Oxford Cambridge and RSA

AS Level Physics A

H156/01 Breadth in physics

Tuesday 23 May 2017 – Morning

Time allowed: 1 hour 30 minutes

You must have:
- the Data, Formulae and Relationships Booklet (sent with general stationery)

You may use:
- a scientific or graphical calculator
- a ruler (cm/mm)

First name	
Last name	

Centre number						Candidate number				

INSTRUCTIONS
- Use black ink. HB pencil may be used for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- This document consists of **28** pages.

SECTION A

You should spend a maximum of 25 minutes on this section.

Answer **all** the questions.

Write your answer to each question in the box provided.

1 Which statement is **not** correct about an electromagnetic wave?

A It can be diffracted.

B It can be polarised.

C It is a longitudinal wave.

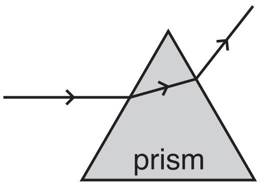
D It can travel through a vacuum.

Your answer ☐ **[1]**

2 A narrow beam of light in air is directed at the surface of a triangular glass prism.

Which is the correct diagram for the light refracted by the prism?

A



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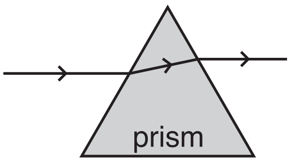

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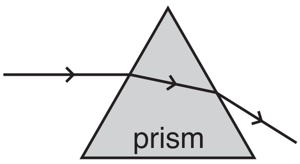

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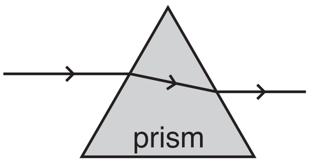
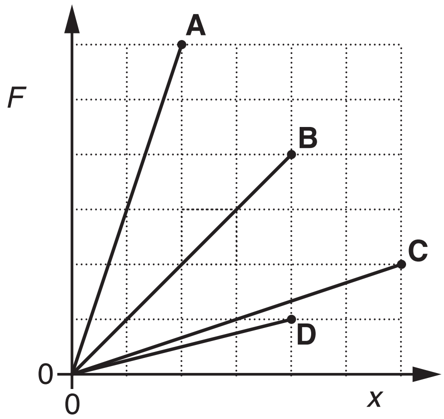


Your answer ☐ **[1]**

3 The force F against extension x graphs for four different wires **A**, **B**, **C** and **D** up to their breaking points are shown below.



Which wire has the greatest work done on it before it breaks?

Your answer ☐ **[1]**

4 An object experiences two forces, 3.0 N and 4.0 N, in the same plane. The directions of the forces are not known.

What is the magnitude of the resultant force F acting on the object?

A $F = 5.0\,\text{N}$

B $F = 7.0\,\text{N}$

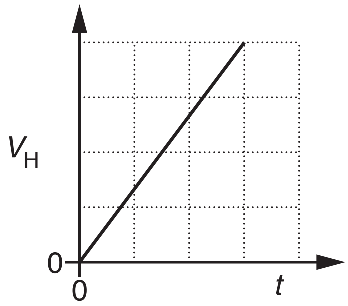
C $1.0\,\text{N} \leqslant F \leqslant 7.0\,\text{N}$

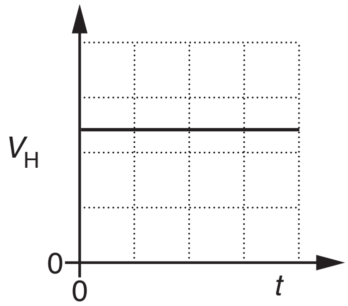
D $4.0\,\text{N} \leqslant F \leqslant 7.0\,\text{N}$

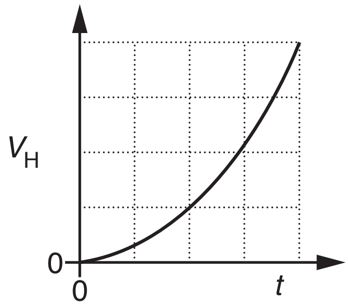
Your answer ☐ **[1]**

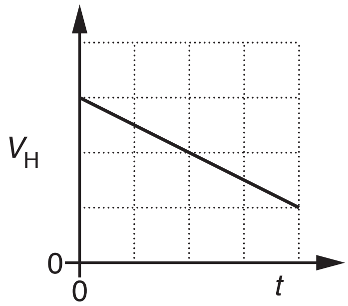
5 A projectile is fired in a horizontal direction at time $t = 0$.
Ignore air resistance.

