AQA

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

Friday 12 June 2020 Morning 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.
- 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).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- 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	
TOTAL	

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

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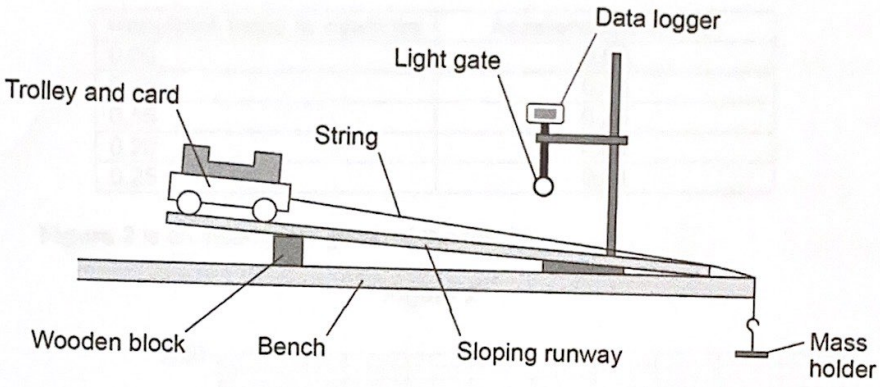
0 1 A student investigated the acceleration of a trolley.

Figure 1 shows how the student set up the apparatus.

Figure 1



0 1 . 1 Before attaching the mass holder the student placed the trolley at the top of the runway. The trolley rolled down the runway without being pushed.

What change to the apparatus in **Figure 1** could be made to prevent the trolley from starting to roll down the runway?

Tick (✓) **one** box. **[1 mark]**

Move the wooden block to the left. ☑

Shorten the length of the runway. ☐

Use a taller wooden block. ☐

0 1 . 2 The student attached the mass holder to the string.

The string rubbed along the edge of the bench as the mass holder fell to the floor.

Suggest what the student could do to prevent the string from rubbing.

[1 mark]

Use a pulley on the edge of the bench

The light gate and data logger were used to determine the acceleration of the trolley.

The student increased the resultant force on the trolley and recorded the acceleration of the trolley.

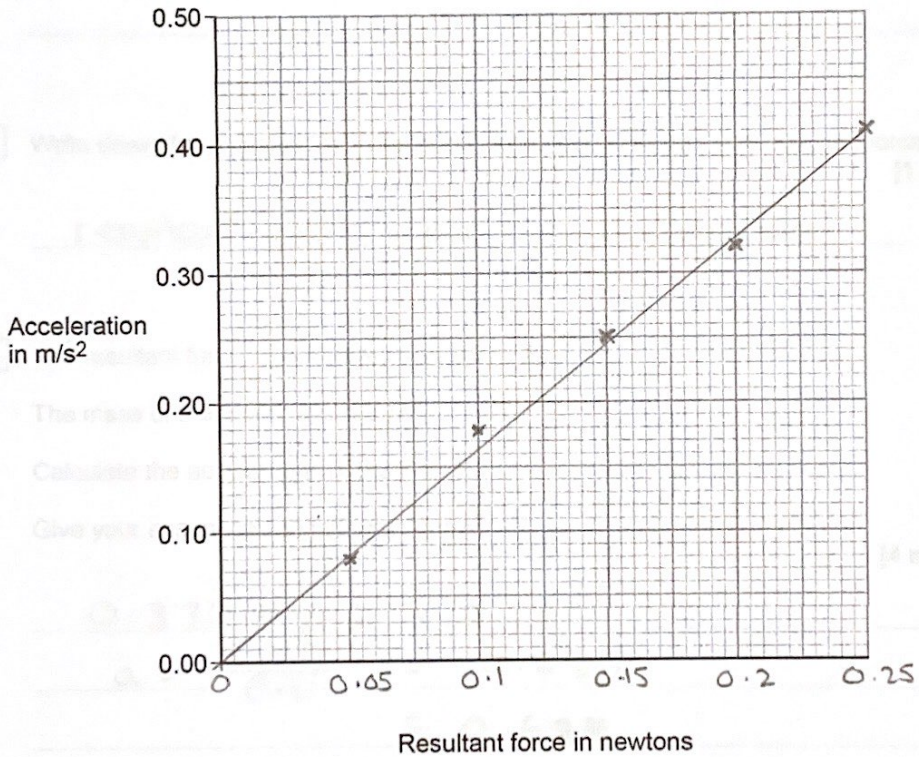
Table 1 shows the results.

