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	

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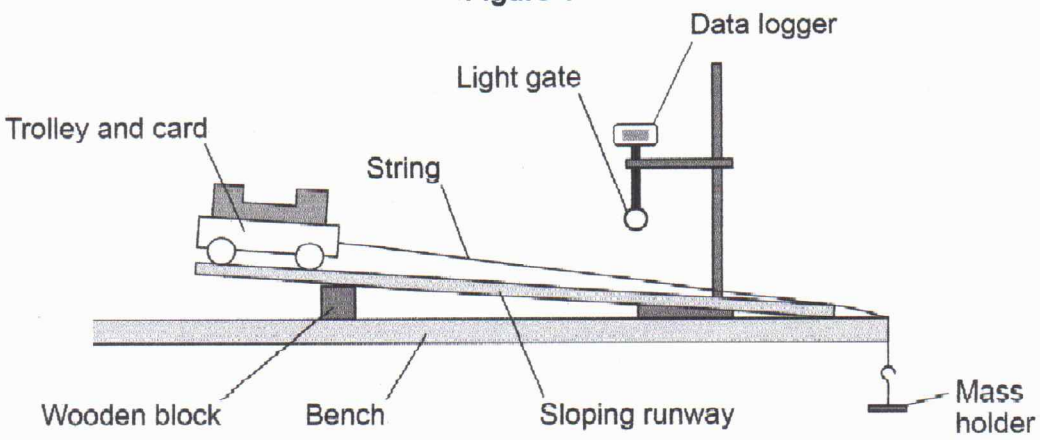
Answer **all** questions in the spaces provided.

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?

[1 mark]

Tick (✓) **one** box.

Move the wooden block to the left. ☑

Shorten the length of the runway. ☐

Use a taller wooden block. ☐

Creates an anticlockwise moment that decreases the slope.

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 at the end of the bench.

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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.

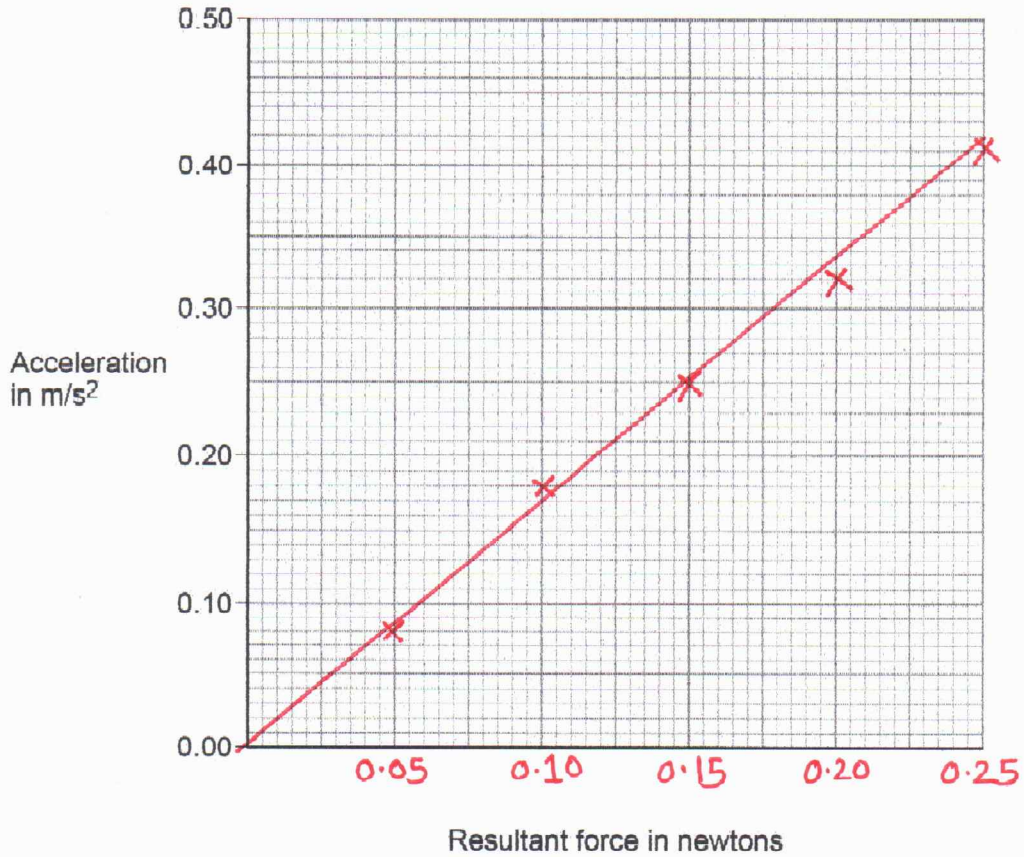
Table 1 shows the results.