Which graph correctly shows the horizontal component of the velocity V_H of the projectile against time t?

A 

B 

C 

D 

Your answer ☐ **[1]**

6 A ball, initially at rest, is struck by a hockey stick. It leaves the hockey stick at speed *v*.

Which quantity, together with the mass of the ball, can be used to determine *v*?

A The time of the impact.

B The weight of the hockey stick.

C The impulse of the force.

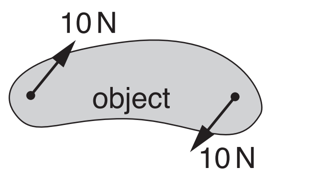
D The final momentum of the hockey stick.

Your answer ☐ **[1]**

7 Two forces act on an object in the same plane.

Which diagram shows a couple?

A



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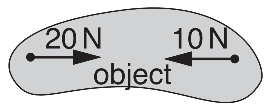

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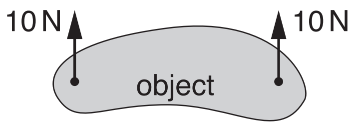

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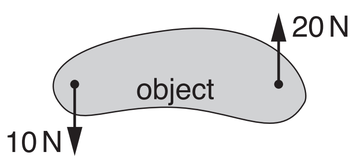


Your answer ☐ **[1]**

8 Two resistors of resistances 120 Ω and 500 Ω are connected in **parallel**.
The percentage uncertainty in the value of resistance of each resistor is 10%.

What is the correct value of the total resistance and the percentage uncertainty?

A 97 Ω ± 10%

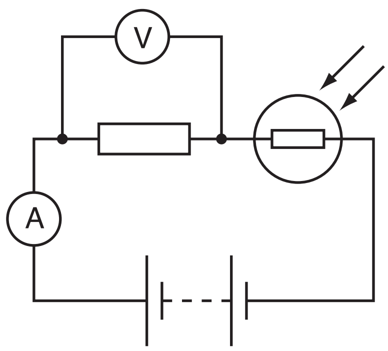
B 97 Ω ± 20%

C 620 Ω ± 10%

D 620 Ω ± 20%

Your answer ☐ **[1]**

9 A potential divider circuit with a light-dependent resistor (LDR) is shown below.



The intensity of the light incident on the LDR is reduced.

Which row correctly describes the observed change on the ammeter and voltmeter readings?

	Ammeter reading	**Voltmeter reading**
A	decreases	decreases
B	decreases	increases
C	increases	stays the same
D	stays the same	decreases

Your answer ☐ **[1]**

10 The minimum potential difference across a light-emitting diode (LED) before it conducts is 2.1 V. The wavelength of the light emitted by the LED is λ.

e = elementary charge
c = speed of light in a vacuum

What is the correct expression for determining the Planck constant h?

A $h = 2.1ec\lambda$

B $h = \dfrac{2.1e}{\lambda}$

C $h = \dfrac{c}{2.1e\lambda}$

D $h = \dfrac{2.1e\lambda}{c}$

Your answer ☐ **[1]**

11 A cable is attached to an object of weight 30 N. The object is pulled vertically upwards with an acceleration of 6.0 m s^{-2}.

What is the tension in the cable?

A 12 N

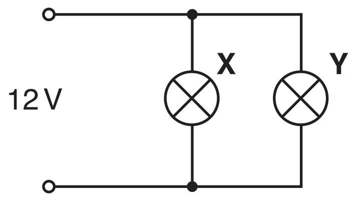
B 18 N

C 30 N

D 48 N

Your answer ☐ **[1]**

12 Two filament lamps **X** and **Y** are connected in parallel to a supply.
The power dissipated by lamp **X** is 24 W and the power dissipated by lamp **Y** is 6.0 W.
The supply has electromotive force (e.m.f.) 12 V and negligible internal resistance.



