Class	Index Number	Name
16		

ST. ANDREW'S JUNIOR COLLEGE
JC 2 2017
Preliminary Examination Paper 1

PHYSICS, Higher 1 **8866/01**

19 Sept 2017 **1 hour**

Instructions to students:

There are **thirty** questions in this paper. Answer **all** the questions. For each question there are four possible answers **A, B, C, D.**

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Optical Mark Sheet (OMS).

Each correct answer will score one mark. Double entry of choices will be considered as a wrong answer. A mark will not be deducted for a wrong answer.

This question paper consists of 15 printed pages including this page.

DATA AND FORMULAE

Data

speed of light in free space	c =	3.00×10^{8} m s^{-1}
elementary charge	e =	1.60×10^{-19} C
the Planck constant	h =	6.63×10^{-34} Js
unified atomic mass constant	u =	1.66×10^{-27} kg
rest mass of electron	m_e =	9.11×10^{-31} kg
rest mass of proton	m_p =	1.67×10^{-27} kg
acceleration of free fall	g =	9.81 m s^{-2}

Formulae

uniformly accelerated motion	s =	$ut + \frac{1}{2}at^2$
	v^2 =	$u^2 + 2as$
work done on/by a gas	W =	$p\Delta V$
hydrostatic pressure	p =	ρgh
resistors in series	R =	$R_1 + R_2 + \ldots$
resistors in parallel	$1/R$ =	$1/R_1 + 1/R_2 + \ldots$

1 Which of the following pairs of units are both SI base units?

A ampere, degree celsius
B ampere, kelvin
C coulomb, degree celsius
D coulomb, kelvin

2 The quantities p and q are measured with estimated errors of Δp and Δq respectively. The quantity r is related to p and q as follows:

$$r = p - 3q$$

Which of the following expression provides the best estimate of the fractional uncertainty of r?

A $\frac{\Delta r}{r} = \frac{\Delta p + 3\Delta q}{p - 3q}$

B $\frac{\Delta r}{r} = \frac{\Delta p - 3\Delta q}{p - 3q}$

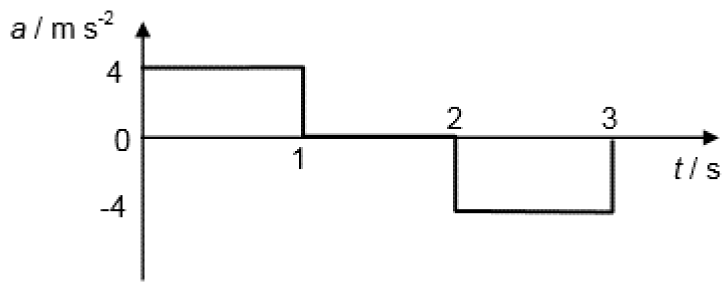
C $\frac{\Delta r}{r} = \frac{\Delta p}{p} + 3\frac{\Delta q}{q}$

D $\frac{\Delta r}{r} = \frac{\Delta p}{p} - 3\frac{\Delta q}{q}$

3 A car accelerates from rest at 2 m s^{-2} on a straight road and then comes to rest after applying the brakes. The total distance travelled by the car is 100 m and the overall time taken is 20 seconds. Determine the maximum velocity attained by the car.

A 5 m s^{-1} **B** 10 m s^{-1} **C** 15 m s^{-1} **D** 20 m s^{-1}

4 The graph below shows the variation with time of the acceleration of a particle. The particle is at rest at time t = 0 s. Determine the displacement of the particle after three seconds.



A 0 m **B** 8 m **C** 12 m **D** 16 m

5 A body is released from rest and falls vertically in air of constant velocity.

Which statement about the motion of the falling body is correct?

A As it accelerates, its weight decreases so that its acceleration decreases until it travels with constant velocity.

B It accelerates initially at 9.8 m s^{-2} but the drag force increases so its acceleration decreases.

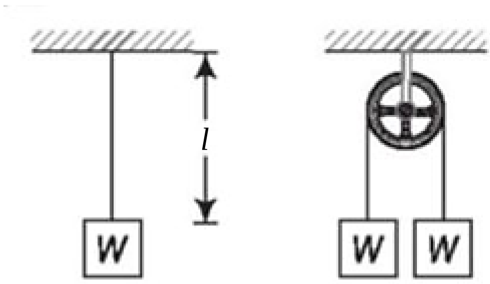
C Its velocity increases at a constant rate until its velocity becomes constant.

D The drag force of the air increases continually and eventually the velocity decreases.

6 A boy threw a ball of mass 0.2 kg vertically upwards. He applied a constant force *F* upwards on the ball as his hand moved by 0.2 m before he released the ball. The ball travelled up to a maximum height of 2.0 m from the release level. Determine the magnitude of the force *F*.

A 4.0 N **B** 16 N **C** 20 N **D** 22 N

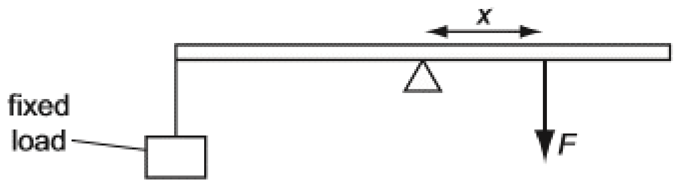
7 Two identical wires of length *l* are loaded in two different ways as shown in the figure.



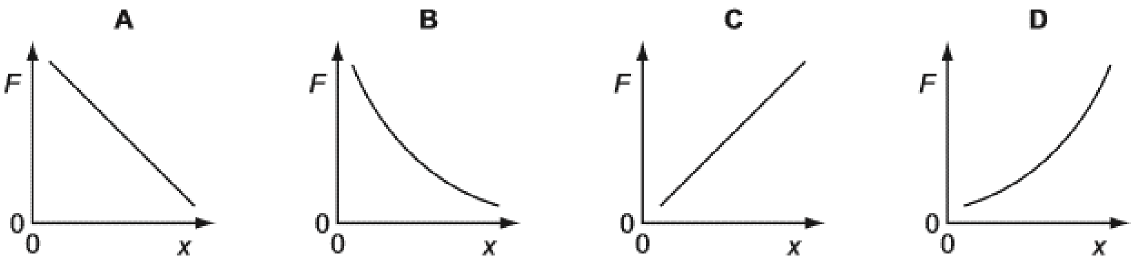
The ratio of the extensions in the two cases is

A 1 **B** 2 **C** 2.5 **D** 4

8 A horizontal bar is supported on a pivot at its centre of gravity. A fixed load is attached to one end of the bar. To keep the bar in equilibrium, a force *F* is applied at a distance *x* from the pivot.



How does *F* vary with *x*?



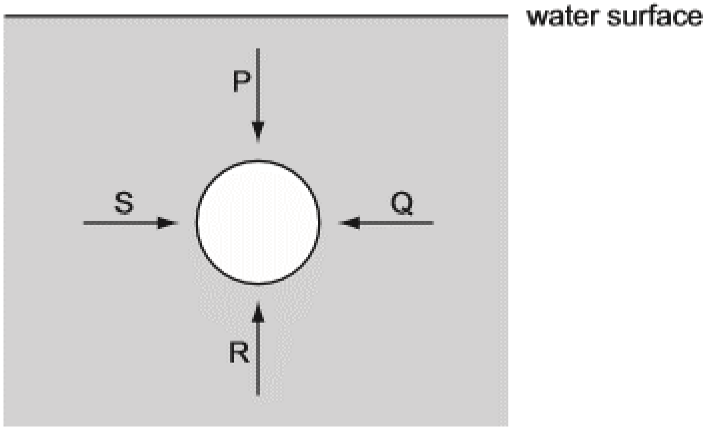
9 Two masses 1 kg and 4 kg are moving with equal kinetic energies. The ratio of their linear momenta is

A $1:\sqrt{2}$ **B** $1:2$ **C** $1:4$ **D** $1:6$

10 A freight engine pulls several train carriages of mass 200 tonnes up an inclined plane at a constant speed of 15 m s^{-1}. The engine travels a height of 1 m for every 98 m on the inclined plane. The mass of the engine is 100 tonnes and the resistive force is 20 N per tonne. What is the power exerted by the engine?

A 90 kW **B** 300 kW **C** 450 kW **D** 540 kW

11 The diagram represents a sphere under water. P, Q, R and S are forces acting on the sphere, due to the pressure of the water.



Each force acts perpendicularly to the sphere's surface. P and R act in opposite directions vertically. Q and S act in opposite directions horizontally.

Which information about the magnitudes of the forces is correct?

A $P < R$ and $S = Q$

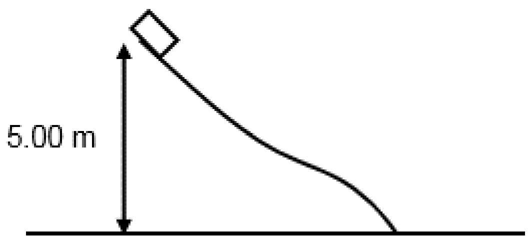
B $P > R$ and $S = Q$

C $P = R$ and $S = Q$ and $P \neq S$

D $P = R$ and $S = Q$ and $P = S$

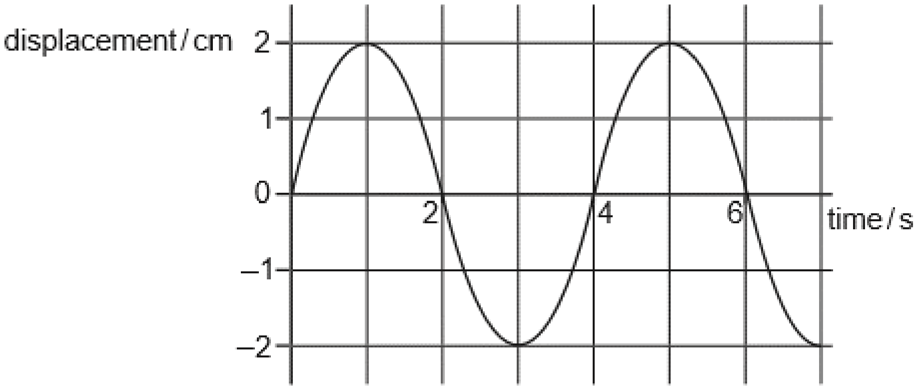
12 At a height of 5.00 m above the ground, a 50.0 kg block is released from the top of the slope with an initial speed of 2.10 m s^{-1}. It then travels a distance of 10.0 m along a curved slope to the ground. The final speed of the block at the end of the slope is only 4.90 m s^{-1} because a constant resistive force acts on it during the descent.

Determine the magnitude of the resistive force.



A 185 N **B** 196 N **C** 550 N **D** 2450 N

13 The graph shows how the displacement of a particle in a wave varies with time



Which statement is correct?

A The wave has an amplitude of 2 cm and could be either transverse or longitudinal.

B The wave has an amplitude of 2 cm and must be transverse.

C The wave has an amplitude of 4 cm and could be either transverse or longitudinal.

D The wave has an amplitude of 4 cm and must be transverse.

