun fusion converts  $H \rightarrow$  Elements upto Fe

Supernova create elements  $>$  Fe



The points on **Figure 11** represent galaxies that are moving away from the Milky Way.



Each arrow represents the **velocity** of the galaxy relative to the Milky Way.

**0 6 . 2** Light from **all galaxies** represented in **Figure 11** is **red-shifted**.

Describe what is meant by **red-shift**.

[2 marks]

The observed increase in wavelength of light from galaxies, as galaxies move away from us.

**0 6 . 3** Explain how **Figure 11** provides evidence for the Big Bang theory.

[2 marks]

The furthest galaxies are moving away from the Milky Way the fastest;  
Which suggests that at some time all galaxies/  
matter started at the same point.

**0 6 . 4** Sometimes scientists have to change theories about the universe.

Give the reason why.

[1 mark]

There are new observations, evidence that does not fit into current theory/model.

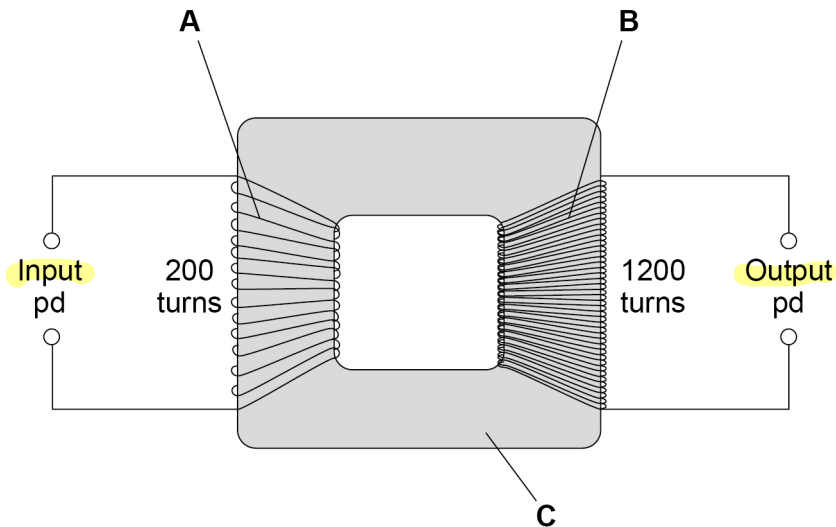


0 7

The National Grid uses transformers to change potential difference (pd).

Figure 12 shows a transformer.

Figure 12



0 7 . 1

Identify the parts of the transformer labelled in Figure 12.

[2 marks]

- A Primary Coil
- B Secondary Coil
- C Iron core

0 7 . 2

There is an alternating input pd of 230 V.

Determine the output pd.

Use the Physics Equations Sheet.

$$\frac{\text{potential difference across primary coil}}{\text{potential difference across secondary coil}} = \frac{\text{number of turns in primary coil}}{\text{number of turns in secondary coil}} \quad \left| \quad \frac{V_p}{V_s} = \frac{n_p}{n_s} \right. \quad [3 \text{ marks}]$$

$$V_p = 230 \text{ V} \quad V_s = ? \quad \frac{V_p}{V_s} = \frac{n_p}{n_s}$$

$$n_p = 200 \quad n_s = 1200$$

$$V_p n_s = n_p V_s$$

$$V_s n_p = V_p n_s$$

Output pd = 1380 V

$$V_s = \frac{V_p n_s}{n_p} = \frac{230 \times 1200}{200}$$

$$= 1380 \text{ V}$$



0 7 . 3

The input pd causes an alternating current.

Explain why there is an alternating current in the output when the transformer is connected to a circuit.

[3 marks]

The alternating current causes a changing magnetic field around the primary coil. Creates magnetic field that changes direction in the core.