What is the total current drawn from the supply by the lamps?

A 0.4 A

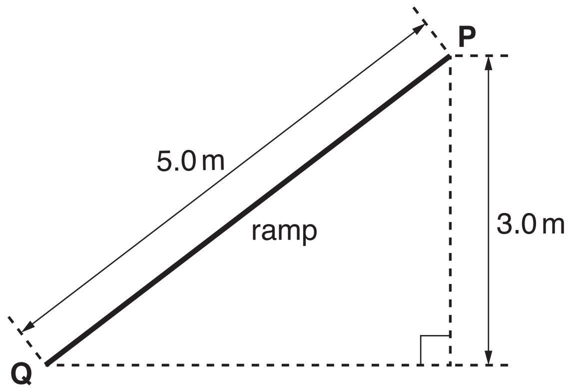
B 0.5 A

C 2.0 A

D 2.5 A

Your answer [1]

13 An object is at the top of a ramp at point **P**. The gravitational potential energy of the object at **P** is 100 J. The object is released from rest at **P**. It travels down the ramp. The kinetic energy of the object at the bottom of the ramp at point **Q** is 60 J.



What is the average resistive force acting on the object as it travels down the ramp?

A 8.0 N

B 10 N

C 12 N

D 20 N

Your answer [1]

14 The de Broglie wavelength of an electron after being accelerated through a potential difference (p.d.) V is λ_0.
The accelerating p.d. is now doubled.

What is the new de Broglie wavelength of the electron in terms of λ_0?

A $\frac{\lambda_0}{2}$

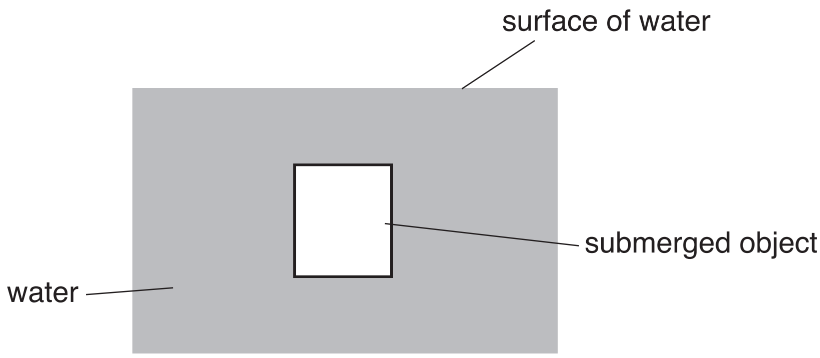
B $\frac{\lambda_0}{\sqrt{2}}$

C $\sqrt{2}\lambda_0$

D $2\lambda_0$

Your answer ☐ **[1]**

15 The diagram below shows an object submerged in water.



The object is stationary in the water.

Which statement about the upthrust acting on the object is correct?

A It is zero.

B It is equal to the mass of the object.

C It is equal to the weight of the object.

D It is equal to the volume of the water displaced.

Your answer ☐ **[1]**

16 The intensity of a laser beam is $2.0\,\text{W}\,\text{m}^{-2}$. The cross-sectional area of the beam is $1.0\,\text{mm}^2$.

What is the energy delivered by the laser beam in a time of 100 s?

A 2.0×10^{-6} J

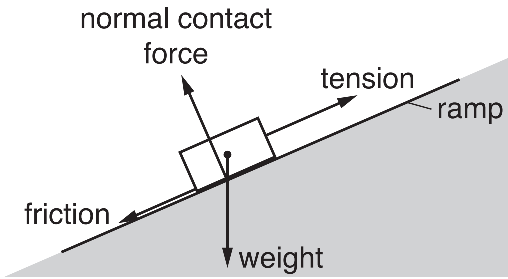
B 2.0×10^{-4} J

C 2.0×10^{-1} J

D 2.0×10^{1} J

Your answer ☐ **[1]**

17 A block moves at **constant** speed up a ramp.
The diagram below shows all the forces acting on the block.



Which force does no work on, or against, the object as it travels up the ramp?

