Candidate's Name ……………………………………………… CTG …..........

YISHUN JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATIONS 2016

PHYSICS **8866/1**
HIGHER 1 **26 August 2016**
Paper 1 Multiple Choice **Friday**
1 hour

Additional Materials:
Optical Mark Sheet

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.

Write your name and CTG on the Optical Mark Sheet in the spaces provided.
Shade your NRIC in the space provided.

There are **thirty** questions in 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 separate Optical Mark Sheet.

Read the instructions on the Optical Mark Sheet carefully.

INFORMATION FOR CANDIDATES

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	=	3.00×10^{8} m s^{-1}
elementary charge,	e	=	1.60×10^{-19} C
the Planck constant,	h	=	6.63×10^{-34} J s
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	=	$\rho g h$
resistors in series,	R	=	$R_1 + R_2 + \ldots\ldots\ldots$
Resistors in parallel,	$\frac{1}{R}$	=	$\frac{1}{R_1} + \frac{1}{R_2} + \ldots\ldots\ldots$

1 A boat changes its velocity from 16 m s^{-1} due north to 12 m s^{-1} due east.

What is its change in velocity?

A 4 m s^{-1} at direction of 37° east of north

B 4 m s^{-1} at direction of 53° west of north

C 20 m s^{-1} at direction of 37° east of south

D 20 m s^{-1} at direction of 53° west of south

2 A student uses an analogue mass balance to measure mass. The mass balance is marked for every 0.2 kg but has a zero error of 0.4 kg. The student is not aware of this zero error and writes down a reading of 2.2 kg.

Is this reading accurate and precise?

	accurate	precise
A	no	no
B	no	yes
C	yes	no
D	yes	yes

3 The e.m.f induced in a coil by a changing magnetic flux is equal to the rate of change of flux with time.

Which is a unit for magnetic flux?

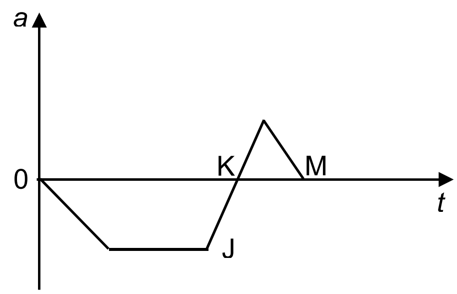
A kg m^2 s^{-2} A^{-1}

B kg m^2 s^{-2} A

C kg m^2 s^{-1} A^{-1}

D m s^{-2} A^{-1}

4 A car starts from rest and travels along a straight road. The graph shows the variation with time t of its acceleration a, during part of the journey.



At which points on the graph does the car have its greatest speed and greatest displacement?

	greatest speed	greatest displacement
A	J	K
B	K	M
C	L	L
D	M	K

5 A motorist travelling at 13 m s^{-1} approaches a traffic light which turns red when he is 25 m away from the stop line. His reaction time (i.e. the interval between seeing the red line and applying the brakes) is 0.70 s and he brakes at a rate of 4.5 m s^{-2}. How far from the stop line will he stop, and on which side of it?

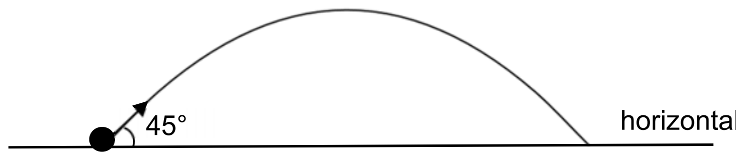
A 2.9 m behind the line

B 2.9 m beyond the line

C 4.0 m behind the line

D 4.0 m beyond the line

6 An object is projected with velocity of 60 m s^{-1} at 45° above the horizontal. Air resistance is negligible.



What is the speed of the object after 6.0 s?

A 20.5 m s^{-1}

B 35.5 m s^{-1}

C 45.5 m s^{-1}

D 50. 5 m s^{-1}

7 A man of weight 590 N is standing on a weighing scale in a lift. The lift is accelerating upwards at 2.00 m s^{-2}. What is the reading on the weighting scale?

A 470 N

B 590 N

C 710 N

D 890 N

8 Newton's third law of motion concerns action and reaction forces.

Which pair of forces is not a valid example?

A The gravitation forces of attraction between the Earth and a satellite orbiting around the Earth.

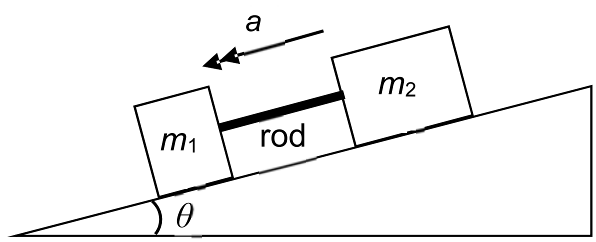
B The forces of repulsion between a horse magnet and a wire carrying current placed in between the horse magnet.

C Tension from a string pulling the object upwards and pulling force by the object on the string.

D Weight of a book placed on a floor and the normal force from the floor on the book.

9 Two masses m_1 and m_2 are connected by a light rod as shown.

The blocks are moving with acceleration *a,* down a smooth slope that is inclined at angle θ. What is the tension in the rod?

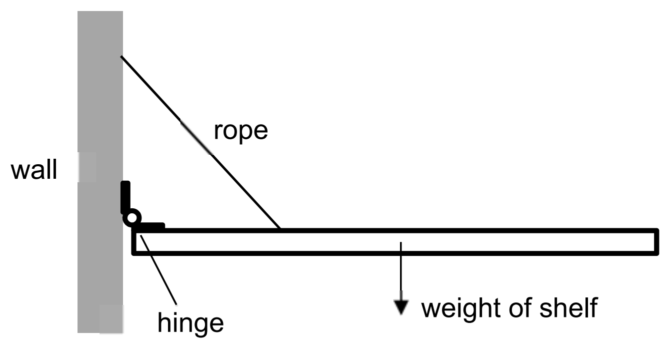


A m_1a (sin θ) **B** $(m_1 - m_2)a$ **C** $(m_1 + m_2)a$ **D** zero

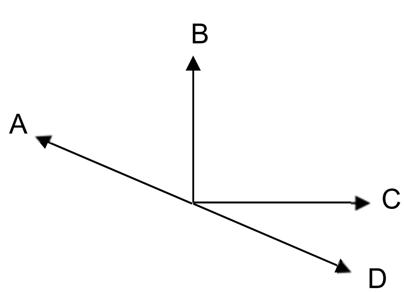
10 A man sitting in a train carriage observes that a pendulum hanging from the ceiling makes an angle of 30° to the vertical. What is the acceleration of the train?

A 4.9 m s^{-2} **B** 5.7 m s^{-2} **C** 8.5 m s^{-2} **D** 9.8 m s^{-2}

11 A hinged shelf is held horizontally against a wall by a rope. The forces acting on the shelf are its weight, the force by the rope and the force by the hinge.



Which arrow could represent the direction of the force the hinge exerts on the shelf?



12 A constant force F is applied to a stationary object of mass m on a frictionless surface. Thus, the velocity of the object increases to some value v in a time t. It covers a distance s during this time.

Which expression represents the kinetic energy gained by the object?

A $F s t$ **B** $F v$ **C** $F s$ **D** $\frac{m s}{2 t}$

13 The power delivered by an engine to a train travelling at a constant speed of 45 m s^{-1} is 2.0 MW. What is the resistive force it experiences?

A 0 N **B** 9.9×10^2 N **C** 2.2×10^4 N **D** 4.4×10^4 N

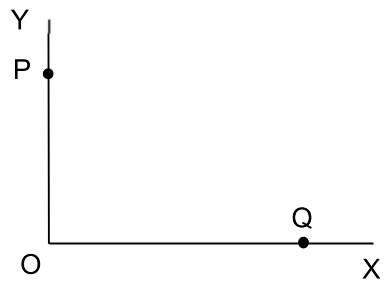
14 A bungee jumper has 27 kJ of gravitational potential energy at the top of his jump. He is attached to an elastic rope which starts to stretch after a short time of free fall. The table below shows values of the gravitational potential energy, elastic potential energy and kinetic energy at the top and bottom of the jump.

	gravitational potential energy / kJ	elastic potential energy / kJ	kinetic energy / kJ
top	27	0	0
bottom	0	27	0

What are the possible values of these three energies when the jumper is one third on the way down? Losses of energy due to air resistance is negligible.

	gravitational potential energy / kJ	elastic potential energy / kJ	kinetic energy / kJ
A	18	1	8
B	18	4	5
C	18	6	3
D	9	9	9

15 The diagram shows a flat surface with lines OX and OY at right angles to each other.

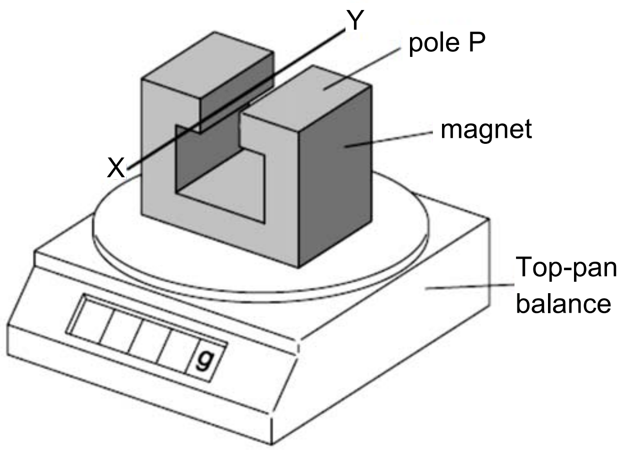


A straight current carrying conductor is placed at a position such that the magnetic field at O is found to be in the direction OX.