14 A vibrating tuning fork of frequency 340 Hz is placed above a vertical cylindrical tube closed at the lower end. The length of the tube is 120 cm. Water is slowly poured in until a loud sound is produced by the tube. Determine the minimum water level in the tube when this resonant sound is produced. (Assume speed of sound is 340 m s^{-1})

A 0.25 m **B** 0.45 m **C** 0.75 m **D** 0.95 m

15 In a Young's double slit experiment, the separation between the slits is 0.5 mm. The distance between the screen and slits is 1.5 m. For a monochromatic light of wavelength 500 nm, determine the distance of the 3rd minima from the central maxima.

A 0.75 mm **B** 1.50 mm **C** 2.25 mm **D** 3.75 mm

16 A beam of light consisting of two wavelengths 650 nm and 520 nm is used to obtain interference fringes in Young's double slit experiment. The distance between slits is 2 mm and between the plane of slits and screen is 120 cm. The least distance from the central maximum where the bright fringes due to both wavelengths coincide is

A 1.17 mm **B** 1.56 mm **C** 3.12 mm **D** 3.34 mm

17 Which effect provides direct experimental evidence that light is a transverse, rather than a longitudinal wave?

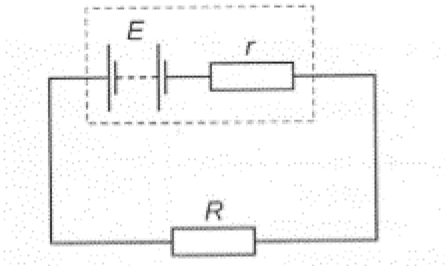
A Light can be diffracted.

B Two coherent light waves can be made to interfere.

C The intensity of light from a point source falls off inversely as the square of the distance from the source.

D Light can be polarised.

18 A battery of electromotive force (e.m.f.) *E* and internal resistance *r* is connected in series with a resistor of resistance *R* as shown.

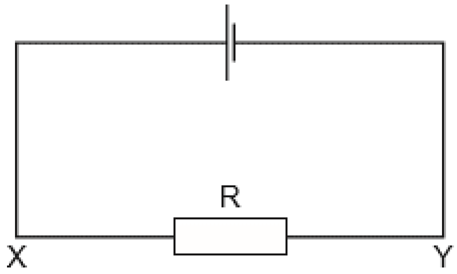


The battery transfers energy *W* at a constant rate in driving charge *Q* round the circuit in time *t*.

What is the e.m.f. *E* of the cell and the potential difference (p.d.) *V* across the external resistor?

	e.m.f. *E*	p.d. *V*
A	$\frac{W}{Q}$	RQ
B	$\frac{W}{Q}$	$R \times \frac{Q}{t}$
C	$(r + R) \times \frac{Q}{t}$	$\frac{W}{Q}$
D	$R \times \frac{Q}{t}$	$\frac{W}{Q}$

19 The current in the circuit shown is 4.8 A.



What is the direction of flow and the rate of flow of electrons through the resistor R?

	direction of flow	rate of flow
A	X to Y	$3.0 \times 10^{19}\ s^{-1}$
B	X to Y	$6.0 \times 10^{19}\ s^{-1}$
C	Y to X	$3.0 \times 10^{19}\ s^{-1}$
D	Y to X	$6.0 \times 10^{19}\ s^{-1}$

20 A relay is required to operate 800 m from its power supply. The power supply has negligible internal resistance. The relay requires 16.0 V and a current of 0.60 A to operate.

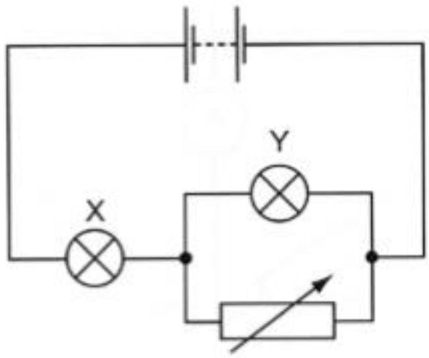
A cable connects the relay to the power supply and two of the wires in the cable are used to supply power to the relay.

The resistance of each of these wires is 0.0050 Ω per metre.

What is the minimum output e.m.f. of the power supply?

A 16.6 V **B** 18.4 V **C** 20.8 V **D** 29.3 V

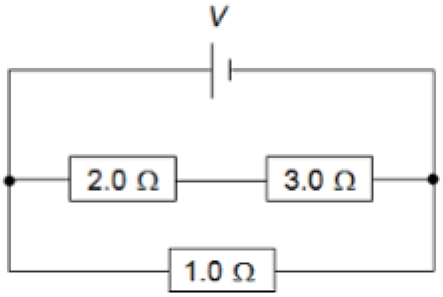
21 A circuit contains a battery, two identical lamps X and Y, and a variable resistor.



The resistance of the variable resistor is decreased. What will happen to the brightness of the lamps?

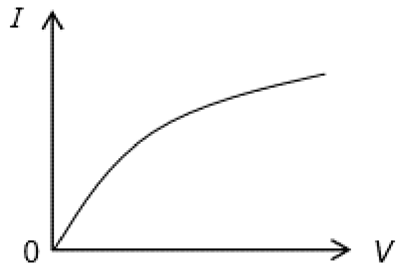
	lamp X	lamp Y
A	brighter	brighter
B	brighter	less bright
C	less bright	brighter
D	less bright	less bright

22 In the circuit below, the electromotive force of the power supply is *V*. If the power dissipated by the 2.0 Ω resistor is *P*, what is the total power supplied by the power supply?

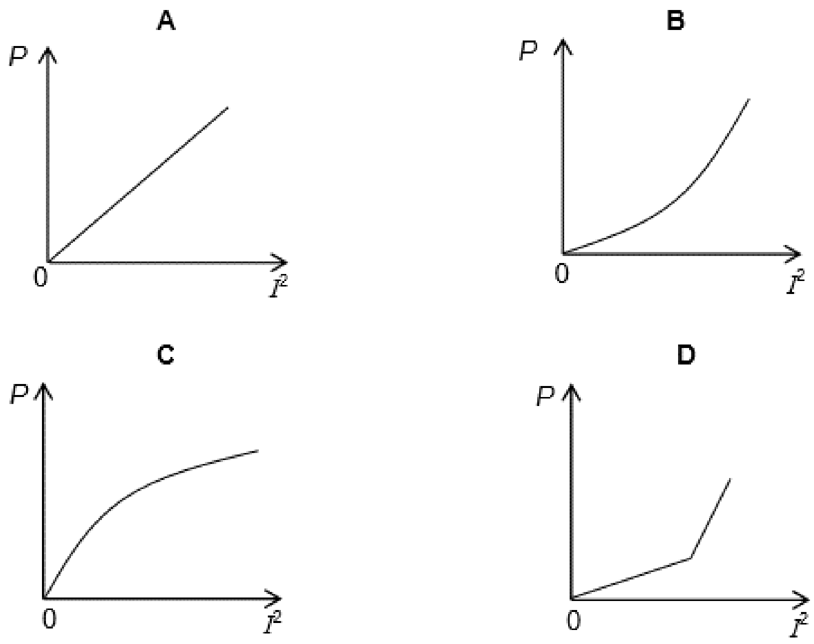


A 3*P** **B** 9*P* **C** 15*P* **D** 78*P*

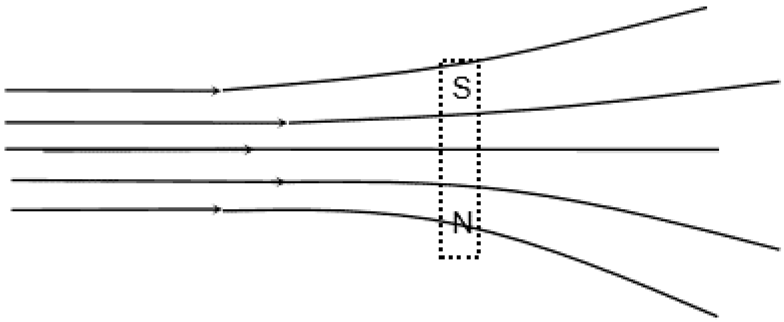
23 The graph below shows the variation of the current I through a lamp with potential difference V across it.



Which of the following graphs best represents the variation of power P dissipated in the same lamp, with I^2?



24 A bar magnet is to be placed in a non-uniform magnetic field as shown.



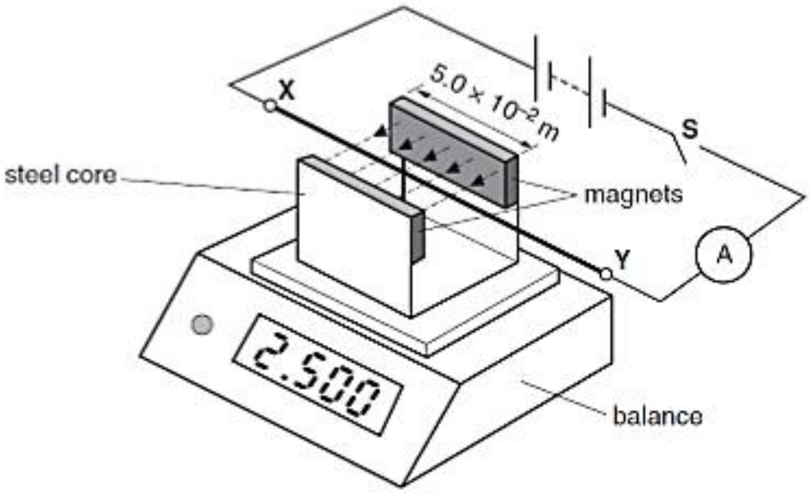
Which line of the table describes the subsequent motion of the magnet?

	rotation	movement
A	anticlockwise	To the left
B	anticlockwise	To the right
C	clockwise	To the left
D	clockwise	To the right

25 Assuming lightning strikes are vertically downwards and they consist of negative charges, in which direction would a lightning occurring at the equator be deflected by the magnetic field of the Earth?

A North **B** South **C** East D West

26 The figure below shows a rigid, straight metal rod XY placed perpendicular to a magnetic field of magnetic flux density 0.080 T. The magnetic field is produced by two magnets that are placed on a U-shaped steel core. The steel core sits on a digital balance. The weight of the steel core and magnets is 2.500 N as displayed on the balance.



When switch S is closed, the ammeter gives a reading of 4.0 A. What is the new reading on the balance?

A 2.448 N **B** 2.484 N **C** 2.500 N **D** 2.516 N

27 A blue laser beam is incident on a metallic surface, causing electrons to be ejected from the metal. If the frequency of the laser beam is increased while the intensity of the beam is held fixed,

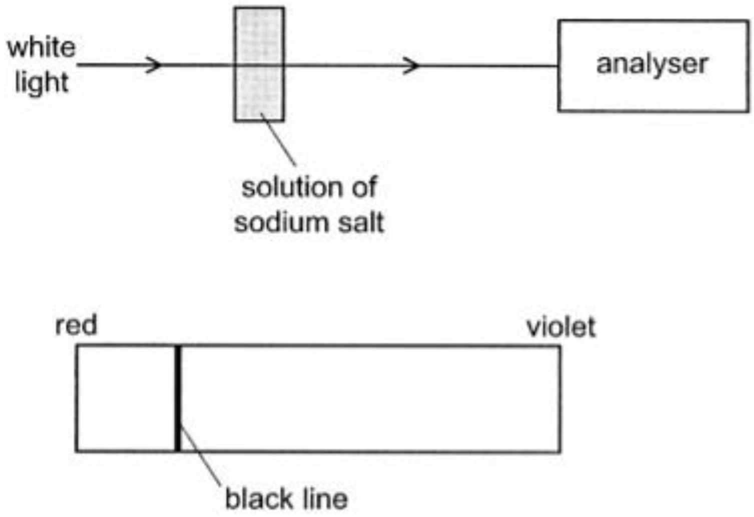
A the rate of ejected electrons will decrease and the maximum kinetic energy will increase.

