Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE
PHYSICS

Higher Tier Paper 2

H

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	
TOTAL	

Answer all questions in the spaces provided.

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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

Do not write outside the box

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 (Δv) and time taken (t).

[1 mark]

acceleration = change in velocity / time (taken)

$a = \Delta v / t$

0 1 . 3 The maximum acceleration of the car is 20 m/s2.

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

[3 marks]

$20 = \frac{28}{t}$

$t = 28/20$

Time taken = 1.4 s

Question 1 continues on the next page

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0 1 . 4 In a trial run, the car accelerates at 10 m/s2 until it reaches its final velocity.

distance travelled by the car = 605 m

initial velocity of the car = 0 m/s

Calculate the final velocity of the car.

Use the Physics Equations Sheet.

[3 marks]

$v^2 - (0)^2 = 2 \times 10 \times 605$

$v^2 = 12100$

$v = 110 \text{ ms}^{-1}$

Final velocity = 110 m/s

Do not write outside the box

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]

work done = force × distance

W = Fs

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]

S = 7500m

W = 4000 × 7500

Work done = 30,000,000 J

13

Turn over for the next question

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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]

Some indicative content could be indicated within a labelled diagram

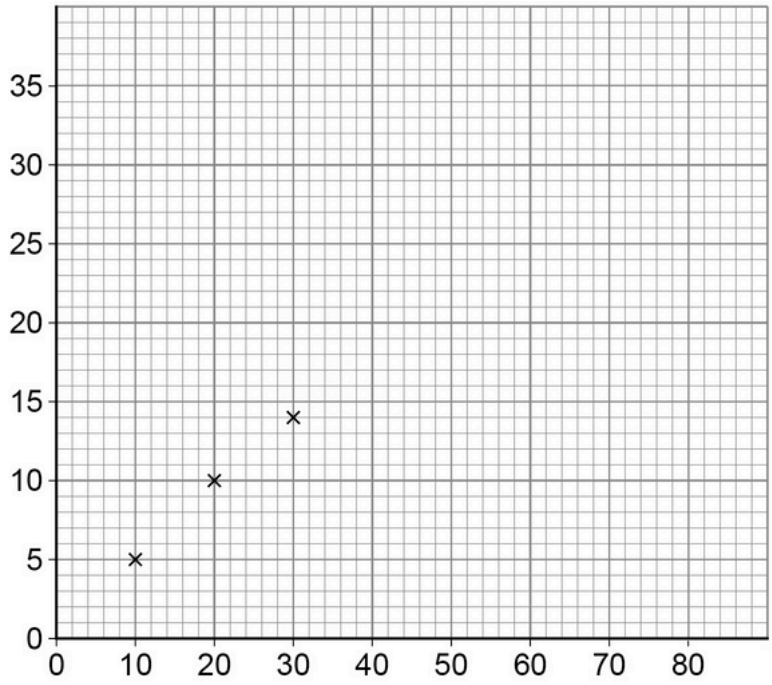
- place a glass block on a piece of paper
- draw around the glass block
- use the ray box to shine a ray of light through the glass block
- mark the ray of light entering the glass block
- ma rk the ray of light emerging from the glass block
- joi n the points to show the path of the complete ray through the block
- an d draw a normal line at 90 degrees to the surface
- use a protractor to measure the angle of incidence
- us e a protractor to measure the angle of refraction

Do not write outside the box

• use a ray box to shine a ray of light at a range of different angles (of incidence)
• increase the angle of incidence in 10 degree intervals
• from an angle of incidence of 10 degrees to an angle of incidence of 80 degrees