Which of the following correctly shows the position of the straight conductor and the direction of its current flow?

	position	direction of current flow
A	P	into the plane
B	P	out of the plane
C	Q	into the plane
D	Q	out of the plane

16 A large horseshoe magnet produces a uniform magnetic field of flux density *B* between its poles. The magnet is placed on a top-pan balance and a wire XY is situated between its poles, as shown in the figure below.



The wire XY is placed perpendicular to the magnetic field. The length of wire between the poles is 4.4 cm. A direct current of magnitude 2.6 A is passed through the wire in the direction from X to Y. The reading on the top-pan balance increases by 2.3 g.

What is the polarity of pole P of the magnet and the magnitude of the flux density between the poles?

	polarity of P	flux density / T
A	north	0.020
B	north	0.20
C	south	0.20
D	south	200

17 An electron is moving along the axis of a current-carrying solenoid.

Which of the following is a correct statement about the electromagnetic force acting on the electron?

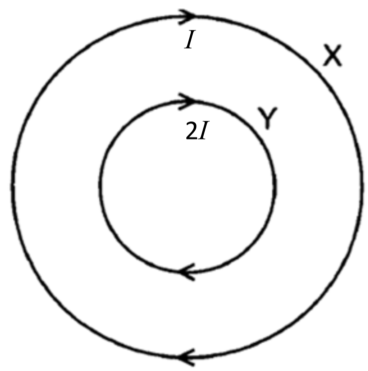
A The electromagnetic force acts radially outwards.

B The electromagnetic force acts radially inwards.

C The electromagnetic force acts in the direction of motion.

D No electromagnetic force acts on the electron.

18 There are two concentric coils X and Y. Each coil carries a current in the same direction as shown below.



Which of the following statements is correct?

A The force on coil X due to the current in coil Y is directed inwards towards the centre and it is twice the force on coil Y due to the current in coil X.

B The force on coil X due to the current in coil Y is directed perpendicular to the plane of the coils and it is twice the force on coil Y due to the current in coil X.

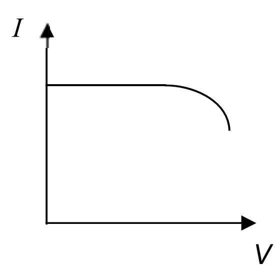
C The direction of the force acting on every point of Y is directed radially inwards, towards the centre of Y.

D The direction of the force acting on every point of Y is directed radially outwards, away from the centre of Y.

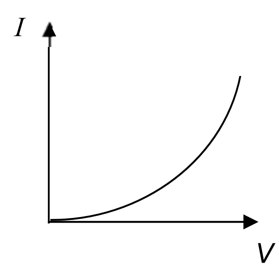
19 Lamps in olden times used carbon filaments. The resistance of these filaments decreases as their temperature increases.

Which graphs shows how the current I in the filament varies with the potential difference V across it?

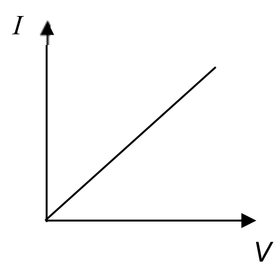
A



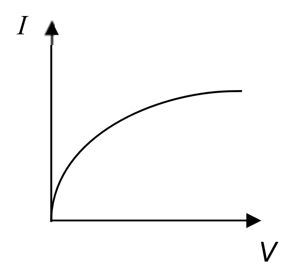
B



C



D

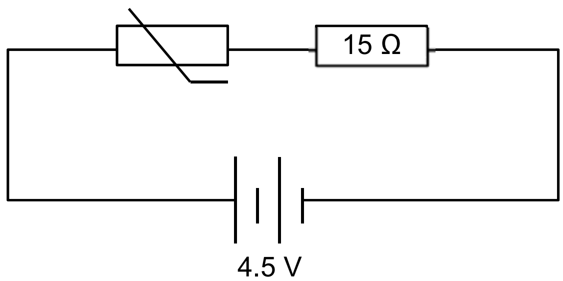


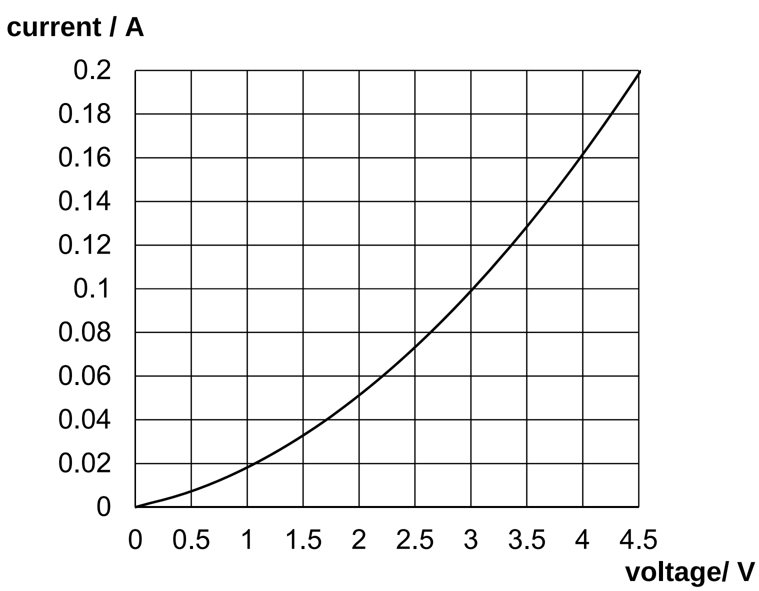
20 A resistor of resistance R has power P when the current in the resistor is I. What is the resistance of a resistor that has power $2P$ when the current in it is $\frac{I}{2}$?

A $\frac{R}{8}$ **B** $\frac{R}{4}$

C $4R$ **D** $8R$

21 A 15 Ω resistor and a thermistor are connected in series to a battery of electromotive force 4.5 V and negligible internal resistance.





The graph above shows the current – voltage characteristic of the thermistor.
What is the current in the circuit?

A 0.05 A **B** 0.10 A

C 0.15 A **D** 0.20 A

22 When four identical lamps P, Q, R and S are connected as shown in diagram 1, they have normal brightness.

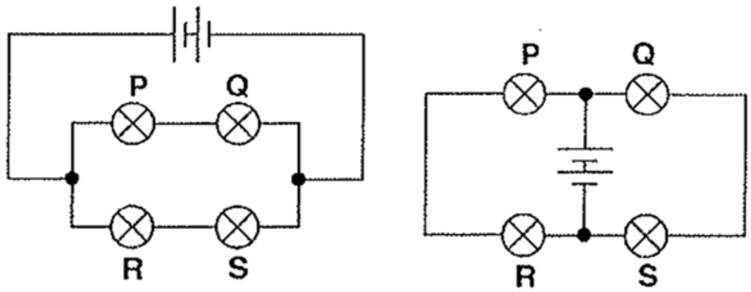


Diagram 1 Diagram 2

When the four lamps are connected as shown in diagram 2, which statement is **correct**?

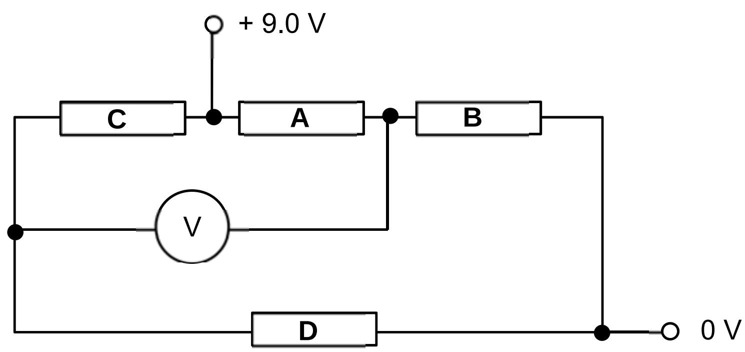
A The lamps do not light up.

B The lamps are less bright than normal.

C The lamps have normal brightness.

D The lamps are brighter than normal.

23 In the circuit shown, the resistance of resistors A and D is *R* while the resistance of resistors C and B is 2*R*.



The potential difference between the input terminals is 9.0 V.

What is the reading on the voltmeter?