Table 1

Resultant force in newtons	Acceleration in m/s^2
0.05	0.08
0.10	0.18
0.15	0.25
0.20	0.32
0.25	0.41

Figure 2 is an incomplete graph of the results.

Figure 2



0 1 . 3 Complete **Figure 2**.

- Choose a suitable scale for the x-axis.
- Plot the results.
- Draw a line of best fit.

[4 marks]

Do not write outside the box

0 1 . 4 Describe the relationship between the resultant force on the trolley and the acceleration of the trolley.

[1 mark]

The resultant force is directly proportional to the acceleration.

0 1 . 5 Describe how the investigation could be improved to reduce the effect of random errors.

[2 marks]

You could repeat the experiment and calculate a mean value after remaving any anomalies.

0 1 . 6 Write down the equation that links acceleration (*a*), mass (*m*) and resultant force (*F*).

[1 mark]

resultant force = mass x acceleration

0 1 . 7 The resultant force on the trolley was 0.375 N.

The mass of the trolley was 0.60 kg.

Calculate the acceleration of the trolley.

Give your answer to 2 significant figures.

[4 marks]

$0.375 = 0.6 \times a$

$a = \frac{0.375}{0.6} = 0.625$

$= 0.63$

Acceleration (2 significant figures) = 0.63 m/s²

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0 2 . 1 Complete the sentences.

[2 marks]

The Sun is a stable star. This is because the forces pulling inwards caused by gravity are in equilibrium with the forces pushing outwards caused by the energy released by nuclear fusion.

0 2 . 2 Write down the equation that links distance travelled (s), speed (v) and time (t).

[1 mark]

distance travelled = speed x time

0 2 . 3 The mean distance between the Sun and the Earth is 1.5×10^{11} m.

Light travels at a speed of 3.0×10^{8} m/s.

Calculate the time taken for light from the Sun to reach the Earth.

[3 marks]

$1.5 \times 10^{11} = 3 \times 10^{8} \times t$

$t = 1.5 \times 10^{11} / 3 \times 10^{8}$

$t = 500$

Time = 500 s

Do not write outside the box

0 2 . 4 Some stars are much more massive than the Sun.

Describe the life cycle of stars much more massive than the Sun, including the formation of new elements.

[6 marks]

Stars initially form from a cloud of dust and gas called a nebula. The force of gravity pulls the dust and gas together to form a protostar. this provides enough thermal energy for the fusion of hydrogen nuclei to form helium nuclei. When the outward pressure of the nuclear fusion equals the gravity pulling everything inwards it is called a main sequence star. When the hydrogen starts to run out, the helium nuclei begin to fuse to form a red super giant. The star will eventually collapse and explode in a supernova, creating elements heavier than iron and distributing them throughout the universe. This leaves behind a black hole or a ~~neutron~~ neutron star.

Question 2 continues on the next page

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0 2 . 5 Stars emit radiation with a range of wavelengths.

Which property of a star does the range of wavelengths depend on?

[1 mark]

Tick (✓) **one** box.