B the rate of ejected electrons will remain the same but the maximum kinetic energy will increase.

C the rate of ejected electrons will increase and the maximum kinetic energy will increase.

D the rate of ejected electrons will remain the same but the maximum kinetic energy will decrease.

28 White light is passed through a solution containing a sodium salt. The light which emerges is analyzed to form a spectrum.



The spectrum consists of a continuous band of colour from red to violet, with a black line in the yellow region.

Why is the black line produced in this spectrum?

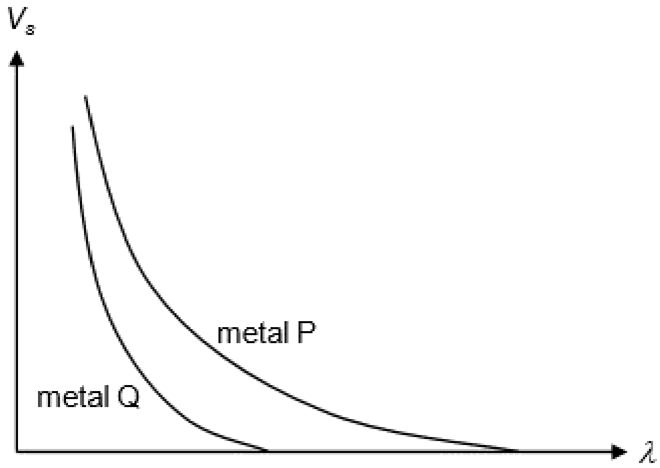
A Electrons of a particular energy are absorbed by the sodium salt.

B Electrons of a particular energy are emitted by the sodium salt.

C Photons of a particular energy are absorbed by the sodium salt.

D Photons of a particular energy are emitted by the sodium salt.

29 The figure below shows the variation of stopping potential V_s with the wavelength of the radiation λ incident on 2 different metals, P and Q.



Which of the following statements is correct?

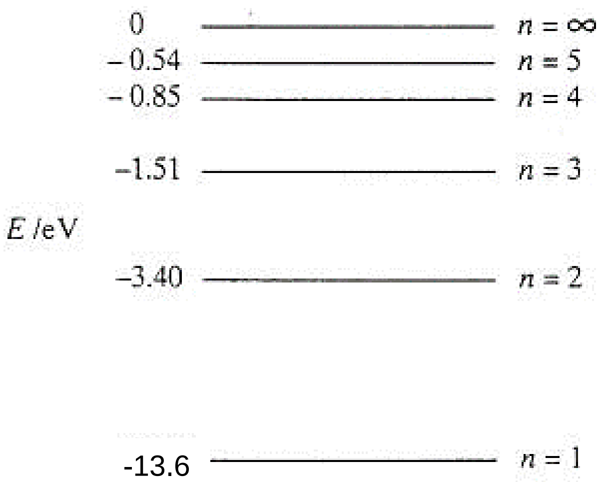
A A higher frequency light is required to produce photoelectric effect in metal Q than in P.

B The work function of metal P is higher than Q.

C The intensity of light incident on metal P is higher than that on Q.

D The gradient of the tangent to the curve gives the value of the Planck constant.

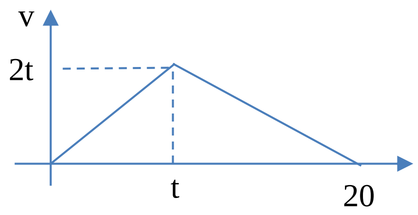
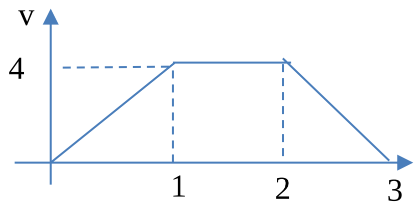
30 A hydrogen atom in its ground state is irradiated by light of wavelength 97.0 nm. Determine the number of lines present in the emission spectrum produced.



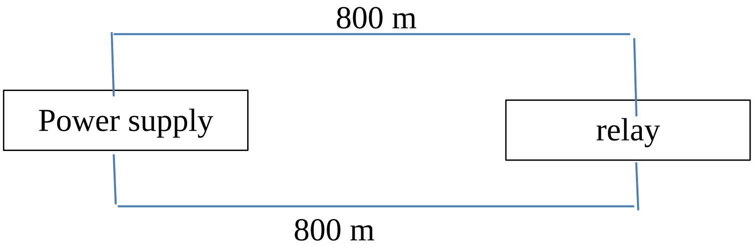
A 1 **B** 3 **C** 5 **D** 6

JC2 Preliminary Exam 2017 (H1 Physics)

Paper 1 Solutions

Qn	Ans	
1	B	
2	A	$\dfrac{\Delta r}{r} = \dfrac{\Delta(p-3q)}{p-3q}$ $\dfrac{\Delta r}{r} = \dfrac{\Delta p + 3\Delta q}{p-3q}$
3	B	 Area under v-t graph = 0.5 x 20 x 2t = 100 t = 5s use v = u + at = 5 x 2 =10
4	B	 Area under v-t graph = 0.5 x 4 x (3+1) = 8
5	B	
6	D	Since the ball reaches max hgt of 2.0m Find the initial velocity after release from the hand $v^2 = u^2 + 2as$ $0 = u^2 + 2\ (-9.81)\ 2.0$ $u = 6.26\ m\ s^{-1}$ Conservation of Energy Work done by hand = ΔE = ΔGPE+ ΔKE F x 0.2 = 0.2 (9.81) 0.2+ 0.5 (0.2) 6.26^2 F = 21.6 N
7	A	
8	B	Principle of moments

		WL/2 = Fx F = const / x
9	B	Let KE be K $K = \frac{p^2}{2m}$ For 1kg : $p_1 = \sqrt{2K}$ For 4kg : $p_2 = \sqrt{2(4)K} = 2\sqrt{2K}$
10	D	$\sin\theta = \frac{1}{98}$ For constant speed Engine force: F_E = 300 x 20 (resistive force) + 300000g sin θ = 36000 N Power P = F_E v =36000 x 15 = 540000W
11	A	
12	B	Use conservation of energy F is the resistive force E (initial at top) = E (final at bottom) 50 x 9.81 x 5 + ½ x 50 x 2.10^2 = F x 10 + ½ x 50 x 4.9^2 + 0 F = 196 N
13	A	
14	B	Wavelength of sound by tuning fork λ = v/f = 340 / 340 = 1.0 m 1st Harmonic at L= λ/4 = 25 cm 2nd Harmonic at L= 3λ/4 = 75 cm 3rd Harmonic at L= 5λ/4 = 125 cm As water poured into the cylinder, 2nd harmonic is heard first Water level = 120 – 75 = 45 cm
15	D	Use Young double slit equation $\frac{x}{D} = \frac{m\lambda}{d}$ $x = \frac{2.5 \times 500 \times 10^{-9} \times 1.5}{0.5 \times 10^{-3}} = 3.75\ mm$
16	B	Find separation of fringes for each wavelength of light 650 nm : $\Delta x = \frac{\lambda D}{d} = \frac{650\times10^{-9}\times1.2}{2\times10^{-3}} = 0.39\ mm$ 520 nm : $\Delta x = \frac{\lambda D}{d} = \frac{520\times10^{-9}\times1.2}{2\times10^{-3}} = 0.312\ mm$ Consider ratio the wavelengths 650 : 520 = 5:4 The first coincident fringe will be 4th bright fringe of 650 nm and 5th bright fringe of 520 nm. Distance from central maximum = 4 x 0.39 = 1.56 mm
17	D	
18	B	
19	C	I = Ne N = 4.8/1.6 x 10^{-19}

20	C	 Resistance of wire Rw = 800 x 2 x 0.0050 Ω = 8.0 Ω Resistance of relay = V/I = 16.0/0.60 = 26.7 Ω Use potential divider theorem, 16.0 = $\frac{26.7}{26.7+8}\ E$ E = 20.8 V
21	B	Parallel portion Y will reduce in equivalent resistance as variable resistance decrease. Lamp Y will decrease in PD across while X will increase in PD X will be brighter and Y will be less bright.
22	C	Use potential divider theorem to determine PD across 2.0 Ω V_2 = 2V/5 P_2 = P =V_2^2 /2 = 2V^2/25 V_3 = 3V/5 P_3 = V_3^2 /3 = 3V^2/25 P_1 = V^2 Total power = 2V^2/25 + 3V^2/25 + V^2 = 6V^2/5 =6/5 x 25P/2 =15P
23	B	Resistance R increases with V R also increases with I
24	A	Closer magnetic flux lines means a stronger field to the left. Flux lines pointing left to right suggests a N pole at the left. N pole of bar magnet will be repel while S pole will be attracted, therefore bar magnet will turn anticlockwise and to the left.
25	D	B-field directed northwards I directed vertically upwards since negative charges move downwards. By Fleming left hand, force is directed to left or West.
26	B	Using FLH rule, the force on XY is downwards. Since XY is fixed in place, the core magnet will be lifted upwards by N3L F =B I l = 0.08 x 4.0 x 5 x10^{-2} = 0.016 N Reading on balance 2.500-0.016 = 2.484 N
27	A	
28	C	
29	A	Einstein's eq h f = e V_s + ϕ V_s =$\frac{hc}{e\lambda} - \frac{\phi}{e}$

		When $V_s = 0$ => $\phi = hc/\lambda$ $\lambda_p > \lambda_q$ $\phi_p < \phi_q$
30	D	$\Delta E = hc/\lambda = 12.8$ eV Electron is promoted to n=4 from n=1 n=4 -> n=3,2,1 n=3 -> n=2,1 n=2 -> n=1 6 lines

End of solutions

Class	Index Number	Name
16		

ST. ANDREW'S JUNIOR COLLEGE
JC 2 2017
Preliminary Examination Paper 2

PHYSICS, Higher 1 **8866/02**

14 Sept 2017 **2 hours**

READ THESE INSTRUCTIONS FIRST

Write your name, index number and Civics Group on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid..

Section A
Answer **all** questions.

Section B
Answer **any two** questions.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets **[ ]** at the end of each question or part question.

For Examiner's Use	
Paper 1	**/ 30**
Paper 2	
Section A	**/ 40**
Section B	**/ 40**
Total	**/ 110**
Percentage	**/ 100**
Grade	

This question paper consists of 24 printed pages including this page.

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Data

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Formulae

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hydrostatic pressure	p	=	ρgh
resistors in series	R	=	$R_1 + R_2 + \ldots$
resistors in parallel	$1/R$	=	$1/R_1 + 1/R_2 + \ldots$

Section A – Answer all questions in the space provided

1 **(a)** For each of the following, tick [✓] one box to indicate whether the experimental technique would reduce random error, systematic error or neither. The first row has been completed as an example.