Table 1

Resultant force in newtons	Acceleration in m/s²
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]

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

[1 mark]

They are directly proportional

0 1 . 5 Describe how the investigation could be improved to reduce the effect of random errors. [These errors arise in the process of the experiment].

[2 marks]

Repeat the measurements, avoid the anomalies and average.

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

[1 mark]

$F = m \times a$

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]

$a = \frac{F}{m} = \frac{0.375}{0.60}$

$= 0.625 \text{ m/s}^2$

$= 0.63$ (2sf)

Acceleration (2 significant figures) = 0.63 m/s^2

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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]

$s = v \times t$

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]

$t = \frac{s}{v} = \frac{1.5 \times 10^{11}}{3.0 \times 10^{8}}$

$t = 500$

Time = 500 s

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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]

Initially, the cloud of gases are pulled together by gravitational force.
As they are pulled together, the temperature of the nebula rises and reaches a critical point where the hydrogen fuel starts, and produces helium.
After the Hydrogen fuel is exhausted, the star starts to fuse Helium to make heavier elements upto to Iron-56.
The star produces so much energy and expands to make a red-super giant.
Finally it explodes and makes a Supernova type II.
If the remaining Mass is greater than 5 times the mass of the Sun, it forms a blackhole otherwise it produces a 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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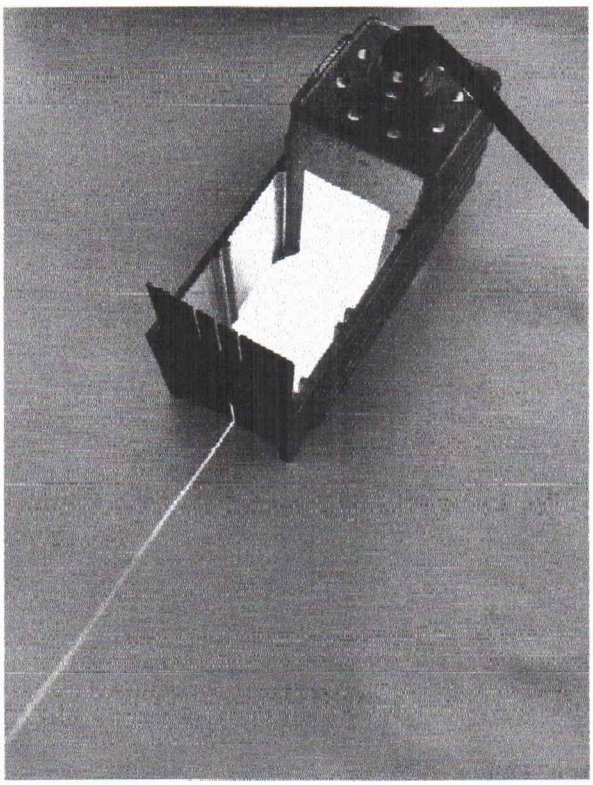
0 3 A student investigated the refraction of light at the boundary between air and glass.

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]

For a wider ray, it becomes difficult to judge where the center of the ray is causing a larger uncertainty.