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

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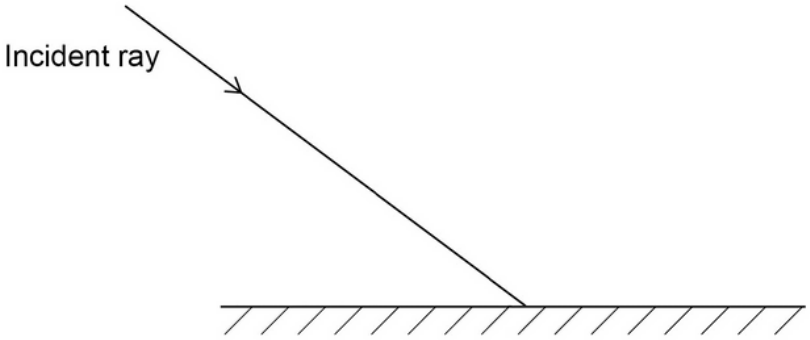
0 2 . 3 Complete the ray diagram in Figure 3 to show the reflection of light from the surface of a plane mirror.

You should:

- draw the normal line
- draw the reflected ray.

[2 marks]

Figure 3



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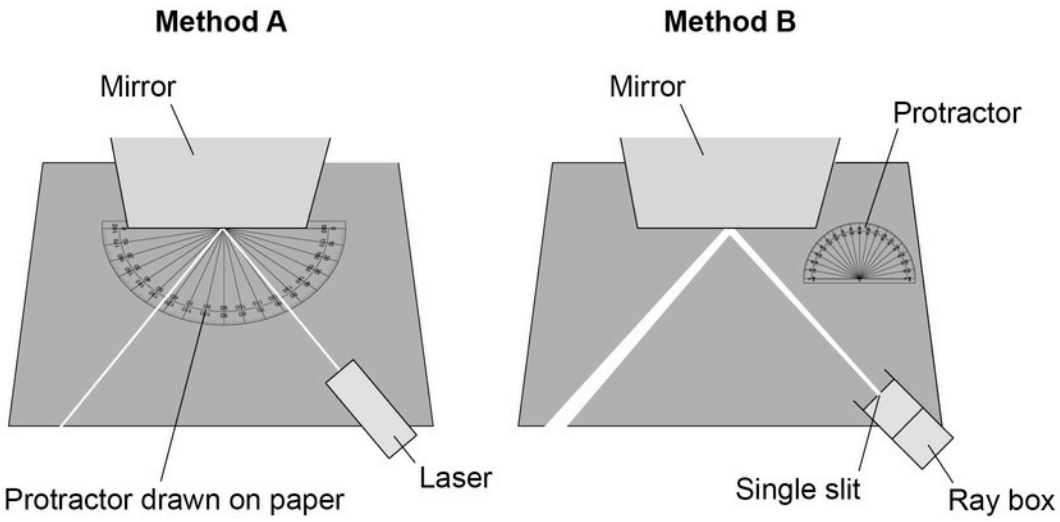
0 2 . 4 Two students investigated the reflection of light by a plane mirror.

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 / or reflection

2 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

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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 / 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]