A 0 V **B** 3.0 V **C** 6.0 V **D** 9.0 V

24 Which of the following statements is incorrect about progressive mechanical waves?

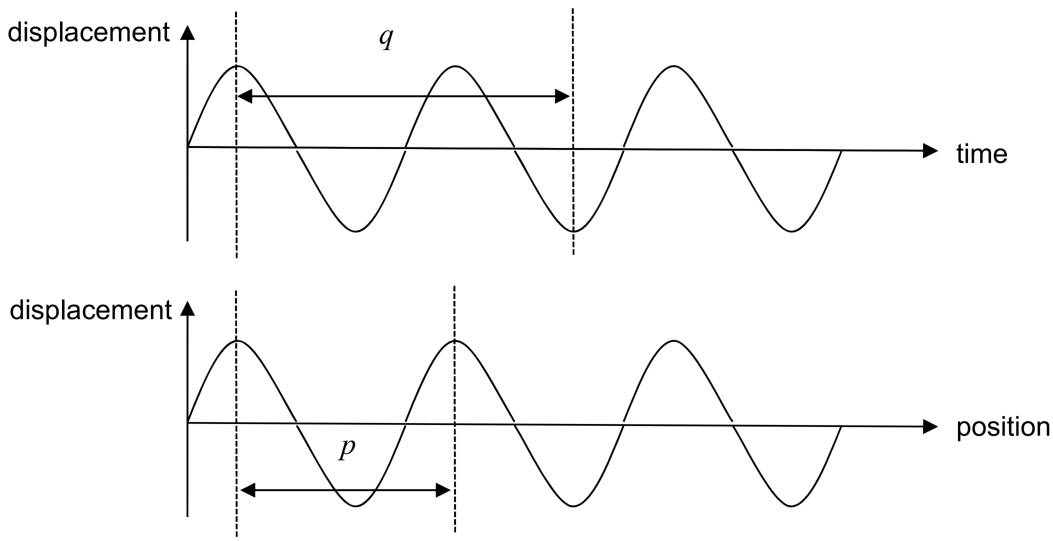
A They propagate due to interaction between the particles of the medium.

B They can be transverse or longitudinal.

C They carry energy as they propagate.

D They can always be polarized.

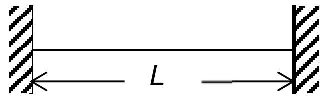
25 A progressive wave can be represented by the following graphs.



Which of the following gives the speed of the wave?

A $\frac{q}{p}$ **B** $\frac{p}{q}$ **C** $\frac{2p}{3q}$ **D** $\frac{3p}{2q}$

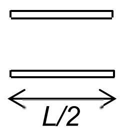
26 The figure below shows a stretched string of length *L*. The speed of waves on the string has the same speed as sound waves in the air. The fundamental mode of oscillation is then set up on the string.



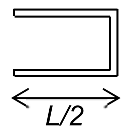
Pipes **A**, **B**, **C** and **D** below have lengths of *L/2*, *L/2, L* and *2L* respectively.

In which pipe will the sound produced by the string cause resonance?

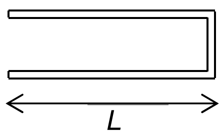
A



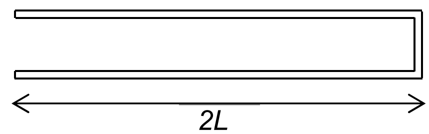
B



C



D



27 Electrons in a beam undergo diffraction when incident on a crystalline solid. Given that the order of magnitude of the separation of atoms in the solid is 0.1 nm, what is the estimated speed of an electron in the beam?

A 10^{-24} m s^{-1} **B** 10^{-10} m s^{-1} **C** 10^{5} m s^{-1} **D** 10^{6} m s^{-1}

28 Which of the following observations in the photoelectric effect does not require the use of quantum theory of electromagnetic radiation to explain?

A The existence of a threshold frequency

B The dependence of stopping voltage with frequency of incident radiation

C The relationship between photocurrent and intensity of incident radiation

D The almost instantaneous emission of electrons once radiation of high enough frequency is incident

29 The transition of electrons between three consecutive energy levels in a particular atom gives rise to three spectral lines. The shortest and longest wavelengths of those spectral lines are λ_1 and λ_2 respectively. The wavelength of the other spectral line is

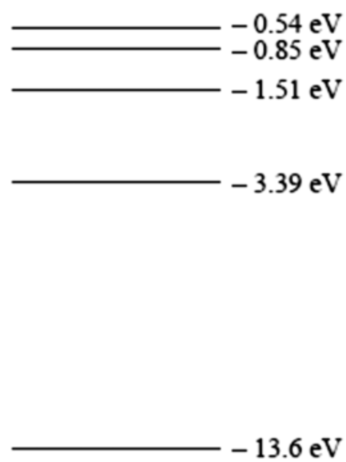
A $\dfrac{\lambda_1 + \lambda_2}{2}$

B $\lambda_1 - \lambda_2$

C $\dfrac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$

D $\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)^{-1}$

30 Some of the energy levels of the hydrogen atom are shown below.

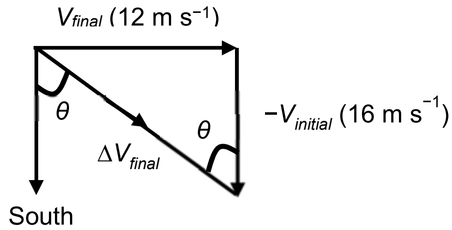


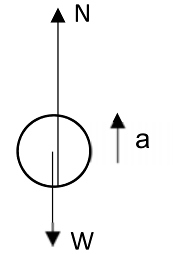
Electrons are excited to the –1.51 eV level. How many different photon frequencies will be detected when the electrons de-excite?

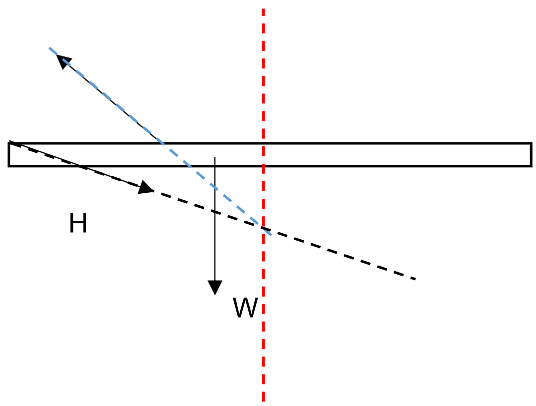
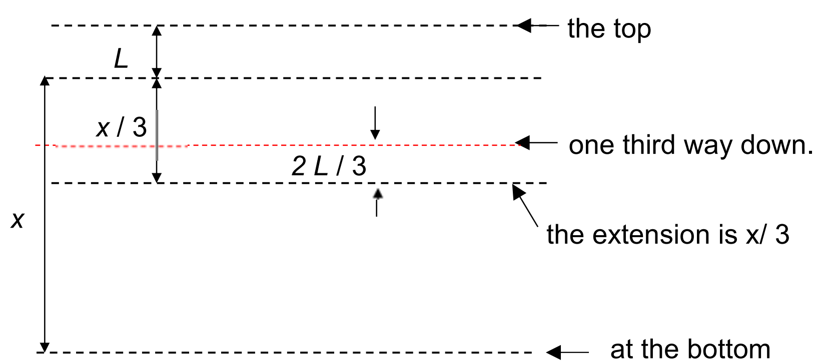
A 2 **B** 3 **C** 4 **D** 5

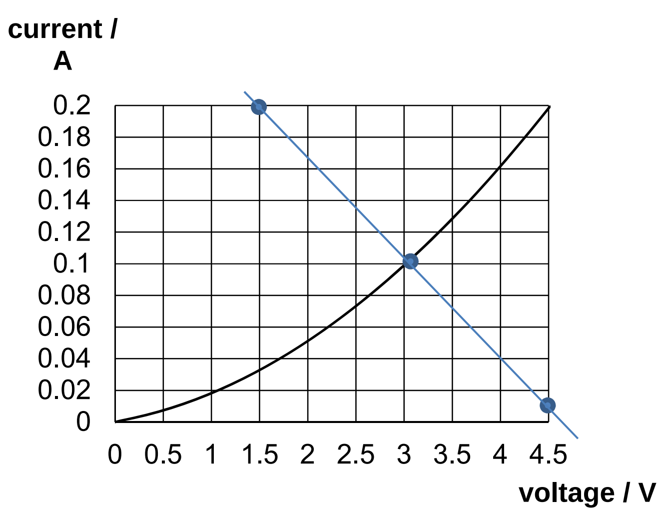
END OF PAPER

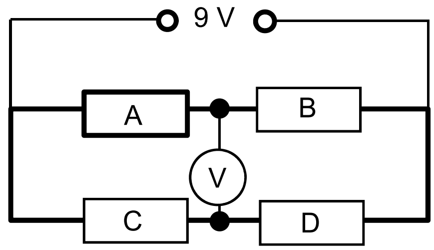
Paper 1 MCQs Solution:

S/N	Answer	Explanation
1	C	 V_{final} (12 m s^{-1}) θ θ $-V_{initial}$ (16 m s^{-1}) ΔV_{final} South $\Delta V_{final}{}^2 = 12^2 + 16^2$ ΔV_{final} = 20 m s^{-1} tan θ = 12 /16 θ = 37°
2	B	The smallest division on the mass balance is 0.2 kg. Absolute uncertainty is 0.1 kg for 1 reading. (1 measurement takes 2 readings so absolute uncertainty for 1 measurement is 0.2 kg.) The student has recorded his reading to the right precision. Hence, the reading is precise. However, it is not accurate as there is zero error which is unaccounted for.
3	A	Φ is the flux linkage $e.m.f = \frac{d\Phi}{dt}$ $[\Phi] = [\,e.m.f\,][\,t\,]$ $= [\,p.d\,][\,t\,]$ $= \left[\frac{P}{I}\right][\,t\,]$ $= \left(\frac{\text{kg m}^2\text{s}^{-3}}{\text{A}}\right)(\text{s})$ $= \text{kg m}^2\text{s}^{-2}\text{A}^{-1}$
4	B	Car accelerates (gain in speed) until point K. Since area under triangle between K and M is smaller than area under trapezium from 0 to K, the car maintains motion in the same direction. Therefore, car is gaining displacement until point M.
5	B	Distance traveled before brakes are applied = 13 x 0.7 = 9.1 m Using $v^2 = u^2 + 2as$, s = 18.8 m Total distance travelled = 9.1 + 18.8 = 27.9 m. Distance beyond the stop line = 27.9 – 25 = 2.9 m
6	C	$v_y = u_y - a_y t$ = 60 sin 45° – 9.81 × 6 = – 16. 4 m s^{-1} $v_x = u_x$ = 60 cos 45° = 42. 4 m s^{-1} $v^2 = v_x^2 + v_y^2$ $v^2 = (-16.4)^2 + (42.4)^2$ v = 45.5 m s^{-1}

7	**C**	$F_{net} = m\,a$ $N - W = m\,a$ $N - 590 = (590 / 9.81)(2.00)$ $N = 710$ N 
8	**D**	The gravitation force of attraction between satellite and earth is a pair of action and reaction force. Wire with current flowing will generate magnetic field around it. Hence, the wire acts a magnet which interacts with the horse magnet. Hence the magnetic forces of repulsion is a pair of action and reaction force. The upthrust is a force exerted by the water on the block. Hence upthrust and force by the block on the water is a pair of action and reaction force. The normal force is exerted by the floor on the floor. Weight of the book is exerted by the earth on the book. These two forces are of different type of forces and hence they cannot be a pair of action and reaction force.
9	**D**	m_1 and m_2 have the same acceleration. Considering rod, m_1 and m_2 as a system, $(m_1 + m_2)g \sin\theta = (m_1 + m_2)\,a$ $a = g \sin\theta$ considering m_1 as a system, $m_1 g \sin\theta - T = m_1 a$, $m_1 a - T = m_1 a$, $T = 0$
10	**B**	Since object is in translational equilibrium, (leftwards forces = rightward forces) Mass of ball x Acceleration of ball = horizontal component of Tension in string. ma = T sin 30 – (1) (upward forces = downward forces) Weight of ball = vertical component of Tension in string. mg = T cos 30 – (2) (1)/(2): a/g = tan 30 a = g tan 30 = 5.7

11	**D**	By <u>extending the lines of three forces</u>, they should meet at a point only. This to ensure the net moment (torque) due to all the three forces will be zero so that the shelf will be rotational equilibrium. The horizontal component of H is acting to the right to balance the leftward horizontal component of T so that the net horizontal force is zero. 
12	**C**	Work done by the net external force = change in K.E $F\,s = K.E_{final} - K.E_{intial} = K.E_{final}$
13	**D**	$P_{eng} = F_{eng}\,v \Rightarrow F_{eng} = 2 \times 10^6 / 45 = 4.4 \times 10^4$ N Since velocity is constant, $F_{resist} = F_{eng}$
14	**A**	Let the natural length of the rope be *L*. Let the total extension of rope be *x* when it is at the bottom of the jump.  When it is one third way down: Extension = $(L + x) / 3 - L = x / 3 - 2L / 3$ which less than $x / 3$. Hence E.P.E cannot exceed 3 kJ which is the E.P.E when the extension is $x / 3$. Hence the possible answer is only A.
15	**B**	Using right hand grip rule, a current coming out of the plane at P will result in a magnetic field that is anticlockwise. (in the direction OX)

16	**B**	force on magnet / balance is downwards => by Newton's third law force on wire is upwards => pole P is a north pole F = BIL = mg $B \times 2.6 \times 4.4 \times 10^{-2} = 2.3 \times 10^{-3} \times 9.81$ B = 0.20 T
17	**D**	B field and electron motion are parallel to each other. No force is acting on electron.
18	**D**	The setup has two currents flowing in the same direction. Thus, they will attract each other with the same magnitude of force that are opposite in direction-an action reaction pair.
19	**B**	As the voltage increases: • the current will increase, the heating power dissipated across the lamp increase. • the temperature increases. • resistance decreases. • ratio of I / V should increases since I / V = 1 / R • The graph should be steeper.
20	**D**	$P = I^2 R$ .... (1) $2P = (I / 2)^2 R_{new}$ .... (2) (2) / (1): $R_{new} = 8R$
21	**B**	 $4.5 = 15 \times I + V_{thermistor}$ $I = (4.5 - V_{thermistor}) / 15$ Plot a line of $I = (4.5 - V_{thermistor}) / 15$ on the same graph. When both lines meet, the Y co-ordinate of the point gives current flowing in circuit.
22	**C**	Both circuits are identical.

23	**B**	 p.d across voltmeter = p.d across C – p.d across A = (2R/3R) x 9 – (R/3R) x 9 = 3 V
24	**D**	Only transverse waves can be polarized. Longitudinal waves is a progressive mechanical wave as well but it cannot be polarized.

25	**D**	q = $\frac{3T}{2}$; p = λ; v = $\frac{distance}{time}$ = $\frac{\lambda}{T}$ = $\frac{3p}{2q}$
26	**B**	For string, L = $\frac{\lambda}{2}$ For L/2 closed pipe, L/2 = $\frac{\lambda}{4}$. Therefore, L = $\frac{\lambda}{2}$, same wavelength as that of string.
27	**D**	For significant diffraction, $\lambda \sim d$ (atomic separation) According to de Broglie, $\lambda = h / (mv)$ $\Rightarrow v = 6.63 \times 10^{-34} \div (9.11 \times 10^{-31} \times 10^{-10}) = 7.3 \times 10^{6}$ m/s
28	**C**	This observation can be explained by wave theory
29	**D**	For the shortest spectral line, the energy difference between involved levels = $\frac{hc}{\lambda_1}$ For the longest spectral line, the energy difference between involved levels = $\frac{hc}{\lambda_2}$ Thus, the energy difference between levels for the third spectral line = $\frac{hc}{\lambda_1} - \frac{hc}{\lambda_2}$ Let the wavelength of this third spectral line be λ_3. Thus, the energy difference can also be expressed as $\frac{hc}{\lambda_3}$. We then have $\frac{hc}{\lambda_3} = \frac{hc}{\lambda_1} - \frac{hc}{\lambda_2}$
30	**B**	– 1.51 eV to – 3.39 eV – 3.39 eV to – 13.6 eV – 1.51 eV to – 13.6 eV

Parent's Signature …………………..

Candidate's Name ………………………………………… CTG ……………..

YISHUN JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATIONS 2016

PHYSICS **8866/2**
HIGHER 1 **19 August 2016**
Paper 2 **Friday**
Structured Questions **2 hours**

Candidates answer on the Question Paper.
No Additional Materials are required.

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Section A
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Paper 2	
Section A	
Q1	/5
Q2	/11
Q3	/6
Q4	/6
Q5	/6
Q6	/6
Section B	
Q7	/20
Q8	/20
Q9	/20
Penalty	
Total	
	/80
	%

This question paper consists of **21** printed pages.

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} J s
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	=	$\rho g h$
resistors in series,	R	=	$R_1 + R_2 + \ldots\ldots\ldots\ldots$
Resistors in parallel,	$\frac{1}{R}$	=	$\frac{1}{R_1} + \frac{1}{R_2} + \ldots\ldots\ldots$

Section A
Answer **all** the questions in this section.

1 A student times the fall of a small metal ball. Data for the time t taken for the ball to fall through a vertical distance h from rest are given below.

h = (348 ± 1) cm
t = (0.842 ± 0.001) s

Use these data to determine

(a) the acceleration of free fall, g to five significant figures.

g = ………………………………….. m s^{-2} [2]

(b) the value of g and its uncertainty, to an appropriate number of significant figures.

g = ……………………………… ± ……………………….. m s^{-2} [3]

2 The graph of Fig 2.1 shows the variation with time t of the velocity v of a ball from the moment it is thrown with velocity v of 26 m s^{-1} vertically upwards.