Question 3 continues on the next page

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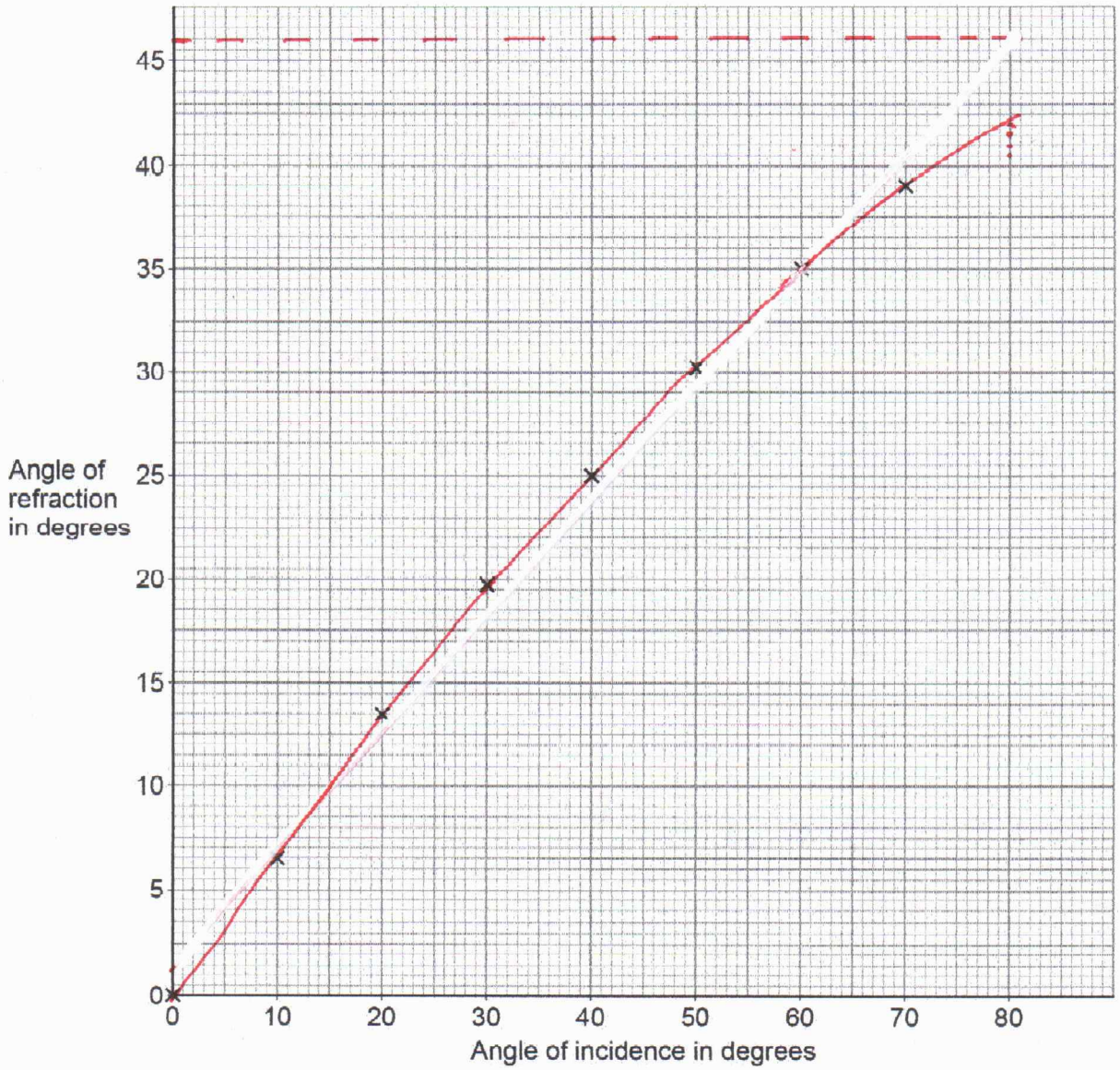
Figure 4 shows the results.

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]

- Place a glass block on a plain paper and draw the outline of the glass block.
- Draw a normal perpendicular to the upper part of the outline of the glass block
- Using a protractor, Measure an angle of incidence e.g 10° then use a ray box to shine a ray of light through the glass block.
- Mark the ray of light emerging from the block and join the points to show the path of the complete ray through the block.
- Use a protractor to measure the angle of refraction.
- Repeat the experiment with ~~different~~ angles of incidence upto 70°.

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.

$\frac{28+25+22}{3} = 25$

$28-25=3$
$25-22=3$

[2 marks]

or

$\frac{\text{Range}}{2} \Rightarrow \frac{28-22}{2} = \frac{6}{2} = 3$

Uncertainty = ± 3 °

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

[1 mark]

Tick (✓) **one** box.

Colour ☐

Frequency ☐

Velocity ☑

13

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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.

