HWA CHONG INSTITUTION
JC2 Preliminary Examination
Higher 1

CANDIDATE NAME		**CT GROUP**	16S
CENTRE NUMBER		**INDEX NUMBER**	

PHYSICS **8866/01**

Paper 1 Multiple Choice **21 September 2017**

1 hour

Additional Materials: Optical Mark Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Write your name, CT, NRIC or FIN number on the optical mark sheet (OMS). Shade your NRIC or FIN in the spaces provided.

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

Choose the **one** you consider correct and record your choice in **soft pencil** on the OMS.

Each correct answer will score one mark. A mark will **not** be deducted for a wrong answer.

Any rough working should be done in this booklet.

Data	
speed of light in free space,	$c = 3.00 \times 10^{8}$ m s^{-1}
elementary charge,	$e = 1.60 \times 10^{-19}$ C
the Planck constant,	$h = 6.63 \times 10^{-34}$ J s
unified atomic mass constant,	$u = 1.66 \times 10^{-27}$ kg
rest mass of electron,	$m_e = 9.11 \times 10^{-31}$ kg
rest mass of proton,	$m_p = 1.67 \times 10^{-27}$ 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	$p = \rho gh$
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 is equivalent to the quantity, 37.86×10^{-4} MJ cm^{-4}?

A 37.86×10^{-18} J m^{-4}

B 37.86 μJ m^{-4}

C 378.6 TJ m^{-4}

D 378.6 GJ m^{-4}

2 Which of the following is the best estimate of the population density (population per unit area) in Singapore?

A 10^0 km^{-2} **B** 10^2 km^{-2} **C** 10^4 km^{-2} **D** 10^6 km^{-2}

3 A particle has an initial speed *v* along the 0-*x* direction as shown in Fig. (a).

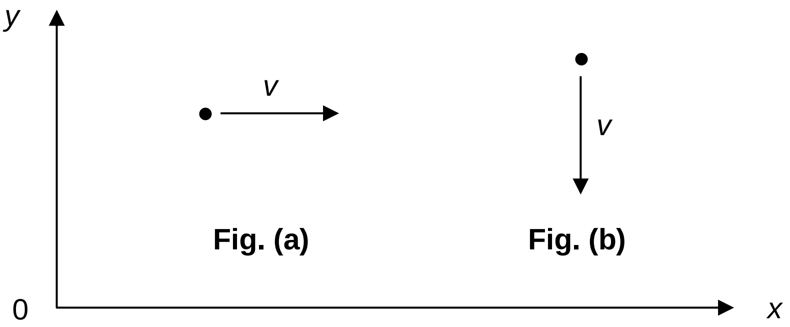
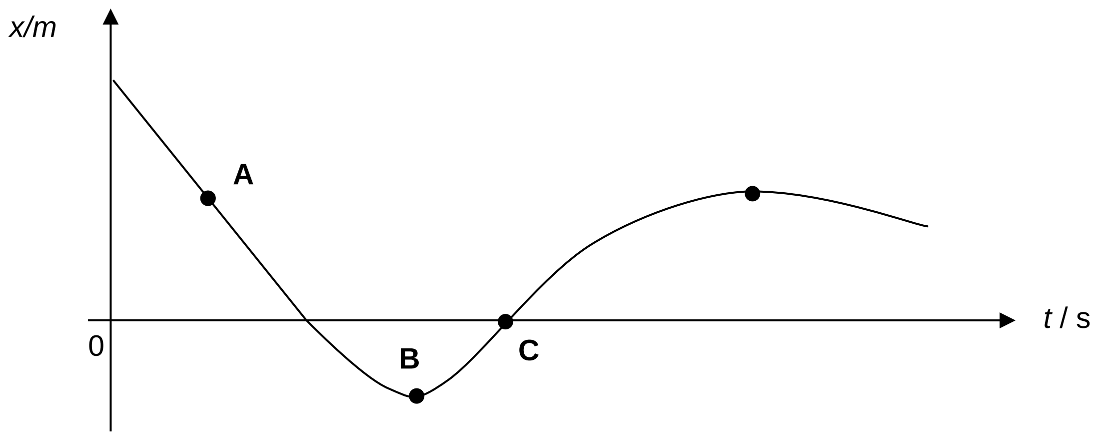


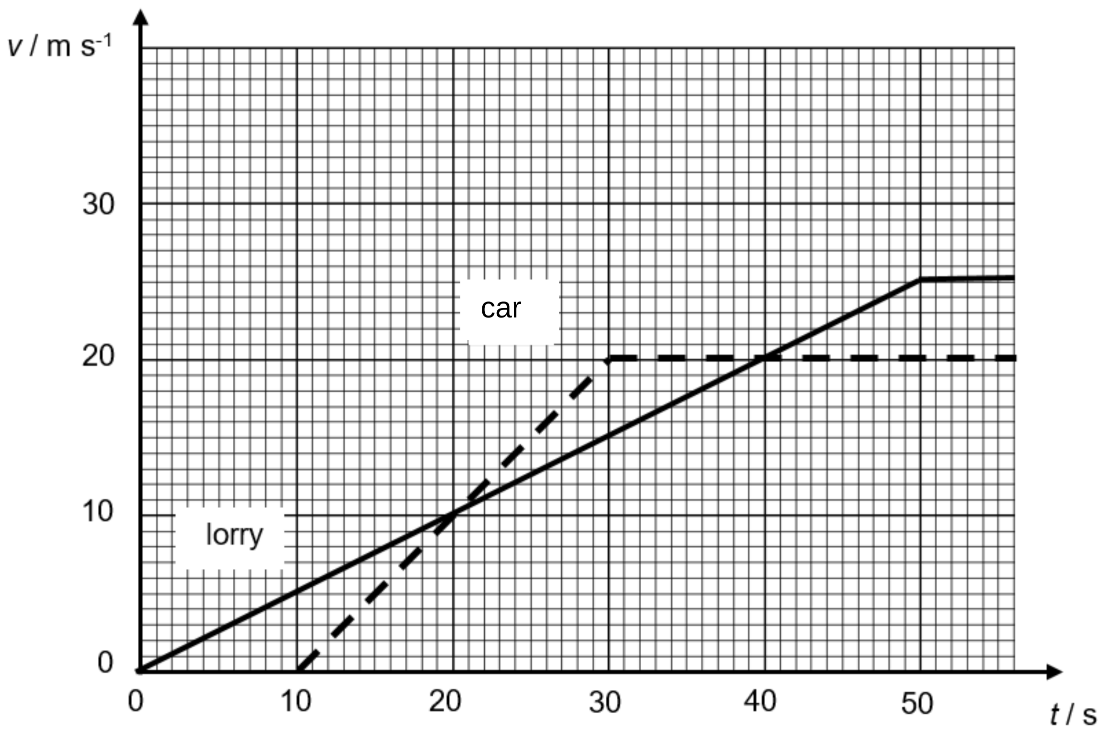
Fig. (a) **Fig. (b)**

After some time, it travels with the same speed *v* in a direction perpendicular to its original direction as shown in Fig. (b). Which of the following shows the direction of the change of velocity that has taken place in this time interval?

4 A ball moves along a straight line. The variation of its displacement *x* with time *t* is given by the graph. At which point is the acceleration of the ball the greatest?



5 The variation with time *t* of the speed *v* of a lorry after leaving a petrol station is shown. A car leaves the petrol station 10.0 s later and its speed-time graph is also shown.



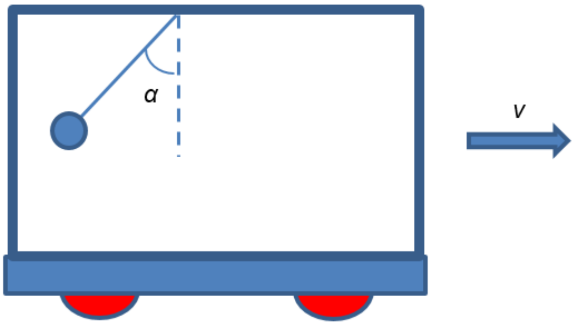
At which of the following times would the distance between the lorry and car be the least?

A 20.0 s **B** 30.0 s **C** 40.0 s **D** 50.0 s

6 A hot air balloon ascends from rest with an acceleration of 2.50 m s^{-2}. When it reaches an altitude of 48.0 m above the initial ground level, its ballast of mass 5.00 kg is suddenly released. Taking g as 10 m s^{-2} and ignoring air resistance, what is the speed of the ballast, in m s^{-1}, just before it impacts the ground?

A 35.8 **B** 34.6 **C** 31.1 **D** 28.3

7 A mass m hangs at the end of a rope which is attached to a support fixed on a trolley moving to the right with a speed v on a horizontal track as shown. The angle, α, is the angle the rope makes with the vertical.



Which of the following statements is **false**?

A The angle α is zero when the trolley moves with a uniform speed.

B When the trolley moves with a constant acceleration a, the magnitude of angle α is only determined by a and g.

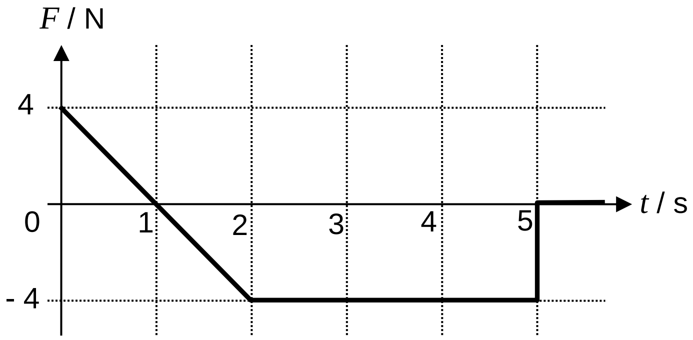
C The tension T in the rope is larger when the trolley moves with a uniform speed than when it moves with a constant acceleration.

D The ball swings to the right when the trolley decelerates.

8 A girl, riding in an elevator, weighs herself by standing on a scale that is placed on the floor of the elevator. The scale reads 65.0 kg when the elevator is moving at constant velocity. What is the reading of the scale when the elevator is accelerating downwards at 2.00 m s^{-2}?

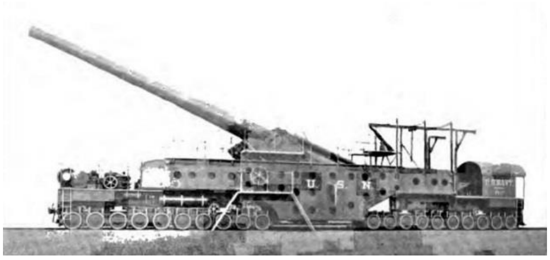
A 51.7 kg **B** 60.0 kg **C** 65.0 kg **D** 78.3 kg

9 A force F acts on a 2.0 kg body for 5.0 s. The body moves with an initial velocity of 4.0 m s^{-1} along the positive x direction. A graph of the force on the body against time is shown. What is the velocity of the body at 5.0 s?



A -2.0 m s^{-1} **B** 6.0 m s^{-1} **C** -6.0 m s^{-1} **D** 8.0 m s^{-1}

10 A 70 000 kg railway gun sitting on the railway platform in contact with the Earth is shown below.



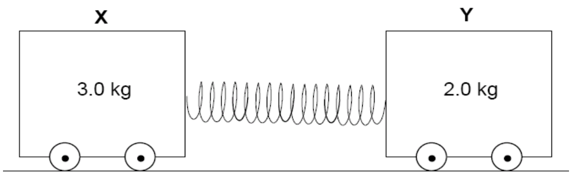
It fires a 500 kg artillery shell at an angle of 45° and with a muzzle velocity of 200 m s^{-1}. What is the magnitude of the recoil velocity of the gun?