distance = speed × time

longer reaction time = longer distance

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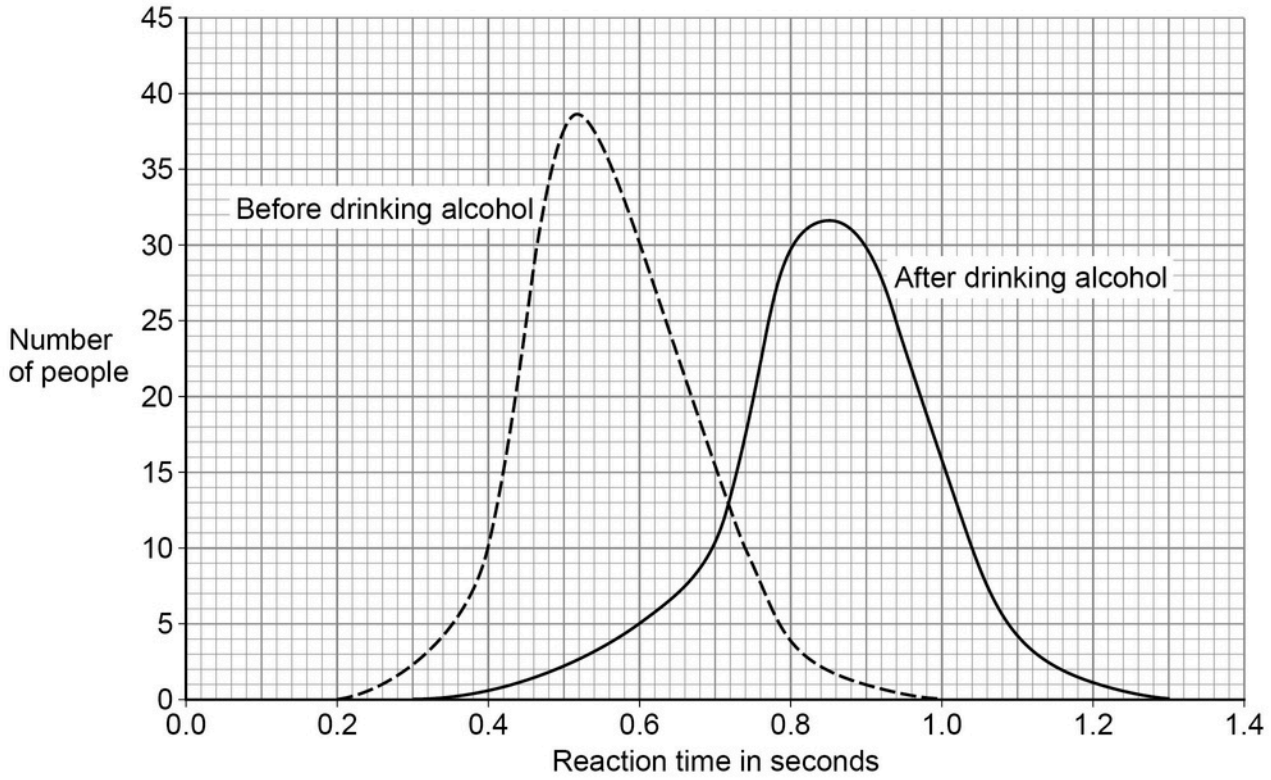
0 3 . 3 Scientists have investigated how drinking alcohol affects a person's reaction time.

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

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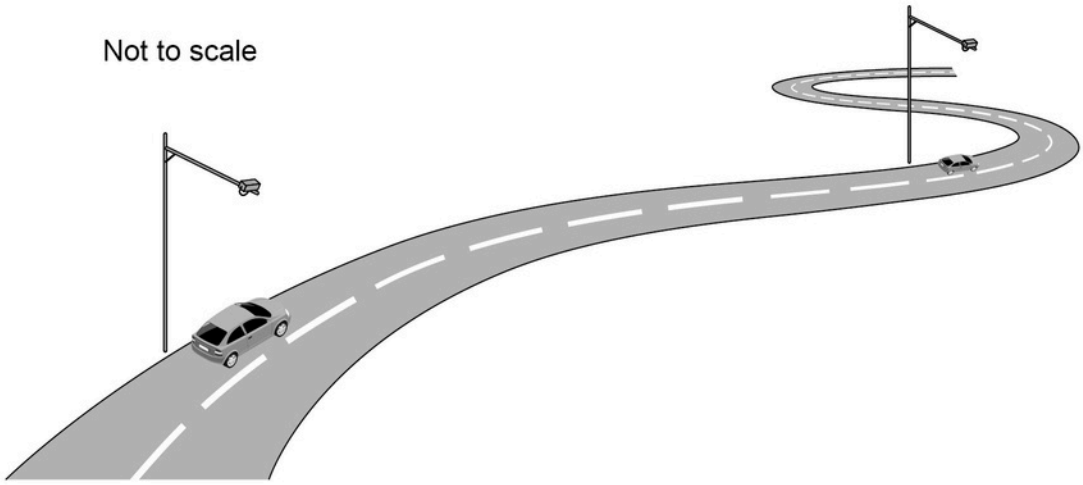
Figure 6 shows some speed cameras on a road.