Density ☐

Mass ☐

Temperature ☑

Volume ☐

13

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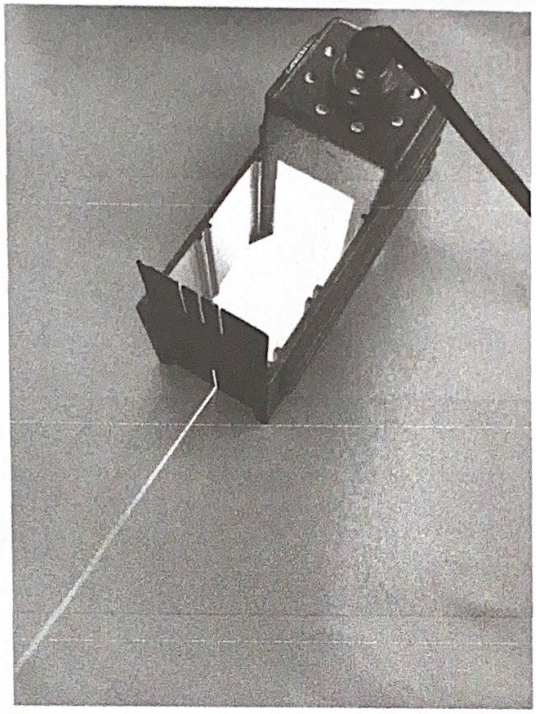
0 3 A student investigated the refraction of light at the boundary between air and glass.

Figure 3 shows the ray box used.

Figure 3



0 3 . 1 The ray of light from the ray box should be as narrow as possible.

Explain why using a wider ray would give less accurate results than using a narrower ray.

[2 marks]

It is harder to judge where the centre of a wider ray is which will cause a larger uncertainty.

Question 3 continues on the next page

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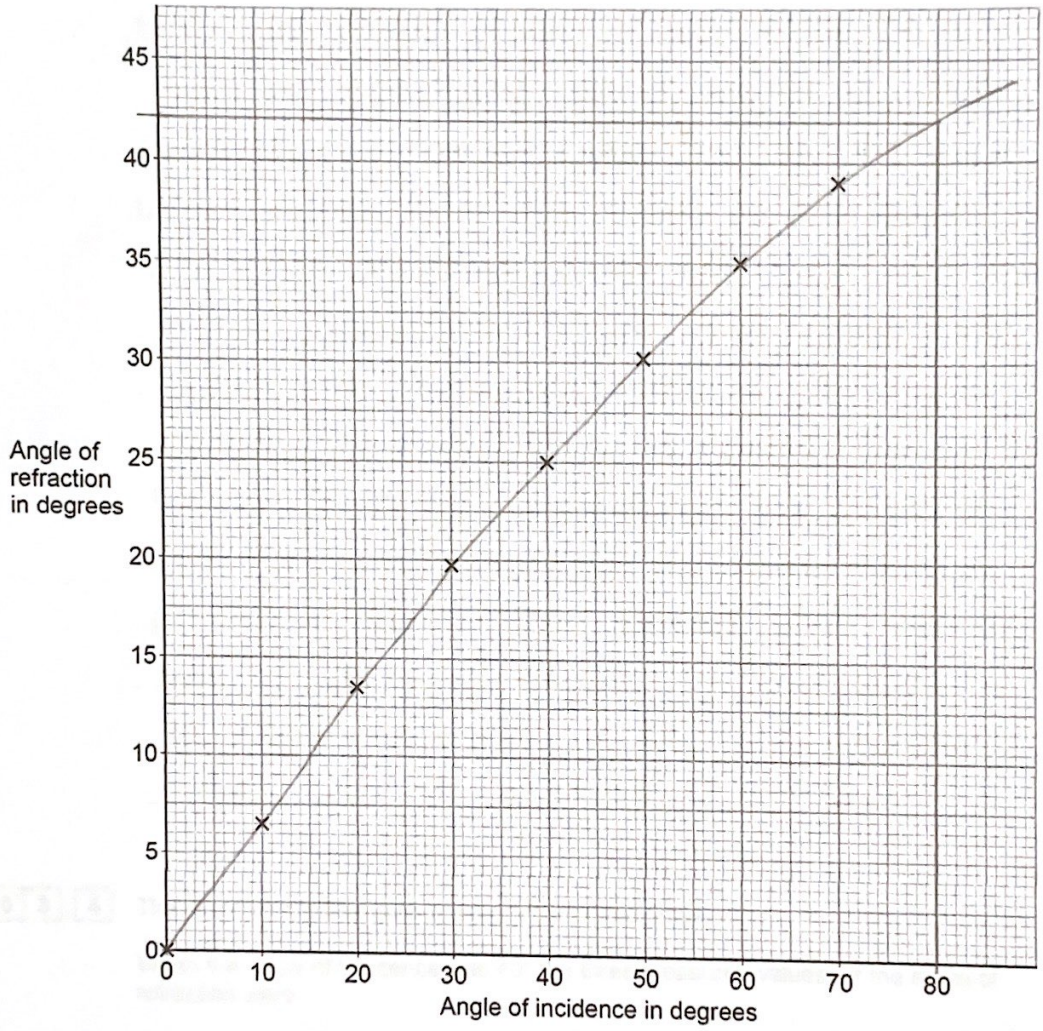
Figure 4 shows the results.