A 0.5 m s^{-1} **B** 1.0 m s^{-1} **C** 1.4 m s^{-1} **D** 2.8 m s^{-1}

11 Mass M has the same kinetic energy as mass m. The ratio of their momenta $\frac{p_M}{p_m}$ is

A $\frac{M+m}{M}$ **B** $\frac{M}{M+m}$ **C** $\sqrt{\frac{M}{m}}$ **D** $\sqrt{\frac{m}{M}}$

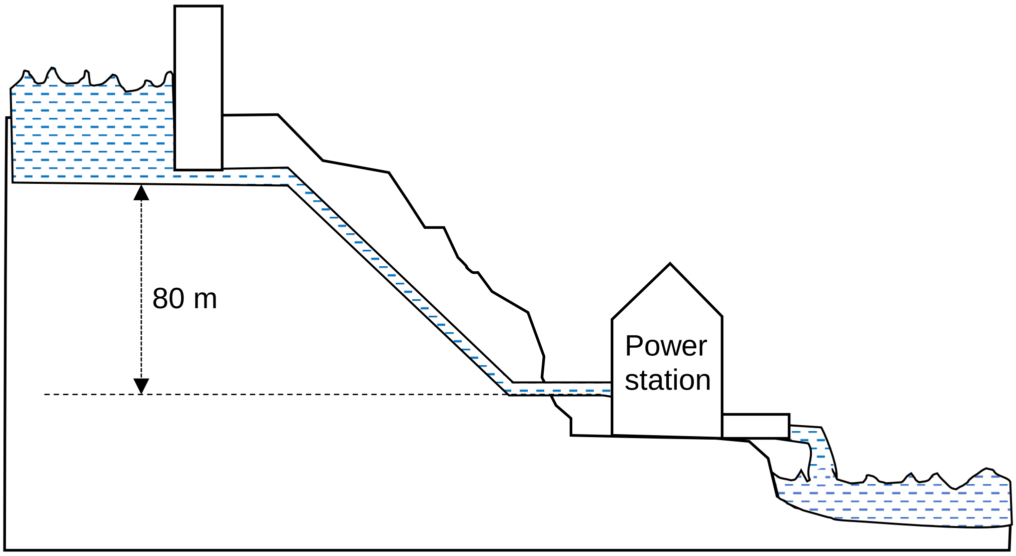
12 Two trucks, X and Y, are held with a light spring between them as shown. The spring is attached to truck X but not to Y.



When the trucks are released, X is found to be moving to the left at 4.0 m s^{-1}. If the ground is smooth, the energy, in J, initially stored in the compressed spring must have been

A 24 **B** 36 **C** 48 **D** 60

13 A hydroelectric power station is shown.



Water is supplied from a reservoir which is 80 m above the power station. The water passes through its turbines at a rate of 6.0 $m^3 s^{-1}$.

Assume that the density of water is 1000 kg m^{-3}.

If the efficiency of the power station is 60%, the electrical power output is

A 0.29 MW **B** 1.9 MW **C** 2.8 MW **D** 4.7 MW

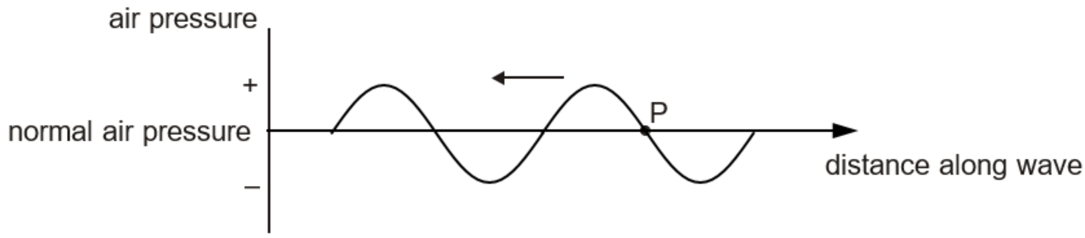
14 The engine of a boat delivers 30.0 kW to the propeller while the boat is moving at a constant speed of 15.0 m s^{-1}. The total drag on the boat is proportional to the square of the speed of the boat. If the boat is being towed at 5.0 m s^{-1} after its engine has broken down, the average tension in the towline will be

A 44.4 N **B** 220 N **C** 2000 N **D** 3330 N

15 The least distance between two points of a progressive transverse wave which have a phase difference of $\frac{\pi}{3}$ rad is 0.050 m. If the frequency of the wave is 500 Hz, what is the speed of the wave, in m s^{-1}?

A 75 **B** 150 **C** 250 **D** 1670

16 The graph shows the variation of air pressure with distance along a wave at one given time. The arrow indicates the direction of travel of the wave.



The air pressure at point P is

A decreasing **B** increasing **C** constant **D** zero

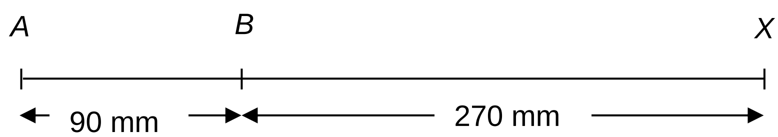
17 A point source of sound emits energy equally in all directions at a constant rate and a detector placed 2.0 m from the source measures an intensity of 4.0 W m^{-2}. The power of the source is then halved. What intensity, in W m^{-2}, would the detector measure if it is now placed at a distance 4.0 m from the source?

A 0.25 **B** 0.50 **C** 1.00 **D** 2.00

18 In Young's double slit experiment, the slit separation is 0.960 mm and the distance between the slits and the screen is 13.7 m. The distance between the two third-order bright fringes is measured to be 5.00 cm. Determine the wavelength of the source.

A 5.26×10^{-7} m **B** 5.84×10^{-7} m **C** 7.00×10^{-7} m **D** 1.17×10^{-6} m

19

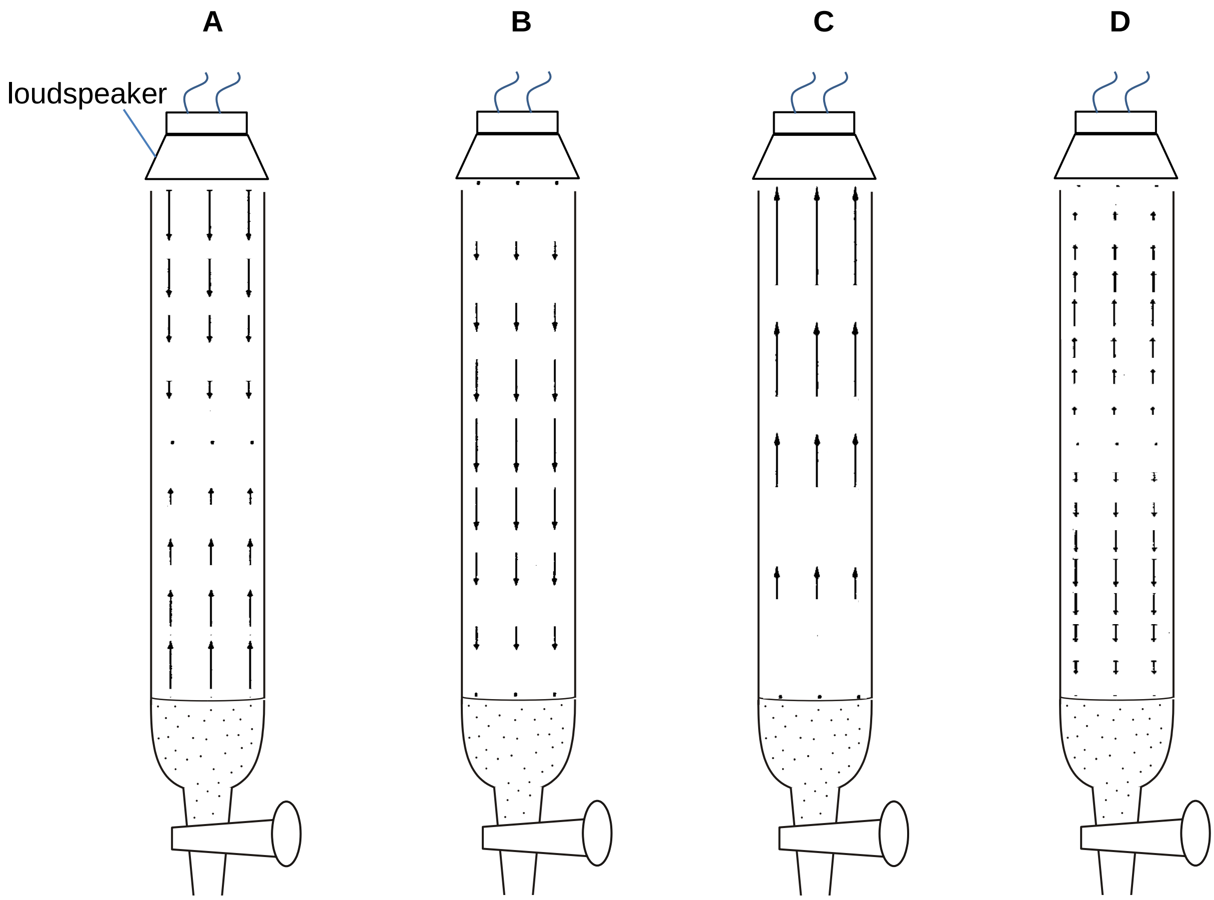


A and *B* are two coherent sound sources which are in phase. Point *X* shows permanent zero displacement. From the options given below, choose the sound wave with the minimum wavelength that can satisfy this condition.

A 180 mm **B** 90 mm **C** 60 mm **D** 45 mm

20 A loudspeaker generating a sound of a fixed frequency is held above the top of a burette filled with water. The water gradually runs out of the burette until a maximum loudness of the sound is heard.

Which of the following best shows a possible standing wave pattern set up by air molecules in the burette at this position?



21 A stationary sound wave exists in a horizontal tube which is closed on one end and opened on the other end. The sound wave can be described in terms of the amplitude of oscillation Δx of the air molecules from their mean positions and of the fluctuation of pressure Δp above and below the average pressure. Which of the following correctly describes the situation at each end of the tube when the tube is in resonance?

	at closed end		at open end	
	Δx	Δp	Δx	Δp
A	zero	maximum	zero	maximum
B	zero	maximum	maximum	zero
C	maximum	zero	maximum	zero
D	maximum	zero	zero	maximum

22 A wave is diffracted as it passes through an opening in a barrier. The amount of diffraction that the wave undergoes depends on both the

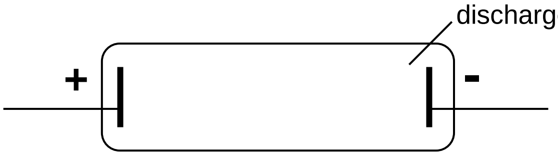
A amplitude and frequency of the incident wave.

B wavelength and speed of the incident wave.

C wavelength of the incident waves and the size of the opening.

D amplitude of the incident wave and the size of the opening.