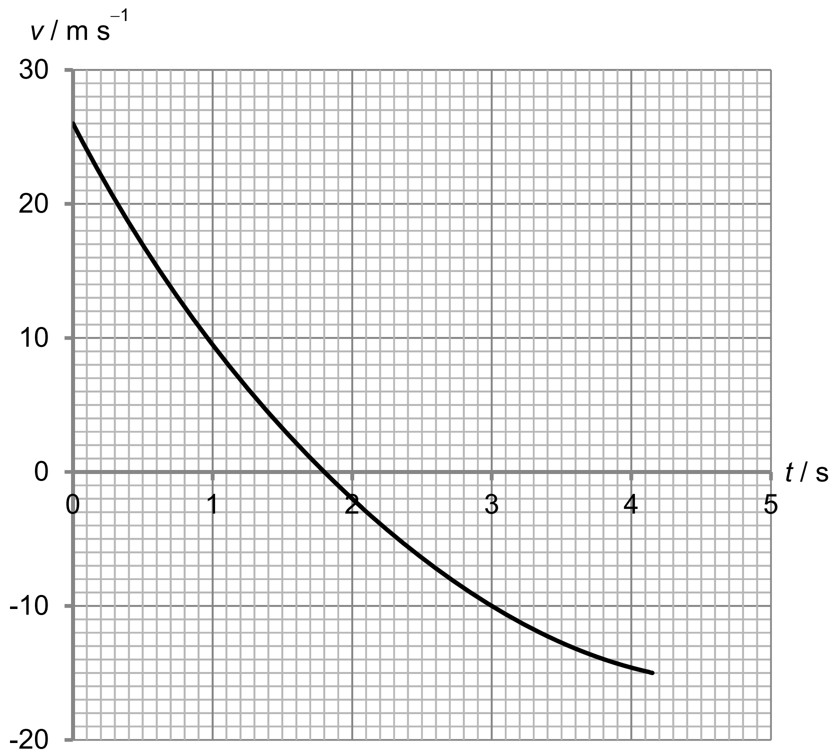


Fig. 2.1

(a) State the time at which the ball reaches its maximum height.

time = ………………….. s [1]

(b) Just after the ball leaves the thrower's hand, it has a downward acceleration of approximately 20 m s^{-2} which is much larger than g. Explain how this is possible.

……………………………………………………………………………………………

……………………………………………………………………………………………

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

(c) It is found that the acceleration at t = 1.8 s is g. Explain how this is possible.

....

....

.... [2]

(d) Sketch the acceleration-time graph and displacement-time graph in Fig. 2.2 for the motion from t = 0 to t = 4 s, following the sign convention taken for the velocity-time graph in Fig. 2.1. The value of g is marked out in the acceleration-time graph. Label other critical values. [6]

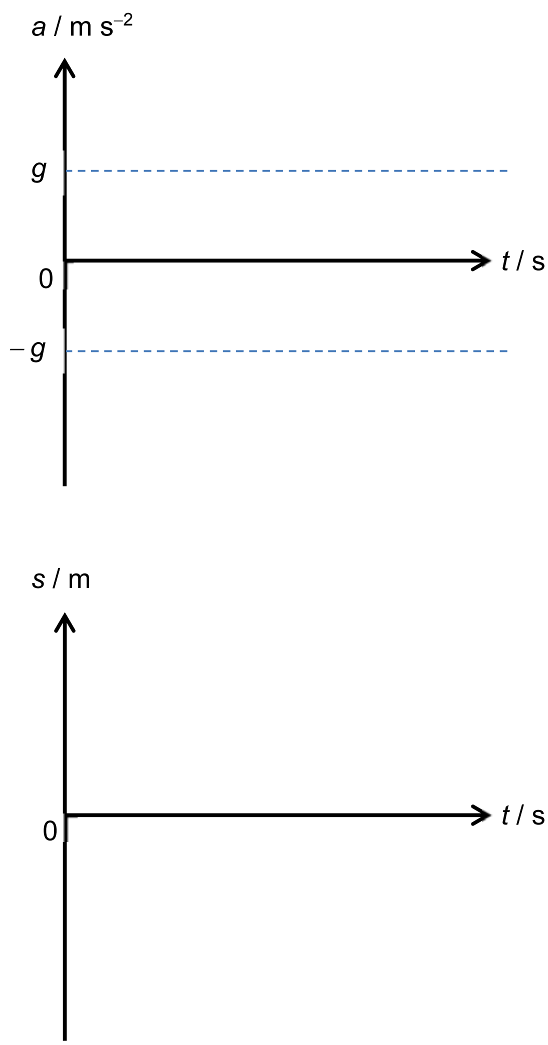


Fig. 2.2

3 A light helical spring is suspended vertically from a fixed point, as shown in Fig. 3.1.

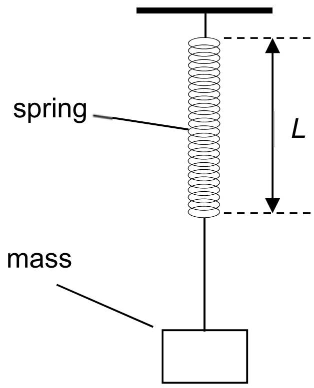


Fig. 3.1

Different masses are suspended from the spring. The weight *W* of the mass and the length *L* of the spring are noted.

The variation with the weight *W* of the length *L* is shown in Fig. 3.2

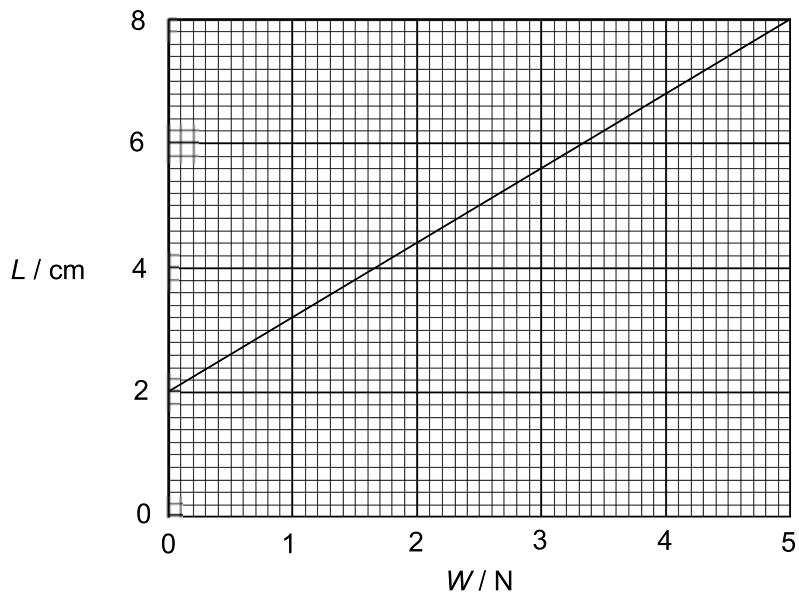


Fig. 3.2

(a) On Fig. 3.2, shade the area in the graph that represents the energy stored in the spring when the weight on the spring is increased from zero to 5.0 N. [1]

(b) A mass of weight 4.0 N is suspended from the spring.

When the mass is stationary, a force is then applied to pull the mass downwards through a distance of 1.0 cm and held stationary.

At this position,

(i) Determine the total length of the spring.

length = …………………………… cm [1]

(ii) Determine the total elastic potential energy of the spring.

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

(iii) Determine the force required to hold the mass stationary.

Force = ……………………………….. N [2]

4 A common game in carnivals is the "high striker" whereby a player uses a hammer to hit a target pad at one end of a lever in order to launch a puck at the other end. The player wins if the puck hits the bell at the top of a tower. This is illustrated in Fig. 4.1.

In one such carnival, the hammer and puck weigh 9.00 kg and 0.40 kg respectively. The bell is located 5.00 m above the puck.

A student plays the game and just manages to ring the bell.

(a) Determine the gain in gravitational potential energy of the puck.

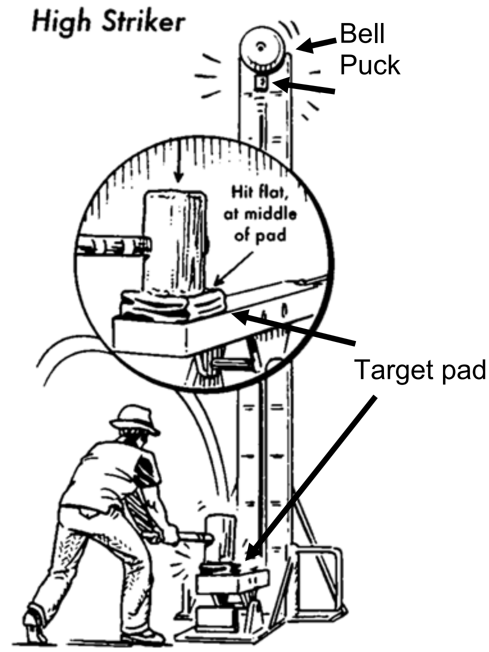


Fig. 4.1

gain in gravitational potential energy = ………… J [1]

(b) Suppose that 75% of the final kinetic energy of the hammer is transformed into thermal and sound energy, calculate the speed of impact of the student's hammer with the lever.

speed of impact = ……………. m s^{-1} [3]

(c) Suggest and explain one modification in which the game can be made more difficult to win.