	Random error	**Systematic error**	**neither**
keeping your eye in line with the scale and the liquid level for a single reading of a thermometer		✓	
averaging many readings of the time taken for a ball to roll down a slope			
using a linear scale on an ammeter			
correcting for a non-zero reading when a micrometer screw gauge is close			

[2]

(b) Two of the SI base quantities are mass and time. State two other SI base quantities.

....[1]

2 **(a)** A crossbow can launch a 0.10 kg arrow at 200 m s^{-1}. The arrow accelerates from rest to 200 m s^{-1} over a distance of 0.50 m within the crossbow as it is launched.

(i) Determine the momentum of the arrow at launch.

momentum = …………………….. kg m s^{-1} [1]

(ii) Calculate the average force exerted on the arrow by the crossbow.

average force = …………………… N [2]

(b) An arbalist uses the crossbow to shoot at a circular target of diameter 20 cm at a distance of 30 m away. Assuming that the arrow is launched horizontally, with the centre of the circular target in the line of sight of the crossbow,

(i) determine how far away from the centre of the target will the arrow hit. (Ignore the effect of air resistance.)

distance from target centre = ……………………. cm [2]

(ii) Explain whether the arrow will land within the circular target.

....

....[1]

(iii) Comment on whether the approach adopted in **(i)** leads to realistic results.

....

....[2]

3 **(a)** A variable resistor is used to control the current in a circuit, as shown in Fig. 3.1.

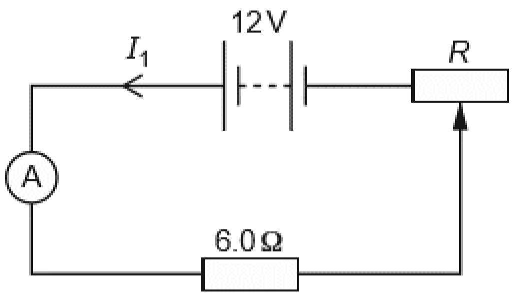


Fig. 3.1

The variable resistor is connected in series with a 12 V power supply of negligible internal resistance, an ammeter and a 6.0 Ω resistor. The resistance R of the variable resistor can be varied between 0 and 12 Ω.

(i) The maximum possible current in the circuit is 2.0 A. Calculate the minimum possible current.

minimum current = ... A [1]

(ii) On Fig. 3.2, sketch the variation with R of current I_1 in the circuit.

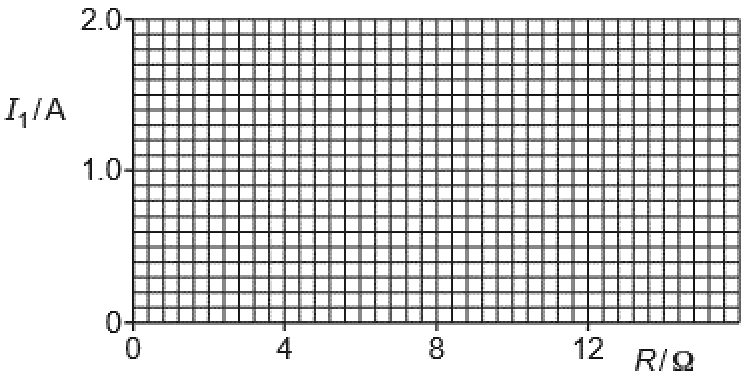


Fig 3.2

[2]

(b) The variable resistor in **(a)** is now connected as a potential divider, as shown in Fig. 3.3

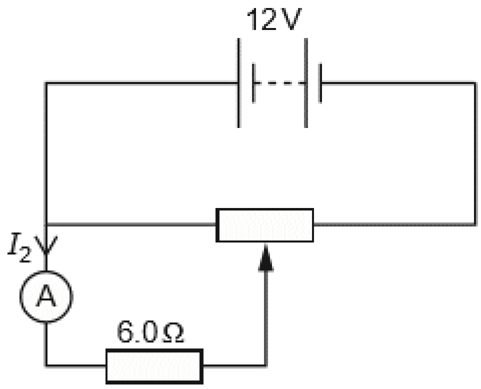


Fig 3.3

Calculate the maximum possible and minimum possible current I_2 in the ammeter.

maximum I_2 = ... A

minimum I_2 = ... A [2]

(c) **(i)** Sketch on Fig. 3.4 the I – V characteristic of a filament lamp

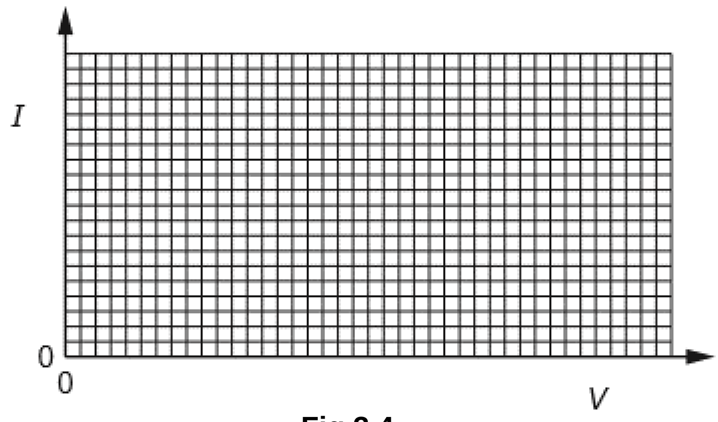


Fig 3.4

[1]

(ii) The resistor of resistance 6.0 Ω is replaced with a filament lamp in the circuits of Fig. 3.1 and Fig. 3.3.

State an advantage of using the circuit of Fig. 3.3, compared to the circuit of Fig 3.1, when using the circuits to vary the brightness of the filament lamp.

…………………………………………………………………………………………

…………………………………………………………………………………………[1]

4 **(a)** State what is meant by a photon.

…………………………………………………………………………………………

…………………………………………………………………………………………[2]

(b) Light in a beam has a continuous spectrum that lies within the visible region. The photons of light have energies ranging from 1.60 eV to 2.60 eV.

The beam passes through some hydrogen gas. It then passes through a diffraction grating and an absorption spectrum is observed.

(i) All of the light absorbed by the hydrogen is re-emitted. Explain why dark lines are still observed in the absorption spectrum.

…………………………………………………………………………………………

…………………………………………………………………………………………[1]

(ii) Some of the energy levels of an electron in a hydrogen atom are illustrated in Fig. 4.1.

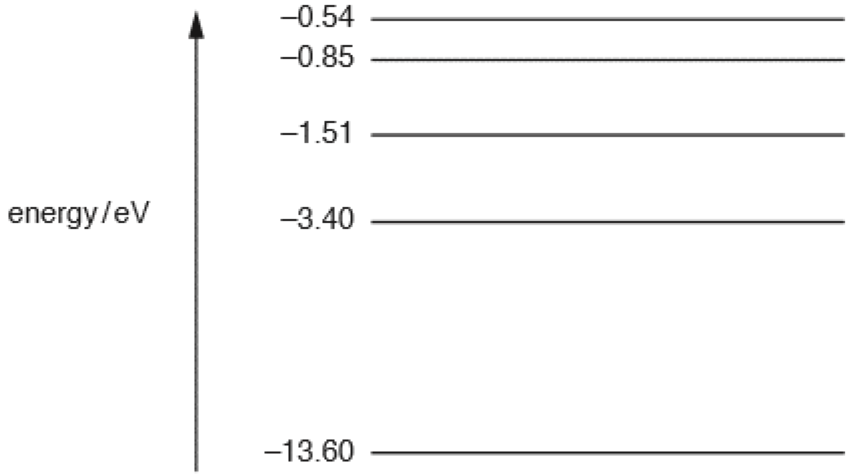


Fig 4.1 (not to scale)

The dark lines in the absorption spectrum are the result of electron transitions between energy levels.

On Fig. 4.1, draw arrows to show the initial electron transitions between energy levels that could give rise to dark lines in the absorption spectrum. [2]

(iii) Calculate the shortest wavelength of the light in the beam.

wavelength = ...m [2]

5 **(a)** A 6000 kg freight car rolls along the rails with negligible friction. The car is brought to rest by a combination of two coiled springs as shown in Fig. 5.1. Both springs obey Hooke's law. After the first spring compresses a distance of 30.0 cm, the second spring acts with the first to increase the force as additional compression occurs as shown in the graph (Fig 5.2). The car comes to rest 50.0 cm after first contacting the two-spring system.

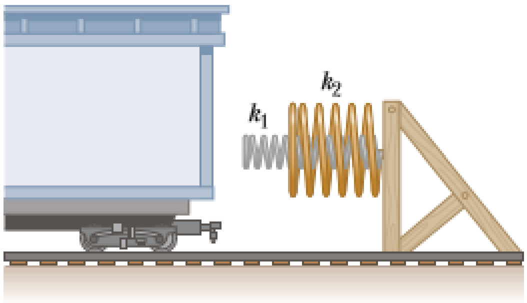


Fig 5.1

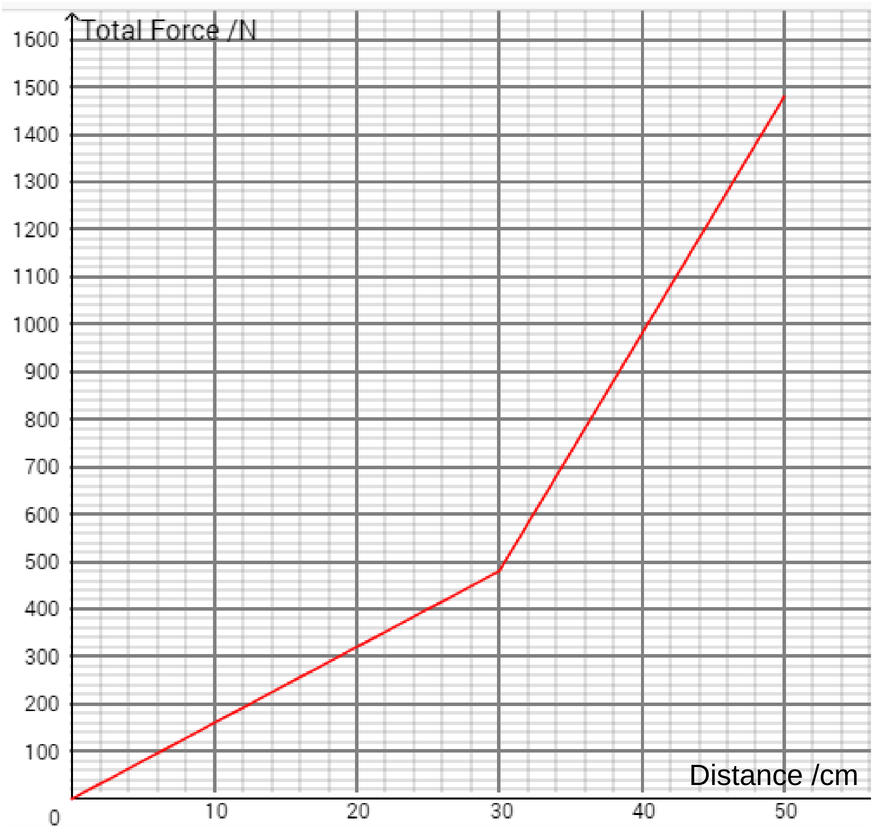


Fig. 5.2

(i) State the energy conversions that occur in the train and spring system.