23 A high potential is applied between the electrodes of a gas discharge tube so that the gas is ionised. The current flowing in the discharge tube is 8.16 mA and the number of electrons passing any point in the gas per unit time is 2.58×10^{16} s^{-1}.



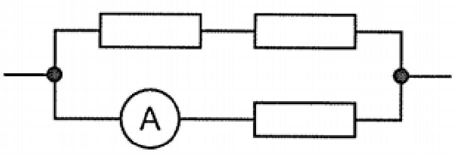
If the charge on each positive ion is 3.2×10^{-19} C, what is the number of positive ions passing any point in the gas per unit time?

A 1.26×10^{16} s^{-1} **B** 2.58×10^{16} s^{-1} **C** 3.84×10^{16} s^{-1} **D** 5.10×10^{16} s^{-1}

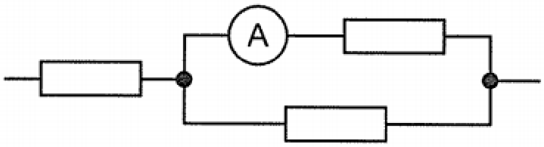
24 Four different arrangements of identical resistors are connected to the same constant voltage power supply. An ammeter of negligible resistance is connected as shown in each arrangement.

In which arrangement will the ammeter show the minimum reading?

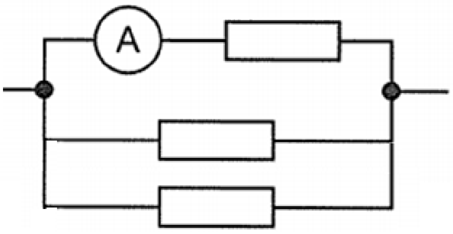
A



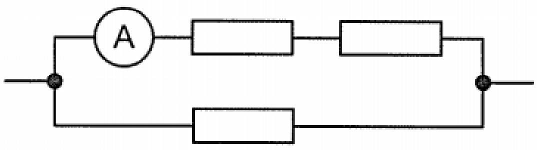
B



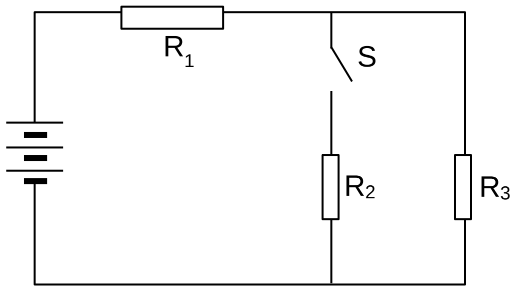
C



D



25 The diagram shows a network of resistors R_1, R_2 and R_3 connected to a battery of negligible internal resistance.

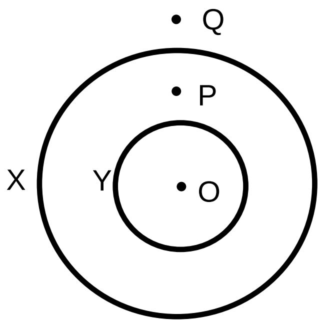


When the switch S is closed, the potential difference (p.d.) across R_2 rapidly increases to a steady value.

What happens to the potential difference (p.d.) across each of the other two resistors, and to the power output of the battery?

	p.d. across R_1	p.d. across R_3	battery power output
A	decreases	decreases	decreases
B	increases	decreases	decreases
C	increases	decreases	increases
D	increases	stays the same	increases

26 X and Y are two coaxial circular coils lying on a table. O, P and Q are three points on the table.



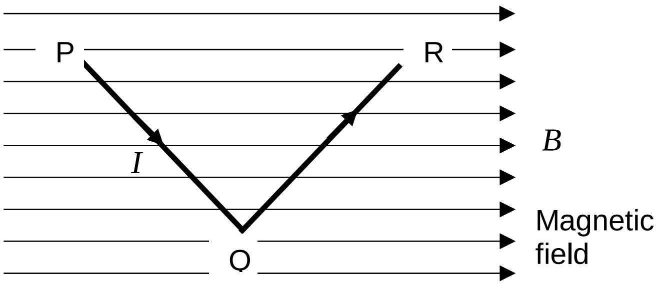
Initially, there is a constant current in coil X and no current in coil Y.

A small current is now passed through coil Y, which increases the magnitude of the magnetic flux density at O.

How does the magnitude of the flux density change at P and Q?

	P	Q
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

27 The figure shows a conductor PQR, carrying a current I and subjected to a uniform magnetic field.



What effect is experienced by the conductor PQR as a result of the magnetic field?

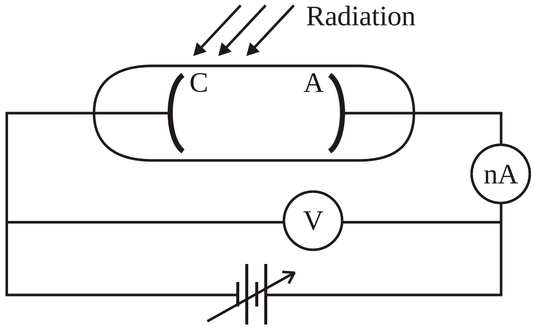
A No resultant force and no resultant torque.

B No resultant force but a couple is produced.

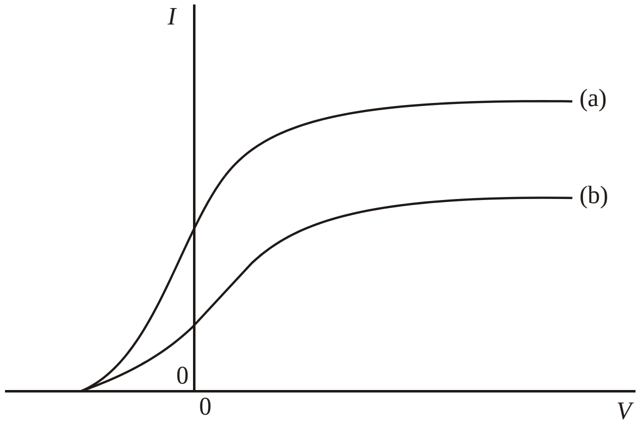
C Net force out of the page and a couple is produced.

D Net force into the page and no resultant torque.

28 The diagram shows the apparatus for an experiment on the photoelectric effect.



Monochromatic radiation strikes the cathode C and photoelectrons are emitted towards the anode A. When a potential difference *V* is applied, a current *I* is measured on the very sensitive ammeter. Data can also be obtained with the polarity of the supply reversed. Using this apparatus, graph (a) below was obtained. After a change to the intensity of incident radiation, graph (b) was obtained.



Which of the following cannot be deduced from the graph?

A Intensity does not affect the maximum kinetic energy of the photoelectrons.

B Photoelectrons are being emitted at a slower rate for graph (b).

C The intensity of light is proportional to the current.

D Electrons are ejected with different kinetic energies.

29 The continuous optical spectrum of light from the Sun, observed from the Earth is crossed by dark lines at particular wavelengths. The photosphere is the outer layer of gas around the Sun's core. Which one of the following statements correctly accounts for these dark lines?

A The elements that exist in the photosphere which are hotter than the Sun's inner regions, absorb the photons emitted from the Sun.

B The elements that exist in the solar interior absorb the photons emitted from the Sun.

C The elements found in the Earth's atmosphere absorb the photons emitted from the Sun.

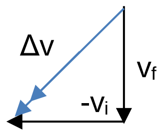
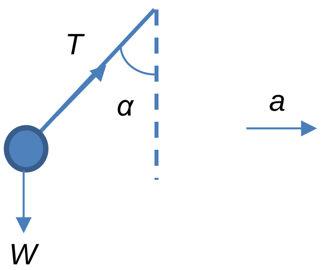
D The elements that exist in the cooler photosphere absorb the photons emitted from the Sun.

30 A beam of light of wavelength λ is totally reflected at normal incidence by a plane mirror. The intensity of the light is such that photons hit the mirror at a rate *n*. Given that the Planck constant is *h*, the force exerted on the mirror by the beam is

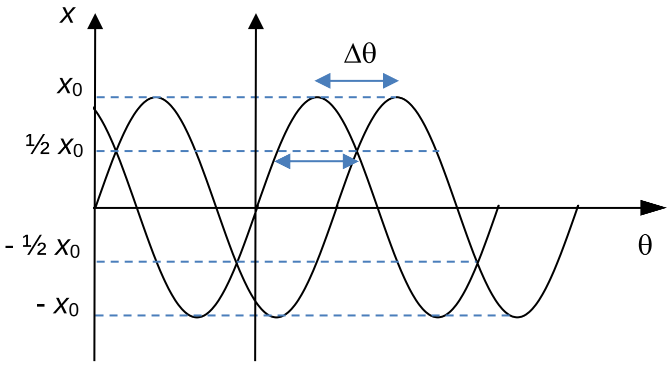
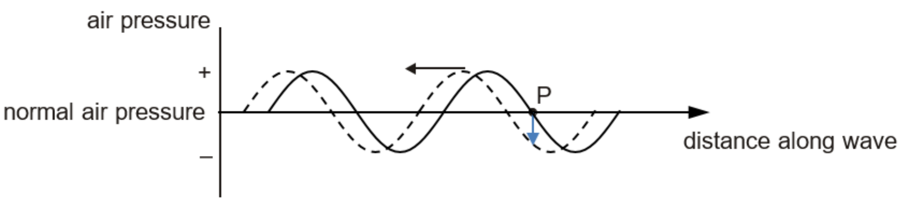
A $nh\lambda$ **B** $2nh/\lambda$ **C** $2nh\lambda$ **D** nh/λ

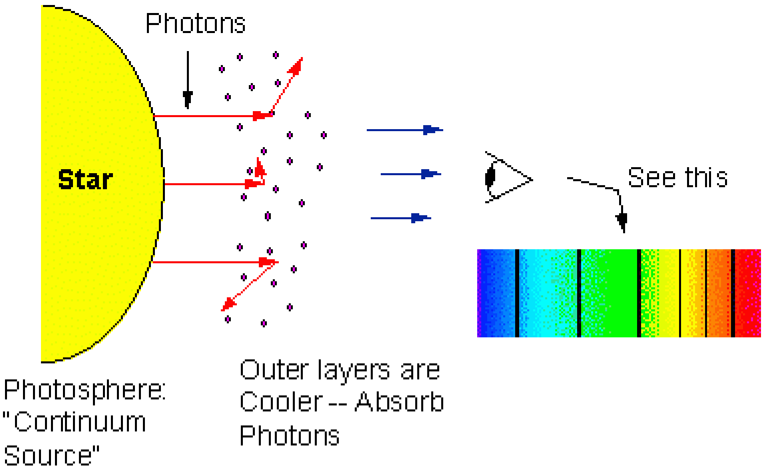
~ End of Paper ~

Solutions to 2017 HCI H1 Physics Paper 1

1	**D**	37.86×10^{-4} MJ cm^{-4} $= 37.86 \times 10^{-4}\ 10^{6}$ J $(10^{-2}\text{ m})^{-4}$ $= 37.86 \times 10^{-4} \times 10^{8} \times 10^{6}$ J m^{-4} $= 3.786 \times 10^{11}$ m^{-4} J $= 378.6 \times 10^{9}$ J m^{-4} $= 378.6$ GJ m^{-4}
2	**C**	Estimate the population as 6 million people and the land as 700 km^2. $\dfrac{6 \times 10^{6}}{7 \times 10^{2}\ \text{km}^2} \approx 10^{4}\ \text{km}^{-2}$
3	**D**	
4	**B**	Greatest acceleration is where the rate of change of velocity is greatest, i.e. where the gradient of the x-t graph changes most quickly.
5	**C**	The distance travelled by each vehicle is given by the area under their respective graphs. For both car and lorry, the distance travelled between 0 and 40 seconds is the same at 400 m. This means the separation distance is zero at 40 s, which is also the least distance.
6	**B**	Velocity at release: $v^2 = 0 + 2(2.50)(48.0)$ → v = 15.49 m s^{-1} upward Velocity on impact: $v^2 = (-15.49)^2 + 2(10)(48.0)$ → 34.6 m s^{-1} downward
7	**C**	Option A: True. At the uniform speed the rope does not experience any horizontal acceleration. Hence, the angle is zero. Option B: True. See the working below  *T* sin α = *ma* *T* cos α = *W* = *mg* tan α = *a* / *g* Option C: False. Tension is *W* / sin α when it is accelerates. Tension is equal to *W* when it moves with a uniform speed. *W* / sin α > *W* Option D: True. When the car decelerates, the net horizontal force is leftwards which swings the rope to the right.