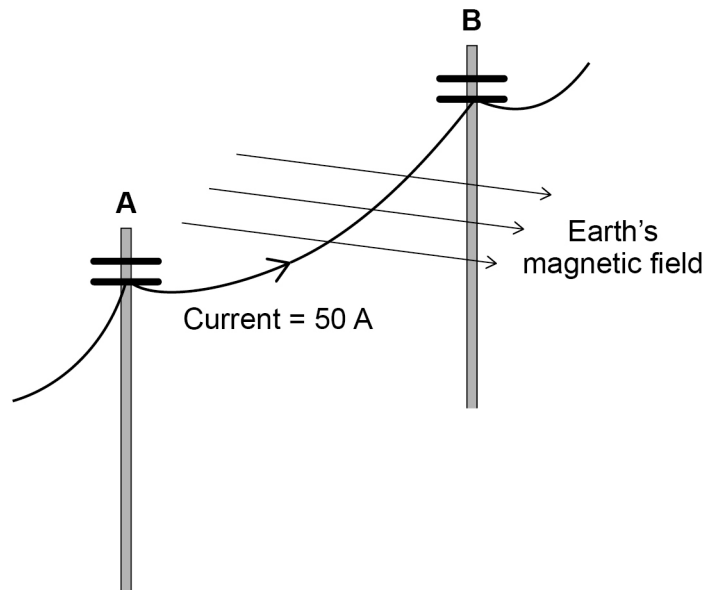
This induces an alternating potential difference across the secondary coil causing an alternating current.

Question 7 continues on the next page



**Figure 13** shows a large cable supported by two wooden poles. The cable is connected to an electricity supply.

**Figure 13**



0 7 . 4

There is a force on the cable due to the Earth's magnetic field when the current is in the direction **A** to **B**.

What is the direction of this force?

[1 mark]

Tick (✓) **one** box.

*Fleming's Left Hand Rule.*

Down

Left

Right

Up



0 7 . 5

The cable experiences a force of 0.045 N due to the Earth's magnetic field.

magnetic flux density =  $60 \mu\text{T}$

current = 50 A

Calculate the length of the cable between **A** and **B**.

Use the Physics Equations Sheet.

force on a conductor (at right angles to a magnetic field) carrying a current =  
magnetic flux density  $\times$  current  $\times$  length

$$F = B I l \quad [4 \text{ marks}]$$

$$F = 0.045 \text{ N}$$

$$F = B I l$$

$$B = 60 \mu\text{T}$$

$$B I l = F$$

$$= 60 \times 10^{-6} \text{ T}$$

$$l = \frac{F}{B I}$$

$$I = 50 \text{ A}$$

$$B I$$

$$l = ?$$

$$l = \frac{0.045}{60 \times 10^{-6} \times 50}$$

$$60 \times 10^{-6} \times 50$$

$$l = 15 \text{ m}$$

$$\text{Length} = \underline{15} \text{ m}$$

0 7 . 6

State **one** assumption you made in your calculation.

[1 mark]

The wire, force is at right angles to the magnetic field

14

Turn over for the next question

Turn over ►

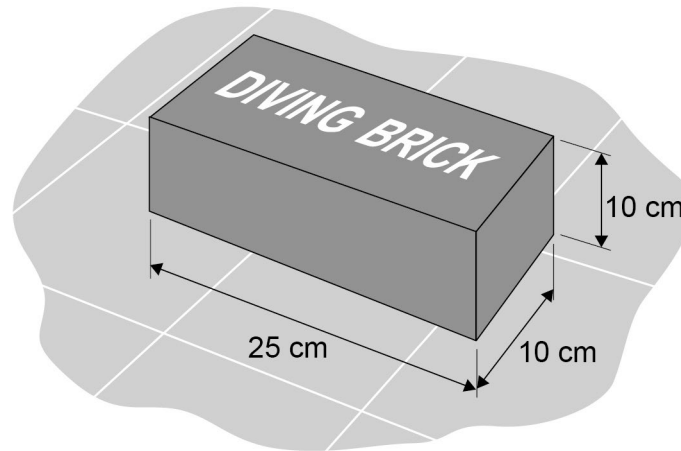


0 8

Diving bricks sink to the bottom of a swimming pool.

Figure 14 shows a diving brick.

Figure 14



Swimmers practise diving to the bottom of the swimming pool to pick up the diving brick.

0 8 . 1

Explain why the forces on the brick at the bottom of the pool cause the brick to be stationary.

[3 marks]

Upthrust acts upwards on the brick  
 Normal contact force acts upwards on the brick  
 Weight is equal to upthrust plus normal contact force. Thus brick is stationary.



0 8 . 2

When the brick from **Figure 14** is at the bottom of the pool, the **top surface** of the brick is **2.50 m below** the surface of the water.

The force acting on the top surface of the brick due to the weight of the water is 637 N.  $F$

gravitational field strength = 9.8 N/kg  $g$

Calculate the density  $\rho$  of the water in the swimming pool.