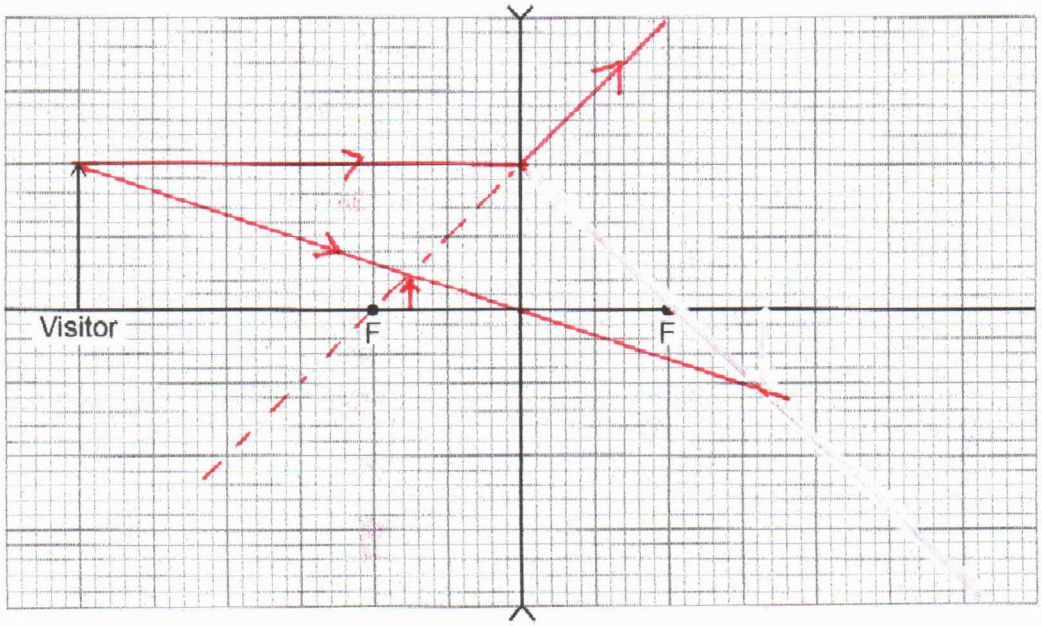
0 4 . 1 **Figure 5** is an incomplete ray diagram representing a visitor standing near the security lens.

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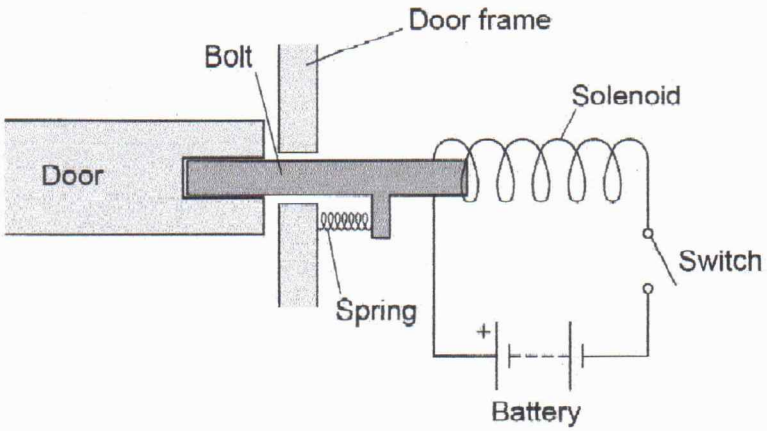
Figure 6 shows a diagram of the lock. The door unlocks when the switch is closed.

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]

The Current flows in the solenoid and creates a magnetic field. This causes the Bolt to be attracted unlocking the door.

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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]

$F = K\Delta x.$

$K = \frac{F}{\Delta x} = \frac{2.88\,N}{1.50\,cm} = \frac{2.88\,N}{0.015\,M}$

$= 192\ N/M.$

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 Solenoid

2 By increasing the number of turns on the solenoid.

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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]

Total momentum before = Total momentum after.

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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]

Total p before = $(78 \times 7.5) + (91 \times -5.5)$

$= 585 + -500.5$

$= 84.5$

Total p After Collisions:

$(M_1 + M_2) \times V = (78 + 91) \times V$

$= 169V$

$169V = 84.5$

$V = \frac{84.5}{169} = 0.5$

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 pads increase the time taken for the change of momentum to decrease which tends to decrease the rate of change of momentum.

This reduces the force on the hockey player. $\left[F = \frac{\Delta p}{t} \right]$.

8

Turn over for the next question

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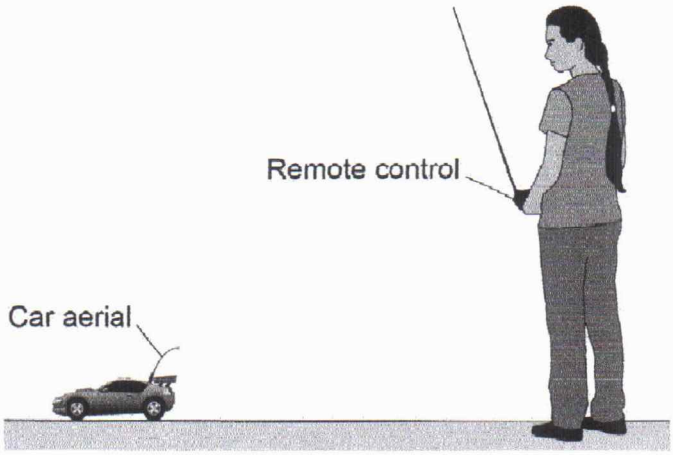
0 6 **Figure 8** shows a student playing with a remote-controlled car.