8	**A**	Net force downward = W – N 65.0(2.00) = 65.0(9.81) – N N = 507.65 N Reading = 507.65/9.81 = 51.7 kg
9	**A**	Impulse = change in momentum = area under graph = -12 Ns -12 = 2.0v – 2.0(4.0) v = -2.0 m s^{-1}
10	**B**	Since the railway platform is in contact with the Earth, the Earth absorbs the vertical momentum. Therefore, by PCOLM, $P_{1x} = P_{2x}$ 1: bullet 2: gun $M_1 v_1 \cos 45° = m_2 v_2$ v_2 = (500)(200)cos 45°/70000 = -1.01 ms^{-1}
11	**C**	KE = p^2/2m p^2 = 2m×KE $\frac{p_M}{p_m} = \sqrt{\frac{M}{m}}$
12	**D**	By the principle of conservation of momentum, Magnitude of momentum of Y = magnitude of momentum of X = 12 N s Hence speed of Y = 6 m s^{-1} EPE transformed to KE, which is ½ $(3.0)(4.0)^2$ + ½ $(2.0)(6.0)^2$ = 60 J
13	**C**	Raw Power input = Rate of GPE converted to Electrical Energy $= \frac{mgh}{t}$ $= \frac{\rho Vgh}{t}$ $= \frac{1000(6.0)(9.81)(80)}{1\text{ sec}}$ = 4.7088 MW Since Efficiency $= \frac{P_{out}}{P_{in}}$ = 0.60 Then P_{out} = 0.60 x 4.7088 = 2.8 MW
14	**B**	The driving force by the propeller equals the drag force on the boat when the boat is at constant speed. $P_{engine} = F_{engine}v = F_{drag}v$ 30000 = F_{drag}(15.0) F_{drag}= 2000 N Since $F_{drag} = kv^2$ 2000 = k $(15.0)^2$ So drag constant k = 8.889 When v = 5.0 m s^{-1}, $F_{drag} = kv^2 = 8.889 \times 5.0^2$ = 222 N When the boat is being towed at constant speed at 5.0 m s^{-1}, the drag force equals the towline tension.

15	B	Wavelength = $0.050/(\pi/3) \times 2\pi = 0.30$ m Speed = $0.30 \times 500 = 150$ m s^{-1}
15	B	Since we are determining phase difference, it is easier to work directly in x- θ equation instead of x-t equation. Determine the phase angle such at $x = x_0/2$: $x_0/2 = x_0 \sin\theta \Rightarrow \theta = \sin^{-1}(½) = 30°, 150°$  $\Delta\theta = 150° - 30° = 120°$
16	A	The pressure variation “moves” along with the energy, compression and rarefaction will move to the left. 
17	B	Original: $4.0 = P/4\pi(2.0)^2$ New: Intensity = $0.5P/4\pi(4.0)^2$ Intensity = 0.50 W m^{-2}
18	B	$6\Delta y = 0.0500$ m $= 6\lambda(13.7)/(0.960 \times 10^{-3})$ $\lambda = 584$ nm
19	C	Path difference = AX – BX = 90 mm = $(n + ½)\lambda$, where n is an integer >= 1
20	C	The longitudinal stationary wave will form a displacement node at the closed (water) end and a displacement antinode at the open end (loudspeaker, with vibrating diaphragm)
21	B	Concept.
22	C	Concept.
23	B	I = Q/t $0.00816 = (1.6 \times 10^{-19})(2.58 \times 10^{16}) + (3.2 \times 10^{-19})(n/t)$ $n/t = 1.26 \times 10^{16}$ s^{-1}

24	**B**	Taking V to be the voltage applied, In both A and C the current is V/R. In D the current is V/2R In B the current is ½ × (V/1.5R) = V/3R
25	**C**	Effective resistance of entire circuit decreases, hence current drawn from battery increases → larger power output and larger PD across R_1. By potential divider principle, the PD across the parallel branches of R_2 and R_3 will be smaller than the PD across R_3 along before the switch was closed.
26	**B**	Since the current in Y increases the magnetic flux density at O, the current in Y is flowing in the same direction as that in X. Hence at Q the flux density should also be reinforced, and the flux density between the coils oppose each other.
27	**B**	By Fleming's left-hand rule, force on PQ is out of the page while force on QR is into the page.
28	**C**	A can be deduced because the saturation current changed with intensity. B can be deduced from th fact that graph (b) has lower saturation current. D can be deduced from the slope of the graphs down to stopping potential. C cannot be deduced because we do not know by how much the intensity as changed.
29	**D**	In the solar absorption line spectra, the dark lines are caused by photons being absorbed by elements in the cooler photosphere, to excite to higher energy states. 
30	**B**	p = h/λ Totally reflected, so change in momentum = 2p = 2h/λ Force is rate of change of momentum = n × 2h/λ

HWA CHONG INSTITUTION
JC2 Preliminary Examination
Higher 1

CANDIDATE NAME		**CT GROUP**	16S
TUTOR NAME			

PHYSICS **8866/02**

Paper 2 Structured Questions **13 September 2017**

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your **name, CT class and tutor's name** clearly on all 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, paperclips, highlighters, glue or correction fluid.

Section A

Answer **all** questions.

Section B

Answer any **two** questions.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use		
1		9
2		10
3		10
4		11
5		20
6		20
7		20
Deductions		
Total		80

Data

speed of light in free space,

$c = 3.00 \times 10^{8}$ m s^{-1}

elementary charge,

$e = 1.60 \times 10^{-19}$ C

the Planck constant,

$h = 6.63 \times 10^{-34}$ J s

unified atomic mass constant,

$u = 1.66 \times 10^{-27}$ kg

rest mass of electron,

$m_e = 9.11 \times 10^{-31}$ kg

rest mass of proton,

$m_p = 1.67 \times 10^{-27}$ 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	$p = \rho gh$
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** the questions in this section.

1 **(a)** Define the ohm.

………………………………………………………………………………………………………

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

(b) An experiment is performed to determine the resistivity ρ of the material used to manufacture a wire. The average of the measurements, with their actual uncertainties, are shown in Fig. 1.1.

potential difference / V	current / A	diameter of wire / mm	length of wire / cm
1.20 ± 0.01	0.29 ± 0.01	0.23 ± 0.01	42.0 ± 0.1

Fig. 1.1

(i) Calculate the value of *ρ*.

ρ = ……………………………… Ω m [3]

(ii) Calculate the actual uncertainty in *ρ*.

actual uncertainty = …………………….. Ω m [2]

(iii) State the value of ρ and its actual uncertainty to the appropriate number of significant figures.

ρ = …………………… ± …………………… Ω m [1]

(c) The accepted value for ρ is 4.5×10^{-7} Ω m.

Use your answer in **(b)(iii)** to distinguish between *accuracy* and *precision*.

Accuracy ……………………………………………………………………………………………

……………………………………………………………………………………………………

Precision ……………………………………………………………………………………………

…………………………………………………………………………………………………… [2]

2 **(a)** State the two conditions for equilibrium.

…………………………………………………………………………………………………

………………………………………………………………………………………………… [2]

(b) A uniform rigid rod of mass 30 kg is attached to a vertical wall by a hinge as shown in Fig. 2.1. The other end of the rod is held to the ceiling by a cable.

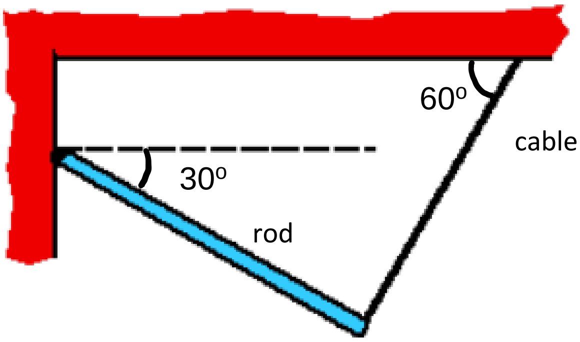


Fig. 2.1

(i) On Fig. 2.1, draw and label clearly all the forces acting on the rod. [2]

(ii) Show that the tension in the cable is 127 N. [2]

(iii) Determine the force acting on the rod by the hinge.

magnitude of force = ……………….. N

direction = …………………………… [4]

3 In order to investigate the photoelectric effect, a student varied the wavelength of the radiation incident on the metal surface. For each value of wavelength λ, the stopping voltage V_s required just to prevent electrons from reaching the collector was measured. Two such data are shown in Fig. 3.1.

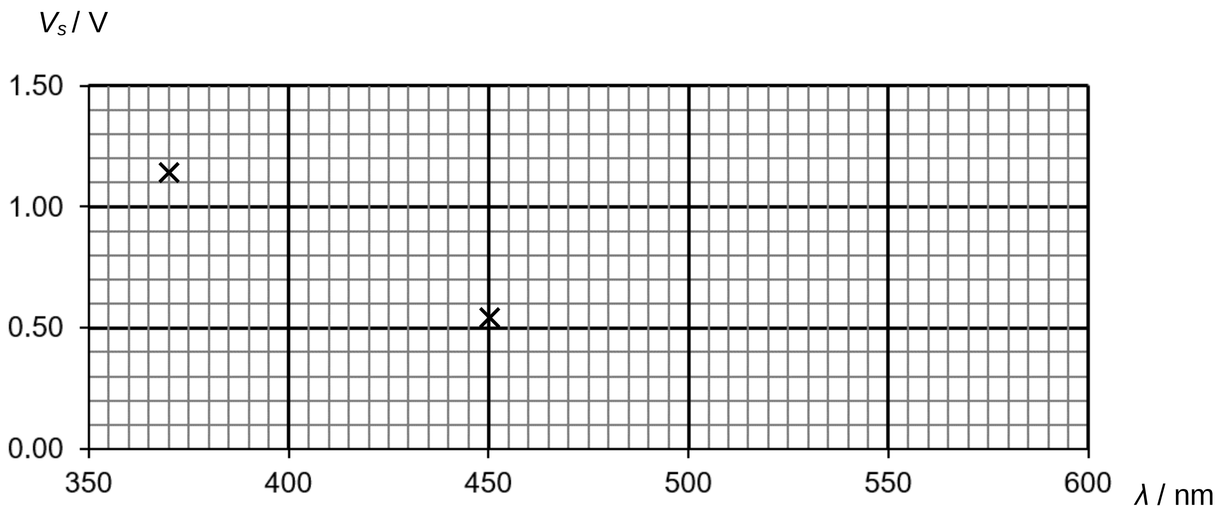


Fig. 3.1

(a) What is the maximum kinetic energy of a photoelectron emitted from the metal surface by radiation of wavelength 370 nm?

maximum kinetic energy = ………….……….…….. J [2]

(b) Calculate the energy of a photon of wavelength 370 nm.

energy of photon = ………….……….…….. J [2]

(c) Using your answers to **(a)** and **(b)**, show that the threshold wavelength is 560 nm. [2]

(d) Without further calculations, sketch in Fig. 3.1 the graph that the student should obtain at the end of the experiment.