……………………………………………………………………………………………

……………………………………………………………………………………………[1]

(ii) Use the graph to determine the magnitude of spring constant k_1.

spring constant k_1 = …………………….. N m^{-1} [2]

(iii) Calculate the magnitude of spring constant k_2.

spring constant k_2 = …………………….. N m^{-1} [3]

(iv) Hence or otherwise, determine the total elastic potential energy stored in both springs when the train first come to a stop.

total elastic potential energy = …………………….. J [2]

(v) Determine the initial velocity of the freight train just before it hits the first spring.

initial velocity = …………………….. m s^{-1} [2]

(b) A 10000 N shark is supported by a rope attached to a 4.0 m rod that can pivot at the base (Fig. 5.3). Ignore the weight of the rod.

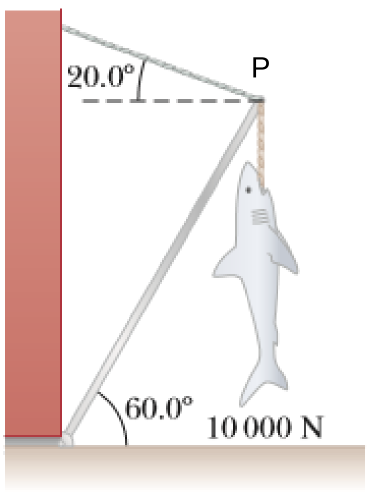


Fig. 5.3

(i) Draw and label on Fig. 5.3 the forces acting at the end of the rod at point P.

[2]

(ii) Determine the tension in the cable between the rod and the wall.

tension = ………………………….. N [3]

Section B – Answer two of the questions in this section.

6 **(a)** Draw a labelled diagram of an experimental setup to demonstrate the photoelectric effect.

[3]

(b) It is found that, on exposure of a metal surface to light, either electrons are emitted immediately or they are not emitted at all.

Suggest why this observation does not support a wave theory of light.

…………………………………………………………………………………………

…………………………………………………………………………………………..

…………………………………………………………………………………………

…………………………………………………………………………………………..

…………………………………………………………………………………………

……………………………………………………………………………………….[3]

(c) Data for the wavelength λ of the radiation incident on the metal surface and the maximum kinetic energy E_K of the emitted electrons are shown in Fig. 6.1.

λ / nm	E_K / 10^{-19} J
650 240	– 4.44

Fig. 6.1

(i) Without any calculation, suggest why no value is given for E_K for radiation of wavelength 650 nm.

……………………………………………………………………………………..

……………………………………………………………………………………

……………………………………………………………………………………..[1]

(ii) Use data from Fig. 6.1 to determine the work function energy of the surface.

work function energy = ... J [3]

(d) Radiation of wavelength 240 nm gives rise to a maximum photoelectric current I when the same metal surface as in **(c)** is used. The intensity of the incident radiation is maintained constant and the wavelength is now reduced.

State and explain the effect of this change on

(i) the maximum kinetic energy of the photoelectrons,

……………………………………………………………………………………..

……………………………………………………………………………………

……………………………………………………………………………………..[2]

(ii) the maximum photoelectric current I.

…………………………………………………………………………………………..

…………………………………………………………………………………………

…………………………………………………………………………………..[2]

(iii) Sketch a graph in Fig. 6.2 showing the relationship between the maximum kinetic energy E_K and the frequency of the incident light for the above experimental setup. Label the threshold frequency.

[2]

Fig. 6.2

(e) **(i)** Determine the minimum de Broglie wavelength of the electron produced in **(d)**.

de Broglie wavelength = …………………….. m [2]

(ii) Without any calculation, explain how the de Broglie wavelength will change if the wavelength of the incident radiation in (d) is reduced.

……………………………………………………………………………………..

………………………………………………………………………………………

………………………………………………………………………………….[2]

7 **(a)** The variation with time *t* of the displacement *y* of a wave X, as it passes a point P, is shown in Fig. 7.1.

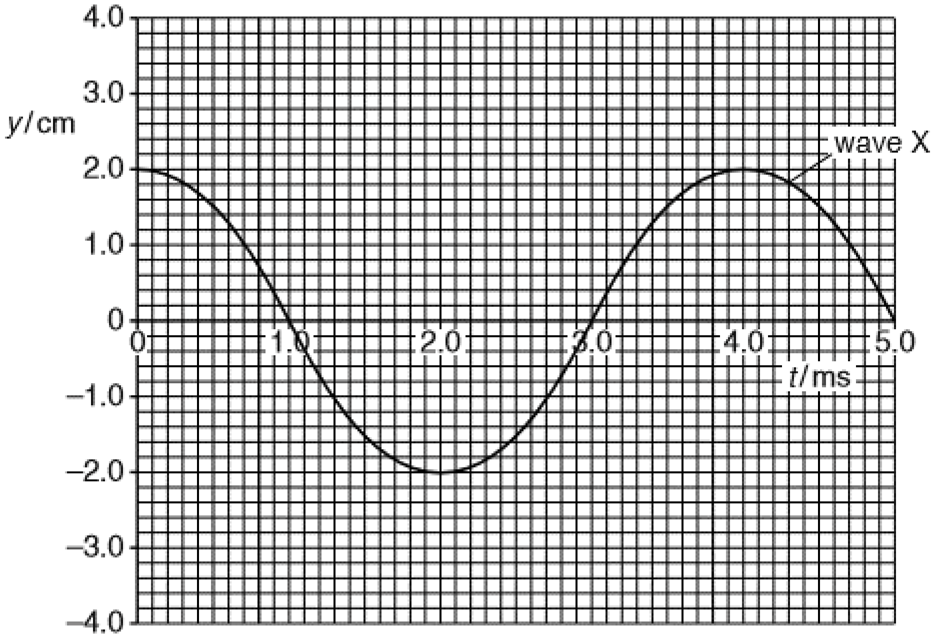


Fig. 7.1

.

The intensity of wave X is I.

(i) Use Fig. 7.1 to determine the frequency of wave X.

frequency = ... Hz [2]

(ii) A second wave Z with the same frequency as wave X also passes point P. Wave Z has intensity $2I$. The phase difference between the two waves is 90°.

On Fig. 7.1, sketch the variation with time t of the displacement y of wave Z.

Show your working.

[3]

(b) Fig. 7.2 shows the light intensity on a screen behind a double slit. The slit separation is 0.2 mm and the wavelength of the monochromatic light source is 600 nm.

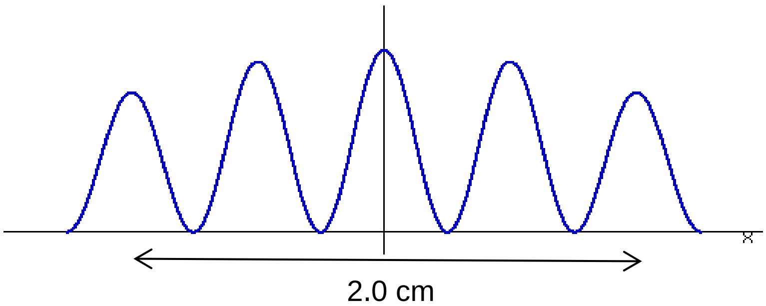


Fig. 7.2

(i) Determine the distance between the screen and the double slit.

screen distance = …………………………… m [2]

(ii) Now the distance from the screen to the double slits is increased. Draw the new light intensity graph relative to the earlier graph on Fig. 7.3.

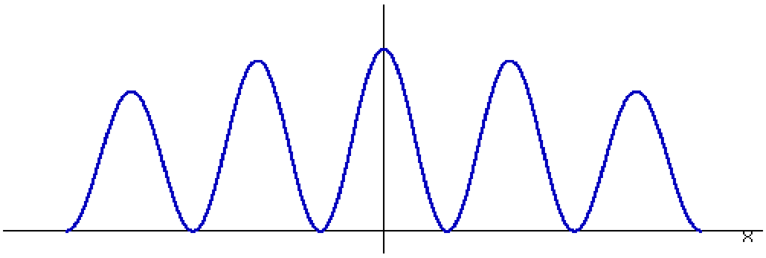


Fig. 7.3

[2]

(iii) One of the slits is now covered up. Draw the new shape of the light intensity graph on Fig. 7.4.

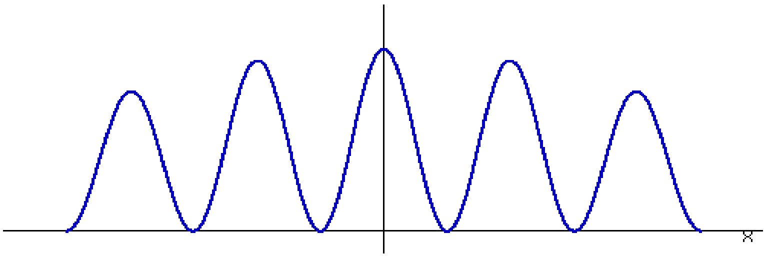


Fig. 7.4

[1]

(iv) Blue light is now shone on the double slits. Draw the new shape of the light intensity graph on Fig. 7.5. Suggest a value for the wavelength of blue light.

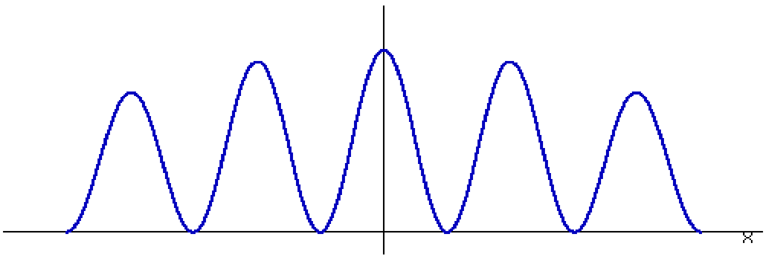


Fig. 7.5

wavelength = ……………………………… nm [3]

(c) The eardrum, which transmits vibrations to the sensory organs of your ear, lies at the end of the ear canal. As Fig. 7.6 shows, the ear canal in adults is about 2.5 cm in length

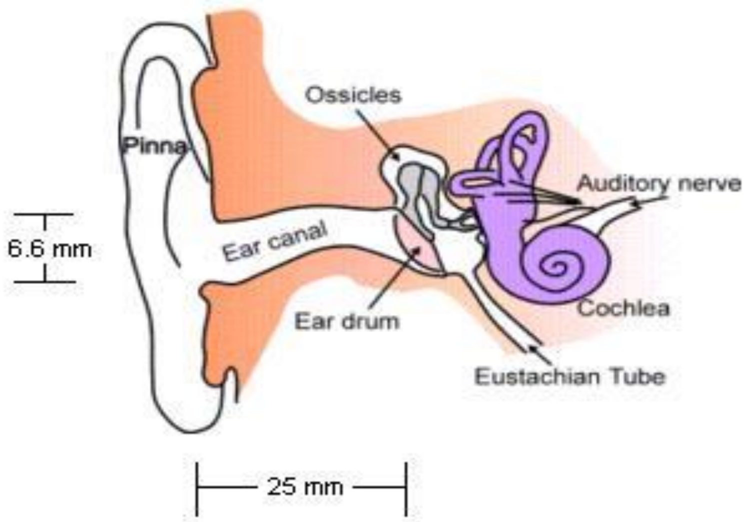


Fig. 7.6

(i) Draw and label in Fig. 7.6, the fundamental frequency of the eardrum. [1]

(ii) The human ear can hear sounds between 20 Hz and 20 kHz.