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. $= 320 \times 10^6$ Hz

speed of radio waves = 3.0×10^8 m/s

Calculate the wavelength of the radio waves.

Give the unit.

[5 marks]

$v = f \times \lambda$

$\lambda = \frac{v}{f} = \frac{3.0 \times 10^8}{320 \times 10^6} = \frac{3.0 \times 10^8}{3.2 \times 10^8}$

$= 0.9375$

Wavelength = 0.9375 Unit m

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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]

Alternating current was induced in the electrical circuit, with the same frequency as the radiowave.

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 waves as the sound waves are longitudinal.

2 Radiowaves are electromagnetic while sound waves are Mechanical Waves.

Question 6 continues on the next page

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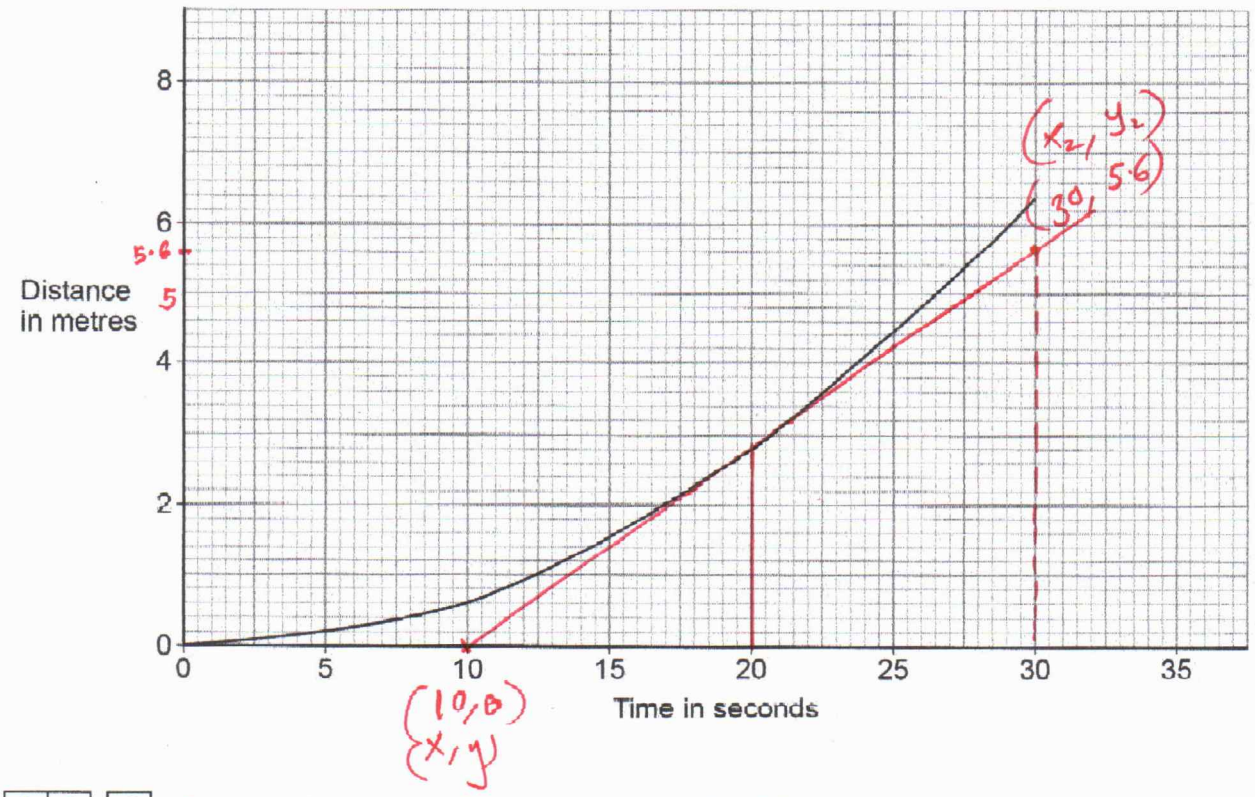
Figure 9 shows the distance-time graph for the first 30 seconds of the car's motion.