A weight

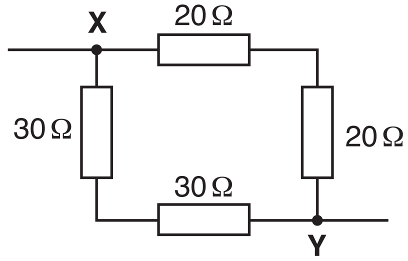
B friction

C tension

D normal contact force

Your answer ☐ **[1]**

18 The diagram below shows a circuit connected by a student.



What is the total resistance of the circuit between points **X** and **Y**?

A 24 Ω

B 29 Ω

C 38 Ω

D 100 Ω

Your answer ☐ **[1]**

19 What is a reasonable estimate for the momentum of a car travelling at $10\,\mathrm{m\,s^{-1}}$?

A $10^2\,\mathrm{kg\,m\,s^{-1}}$

B $10^4\,\mathrm{kg\,m\,s^{-1}}$

C $10^6\,\mathrm{kg\,m\,s^{-1}}$

D $10^8\,\mathrm{kg\,m\,s^{-1}}$

Your answer ☐ **[1]**

20 Which is **not** an International System (S.I.) base unit?

A second (s)

B kelvin (K)

C kilogram (kg)

D coulomb (C)

Your answer ☐ **[1]**

SECTION B

Answer **all** the questions.

21 A student uses a motion sensor to investigate the motion of a trolley crashing into a soft barrier. Fig. 21 shows the displacement *s* against time *t* graph for the trolley in one experiment.

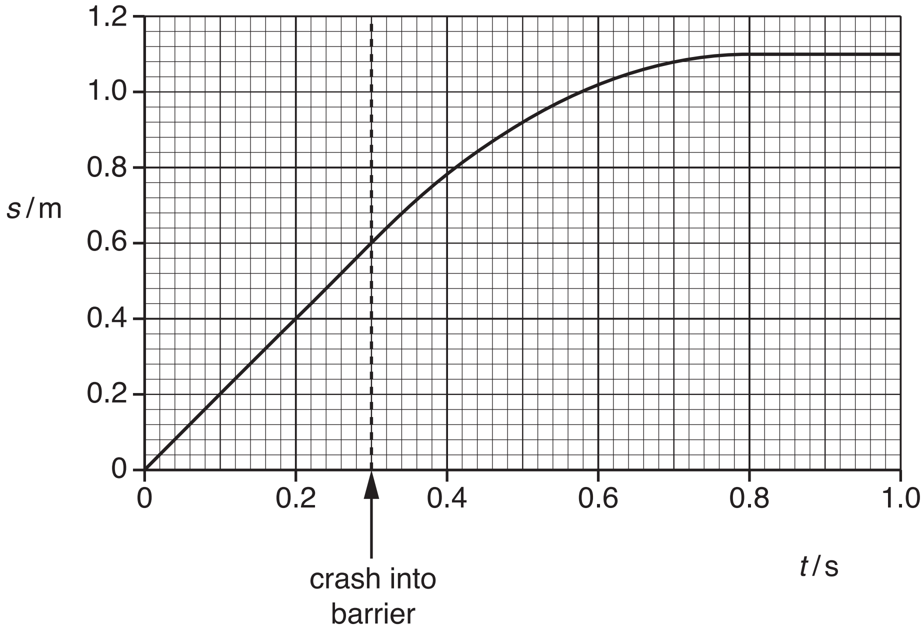


Fig. 21

The trolley has mass 900 g and an initial speed of 2.0 m s^{-1}. It crashes into the barrier at time t = 0.3 s.

(a) Calculate the initial kinetic energy of the trolley.

kinetic energy = ... J **[1]**

(b) Use Fig. 21 to describe and explain the variation of the velocity of the trolley from t = 0 to t = 1.0 s.