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 m/s.

The cameras in Figure 6 are 1.5 km apart.

Calculate the minimum time it takes to travel 1.5 km without breaking the speed limit.

Use the Physics Equations Sheet.

[4 marks]

$d = 1500 (m)$

$1500 = 20 \times t$

$t = \frac{1500}{20}$

Minimum time = 75 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 road is not straight.
Therefore direction changes so the velocity changes

13

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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]

There is a resultant force acting

0 4 . 2 The hailstone stops accelerating and reaches terminal velocity.

Explain why the hailstone reaches terminal velocity.

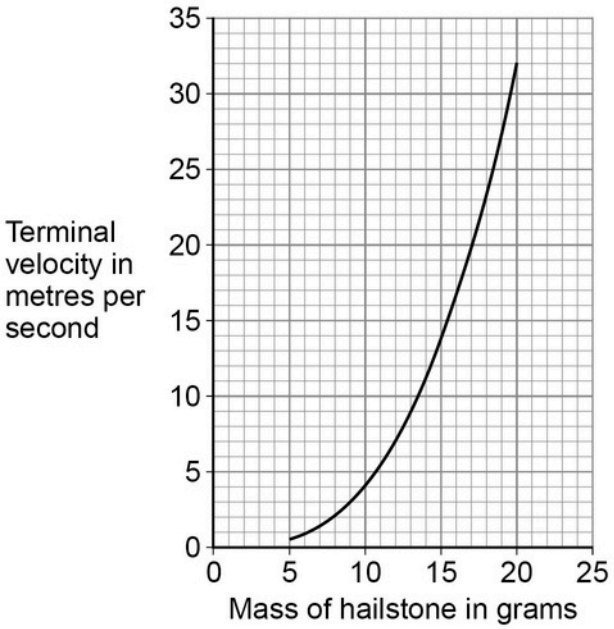
[3 marks]

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.

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

Figure 8 shows the results.

Figure 8



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. ☑

Do not write outside the box

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]

Kinetic energy depends on both mass and velocity as mass increases so does terminal / maximum velocity.
Kinetic energy ∝ m and kinetic energy ∝ v2 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 N m ☑
- 1 N/m ☐
- 1 N/m2 ☐
- 1 Nm2 ☐

Question 4 continues on the next page

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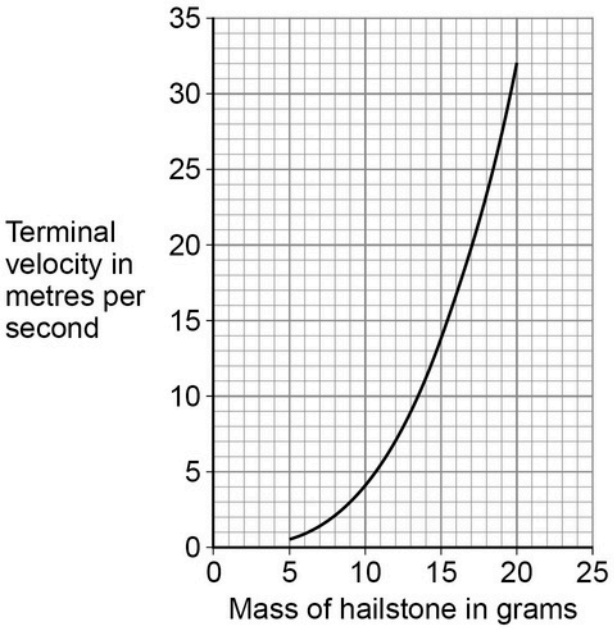
Figure 8 is repeated below.

Figure 8



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

The hailstone took 0.060 s to stop moving.

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

Use information from Figure 8.

Use the Physics Equations Sheet.