Figure 4



0 3 . 2 Estimate the angle of refraction when the angle of incidence is 80°.

Show on **Figure 4** how you obtained your answer.

[2 marks]

Angle of refraction = 42 °

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0 3 . 3 Describe a method the student could have used to obtain the results shown in **Figure 4.**

[6 marks]

First you would place a glass block on a piece of paper and draw around it. Then, shine a ray ~~box~~ of light through the glass using a ray box and mark on the paper the ray entering and emerging from the block. Remove the block and connect the points to show the path of the light through the glass. Draw a normal line at 90° to the surface and measure the angle of refraction and angle of incidence using a protractor. Repeat the process with the ray box at different angles of incidence in 10 degree intervals up to 70° and plot the results on a graph.

0 3 . 4 The student repeated each measurement three times.

When the angle of incidence was 40° the three measured values for the angle of refraction were

28° 25° 22°

Estimate the uncertainty in the angle of refraction when the angle of incidence was 40°.

Show how you determine your estimate.

[2 marks]

$\frac{28+25+22}{3} = 25$ range = 28 − 22 = 6

6 ÷ 2 = 3

25° ± 3°

Uncertainty = ± 3 °

Do not write outside the box

0 3 . 5 What property of the light wave changes when it is refracted?

[1 mark]

Tick (✓) **one** box.

Colour ☐

Frequency ☐

Velocity ☑

13

Do not write outside the box

0 4 A door is fitted with a security lens and a lock.

The security lens allows a person to see a visitor before opening the door.

The security lens is concave.

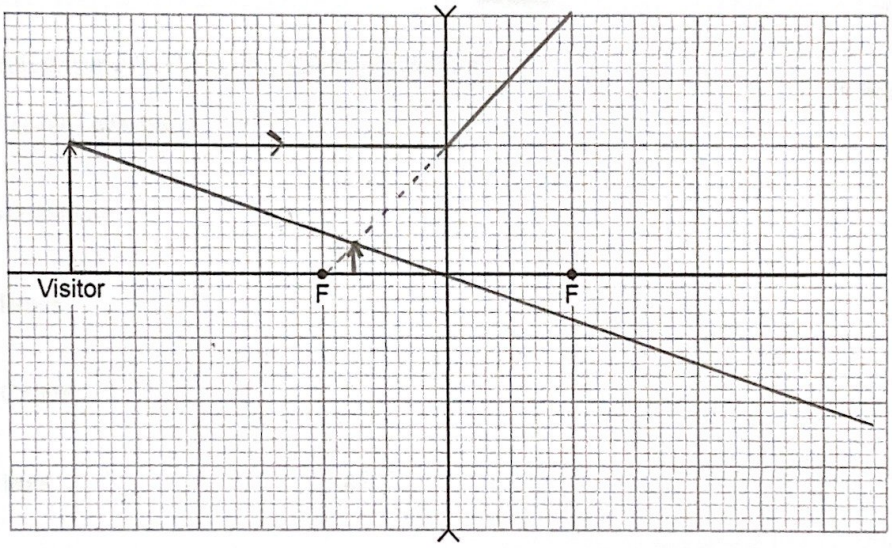
0 4 . 1 **Figure 5** is an incomplete ray diagram representing a visitor standing near the security lens.

Complete **Figure 5** to show how an image of the visitor is formed by the concave lens.

Draw an arrow to represent the image.

[3 marks]

Figure 5



0 4 . 2 The visitor moves further away from the security lens in the door.

How does the size of the image change?

[1 mark]

Tick (✓) **one** box.