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.... **[4]**

(c) The student assumes that the deceleration of the trolley is constant during the crash. Use Fig. 21 to determine the magnitude of the deceleration.

deceleration = ... m s^{-2} **[2]**

22 Fig. 22 shows a uniform platform secured to a wall and resting on a vertical concrete pillar.

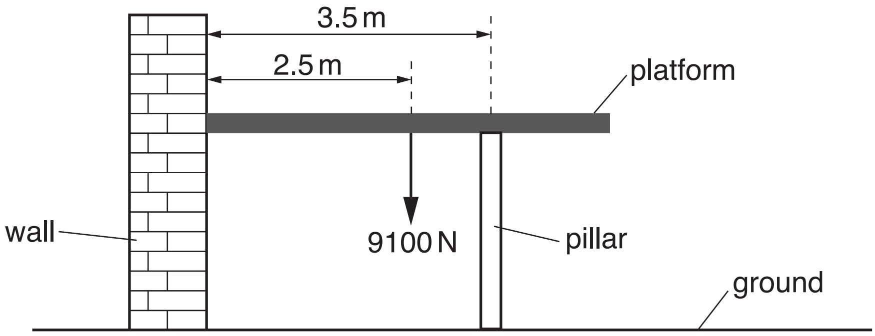

Fig. 22

The platform is in a horizontal position.
The weight of the platform is 9100 N and it has length 5.0 m. The centre of the pillar is 3.5 m from the wall.

(a) Use the principle of moments and the information provided in Fig. 22 to calculate the vertical force *F* exerted by the pillar on the platform.

F = ... N **[2]**

(b) The stress in the concrete pillar is 1.1×10^5 Pa. The original length of the pillar was 2.3 m. The Young modulus of concrete is 1.4×10^{10} Pa.
Calculate the compression x of the pillar.

x = ... m **[3]**

23 **(a)** A massive ball is released from rest above the ground.
According to a student, the principle of conservation of momentum is violated because the ball gains momentum as it falls.
Explain why the student's observation is incomplete and discuss how momentum is conserved in this situation.

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.... **[2]**

(b) Two balls **X** and **Y** are travelling in the same direction along a horizontal track.
Ball **X** makes a head-on collision with ball **Y**.
Fig. 23 shows the momentum against time *t* graph for ball **X** before, during and after the collision.

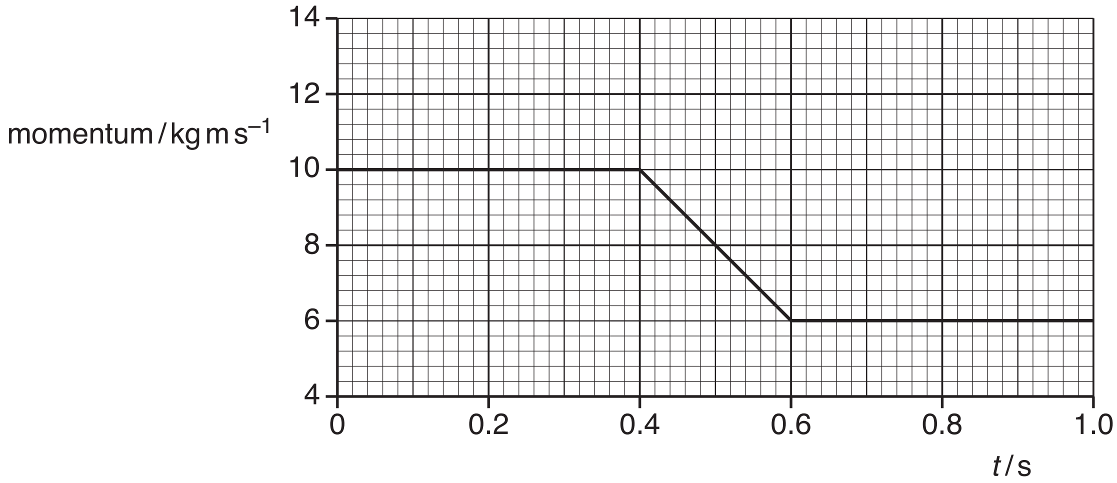

Fig. 23

(i) Use Fig. 23 to calculate the force F acting on ball **X** during the collision.

F = ... N **[2]**

(ii) The momentum of ball **Y** before the collision is 8.0 kg m s^{-1}.
On Fig. 23 sketch a graph to show the variation of the momentum of **Y** with time t. Label this graph **Y**. **[3]**

24 (a) Fig. 24.1 shows a battery connected across a negative temperature coefficient (NTC) thermistor.