[2]

(e) The student decided to repeat the experiment by doubling the intensity of the radiation incident on the metal surface. State and explain whether this change would affect the results obtained in Fig. 3.1.

……

……

……

……[2]

4 A wire-wound resistor is manufactured by winding resistance wire on an insulating former. A commonly used material for the wire is an alloy of nickel and chromium called nichrome. The wire is produced by pulling the nichrome through a suitably sized hole. Nichrome is sufficiently ductile to be drawn into a wire without danger of it cracking or breaking after winding. It resists corrosion and has a fairly high resistivity. The wire itself must be uniform and thin, and is covered with an insulating material.

A manufacturer of resistors of this type supplies information concerning them in the form of a family of lines shown in the graph in Fig. 4.1. Resistors of different resistance R_1, R_2 ... R_5 are shown by the separate lines.

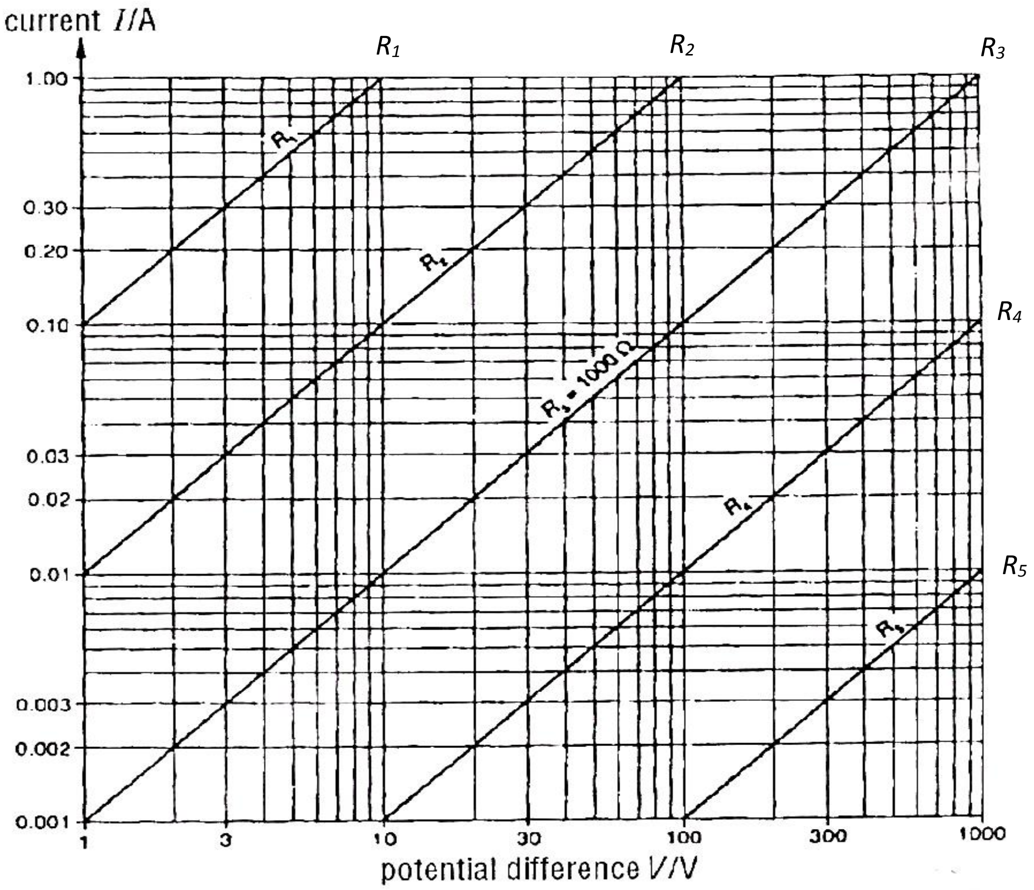


Fig. 4.1

(a) By choosing some values of potential difference and current from Fig 4.1, complete the table below showing the resistances R_1, R_2 ... R_5. [2]

R_1 =	
R_2 =	
R_3 =	1000 Ω
R_4 =	
R_5 =	

(b) Draw two additional lines on Fig. 4.1,

(i) one line for a resistance of 2000 Ω,

(ii) one line for a resistance of 47 Ω. [2]

(c) This particular set of resistors is manufactured so that the resistors can safely be used with power dissipation up to 1 W. Complete the following table to show the maximum safe current in the resistors for the potential differences given. [2]

potential difference / V	**maximum current / A**
1 000	
100	
10	
1	

(d) Plot the points in **(c)** on the graph of Fig. 4.1. On the graph shade the region of safe use for all these resistors. [3]

(e) The lines in Fig. 4.1 represent ideal behaviour. Suggest, with a reason, how the line for a real resistor might differ from the ideal.

……………………………………………………………………………………………………

…………………………………………………………………………………………………… [2]

Section B

Answer **two** of the questions from this section.

5 **(a)** Three blocks of masses 4.0 g, 10.0 g and 3.0 g move on a frictionless horizontal track with speeds of 5.0 m s^{-1}, 3.0 m s^{-1}, and 4.0 m s^{-1} respectively as shown in Fig. 5.1. Velcro couplers make the blocks stick together after colliding.

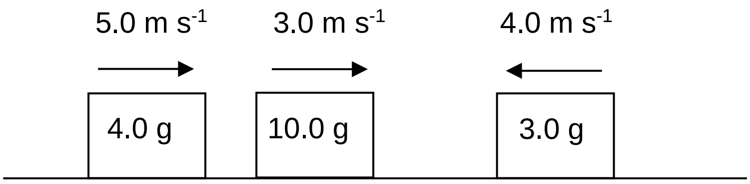


Fig. 5.1

(i) State the principle of conservation of momentum.

....

.... [2]

(ii) Show that the final speed *v* of the train of three blocks after colliding is 2.24 m s^{-1}. [1]

(iii) Fig. 5.2 shows the train of three blocks making a head-on collision with a sphere of mass 9.0 g which is initially at rest and suspended by a stiff light rod pivoted at C. After the collision, the train of three blocks moves off at 1.12 m s^{-1} and the sphere swings upwards.

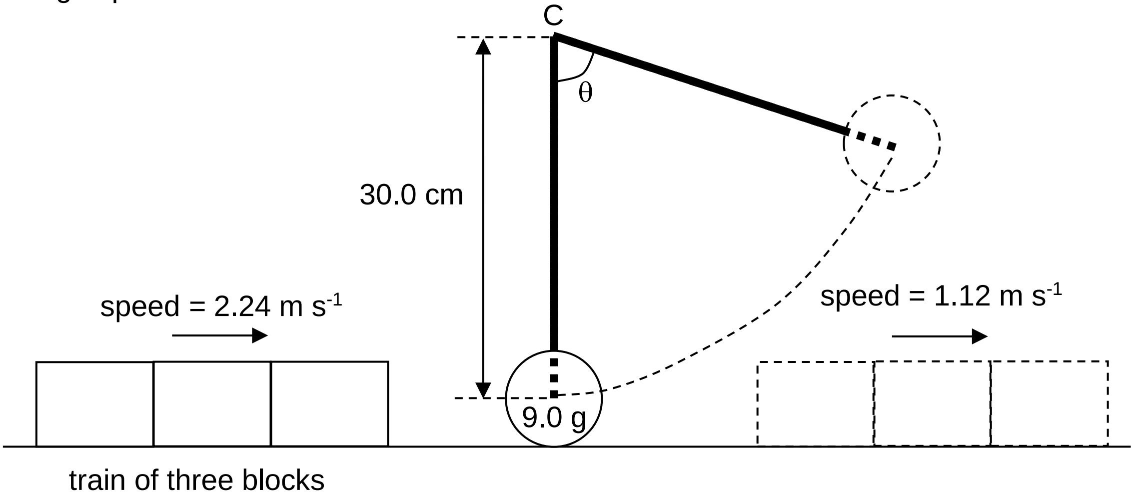


Fig. 5.2

1. Calculate the speed of the sphere immediately after the train of three blocks collide with it.

speed = ……………….. m s^{-1} [2]

2. The distance from the centre of the ball to point C is 30.0 cm. Calculate the angle θ subtended by the rod at the maximum height reached by the sphere after the collision.

θ = …………………….. ° [3]

(b) A car starts from rest and travels upwards along a straight road inclined at an angle of 5.0° to the horizontal, as illustrated in Fig. 5.3.

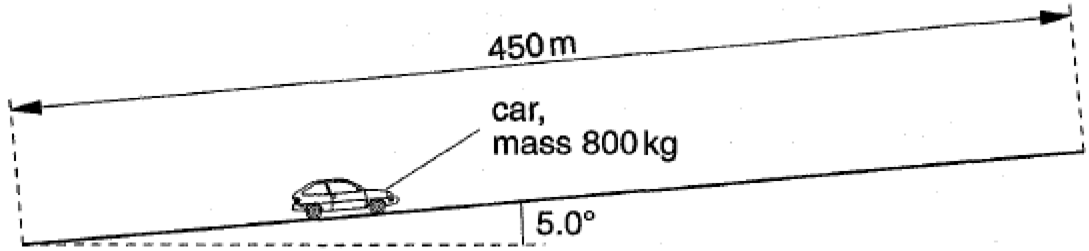


Fig. 5.3

The length of the road is 450 m and the car has mass 800 kg. The speed of the car increases at a constant rate and is 28 m s^{-1} at the top of the slope.

(i) Determine, for this car travelling up the slope,

1. its acceleration,

acceleration = …………………….. m s^{-2} [2]

2. the time taken to travel the length of the slope.

time = ……………………… s [1]

3. the gain in kinetic energy,

gain in kinetic energy = ……………………… J [2]

4. the gain in gravitational potential energy.

gain in gravitational potential energy = ………………….. J [2]

(ii) Use your answers in **(b)(i)** to determine the useful output power of the car.

power = …………………. W [2]

(iii) At the top of the slope, the driver loses control of his car, and veers off the cliff as shown in Fig. 5.4.