Determine the frequencies of the standing waves that can occur in the ear canal that is in the range of human hearing. Assume the speed of sound to be 340 m s^{-1}.

resonant frequencies =…………………………………………………..Hz [4]

(iii) State and explain the effect on the ear when sounds of such frequencies are produced near the ear.

………………………………………………………………………………………

……………………………………………………………………………………….[2]

8 **(a)** A uniform magnetic field has constant flux density B. A straight wire of fixed length carries a current I at an angle θ to the magnetic field, as shown in Fig. 8.1.

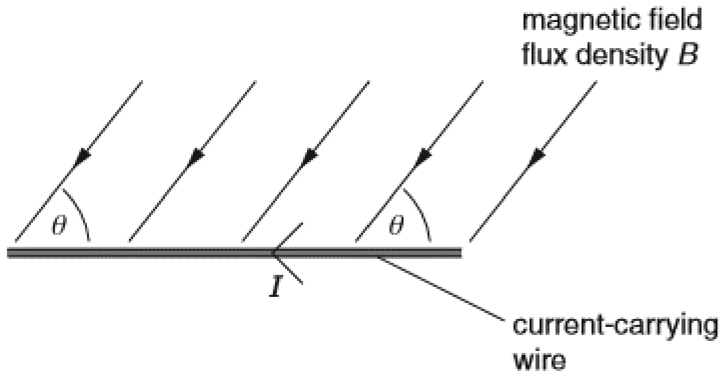


Fig. 8.1

(i) The current I in the wire is changed, keeping the angle θ constant. On Fig. 8.2, sketch a graph to show the variation with current I of the force F on the wire.

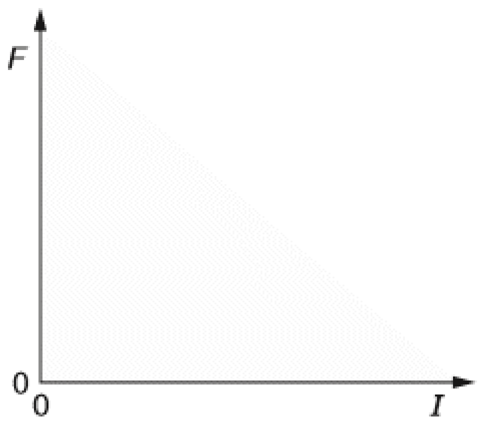


Fig. 8.2

[2]

(ii) The angle θ between the wire and the magnetic field is now varied. The current I is kept constant. On Fig. 8.3, sketch a graph to show the variation with angle θ of the force F on the wire.

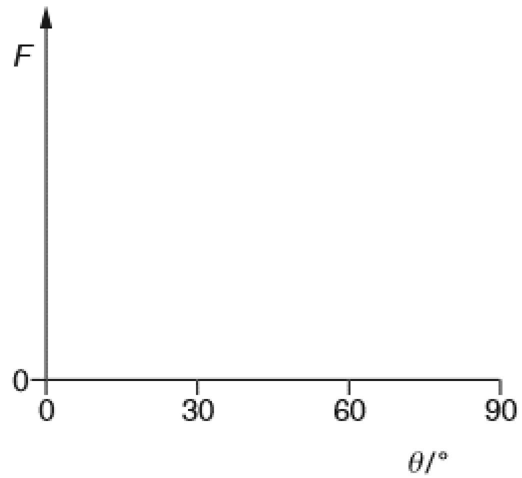


Fig. 8.3

[3]

(b) A uniform magnetic field is directed at right-angles to the rectangular surface PQRS of a slice of a conducting material, as shown in Fig. 8.4.

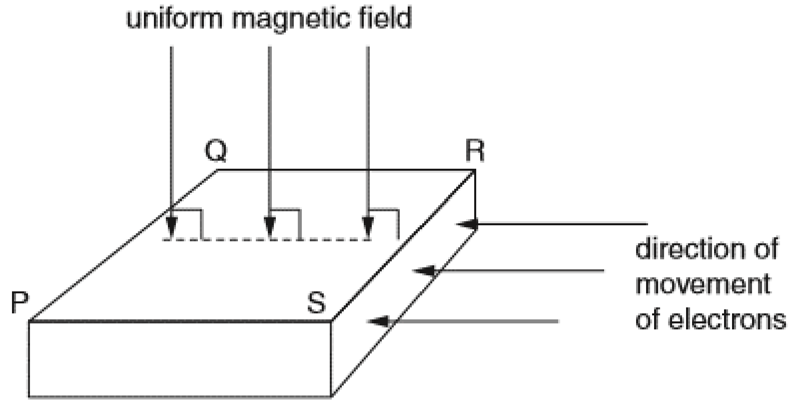


Fig. 8.4

Electrons, moving towards the side SR, enter the slice of conducting material. The electrons enter the slice at right-angles to side SR.

(i) Explain why, initially, the electrons do not travel in straight lines across the slice from side SR to side PQ.

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………….[2]

(ii) Explain to which side, PS or QR, the electrons tend to move.

....

....

....[2]

(c) Two long straight vertical wires X and Y pass through a horizontal card, as shown in Fig. 8.5.

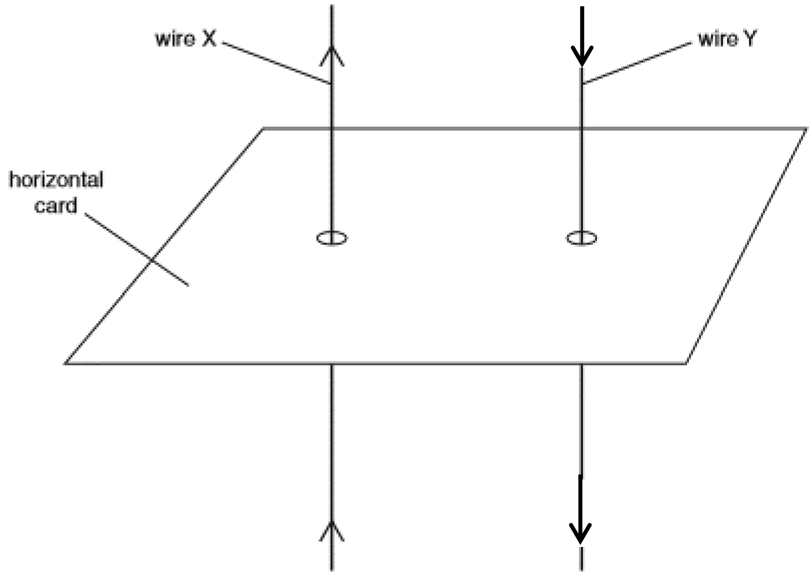


Fig. 8.5

The current in wire X and Y is in the upward and downward direction respectively.

The top view of the card, seen by looking vertically downwards at the card, is shown in Fig. 8.6.

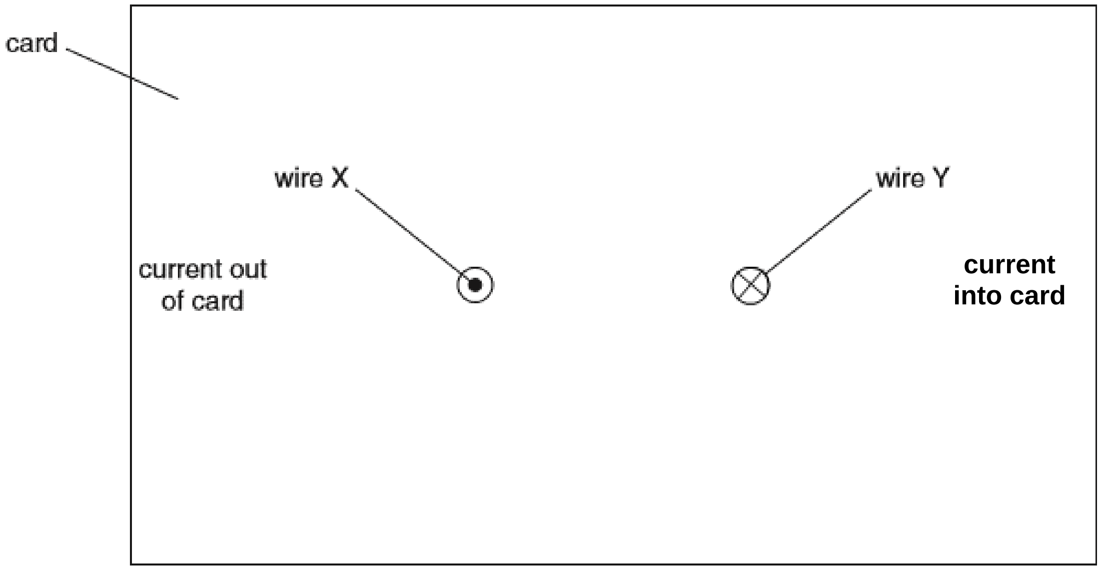


Fig. 8.6 (not to scale)

(i) On Fig. 8.6,

(1) draw four field lines to represent the pattern of the magnetic field around wire X due solely to the current in wire X, [2]

(2) draw an arrow to show the direction of the force on wire Y due to the magnetic field of wire X. [1]

(ii) The magnetic flux density *B* at a distance x from a long straight wire due to a current I in the wire is given by the expression

$$B = \frac{\mu_o I}{2\pi x}$$

where μ_o is the permeability of free space. ($\mu_o = 4\pi \times 10^{-7}$ H m^{-1})

The current in wire X is 5.0 A and that in wire Y is 7.0 A. The separation of the wires is 2.5 cm.

(1) Calculate the force per unit length on wire Y due to the current in wire X.

force per unit length = ... N m^{-1} [3]

(2) The currents in the wires are not equal.

State and explain whether the forces on the two wires are equal in magnitude.

....

....[2]

(iii) An external magnetic field *B* now acts from left to right and perpendicular to the two wires.