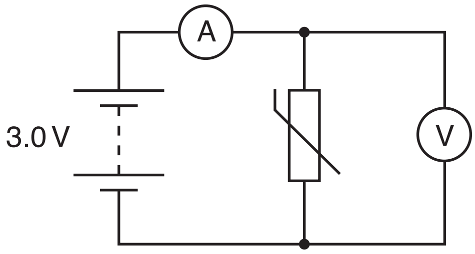

Fig. 24.1

The battery has electromotive force (e.m.f.) 3.0 V and negligible internal resistance. The ammeter has negligible resistance and the voltmeter has a very large resistance.
The thermistor has resistance 100 Ω at room temperature and a cross-sectional area of $3.8 \times 10^{-6}\,m^2$.
The number density of the free electrons within the thermistor is $5.0 \times 10^{25}\,m^{-3}$.

(i) Calculate the mean drift velocity *v* of the free electrons in the thermistor.

v = ... $m\,s^{-1}$ **[2]**

(ii) The thermistor is now heated using a naked flame.
Describe and explain the effect on the ammeter and voltmeter readings.

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(b) Fig. 24.2 shows a circuit designed by a student.

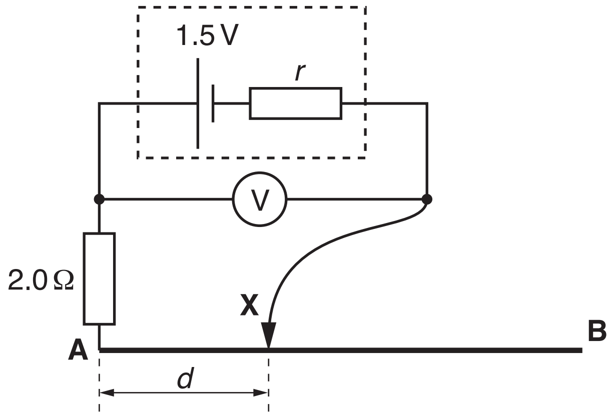

Fig. 24.2

The cell has e.m.f. 1.5 V and an internal resistance *r*.
The uniform wire **AB** has length 1.0 m and resistance 16 Ω.

(i) When the contact **X** is in the **middle** of the wire, the voltmeter reading is 1.2 V.
Calculate the internal resistance *r* of the cell.

r = ... Ω **[3]**

(ii) The contact **X** is now moved along the wire from **A** to **B**.
The distance of the contact **X** from **A** is *d*.
Fig. 24.3 shows the variation of the potential difference *V* across the terminals of the cell.

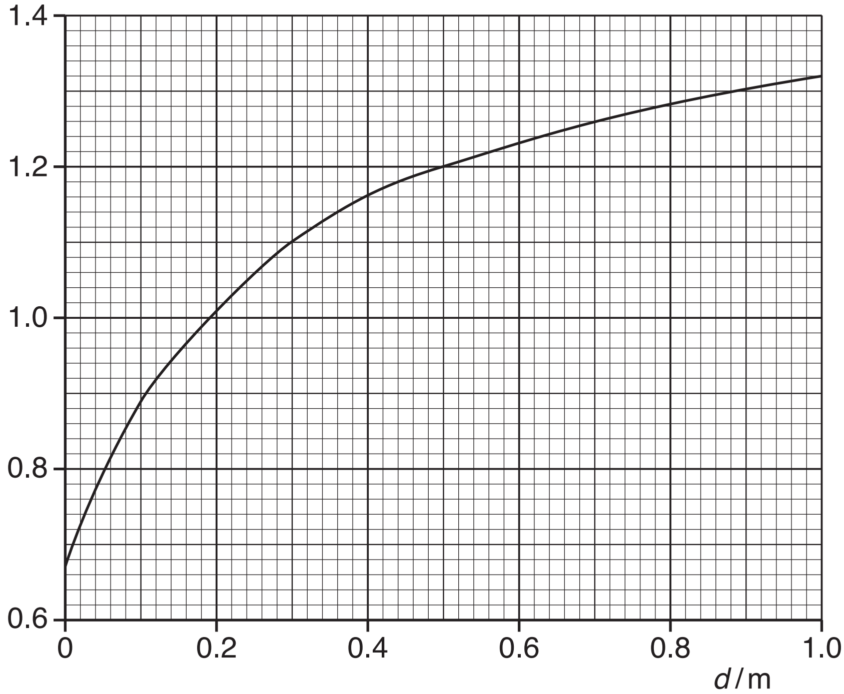

Fig. 24.3

Explain the variation of *V* with *d* in terms of the current in the circuit.