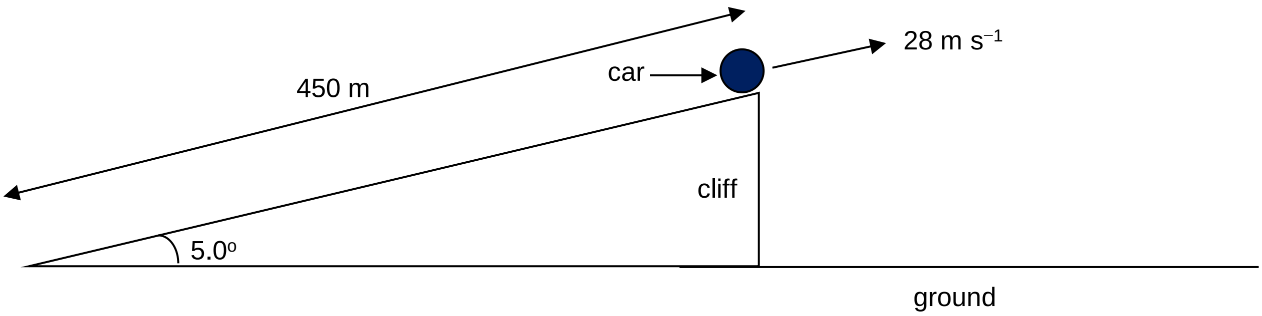


Fig. 5.4

Calculate the height *above the ground* the car reaches.

height = …………………………….. m [3]

6 **(a)** A tuning fork is struck near one end of a glass tube open at both ends. The air molecules in the tube then vibrate at the fundamental frequency.

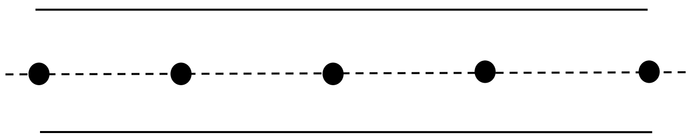


Fig. 6.1

(i) Draw on Fig. 6.1, arrows on the five dots to represent the amplitude and the direction of motion of the air molecules *at* a particular instant when a stationary wave has been set up along the tube. [2]

(ii) State the phase difference between the vibrations of air molecules along the tube situated at adjacent antinodes.

phase difference = ………………. rad [1]

(b) A two-source interference pattern is set up using monochromatic light of a certain wavelength. The light passes through two slits a distance d = 0.75 mm apart. A pattern of light is formed on a screen at a distance D = 2.8 m from the slits. The arrangement and the pattern seen on the screen are shown in Fig. 6.2. The positions of the dark fringes are shown.

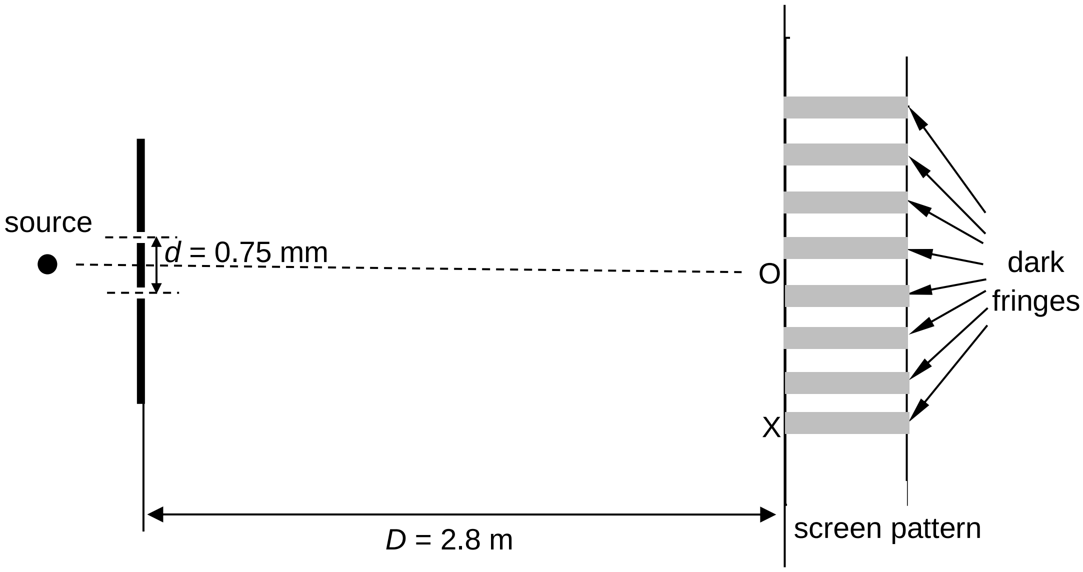


Fig. 6.2 (not to scale)

The central bright fringe is located at O and the dark fringe at X is 5.88 mm from O.

(i) Calculate the wavelength of the light.

wavelength = ………………………… nm [3]

(ii) Describe what happens to the fringes if both slits are covered with sheets of polaroid and that in front of one of the slits is slowly rotated.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………………………………………… [2]

(c) Fig. 6.3 shows two dippers, D and E, mounted on the same vibrating beam. The dippers touch the surface of the shallow water in a ripple tank. When the beam vibrates, waves travel outwards in all directions on the surface of the water from each dipper.

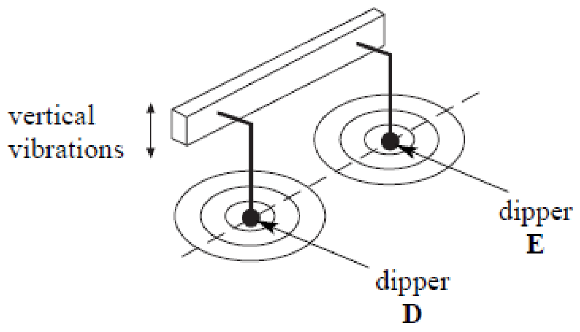


Fig. 6.3

(i) State the principle of superposition as applied to waves.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………………………………………… [2]

(ii) Explain why dippers D and E are *coherent*.

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

(iii) Explain why a stationary wave will be formed on the surface of the water along the line joining D and E.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………………………………………… [2]

(iv) Wavefronts produced by the two sources are illustrated in Fig. 6.4.

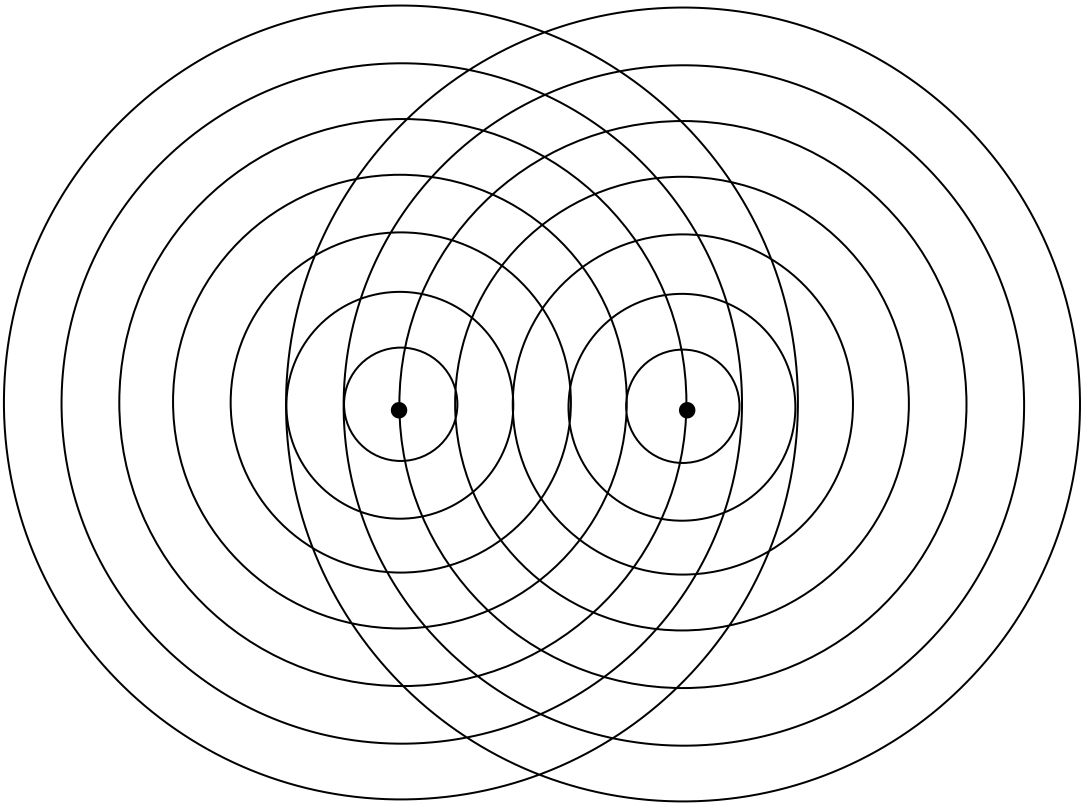


Fig. 6.4

On Fig. 6.4,

1. draw **all** the antinodal lines between the two sources,
2. draw **one** nodal line and label it **N**.

[3]

(v) When the beam vibrates at a certain frequency, the distance between two adjacent nodes along the line between dippers D and E is 12 mm. When the frequency of vibration is increased by 2.0 Hz, the distance between two adjacent nodes is decreased to 10 mm.

1. Calculate the original frequency of vibration of the beam.

frequency = ……………………….. Hz

2. Calculate the speed of wave travel on the water surface.

speed = ………………… m s^{-1} [4]

7 **(a)** A student conducts an experiment to investigate the electromotive force (e.m.f.) E and internal resistance r of a dry cell using the circuit shown in Fig. 7.1.

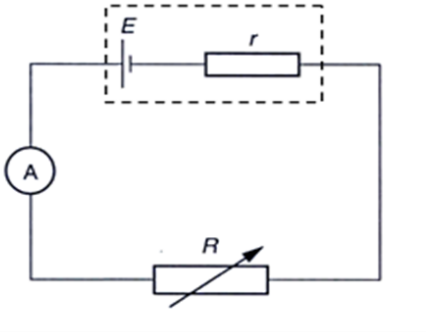


Fig. 7.1

Fig. 7.2 shows the variation with current I through R of the product IR.

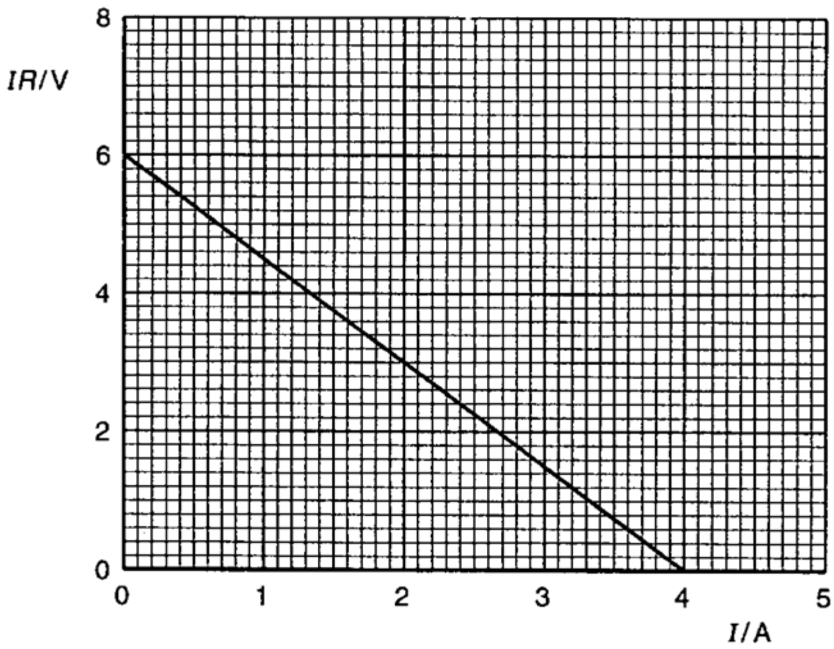


Fig. 7.2

(i) State the relationship between E, r, R, and I. [1]

(ii) Use Fig. 7.2 to determine

1. the e.m.f. of the dry cell,

e.m.f. = …………………… V [1]

2. the power dissipated in the variable resistor when the current in the circuit is 1.2 A.

power = ………………… W [2]

3. the internal resistance of the dry cell.

internal resistance = ……………….. Ω [2]

(iii) To verify his results above, the student decides to connect a voltmeter and switch to the circuit. Include on Fig. 7.1 a switch and a voltmeter so as to allow him to determine either the e.m.f. of the dry cell or the terminal potential difference across the dry cell. [1]

(iv) State whether the switch should be open or closed when measuring

1. the e.m.f.