(1) Draw the resultant magnetic field lines due to the interaction of the external magnetic field and the magnetic field of the wires on Fig. 8.7. [2]

(2) Draw an arrow on wire X and on wire Y to indicate the resultant force due to the external magnetic field B. [1]

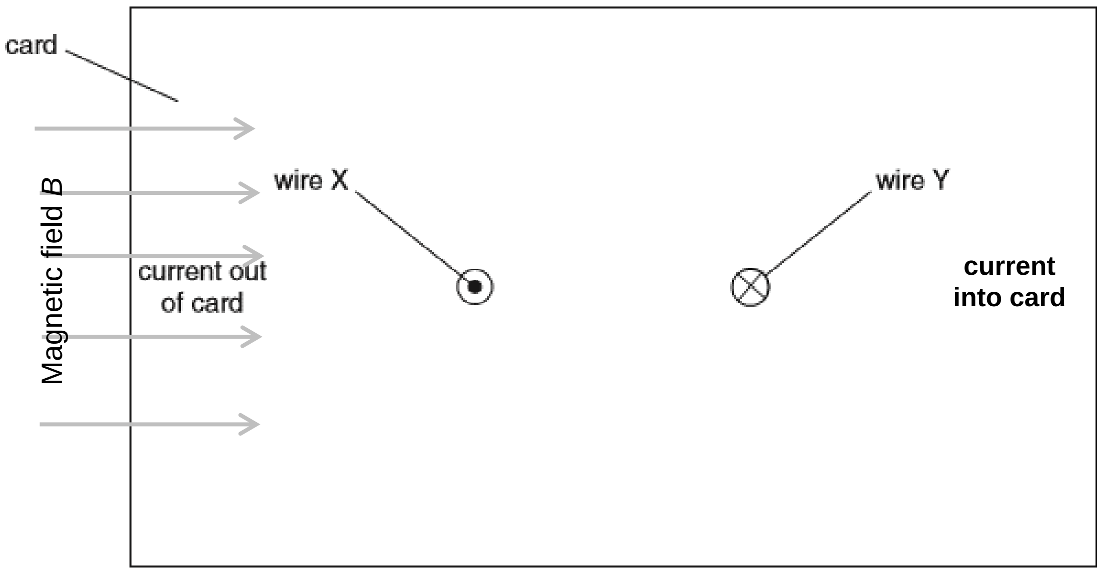


Fig. 8.7 (not to scale)

JC2 H1 Physics Prelims 2017 Solutions

<table>
<tr><th>Qn</th><th></th><th>Marks</th></tr>
<tr><td>1(a)</td><td>
<table>
<tr><th></th><th>Random error</th><th>Systematic error</th><th>neither</th></tr>
<tr><td>keeping your eye in line with the scale and the liquid level for a single reading of a thermometer</td><td></td><td>✓</td><td></td></tr>
<tr><td>averaging many readings of the time taken for a ball to roll down a slope</td><td>✓</td><td></td><td></td></tr>
<tr><td>using a linear scale on an ammeter</td><td></td><td></td><td>✓</td></tr>
<tr><td>correcting for a non-zero reading when a micrometer screw gauge is close</td><td></td><td>✓</td><td></td></tr>
</table>
[2]
All correct 2m
2 correct 1m</td><td>2</td></tr>
<tr><td>1(b)</td><td>Length, electric current, thermodynamic temperature, amount of substance
Any 2 for 1m</td><td>1</td></tr>
<tr><td>2(a)(i)</td><td>p = mv
= 0.1 x 200 = 20 kg m s^{-1}</td><td>1</td></tr>
<tr><td>2(a)(ii)</td><td>Find avg acceleraton
using $v^2 = u^2 + 2as$
$200^2 = 0 + 2a(0.5)$
a = 40000 m s^{-2}
F = ma = 0.1 x 40000
= 4000 N
Or find time t that force is being applied using s= ½ (u+v)t
Then use F t = Δp</td><td>

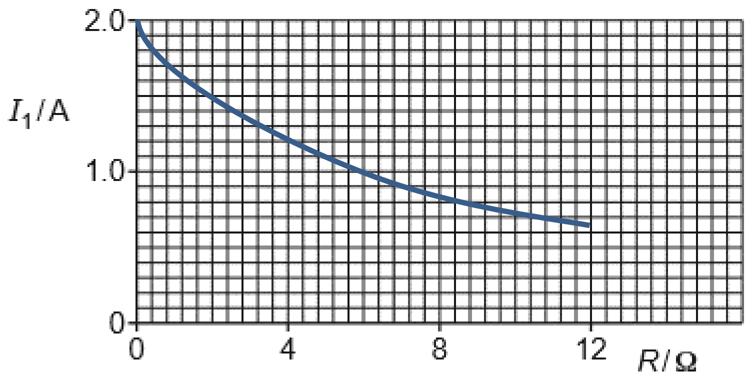
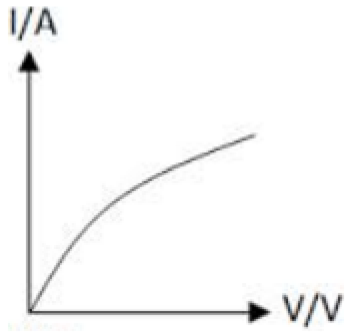
1

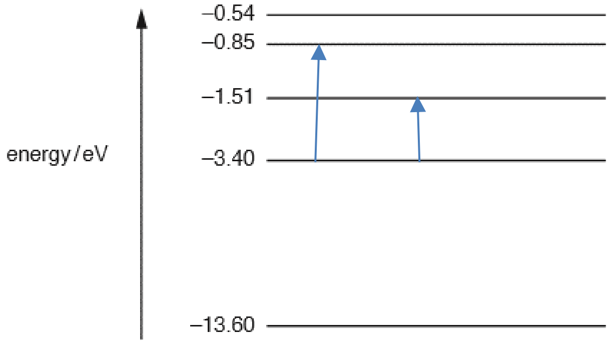
1</td></tr>
<tr><td>2(b)(i)</td><td>Find t to travel horizontal distance
30 = 200 t
t = 0.15 s
vertical distance downwards from centre of target
s = ½ g t^2
= 0.5 (9.81)0.15^2 = 0.11m =11 cm</td><td>

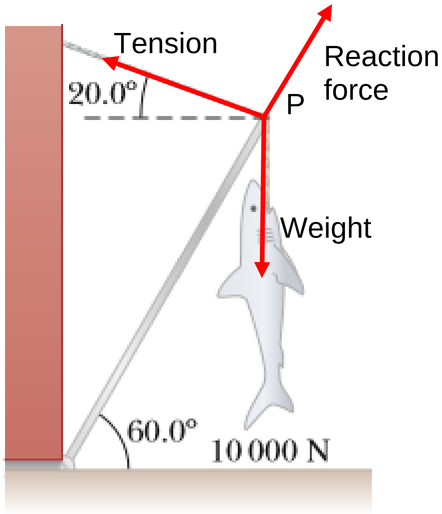
1

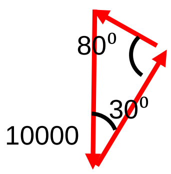
1</td></tr>
<tr><td>2b(ii)</td><td>No, since 11cm > 10cm (radius of target)</td><td>1</td></tr>
<tr><td>2b(iii)</td><td>Ignoring air resistance is not very realistic for arrow
As it is light, the air resistance in the forward direction can be significant</td><td>1
1
(8)</td></tr>
<tr><td>3a(i)</td><td>CIE s11 qp 21 Q5
I = 12 / (6 + 12)
minimum current = 0.67 A</td><td>

1</td></tr>
</table>

3a(ii)	 Fig 3.2 correct start and finish points M1 correct shape for curve with decreasing gradient A1	2
3b	When R=0 Ω I_2 = 0 A When R = 12 Ω I_2 = 2 A	1 1
3c(i)	 Correct shape and starting point 1m	1
3c(ii)	full range of current / p.d. possible or currents / p.d. down to zero or brightness ranging from off to full brightness	1 (7)
4a	CIE m17 qp 42 Q10 Discrete packet / quantum of energy of electromagnetic radiation	 1 1
4b(i)	light is re-emitted in all directions / only part of the re-emitted light is in the direction of the beam	1

4b(ii)	 2 arrows as shown and pointing upwards. 1m each	2
4b(iii)	$E = hc/\lambda$ $2.60 \times 1.60 \times 10^{-19} = (6.63 \times 10^{-34} \times 3.00 \times 10^{8}) / \lambda$ $\lambda = 4.8 \times 10^{-7}$ m	 1 1 (7)
5a(i)	Kinetic energy in the moving train is converted to elastic potential energy in the two springs	1
5a(ii)	Read off from graph x = 0.3m F = 480 N Since the first spring obeys hooke's law 480 = k (0.3) k=1600 N m^{-1}	 1 1
5a(iii)	Reading off graph x=50cm F=1480 N F= k_1 (0.5) + k_2 (0.2) 1480 = 1600 (0.5) + 0.2 k_2 680 = 0.2 k_2 k_2 =3400 N m^{-1}	 1 1 1
5a(iv)	Area under graph E = ½ (0.3)(480) + ½ (0.2)(480+1480) = 268 J Or E = EPE(spring k1)+ EPE(spring k2) = ½ (1600) 0.5^2 + ½ (3400) 0.2^2 =268 J	 1 1
5a(v)	ΔKE = ΔEPE ½ (6000) v^2 = 268 v = 0.299 m s^{-1}	1 1

<table>
<tr><td>5b(i)</td><td>


1 m for 3 forces
1 m for labels</td><td>2</td></tr>
<tr><td>5b(ii)</td><td>


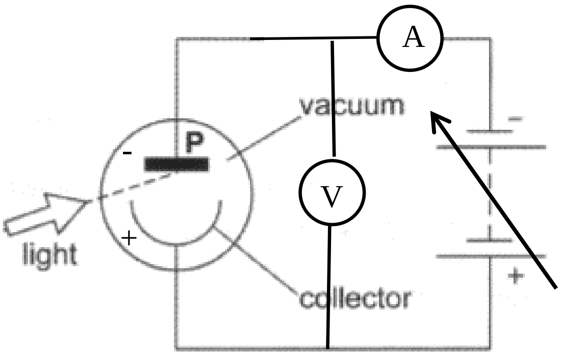
1 m for vector triangle

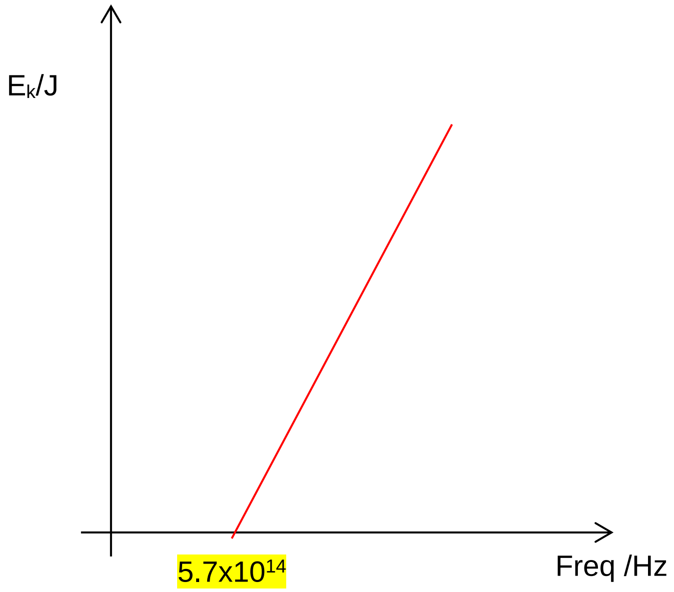
use sine rule
$$\frac{10000}{\sin 80} = \frac{T}{\sin 30}$$
T = 5080 N</td><td>1