....

....[2]

5 (a) When a circuit is connected using an e.m.f. cell with an internal resistor, the following equation is used:

$$V = E - Ir$$

. whereby *E* is the e.m.f., *r* the internal resistance and *I* the mains current. State what *V* represents.

....[1]

(b) A voltmeter connected across the terminals of a cell reads 1.61 V. The reading drops to 1.34 V when a 3.0 Ω resistor is connected in parallel with the voltmeter as shown in Fig. 5.1.

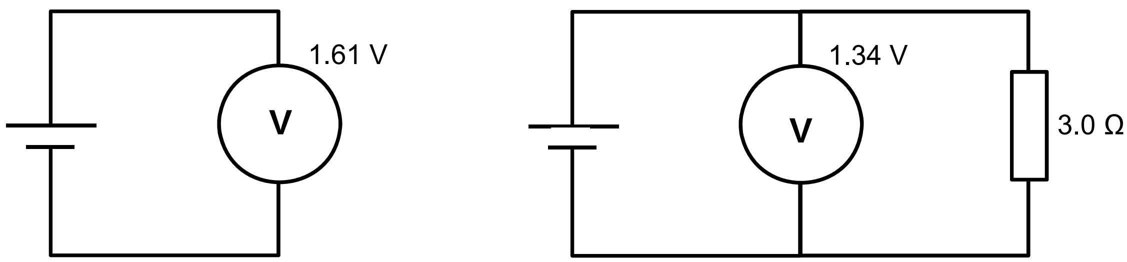


Fig. 5.1

(i) Calculate the internal resistance of the cell.

internal resistance = ……………. Ω [3]

(ii) A second resistor is connected in parallel with the 3.0 Ω resistor. Without doing any calculations, state and explain how *V* changes.

. ..……..………………………………………………………………………..…………

...……..………………………………………………………………………..………...

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

6 Einstein's photoelectric equation appears in several forms, one of which is shown below

$$E_{k\,max} = h\,f - \phi$$

Monochromatic light of frequency 7.40 × 10^{14} Hz is irradiated onto a caesium surface, and $E_{k\,max}$ is measured. The procedure is repeated for three other frequencies, enabling four points to be plotted on the graph grid of Fig. 6.1 below.

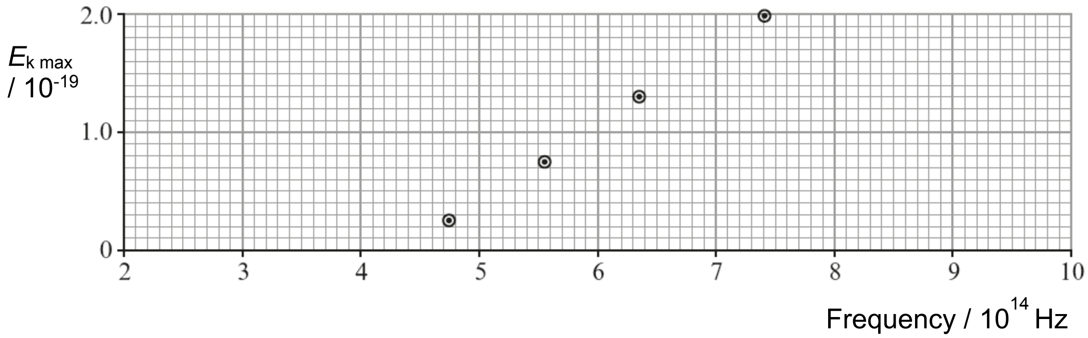


Fig. 6.1

(a) By showing your working, determine from Fig. 6.1

(i) a value for the Planck constant,

Planck constant = ……………….. J s [2]

(ii) the threshold frequency of caesium.

threshold frequency = ……………… Hz [1]

(b) When a lithium surface is used instead of a caesium surface, $E_{k\,max}$ is found to be 0.40 × 10^{-19} J for light of frequency 7.40 × 10^{14} Hz.

(i) Draw the expected line of $E_{k\,max}$ against frequency on the same grid in Fig. 6.1. [1]

(ii) This line cannot be checked satisfactorily by experiment if visible light is used. Name the region of the electromagnetic spectrum which is required.

……………………………………………………………………………………[1]

(iii) State what is different about lithium, as compared to caesium, which makes it necessary to use the region stated in (b)(ii).

……………………………………………………………………………………[1]

Section B

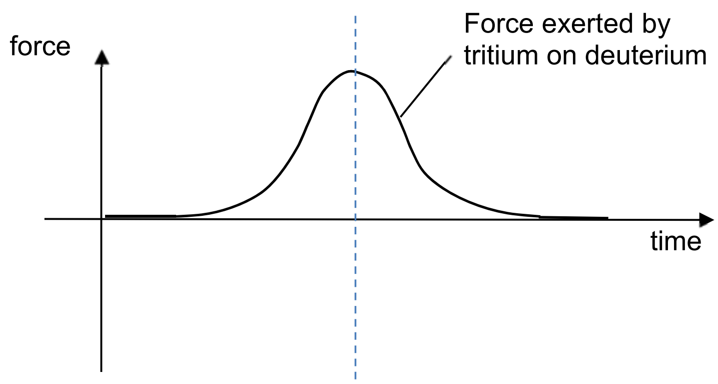
Answer **two** questions in this section.

7 (a) A tritium nucleus moves towards a deuterium nucleus at a large distance from deuterium nucleus as illustrated in Fig. 7.1.

Fig. 7.1

The nuclei initially have the same speed *v*. The tritium nucleus consists of two nucleons and a proton. The deuterium nucleus consists of a neutron and a proton. The proton and neutron have the same mass *m*.

(i) Fig. 7.2 shows the electric force exerted by tritium nucleus on deuterium nucleus. Draw the electric force exerted by deuterium nucleus on tritium nucleus in Fig. 7.2.



[1]

Fig. 7.2

(ii) Explain your answer to **(i)**.

…………………………………………………………………………………………...

…………………………………………………………………………………………...

…………………………………………………………………………………………...

……………………………………………………………………………………… [1]

(iii) Explain how your answer to **(i)** is consistent with the principle of conservation of momentum.

…………………………………………………………………………………………...

…………………………………………………………………………………………...

…………………………………………………………………………………………...

…………………………………………………………………………………………...

…………………………………………………………………………………………...

……………………………………………………………………………………… [3]

(iv) Determine the final speed of tritium nucleus in terms of *v*.

final speed = …………………………… [3]

(b) State Newton's second law of motion.

…………………………………………………………………………………………...

…………………………………………………………………………………………...

……………………………………………………………………………………… [1]

(c) A car of mass 750 kg is travelling at 30 m s^{-1} along a horizontal road. The brakes are applied and the car is brought to rest by an average resistive force *F*. The average deceleration of the car is 5.0 m s^{-2}.

(i) Show that the resistive force, *F* is 3750 N.

[1]

(ii) Calculate the change in momentum of the car.

change in momentum = ………………………… N s [1]

(iii) Hence, using the answer in **(i)** and **(ii)**, calculate the time taken for the car to be brought to rest after the brake is applied.

time = ……………………………… s [1]

(iv) Describe, in terms of Newton's third law, the horizontal forces acting on the tyres and on the road with relation to the motion of the car.

…………………………………………………………………………………………..

…………………………………………………………………………………………..

…………………………………………………………………………………………..

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

(d) The car in **(c)** now travels at 30 m s^{-1} down a slope where the angle to the horizontal is 10°. The car is brought to rest by applying the brakes. The same resistive force, *F* of 3750 N acts on the car.

(i) In Fig. 7.3, draw all the forces acting on the car as it is decelerating. Label the forces clearly. [1]

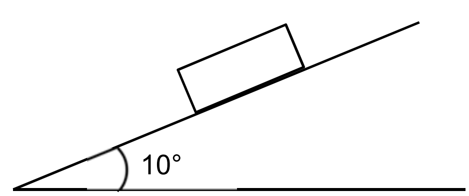


Fig. 7.3

(ii) Explain why the distance that the car travels before coming to rest is greater than that in **(c)**.

……………………………………………………………………………………………..........

…………………………………………………………………………………………….........

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

(iii) Calculate the deceleration of the car.

deceleration = …………………………… m s^{-2} [2]

(iv) The mass of the car is increased from 750 kg to 1000 kg. State and explain what would happen to the deceleration of the car.