Decreases ☑

Increases ☐

Stays the same ☐

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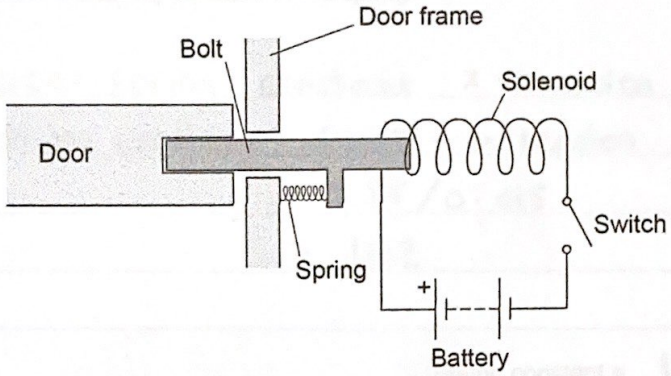
Figure 6 shows a diagram of the lock. The door unlocks when the switch is closed.

Figure 6



0 4 . 3 Which material should the bolt be made from?

[1 mark]

Tick (✓) **one** box.

- Aluminium ☐
- Brass ☐
- Copper ☐
- Iron ☑

0 4 . 4 Explain why the door unlocks when the switch is closed.

[3 marks]

A current can flow around the circuit which creates a magnetic field that attracts the bolt causing the door to unlock.

Do not write outside the box

0 4 . 5 When the door unlocks, a force of 2.88 N is applied to the spring.

The spring extends by 1.50 cm.

Calculate the spring constant of the spring.

[4 marks]

force = spring constant × extension

spring constant = force ÷ extension

= 2.88 / 0.015

= 192

Spring constant = 192 N/m

0 4 . 6 Give **two** ways the resultant force on the bolt could be increased.

[2 marks]

1 Increase the current in the circuit

2 Add more turns to the solenoid.

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Do not write outside the box

0 5 **Figure 7** shows two ice hockey players moving towards each other.

They collide and then move off together.

Figure 7

Before the collision

Player A
Mass = 78 kg
Velocity = +7.5 m/s

Player B
Mass = 91 kg
Velocity = –5.5 m/s

During the collision, the total momentum of the players is conserved.

0 5 . 1 What is meant by 'momentum is conserved'?

[1 mark]

The total momentum before equals the total momentum after

Do not write outside the box

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0 5 . 1 What is meant by 'momentum is conserved'?

[1 mark]

The total momentum before equals the total momentum after

Do not write outside the box

0 5 . 2 Immediately after the collision the two players move together to the right.

Calculate the velocity of the two players immediately after the collision.

[4 marks]

momentum = mass x velocity

momentum A = 78 x 7.5 = 585

momentum B = 91 x -5.5 = -500.5

$$\frac{-500.5+585}{78+91} = 0.5$$

Velocity = 0.5 m/s

0 5 . 3 The ice hockey players wear protective pads filled with foam.

Explain how the protective pads help to reduce injury when the players collide.

[3 marks]

The protective pads will increase the time taken to stop (collision time) which ~~changes~~ decreases the rate of change of momentum and therefore reduces the force on the ice hockey player.

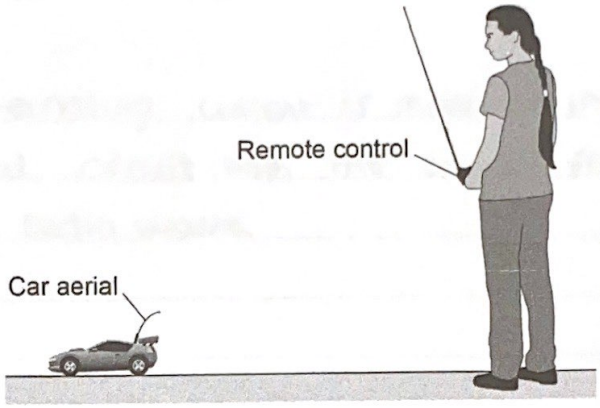
8

Turn over for the next question

Do not write outside the box

0 6 **Figure 8** shows a student playing with a remote-controlled car.

Figure 8



0 6 . 1 The remote control transmits radio waves to the car aerial.