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.... **[3]**

25 **(a)** In a ripple tank experiment, a dipper vibrates on the surface of water.
Circular waves spread out in all directions from the dipper.
The variation of displacement of the water with distance x from the dipper at one instant in time is shown in Fig. 25.1.

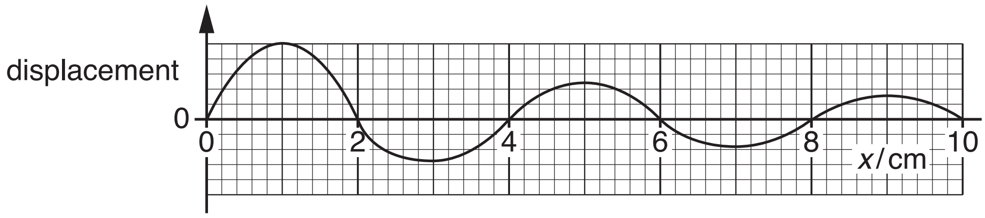

Fig. 25.1

(i) Determine the wavelength λ of the wave in cm.

λ = ... cm **[1]**

(ii) Explain why the **intensity** of the wave changes as the distance x increases.

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.... **[2]**

(b) Fig. 25.2 shows an arrangement used to demonstrate the interference of transverse waves on the surface of water.

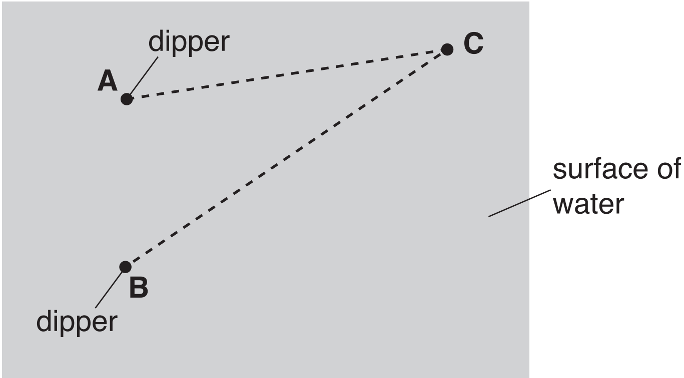

Fig. 25.2 (not to scale)

The dippers **A** and **B** oscillate in phase. Each dipper creates waves of wavelength 3.0 cm. **C** is a point on the surface of the water. The distance **AC** is 10.5 cm and the distance **BC** is 15.0 cm.

(i) Explain what is meant by *interference*.

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.... **[1]**

(ii) State and explain the type of interference occurring at **C**.

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.... **[2]**

26 A long metal wire is stretched between two fixed points across a laboratory bench. The speed v of the transverse wave on the stretched wire is given by the equation

$$v = \sqrt{\frac{T}{\mu}}$$

where T is the tension in the wire and μ is the mass per unit length of the wire.

(a) The SI base units of v, T and μ are shown below.

$v \rightarrow \mathrm{m\,s^{-1}}$ $T \rightarrow \mathrm{kg\,m\,s^{-2}}$ $\mu \rightarrow \mathrm{kg\,m^{-1}}$

Show that the equation above is homogeneous.

[1]

(b) Describe and explain how you could make use of standard laboratory equipment to determine the mass per unit length μ of the wire. State how you would make your results as precise and accurate as possible.

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.... **[3]**

(c) The stretched wire of fixed length is used in an experiment to demonstrate stationary waves. The tension in the wire is kept **constant**.
Fig. 26 shows the three stationary wave patterns that can be formed on the stretched wire.