[3 marks]

mass = 0.0185 (kg)

$F = \frac{0.0185 \times 25}{0.060}$

Average force = 7.708 N

12

Turn over for the next question

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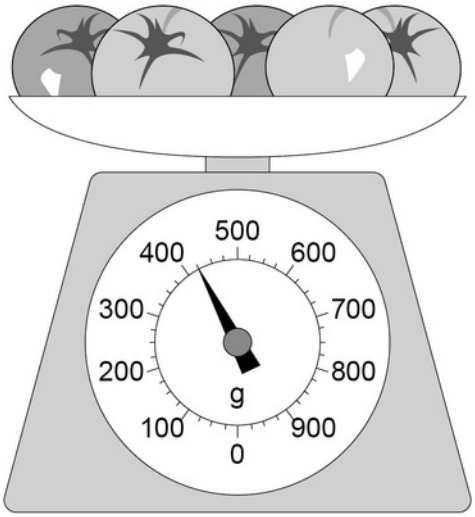
0 5 Figure 9 shows a balance used to measure the mass of five tomatoes.

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

[3 marks]

mass of 5 tomatos = 0.425kg

mass of 1 tomato = 0.085kg

W = (0.085) x 9.8

Weight = 0.833 N

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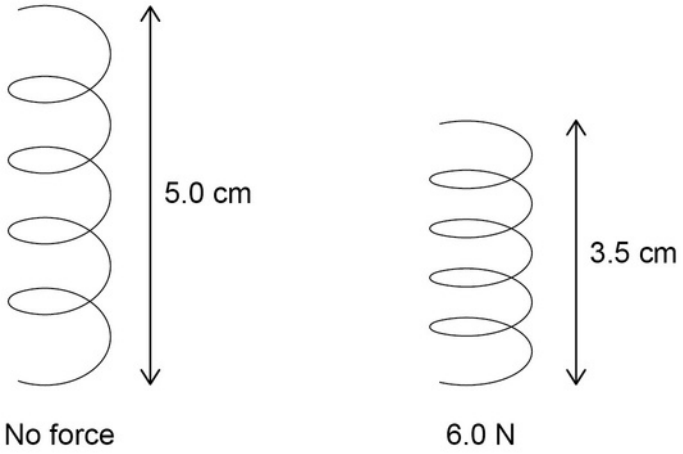
0 5 . 3 The balance in Figure 9 contains a spring that compresses when the tomatoes are placed on the balance.

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.

[3 marks]

$6.0 = k \times 0.015$

$k = \frac{6.0}{0.015}$

Spring constant = 400 N/m

0 5 . 4 Explain one property of the spring that makes it suitable for use in the balance.

[2 marks]

Deforms elastically.

So will return to its original length / shape after force is removed.

9

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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 gas and dust by gravity – mostly hydrogen
• Forms a protostar
• Fusion begins
• Fusion of small nuclei into larger nuclei
• Main sequence star – stable period where gravitational forces balance forces due to fusion processes

Comparisons:

• Stars about the same size as the Sun expand to become a red giant, stars much bigger than the Sun expand to become a red super giant
• Stars about the same size as the Sun contract to become a white dwarf, stars much bigger than the Sun explode in a supernova
• Stars about the same size as the Sun become a black dwarf, stars much bigger than the Sun become either a neu tron star or black hole.

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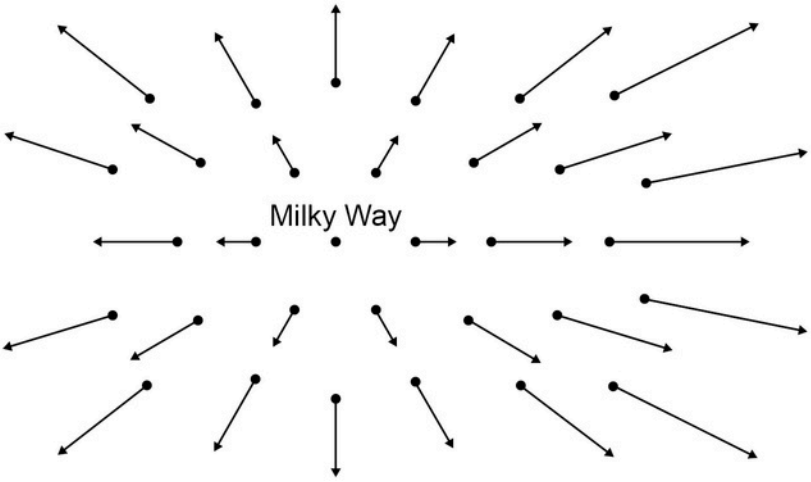
The points on Figure 11 represent galaxies that are moving away from the Milky Way.