Use the Physics Equations Sheet.

[6 marks]

$$\begin{aligned} \text{Area of surface of brick} &= 25 \text{ cm} \times 10 \text{ cm} \\ &= 0.25 \text{ m} \times 0.1 \text{ m} \\ &= 0.025 \text{ m}^2 \end{aligned}$$

pressure =  $\frac{\text{force normal to a surface}}{\text{area of that surface}}$

$$p = \frac{F}{A}$$

$$p = ?$$

$$p = \frac{637 \text{ N}}{0.025 \text{ m}^2}$$

$$F = 637 \text{ N}$$

$$0.025 \text{ m}^2$$

$$A = 0.025 \text{ m}^2$$

$$p = 25480 \text{ Pa}$$

pressure due to a column of liquid =

height of column  $\times$  density of liquid  $\times$  gravitational field strength

$$p = h \rho g$$

$$p = 25480 \text{ Pa}$$

$$h = 2.50 \text{ m}$$

$$p = ?$$

Density of water = 1040 kg/m<sup>3</sup>

$$g = 9.8 \text{ N/kg}$$

$$p = h \rho g$$

$$h \rho g = p$$

$$\rho h g = p$$

$$\rho = \frac{p}{hg} = \frac{25480 \text{ Pa}}{2.50 \text{ m} \times 9.8 \text{ N/kg}} = 1040 \text{ kg/m}^3$$

Question 8 continues on the next page

Turn over ►



**0 8 . 3** Professional divers are trained in a very deep swimming pool.

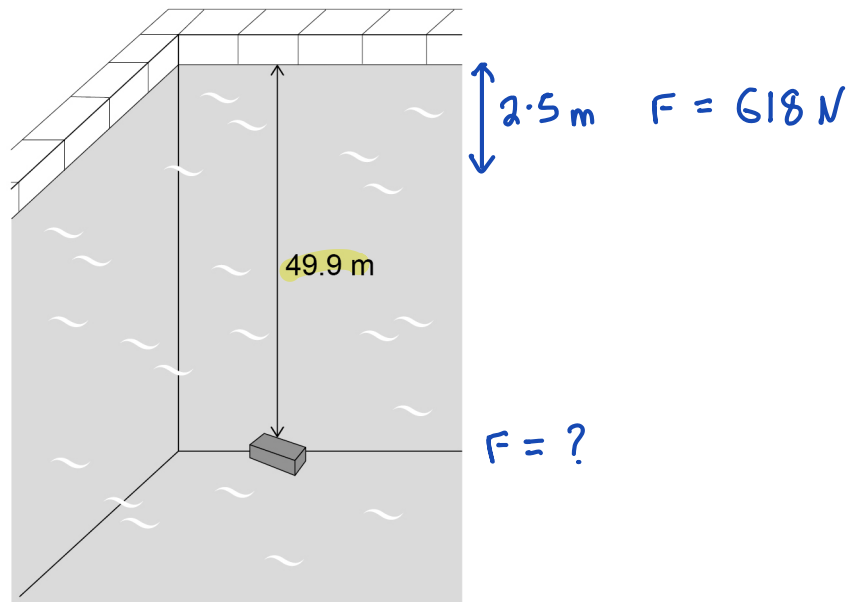
The density of the water in this pool is **not** the same as the density of the water in Question **08.2**

The diving brick was dropped into the very deep swimming pool.

When the brick was at a  <sup>$h$</sup>  depth of 2.50 m, the  <sup>$F$</sup>  force due to the weight of the water on the top surface of the brick was 618 N.

**Figure 15** shows the diving brick at the bottom of the very deep swimming pool.

**Figure 15**



Determine the force due to the weight of the water on the top surface of the brick in Figure 15.

Do not write  
outside the  
box

Use the Physics Equations Sheet.

Give your answer to 3 significant figures.

[3 marks]

$$\text{Force} = 618 \text{ N} \times \frac{49.9 \text{ m}}{2.5 \text{ m}}$$

$$= 12335.28 \text{ N}$$

$$= 12300 \text{ N}$$

Force (3 significant figures) = 12300 N

12

END OF QUESTIONS



**There are no questions printed on this page**

*Do not write  
outside the  
box*

**DO NOT WRITE ON THIS PAGE  
ANSWER IN THE SPACES PROVIDED**