____

2. the terminal p.d.

____ [1]

(v) The student decides to repeat his experiment by replacing the dry cell with another of e.m.f. 0.5E and internal resistance 2r. This new dry cell is connected in series to the original variable resistor R.

On the axes of Fig. 7.2, draw the variation with current I of the product IR for this circuit. [2]

(b) A *light* single-turn square-shaped coil PQRS of sides 25 cm is suspended from a well-insulated spring. The coil is placed half-way in a region of uniform magnetic field of flux density 2.0 T, as shown in Fig. 7.3.

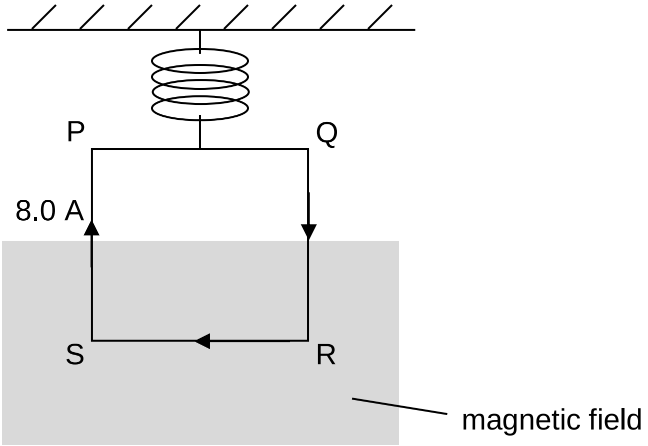


Fig. 7.3

A current of 8.0 A flows through the coil and the spring extends by 10 mm.

(i) Define the *tesla*.

....

....

.... [2]

(ii) State the direction of the magnetic field.

.... [1]

(iii) Calculate the spring constant.

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

(iv) The Earth's magnetic field is in the same direction as the applied magnetic field of 2.0 T. Suggest a reason why the Earth's field does not affect your answer in **(b)(iii)**.

....

.... [1]

(v) The same magnetic field is now applied towards the right, with coil PQRS fully in the region of the uniform field and the plane of the coil parallel to the field, as shown in Fig. 7.4.

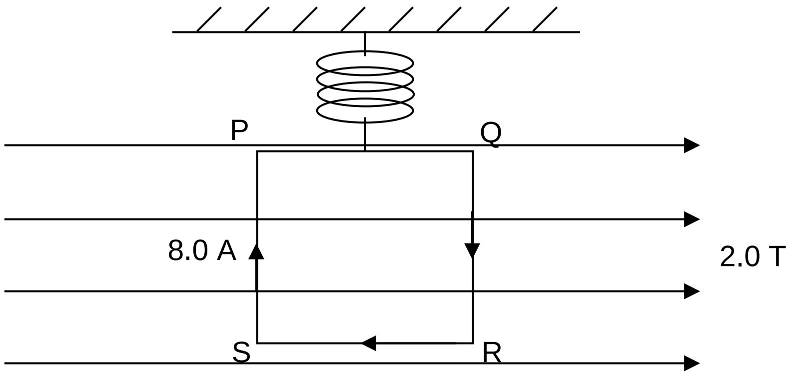


Fig. 7.4

1. Calculate the torque experienced by the coil.

torque = ………………….. N m [2]

2. The coil is then tilted about the vertical axis and makes an angle θ to the horizontal magnetic field lines as shown in Fig. 7.5.

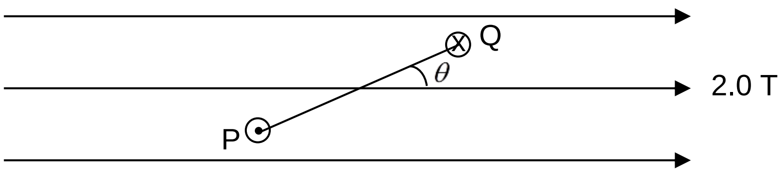


Fig. 7.5

Discuss qualitatively how your answer to **(b)(v)1.** changes.

………………………………………………………………………………………………

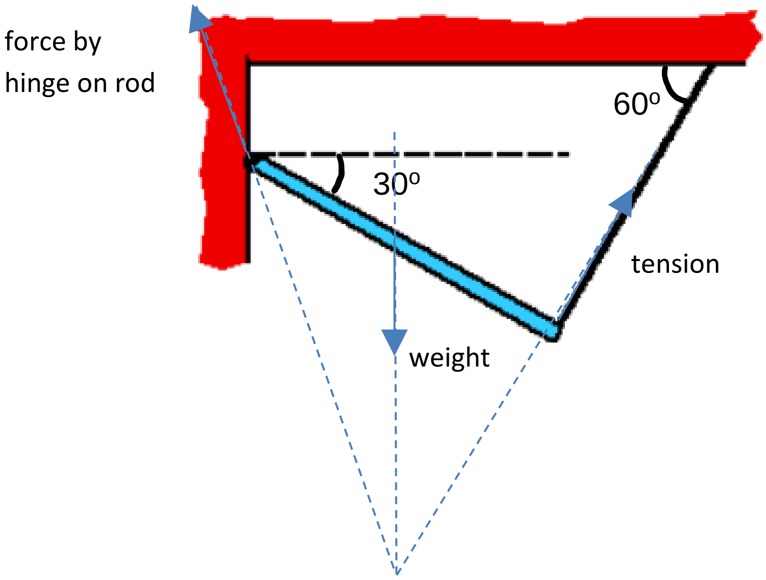
………………………………………………………………………………………………

……………………………………………………………………………………………… [2]

~ End of Paper ~

Solutions to 2017 HCI H1 Physics Paper 2

1	**(a)**		One ohm is the resistance of a device when a current of 1 A flows through it when the potential difference across it is 1 V.	[1]
	(b)	**(i)**	$R = \frac{\rho L}{A} = \frac{4\rho L}{\pi d^2}$ $\rho = \frac{\pi d^2 R}{4L} = \frac{\pi(0.00023)^2 \frac{1.20}{0.29}}{4(0.420)} = 4.09 \times 10^{-7}\ \Omega\ \text{m}$	[1] [2]
		(ii)	$\Delta\rho = \left(\frac{\Delta V}{V} + \frac{\Delta I}{I} + \frac{\Delta L}{L} + 2\frac{\Delta d}{d}\right)\rho = \left(\frac{0.01}{1.20} + \frac{0.01}{0.29} + \frac{0.1}{42.0} + 2\frac{0.01}{0.23}\right) 4.09 \times 10^{-7}$ $\Delta\rho = 5.4 \times 10^{-8}\ \Omega\ \text{m}$	[1] [1]
		(iii)	ρ = (41 ± 5) × 10^{-8} Ω m	[1]
	(c)		Accuracy: Compared to the accepted value, the percentage difference is (4.5-4.1)/4.5 × 100% = 8.9 %. Precision: The spread about the calculate value represents a percentage difference of 5/41 × 100% = 12 %	[1] [1]

2	**(a)**	Net force on a body is zero.		[1]
		Net torque on the body about any point is zero.		[1]
	(b)	**(i)**		[2]
		(ii)	Taking moments about hinge,	
			Sum of clockwise moments = sum of anticlockwise m0°oments	
			Mg (L/2 cos 30°) = T × L	[1]
			T = 30(9.81)(cos 30°) /2 = 127 N	[1]
		(iii)	F_y = Mg – T sin 60° = 30(9.81) – 127 sin 60° = 184 N upward	[1]
			F_x = T cos 60° = 127 cos 60° = 63.5 N leftward	[1]
			$F = \sqrt{184^2 + 63.5^2} = 195$ N	[1]
			$\theta = \tan^{-1}\dfrac{184}{63.5} = 71.0°$	[1]
			The force is 195 N and at 71.0° clockwise from the leftward direction.	

3	**(a)**	Max KE = 1.1 eV = $1.15 \times 1.6 \times 10^{-19}$ = 1.84×10^{-19} J	[1] [1]
	(b)	Energy = hc/λ = $hc/(370 \times 10^{-9})$ = 5.38×10^{-19} J	[1] [1]
	(c)	By Einstein's photoelectric equation, hc/λ_0 = energy of photon – max KE of electron = $(5.38 – 1.84) \times 10^{-19}$ J λ_0 = 560 nm	 [1] [1]
	(d)	Sketch a curve through the two points given, and end at 560 nm.	[1] [1]
	(e)	No change, because higher intensity just means more photons per unit time and does not change the energy of each photon. Since the photon-electron interaction is one-on-one, the maximum ke and hence stopping potential at each photon energy or wavelength will not change.	[1] [1]