The transmitted radio waves have a frequency of 320 MHz.

speed of radio waves = 3.0×10^8 m/s

Calculate the wavelength of the radio waves.

Give the unit.

[5 marks]

320 MHz = 3.2×10^8 Hz

wavespeed = frequency × wavelength

$3 \times 10^8 = 3.2 \times 10^8 \times \lambda$

$\lambda = \frac{3 \times 10^8}{3.2 \times 10^8} = 0.9375$

Wavelength = 0.9375 Unit metres

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0 6 . 2 The car aerial is connected to an electrical circuit in the car.

Describe what happens in the electrical circuit when the car aerial absorbs radio waves.

[2 marks]

An alternating current is induced in the electrical circuit with the same frequency as the radio wave.

0 6 . 3 The car produces sound waves.

Give **two** ways in which radio waves are different to sound waves.

[2 marks]

1 Radio waves are transverse, sound waves are longitudinal

2 Radio waves travel at higher speeds than sound waves.

Question 6 continues on the next page

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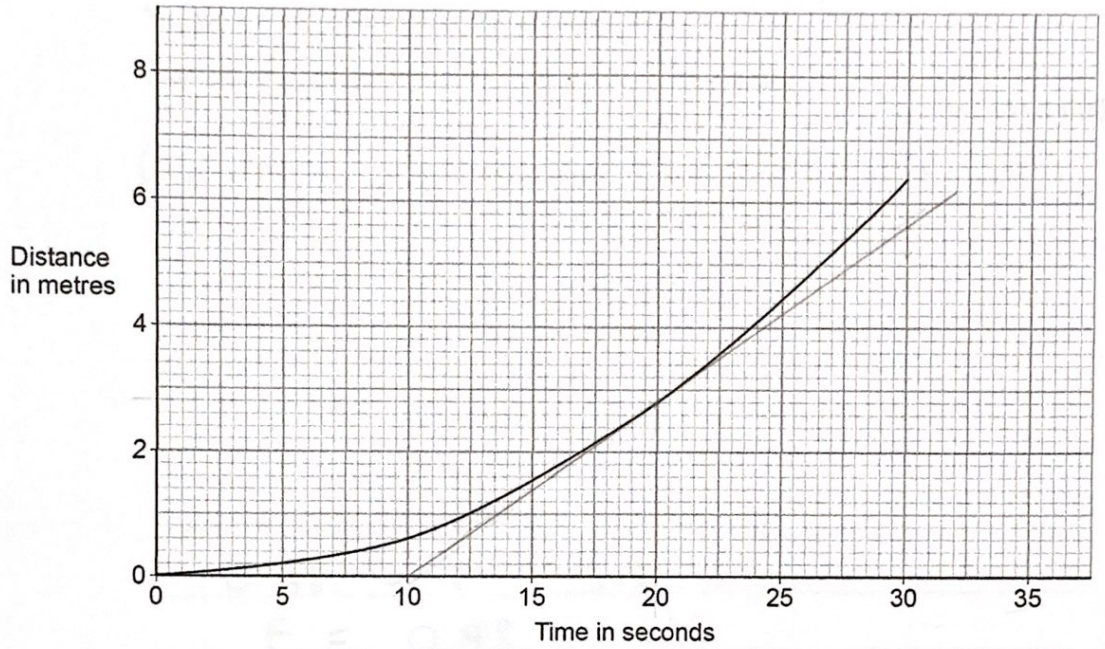
Figure 9 shows the distance-time graph for the first 30 seconds of the car's motion.

Figure 9



0 6 . 4 Describe the motion of the car during the first 30 seconds.

[1 mark]

accelerating

0 6 . 5 Determine the speed of the car 20 seconds after it started to move.

[4 marks]

~~[illegible] = [illegible]~~

$\frac{5.8-0}{30-10} = \frac{5.8}{20} = 0.29$

Speed = 0.29 m/s

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0 6 . 6 A different car accelerated from 0.12 m/s to 0.52 m/s.

The acceleration of the car was 0.040 m/s^2.

The work done to accelerate the car was 0.48 J.

Calculate the resultant force needed to accelerate the car.