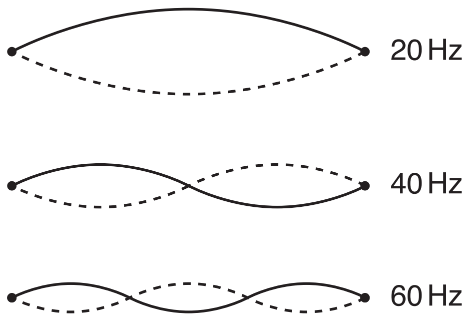

Fig. 26

The frequency *f* of vibration of the stretched wire for each stationary wave is shown on Fig. 26. Use Fig. 26 to describe and explain how the wavelength λ of the progressive wave on the stretched wire depends on the frequency of vibration of the wire.

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.... **[3]**

27 A researcher is investigating the work function of metals using the photoelectric effect.
The table below shows the threshold frequency f_0 and the work function ϕ for various metals.

metal	A	B	C	D	E
$f_0/10^{14}$ Hz	4.5	5.6	6.5	8.0	9.7
ϕ/eV	1.9	2.3	2.7	3.4	4.1

(a) Explain what is meant by *threshold frequency*.

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.... **[1]**

(b) Fig. 27 shows the data points for the metals **A**, **B**, **D** and **E** plotted on a ϕ against f_0 grid.

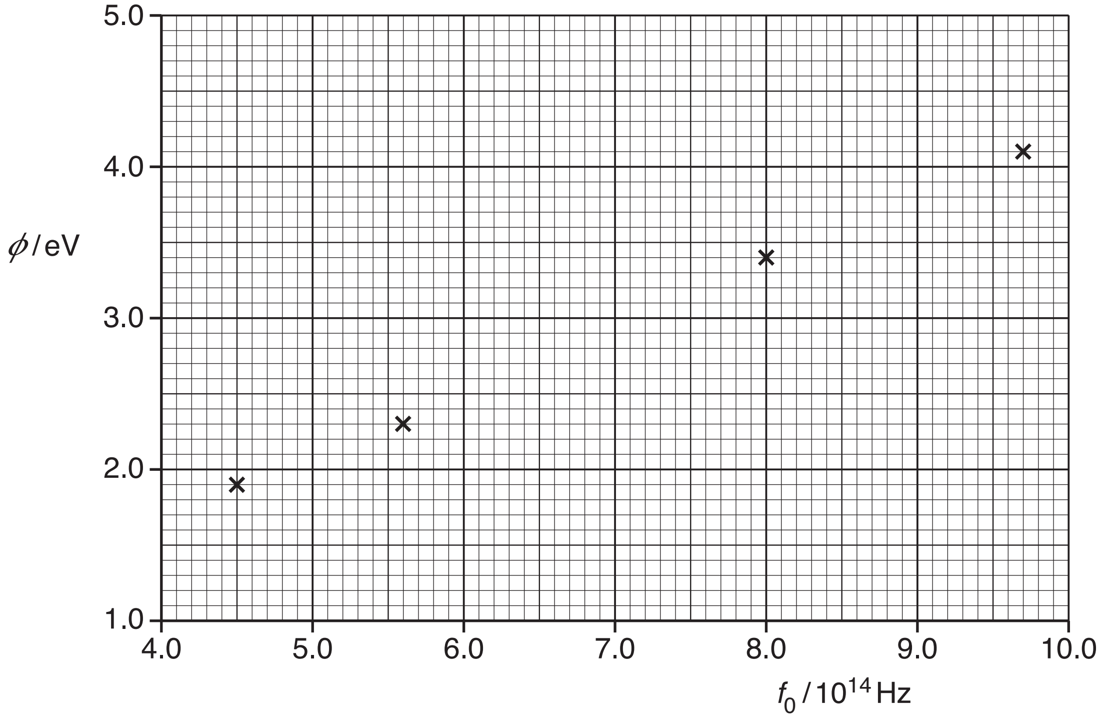

Fig. 27

(i) Use Einstein's photoelectric equation to show

$$\phi = hf_0$$

where h is the Planck constant.

[1]

(ii) Plot the data point for **C** on Fig. 27 and draw the straight line of best fit. **[1]**

(iii) Use Fig. 27 to determine the experimental value for h.

h = ... J s **[2]**

(iv) Explain, without doing any calculations, how you could use Fig. 27 to determine the percentage uncertainty in h.

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.... **[2]**

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).