Figure 9



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

[1 mark]

The Car was accelerating.

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

[4 marks]

(By drawing a tangent at 20th second)

$\frac{\Delta y}{\Delta x} = \frac{5.6}{30-10} = \frac{5.6}{20}$

$= 0.28$

Speed = 0.28 m/s

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0 6 . 6 A different car accelerated from 0.12 m/s (u) to 0.52 m/s (v).

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

The work done to accelerate the car was 0.48 J.

Calculate the resultant force needed to accelerate the car.

[6 marks]

$W = F \times d$ $\quad v^2 = u^2 + 2as$

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

$s = \frac{v^2 - u^2}{2a} = \frac{0.52^2 - 0.12^2}{2 \times 0.040} = 3.2\text{ m}$

$W = F \times d$ or $W = F \times s$

$F = \frac{W}{s} = \frac{0.48}{3.2} = 0.15\text{ N}$

Resultant force = 0.15 N

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

[4 marks]

When the thrust force foward of the car's engine caused the car to accelerate, the air resistance increases. When the air resistance balances with the thrust force, the car can no longer accelerate, but moves at a maximum speed.

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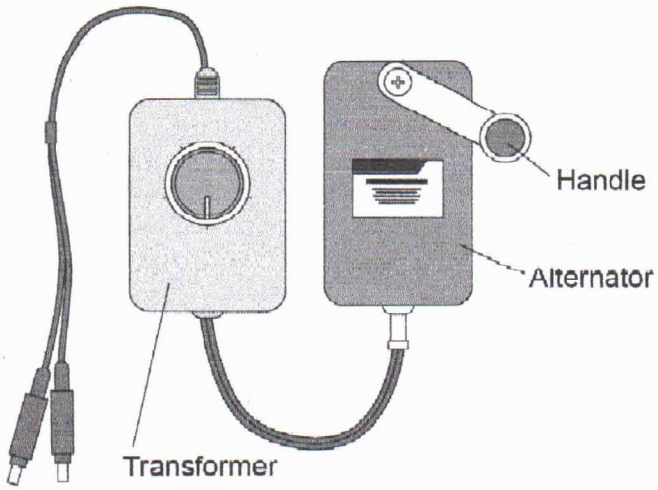
0 7 **Figure 10** shows a portable power supply.

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 that the output potential difference can be varied so that there is no need for 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. $= V_s$

The alternator generates a potential difference of 1.5 V. $= V_p$

The primary coil of the transformer has 150 turns. $= N_p$

Calculate the number of turns needed on the secondary coil. $= N_s$

[3 marks]

$\frac{V_p}{V_s} = \frac{N_p}{N_s} \Rightarrow N_s = N_p \times \frac{V_s}{V_p}$

$= 150 \times \frac{5.0}{1.5}$

Number of turns on the secondary coil = 500

Question 7 continues on the next page

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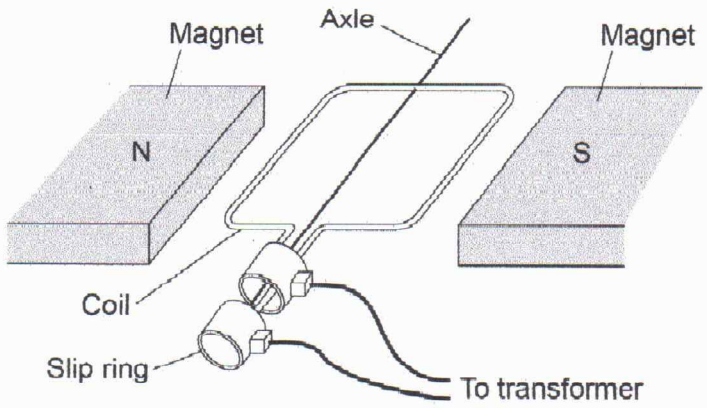
Figure 11 shows the inside parts of the alternator.

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]

When the Coil moves within the magnetic field, it cuts the magnetic field and a potential difference is induced across the Coil.

Since there is a complete circuit, a current is induced and after every half turn, the potential difference reverses the direction and so the current changes direction after every half turn.

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

[1 mark]

They provide a moveable contact so that the wires do not twist.

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]

After the disconnection, there is no induced current so Lenz law does not cause the produced Magnetic field which opposes the movement of the coil.

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END OF QUESTIONS