…………………………………………………………………………………………

……………………………………………………………………………………………...

……………………………………………………………………………………………...

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

8(a) Explain what is meant by the following terms in italics.

(i) *coherent* sources

....

....[1]

(ii) *phase difference*

....

....[1]

(iii) *diffraction*

....

....[1]

(b) (i) State the conditions for a well-defined stationary wave to be formed using two separate sound sources.

....

....

....[2]

(ii) Compare the amplitude, phase and frequency of wave motion between a stationary and progressive wave.

....

....

....

....

....

....

....

....

....

....

....

....

....[5]

(c) In Fig. 8.1, a straight road runs parallel to the line joining two radio transmitting aerials A and B which are 600 m apart. Both aerials radiate signals at a frequency of 50 MHz. The road is 4.8 km from the aerials at its nearest point X.

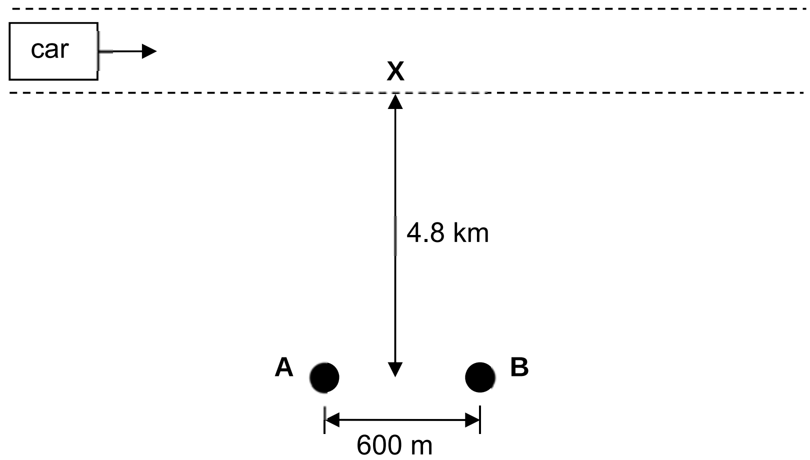


Fig. 8.1

A car travels at a steady speed along the road. As it passes along the road, it receives a radio signal that varies periodically.

(i) Explain why the radio signal varies as described.

…………………………………………………………………………………….............

…………………………………………………………………………………….............

…………………………………………………………………………………….............

…………………………………………………………………………………….............

……………………………………………………………………………………..........[3]

(ii) If the maximum intensity of the radio signal received varies at a frequency of 0.50 Hz, calculate the speed of the car.

speed of car = ………......... m s^{-1} [3]

(d) In Fig. 8.2, S_1 and S_2 are two coherent point sources placed a distance *d* apart.

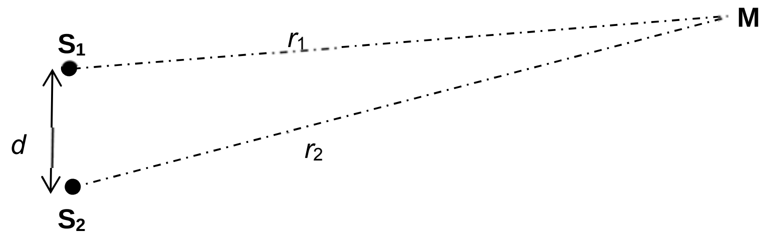


Fig. 8.2

The sources emit waves that are in phase. Each wave has an amplitude *A* and wavelength λ. The distances of M from S_1 and S_2 are r_1 and r_2 respectively.

(i) Deduce the ratios of the intensities and the amplitudes, in terms of r_1 and r_2, of the waves from S_1 and S_2 when they arrive at M. [3]

ratio of intensities = ………………………….

ratio of amplitudes = ………………………….

(ii) Hence or otherwise, explain why there is no complete cancellation of the two waves at M although the waves arrive at M in anti-phase to each other.

……………………………………………………………………………………...............

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

9 **(a)** **(i)** Define magnetic flux density.

………………………………………………………………………………………………..

………………………………………………………………………………………………..

……………………………………………………………………………………… [2]

(ii) Using the definition of magnetic flux density in **(a)(i)**, express the unit of magnetic flux density in terms of SI base units.

SI base units of magnetic flux density = ………………………… [2]

(b) A square coil ABCD with length 20.0 cm and 100 turns is placed in a region of uniform magnetic field of 0.15 T as seen in Fig. 9.1.

The current in the coil is 5.0 A.

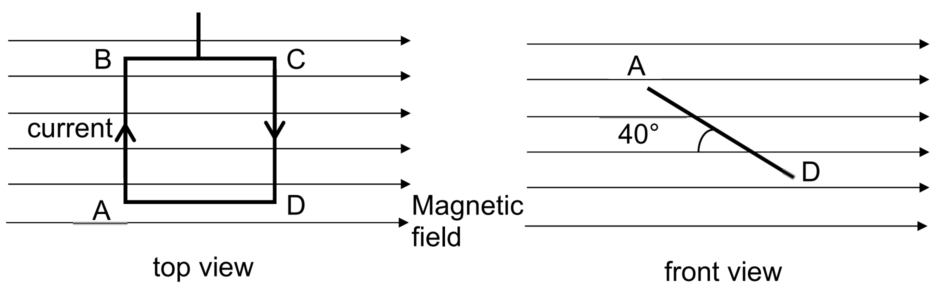


Fig. 9.1

(i) Draw two arrows on the *front* view of Fig. 9.1 to indicate the direction of the magnetic forces acting on wires AB and CD due to the field. [1]

(ii) Calculate the magnetic force acting on side AB of the square coil.

magnetic force = ………………………… N [2]

(iii) Hence determine the torque of the couple acting on the coil at that instant due to the magnetic forces.

torque = ………………………… N m [2]

(c) (i) A simplified *front* view of Fig. 9.1 is shown below in Fig. 9.2.

On Fig. 9.2, sketch the magnetic field lines around the wires AB and CD due to the current flowing in the coil. [2]

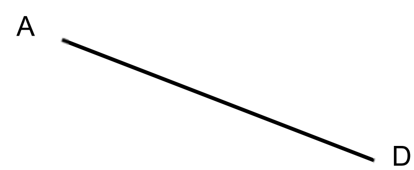


Fig. 9.2

(ii) On Fig. 9.2, draw two arrows to indicate direction of two *other* magnetic forces acting on wires AB and CD due to each other. [1]

(iii) Explain the origin and direction of these two magnetic forces.

……………………………………………………………………………………………...

……………………………………………………………………………………………...

……………………………………………………………………………………………...

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

(d) A light wire frame UVWX is supported on two knife edges A and B so that the section AVWB of the frame lies within a solenoid, as shown in Fig 9.4.

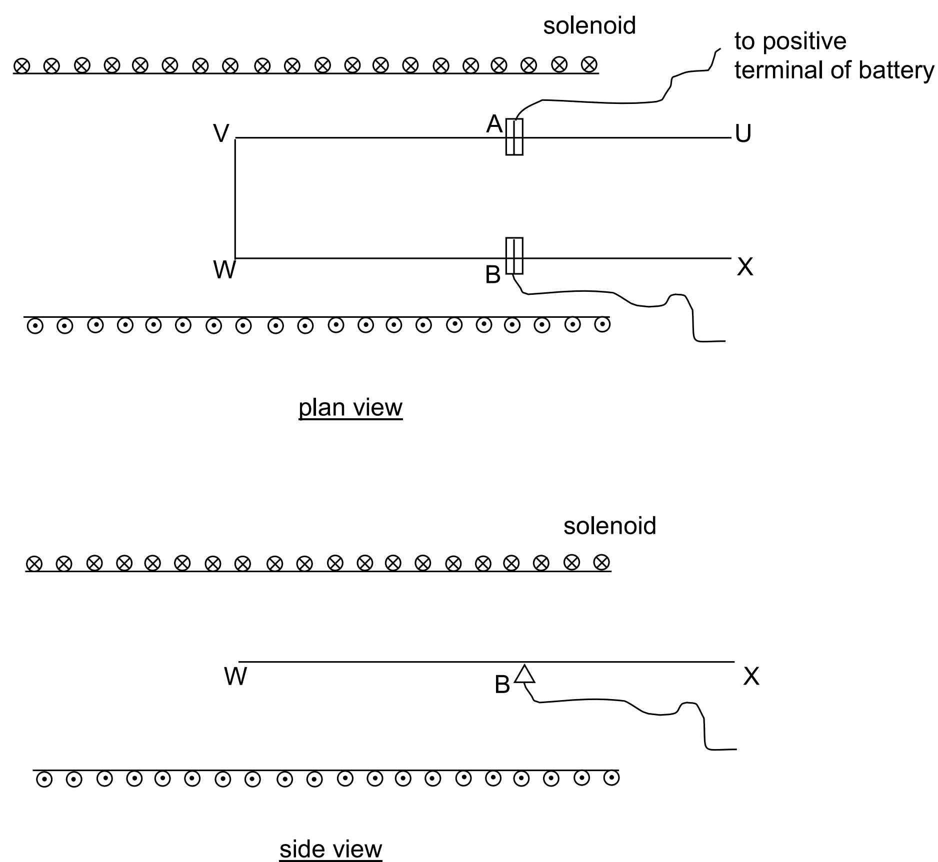


Fig 9.4

Electrical connections are made to the frame through the knife-edges so that AVWB of the frame and solenoid can be connected in series with a battery. When there is no current in the circuit, the frame is horizontal.