Figure 11



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]

Th e furthest galaxies are moving away from the Milky W ay the fastest.
W hich suggests that at some time all galaxies / matter sta rted at the same point.

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

Give the reason why.

[1 mark]

T here are new observations that does not fit into current t heory

11

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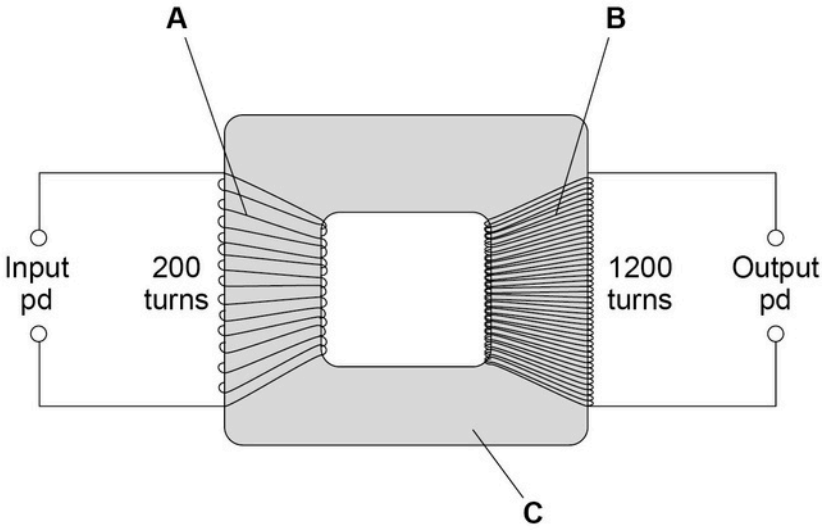
0 7 The National Grid uses transformers to change potential difference (pd).

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.

[3 marks]

$\frac{230}{V_S} = \frac{200}{1200}$

$V_S = \frac{1200 \times 230}{200}$

Output pd = 1380 V

Do not write outside the box

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]

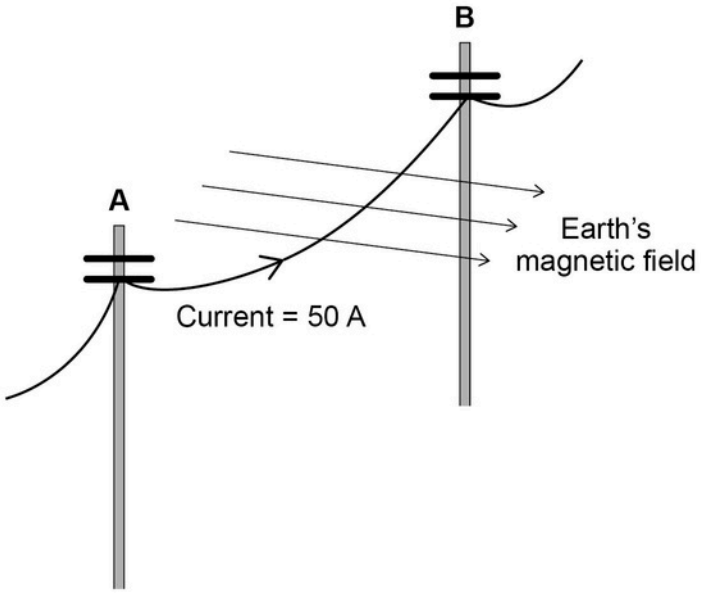
The alternating current causes a changing magnetic field around the primary coil creates magnetic field that changes direction in the core.
This induces an alternating potential difference across the secondary coil causing an alternating current

Question 7 continues on the next page

Do not write outside the box

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?