[6 marks]

(final velocity)^2 - (initial velocity)^2 = 2 x acceleration x distance.

$0.52^2 - 0.12^2 = 2 \times 0.04 \times d$

$d = \frac{0.52^2 - 0.12^2}{2 \times 0.04}$

$d = 3.2$

work done = force x distance

$0.48 = F \times 3.2$

$F = \frac{0.48}{3.2}$

$= 0.15$

Resultant force = 0.15 N

0 6 . 7 Explain why the car has a maximum speed.

[4 marks]

There is a maximum forward driving force provided ~~and~~ by the motor. As the speed of the car increases the air resistance increases until the air resistance is equal to the forward force (so resultant force = 0). This means the car can no longer accelerate.

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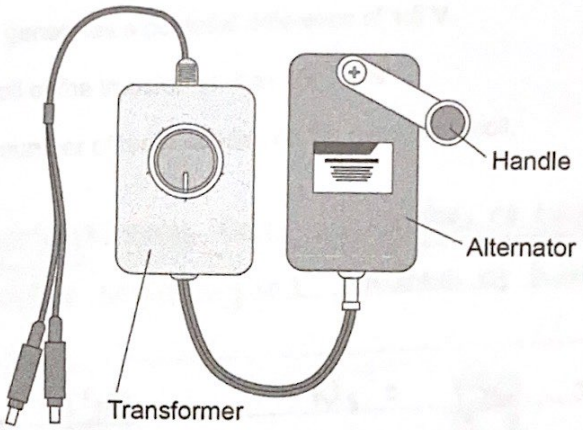
Do not write outside the box

0 7 **Figure 10** shows a portable power supply.

Figure 10



0 7 . 1 The portable power supply has an alternator connected to a transformer.

The transformer can be adjusted to have different numbers of turns on the secondary coil.

Suggest why.

[2 marks]

So you can vary the potential difference depending on the device and so you don't need a different generator for each type of device

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0 7 . 2 A lamp is connected to the power supply.

The lamp requires an input potential difference of 5.0 V.

The alternator generates a potential difference of 1.5 V.

The primary coil of the transformer has 150 turns.

Calculate the number of turns needed on the secondary coil.

[3 marks]

p.d across primary coil / p.d across secondary coil = number of turns on primary / number of turns on secondary

$\frac{1.5}{5.0} = \frac{150}{N_S}$ $N_S = \frac{150}{0.3} = 500$

Number of turns on the secondary coil = 500

Question 7 continues on the next page

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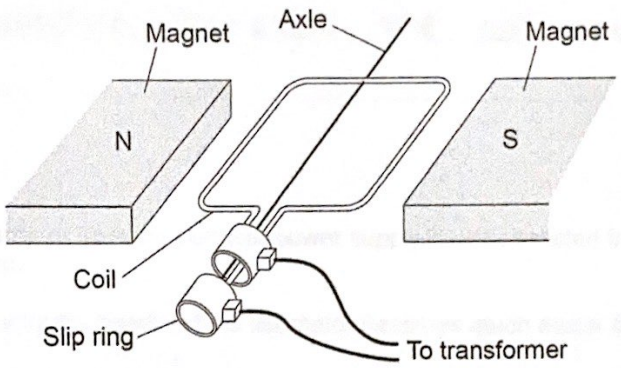
Figure 11 shows the inside parts of the alternator.

Figure 11



0 7 . 3 The handle of the alternator is turned, causing the coil to rotate.

Explain why an alternating current is induced in the coil.

[5 marks]

As the coil moves through the magnetic field a potential difference is induced across the coil. As there is a complete circuit, a current is induced in the coil. Every half turn, the potential difference reverses direction and so the current also changes direction creating an alternating current.

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0 7 . 4 Suggest the purpose of the slip rings.

[1 mark]

Slip rings provide a continuous connection between the coil and transformer

0 7 . 5 The alternator from the portable power supply is disconnected from the transformer and lamp.

Explain why the handle of the alternator becomes much easier to turn.

[3 marks]

When disconnected there is no induced current and so no magnetic field around the coil. There will be no opposing force to the movement of the coil.

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END OF QUESTIONS