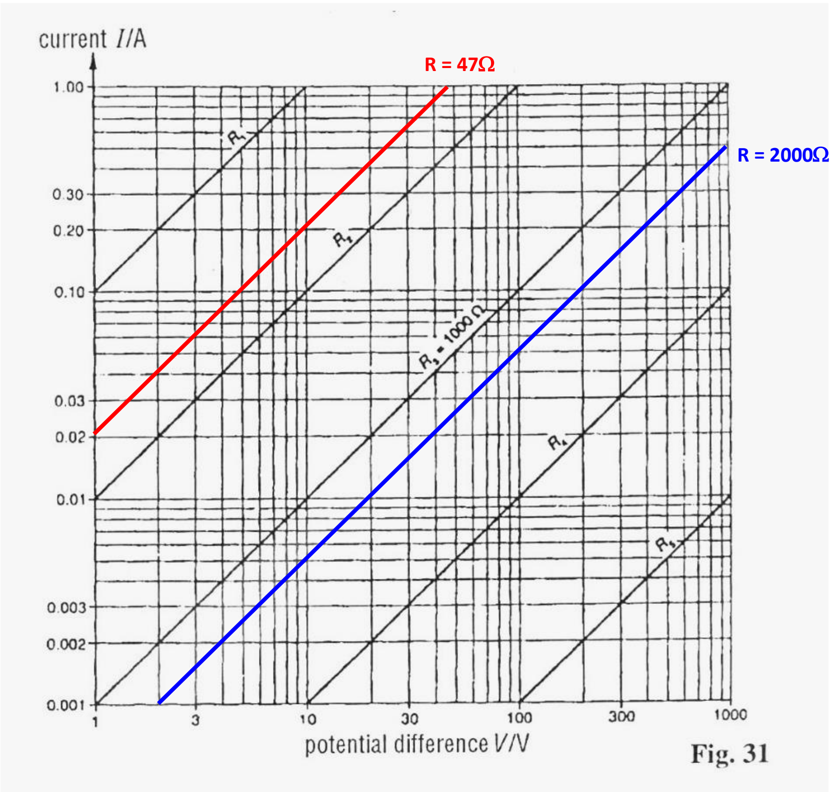
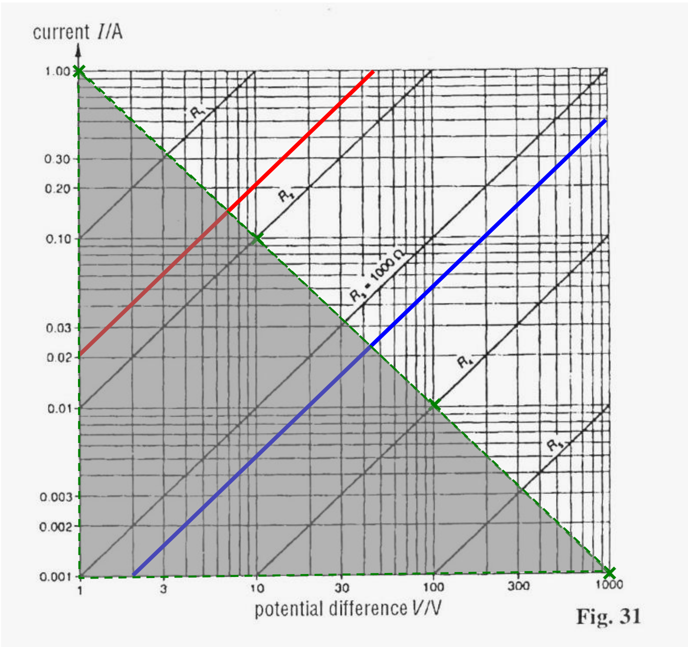
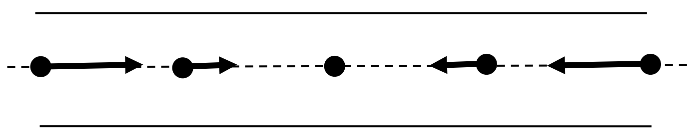
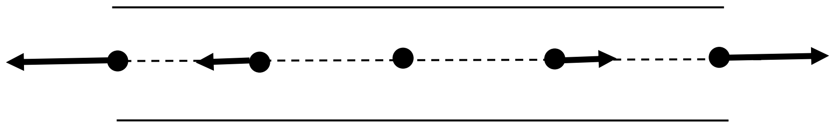
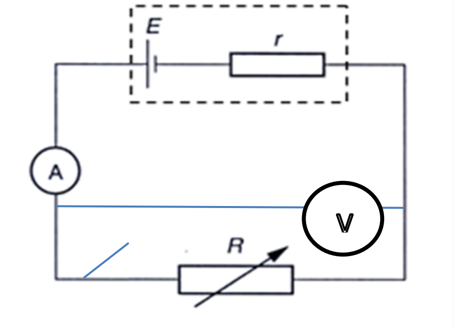
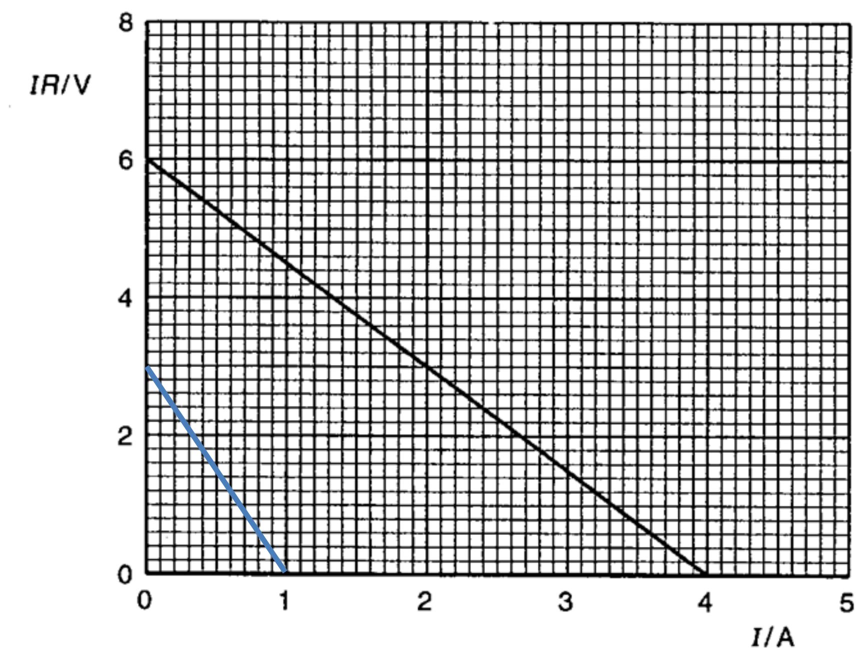
4	(a)	For R_1 : Choose (3, 0.30) $R_1 = \frac{V}{I} = \frac{3}{0.3} = 10\ \Omega$ For R_2 : Choose (30, 0.30) $R_2 = \frac{V}{I} = \frac{30}{0.3} = 100\ \Omega$ For R_4 : Choose (200, 0.02) $R_4 = \frac{V}{I} = \frac{200}{0.02} = 10000\Omega$ For R_5 : Choose (400, 0.004) $R_5 = \frac{V}{I} = \frac{400}{0.004} = 10^5\Omega$	[2]
	(b)	For R = 2000 Ω, When V = 10 V, $I = \frac{V}{R} = \frac{10}{2000} = 0.005A$ When V = 1000 V, $\frac{V}{R} = \frac{1000}{2000} = 0.5A$ For R = 47 Ω, When V = 1, $I = \frac{V}{R} = \frac{1}{47} = 0.021A$ When V = 40, $I = \frac{V}{R} = \frac{40}{47} = 0.85A$ 	[2]

Fig. 31

	(c)	P = 1 W. Maximum safe current, $I = \frac{P}{V}$ For V = 1000 V, $I = \frac{P}{V} = \frac{1}{1000} = 0.001A$ For V = 100 V, $I = \frac{1}{100}$ = 0.01 A For V = 10 V, $I = \frac{1}{10}$ = 0.1 A For V = 1 V, I = 1 A	[2]
	(d)	 Fig. 31	[3]
	(e)	For a real resistor, the resistivity of the material may actually vary with temperature; the resistance will tend to increase when the current is large as the temperature may increase. Therefore, the graph for low currents may be approximately a straight line but that for high currents a curve of a lower gradient may result.	[2]

5	**(a)**	**(i)**	The total momentum of a system is conserved, If no net external force acts on the system.	[1] [1]
		(ii)	Taking rightward as positive, 4.0(5.0) + 10.0(3.0) + 3.0(-4.0) = 17.0v v = 2.24 m s^{-1} (rightward)	 [1]
		(iii)	**1.** By the principle of conservation of momentum, 17.0(2.24) = 9.0(v) + 17.0(1.12) v = 2.12 m s^{-1}	 [1] [1]
			2. By the principle of energy conservation, Gain in GPE = loss in KE m g Δh = ½ m v^2 – ½ m $(0)^2$ $\Delta h = \frac{\frac{1}{2}(2.12)^2}{9.81} = 0.229$ m Δh = 22.9 = 30.0 – 30.0 cos θ θ = 76.3˚	 [1] [1] [1]
	(b)	**(i)**	**1.** $v^2 = u^2 + 2as$ $28^2 = 2a(450)$ a = 0.87 m s^{-2}	 [1] [1]
			2. $s = ut + \frac{1}{2}at^2$ $450 = \frac{1}{2}(0.87111)t^2$ t = 32 s	 [1]
			3. Gain in kinetic energy = ½ m v^2 = ½ (800)$(28)^2$ = 3.1 × 10^5 J	[1] [1]
			4. Gain in gravitational potential energy = m g Δh = 800 (9.81) (450 sin 5˚) = 3.1 × 10^5 J	 [1] [1]
		(ii)	Useful output power = 6.2 × 10^5/32 = 1.9 × 10^4 W	[1] [1]
		(iii)	Consider launch point to top and taking upward as positive, $v^2 = u^2 + 2as$ $0 = (28 \sin 5°)^2 + 2(-9.81)s$, hence s = 0.30 m Height above ground = 450 sin5˚ + 0.30 = 39.5 m	 [1] [1] [1]

6	**(a)**	**(i)**	 Or 	[2]
		(ii)	π rad	[1]
	(b)	**(i)**	Fringe separation = OX/3.5 = $5.88 \times 10^{-3} / 3.5 = 1.68 \times 10^{-3}$ m Using $x = \lambda D/d$, $\lambda = xd/D$ = $1.68 \times 10^{-3} \times 0.75 \times 10^{-3} / 2.8$ = 450 nm	[1] [1] [1]
		(ii)	The intensity of the fringes is maximum when the axes of the polaroids are aligned but the intensity decreases as one of the polaroid is rotated till the axes of the polaroids are perpendicular When the axes of the polaroids are perpendicular, the fringes disappear.	[1] [1]
	(c)	**(i)**	When two or waves of the same type overlap, the resultant displacement at any point at any time is the vector sum of the individual displacements at that point at that time.	[2]
		(ii)	They are mounted on the same vibration beam (same source), hence they always maintain a constant phase difference (in this case zero) between them.	[1]
		(iii)	D and E radiate in all directions. Along the line that joins them, they send waves that are of the same sped, amplitude and frequency towards each other.	[2]
		(iv)	Nine antinodal line (constructive interference). A nodal line between any two antinodal lines (destructive interference).	[2] [1]
		(v)	**1.** At f, wavelength = 24 mm Speed of waves = 24f At (f+2.0) Hz, the wavelength = 20 mm Speed of wave = (f + 2.0)(20) 24f = (f + 2.0)(20) Hence, f = 10 Hz	 [1] [1] [1]
			2. Speed = 0.024 × 10 = 0.24 m s^{-1}	[1]

7	(a)	(i)	E = IR + Ir	[1]
		(ii)	**1.** e.m.f. = 6.0 V (from y-intercept)	[1]
			2. power = VI = 4.2 × 1.2 = 5.0 W	[2]
			3. V = E – Ir r = gradient = (6.0 – 0)/(4.0 – 0) = 1.5 Ω	 [1] [1]
		(iii)		[1]
		(iv)	**1.** Open	
			2. Closed	[1]
		(v)		[2]

	(b)	**(i)**	The magnetic flux density of a magnetic field is said to be 1 tesla, if the force per unit length per unit current which acts on a straight current-carrying conductor placed perpendicular to the magnetic field is 1 newton per metre per ampere.	[2]
		(ii)	Into the page.	[1]
		(iii)	$BIl = ke$ $(2 \times 8.0 \times 0.25) = k \times 10 \times 10^{-3}$ k = 400 N m^{-1}	[1] [1]
		(iv)	The Earth's magnetic flux density is of the order of 10^{-5} T, and is negligible compared to 2 T.	[1]
		(v)	**1.** The torque on the coil is due to the magnetic force F_B acting on the sides PS and QR only. $\tau = F_B \times l$ $\tau = 2 \times 8.0 \times 0.25 \times 0.25$ $\tau = 1.0$ N m	[1] [1]
			2. When the magnetic field is applied at an angle θ to the plane area of the coil, the magnitude of the magnetic force on sides PS and QR of the coil <u>remains the same</u>. However, the perpendicular distance to the magnetic force is <u>smaller</u> than before. Hence, the <u>torque experienced by the coil will decrease</u>.	[1] [1]

~ End of Paper ~