Tick (✓) one box. [1 mark]

Down ✓

Left ☐

Right ☐

Up ☐

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0 7 . 5 The cable experiences a force of 0.045 N due to the Earth's magnetic field.

magnetic flux density = 60 μT

current = 50 A

Calculate the length of the cable between A and B.

Use the Physics Equations Sheet.

[4 marks]

$B = 60 \times 10^{-6}$ (T)

$0.045 = 60 \times 10^{-6} \times 50 l$ (J)

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

$= 15$ m

Length = 15 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

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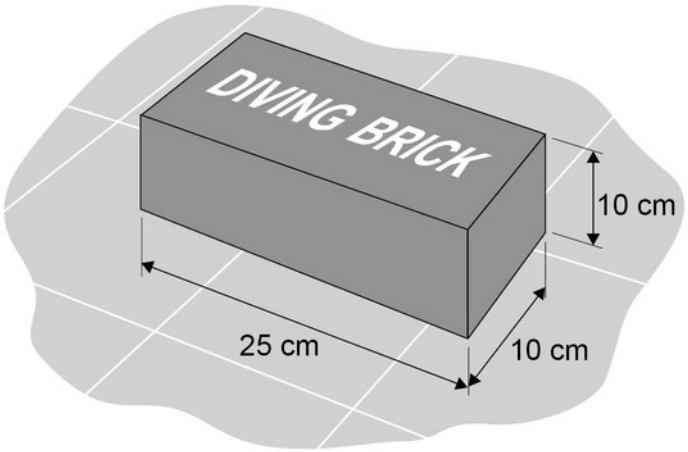
0 8 Diving bricks sink to the bottom of a swimming pool.

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.

Do not write outside the box

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.

gravitational field strength = 9.8 N/kg

Calculate the density of the water in the swimming pool.

Use the Physics Equations Sheet.

[6 marks]

$A = 0.25 \times 0.10 = 0.025\ m^2$

$P = \frac{637}{0.025}$

$P = 25,480\ (Pa)$

$25480 = 2.5 \times \rho \times 9.8$

$\rho = \frac{25480}{2.5 \times 9.8}$

Density of water = 1040 kg/m3

Question 8 continues on the next page

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

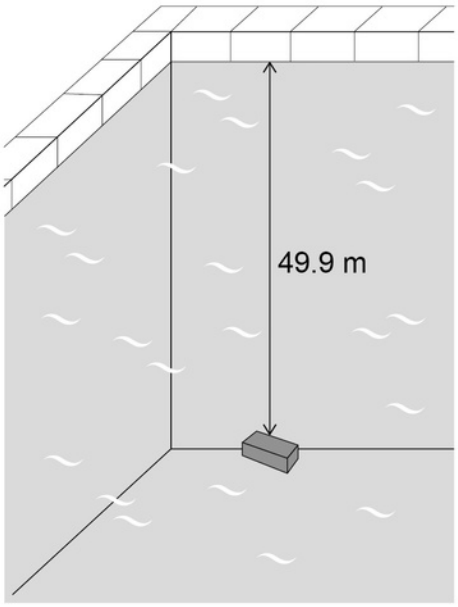
The density of the water in this pool is not the same as the density of the water in Question 08.2

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

When the brick was at a depth of 2.50 m, the 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



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

Use the Physics Equations Sheet.

Give your answer to 3 significant figures.

[3 marks]

$F = 618 \times \frac{49.9}{2.5}$

$F = 12335.28$

Force (3 significant figures) = 12300 N

12

END OF QUESTIONS

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