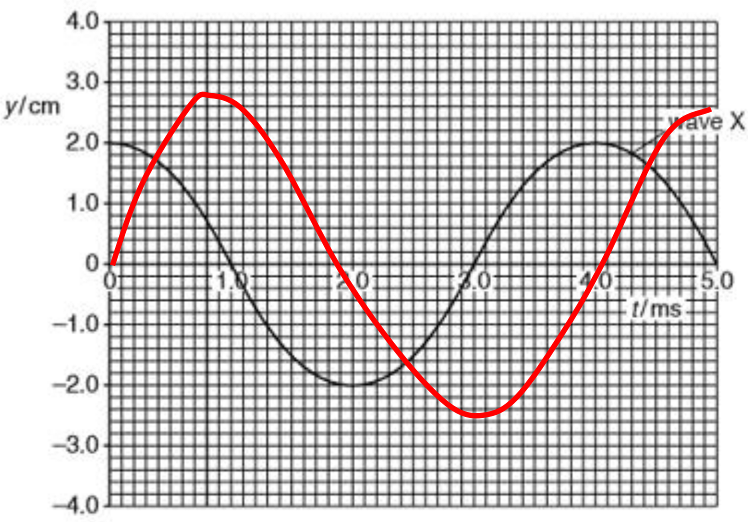
1

1

(15)</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>6a</td><td>CIE s11 qp 41 Q7</td><td>3</td></tr>
</table>

	 Metal plate P (-), Collector (+) Light source Low pressure or evacuated discharge tube or photocell Power source ammeter, voltmeter All items present get 3m Deduct 1m for every 2 omitted items	
6b	for a wave, electron can ‘collect’ energy continuously [1m] for a wave, electron will always be emitted / electron will be emitted at all frequencies [1m] after a sufficiently long delay [1m]	3
6c(i)	wavelength is longer than threshold wavelength or frequency is below the threshold frequency or photon energy is less than work function	1
6c(ii)	$hc / \lambda = E_{MAX} + \phi$ $(6.63 \times 10^{-34} \times 3.0 \times 10^{8}) / (240 \times 10^{-9}) = \phi + 4.44 \times 10^{-19}$ $\phi = 3.8 \times 10^{-19}$ J	1 1 1
6d(i)	photon energy increases as $E = hc/\lambda$ so (maximum) kinetic energy of photoelectrons is larger	1 1
6d(ii)	Intensity = $\frac{nhf}{tA} = \frac{nhc}{tA\lambda}$ For constant intensity, and wavelength decreases, number of incident photons per unit time decrease. Less electrons are emitted so (maximum) photoelectric current decreases	 1 1

6d(iii)	 Correct shape 1m Correct label Threshold freq, 1m	2
6e(i)	Minimum De Broglie wavelength $\lambda = \frac{h}{p}$ $E = \frac{p^2}{2m}$ $\lambda = \frac{h}{\sqrt{2mE}}$ E = 4.44 x 10^{-19} J m = 9.11 x 10^{-31} kg λ =7.4 x 10^{-10} m	1 1
6e(ii)	As wavelength of incident radiation is reduced, the KE_{max} of the photoelectron will increase. Since E increase, the minimum de Broglie wavelength will decrease.	1 1 (20)
7a(i)	CIE s16 qp 21 Q5 Read from graph T = 4 ms f = 1/T = 1/0.004 = 250 Hz	1 1

<table>
<tr><td>7a(ii)</td><td>
intensity ∝ (amplitude)^2 and amplitude = 2.8 (2.83) (cm)

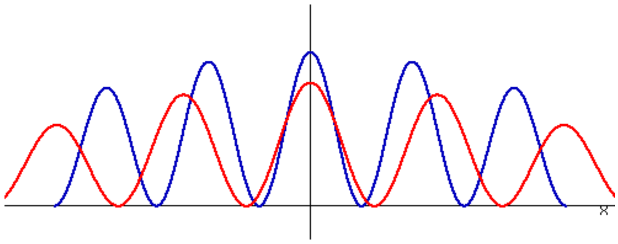
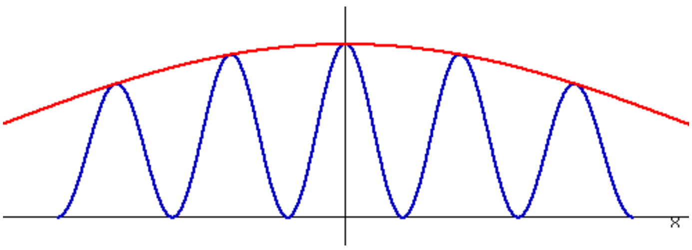
curve with same period and with amplitude 2.8 cm

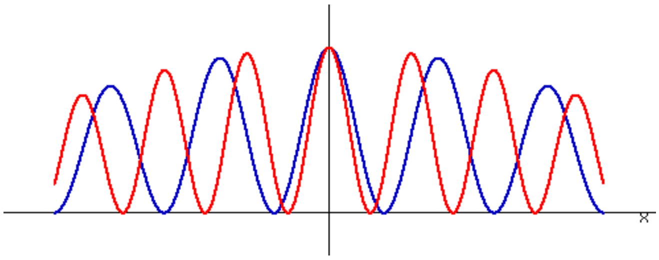
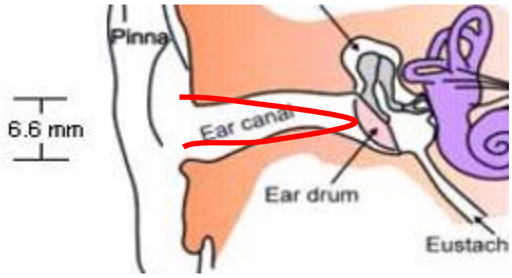
curve shifted 1.0 ms to left or to right of wave X</td><td>1

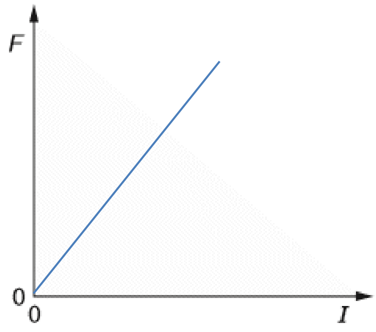
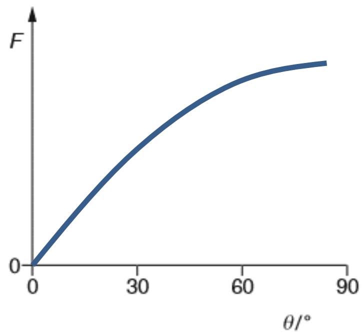
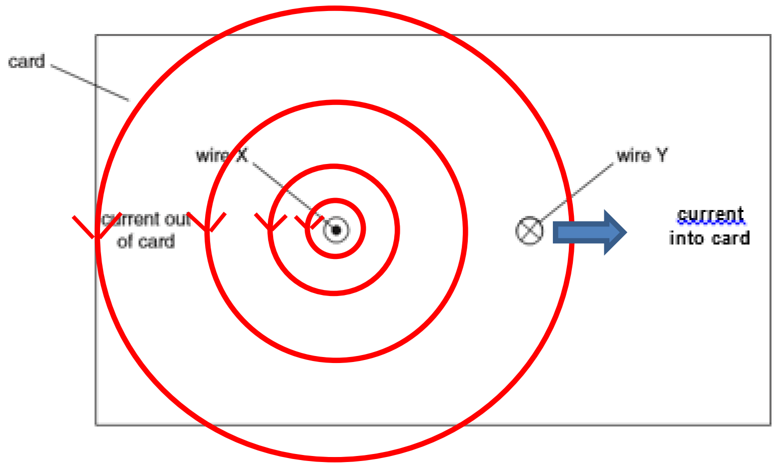
1

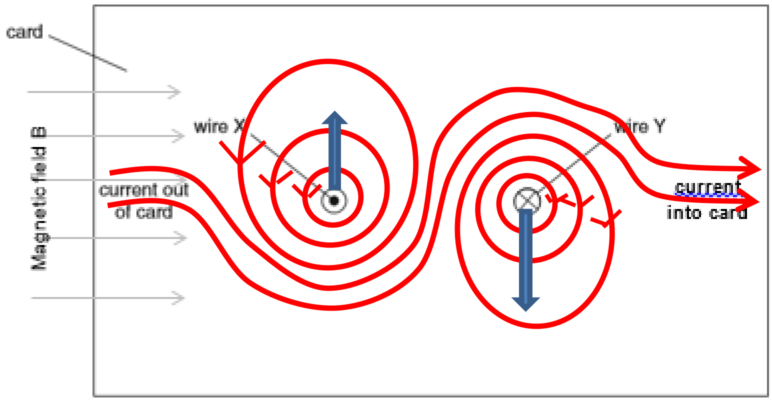
1</td></tr>
<tr><td>7b(i)</td><td>Use Young double slit equation for light

$\frac{\Delta x}{D} = \frac{\lambda}{d}$
Δx = 2.0/4 =0.5 cm
$\frac{0.5 \times 10^{-2}}{D} = \frac{600 \times 10^{-9}}{0.2 \times 10^{-3}}$
D = 1.67 m</td><td>1

1</td></tr>
<tr><td>7b(ii)</td><td>
Decrease in intensity
Fringe separation is further apart</td><td>2</td></tr>
<tr><td>7b(iii)</td><td>
Replaced by one single bright fringe</td><td>1</td></tr>
</table>

7b(iv)	 Fringe separation is smaller 1m Intensity remain the same 1m Blue wavelength = 400 nm 1m	3
7c(i)	 Wavelength/4	1
7c(ii)	Length of ear canal $L=\lambda/4$ (fundamental) Fundamental freq $f_1 = v/\lambda = v/4L$ $f_1 = 340/(4 \times 25 \times 10^{-3})$ $= 3400$ Hz 3rd Harmonic $f_3 = 3 \times 3400 = 10200$ Hz 5th Harmonic $f_5 = 5 \times 3400 = 17000$ Hz Only 1st, 3rd, and 5th harmonics are within the hearing range higher harmonics are not in the range.	 1 1 1 1
7c(iii)	Incoming sounds at these frequencies produce resonance condition in the ear canal, give rise to large amplitudes of the oscillation, resulting in an increased sensitivity to these frequencies.	1 1 (20)
	CIE s10 qp 43 Q8+ w09 qp 42 Q5	

8a(i)	 straight line with positive gradient 1m through origin 1m	2
8a(ii)	 maximum force shown at θ = 90° 1m zero force shown at θ = 0° 1m reasonable curve with F about ½ max at 30° 1m	3
8b(i)	force on electron due to magnetic field 1m force on electron normal to magnetic field and direction of electron 1m	2
8b(ii)	quote / mention of (Fleming's) left hand rule 1m electron moves towards QR 1m	2
8c(i)(1), (2)		2 1

	concentric circles, anticlockwise (minimum 3 circles) 1m separation of lines increases with distance from wire 1m direction to the right of Y	
8c(ii)(1)	flux density at wire Y $= (4\pi \times 10^{-7} \times 5.0) / (2\pi \times 2.5 \times 10^{-2})$ $= 4.0 \times 10^{-5}$ T force per unit length = BI $= 4.0 \times 10^{-5} \times 7.0$ $= 2.8 \times 10^{-4}$ N	 1 1 1
8c(ii)(2)	force depends on product of the currents in the two wires so equal *or* (isolated system so) Newton's 3rd law applies so equal	1 1
8c(iii)(1)(2)	 Anticlockwise circles around X, and clockwise circles around Y 1m External field lines following the anticlockwise flow about X and then following the clockwise flow about Y. 1m Magnetic force at X is upward and downward at Y. 1m	3 (20)