(i) The solenoid has 500 turns per metre and carries a current of 3.5 A. Given that the magnetic flux density B inside a long solenoid is $B = \mu_0 n I$, where $\mu_0 = 4\pi \times 10^{-7}$ H m^{-1}, n is the number of turns per metre and I is the current, calculate the magnetic flux density experienced by side VW of the frame.

magnetic flux density = ………………….. T [2]

(ii) Side VW has length 4.0 cm. Calculate the force acting on VW due to the magnetic field in the solenoid.

force on VW = ………………….. N [2]

(iii) A small object of mass 0.10 g is placed on the side BX and positioned so as to keep the frame horizontal. The length of BW is 15.0 cm. Determine the distance from the knife-edge where the object must be positioned.

distance from knife-edge = ………………….. cm [2]

End of Paper

Parent's Signature …………………..

Candidate's Name ………………………………………. CTG ……………

YISHUN JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATIONS 2016

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HIGHER 1 **19 August 2016**
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resistors in series,	R	=	$R_1 + R_2 + \ldots\ldots\ldots$
Resistors in parallel,	$\frac{1}{R}$	=	$\frac{1}{R_1} + \frac{1}{R_2} + \ldots\ldots$

Section A

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h = (348 ± 1) cm
t = (0.842 ± 0.001) s

Use these data to determine

(a) the acceleration of free fall, g to five significant figures.

$$h = \frac{1}{2} g t^2$$

$$g = \frac{2h}{t^2} = \frac{2 \times 3.48 \times 10^{-2}}{0.842^2} \quad [1]$$

$$= 9.8171 \text{ m s}^{-2} \quad [1]$$

g = ………………………………. m s^{-2} [2]

(b) the value of g and its uncertainty, to an appropriate number of significant figures.

$$\frac{\Delta g}{g} = \frac{\Delta h}{h} + 2\frac{\Delta t}{t}$$

$$\frac{\Delta g}{9.8171} = \frac{1}{348} + 2 \times \frac{0.001}{0.842} \quad [1]$$

Δg = 0.0052489 = 0.006 s (round up to 1 S.F) [1]

g = 9.817 ± 0.006 s (round off to same d.p as error) [1]

g = ……………………………… ± ……………………….. m s^{-2} [3]

2 The graph of Fig 2.1 shows the variation with time t of the velocity v of a ball from the moment it is thrown with velocity v of 26 m s^{-1} vertically upwards.

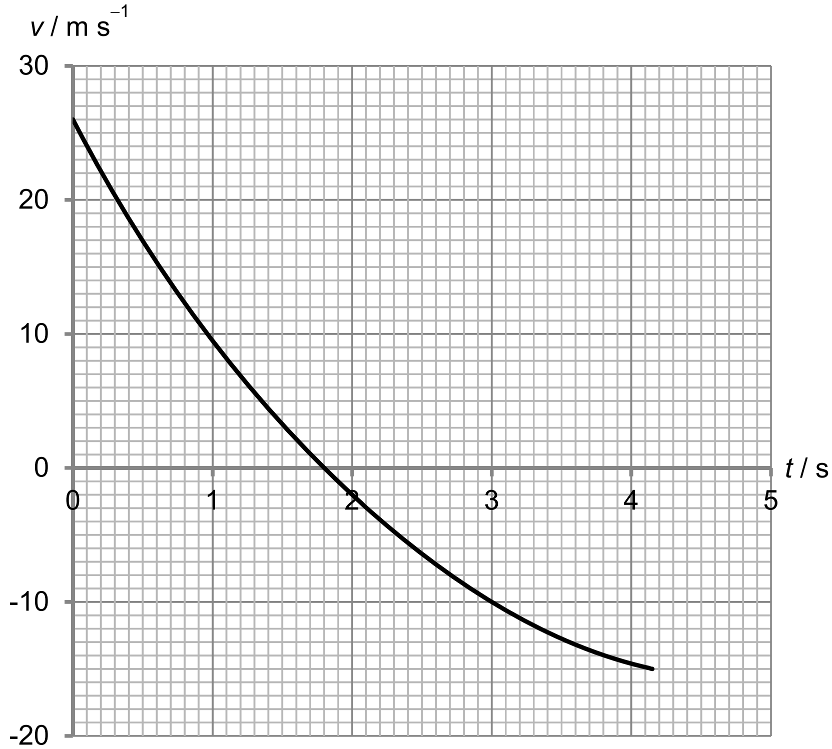


Fig. 2.1

(a) State the time at which the ball reaches its maximum height.

At max height, v = 0
From the graph, ***t* = 1.8 s** when v = 0.

time = …………………… s [1]

(b) Just after the ball leaves the thrower's hand, it has a downward acceleration of approximately 20 m s^{-2} which is much larger than g. Explain how this is possible.

Downward drag force due to air resistance is acting on it. [1]

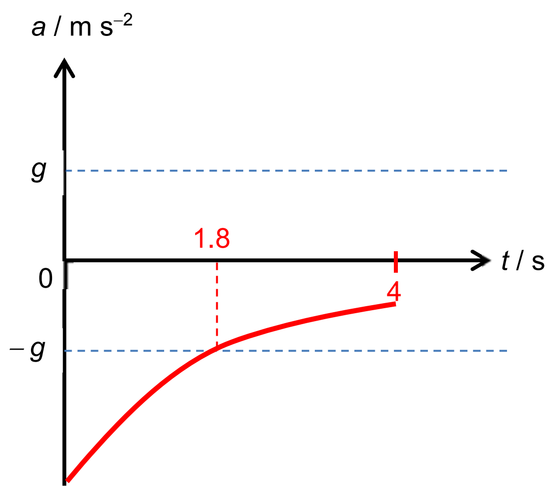
The resultant force which equals to the sum of the weight and the drag force is larger than the weight. [1] Hence the acceleration is larger than g. [2]

(c) It is found that the acceleration at t = 1.8 s is g. Explain how this is possible.

The velocity of object is zero, hence no drag force is acting on it. [1]

The resultant force acting on the object equals to the weight [1]. Hence the acceleration equals to g. [2]

(d) Sketch the acceleration-time graph and displacement-time graph in Fig. 2.2 for the motion from t = 0 to t = 4 s, following the sign convention taken for the velocity-time graph in Fig. 2.1. The value of g is marked out in the acceleration-time graph. Label other critical values. [6]



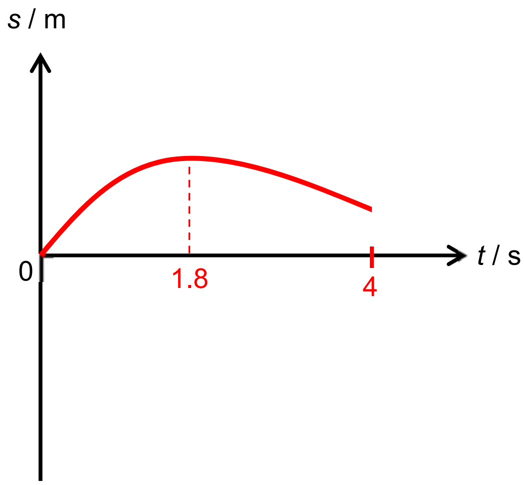
Max 3 marks

Curve with decreasing gradient – 1M

Shown cutting value of g at t = 1.8 s + labelling of 1.8 s & 4 s – 1M

Understanding the sign convention – 1M

If drawn cutting the time-axis at any point including t = 4s will have 1M deducted.



Max 3 marks

Asymmetrical curve skewed towards left – 1M

Shown max height at t = 1.8 s + labelling of 1.8 s & 4 s – 1M

If graph cuts time-axis at t = 4s will have 1M deducted.

Fig. 2.2

3 A light helical spring is suspended vertically from a fixed point, as shown in Fig. 3.1.

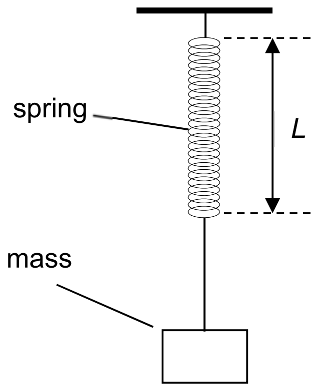


Fig. 3.1

Different masses are suspended from the spring. The weight *W* of the mass and the length *L* of the spring are noted.

The variation with the weight *W* of the length *L* is shown in Fig. 3.2

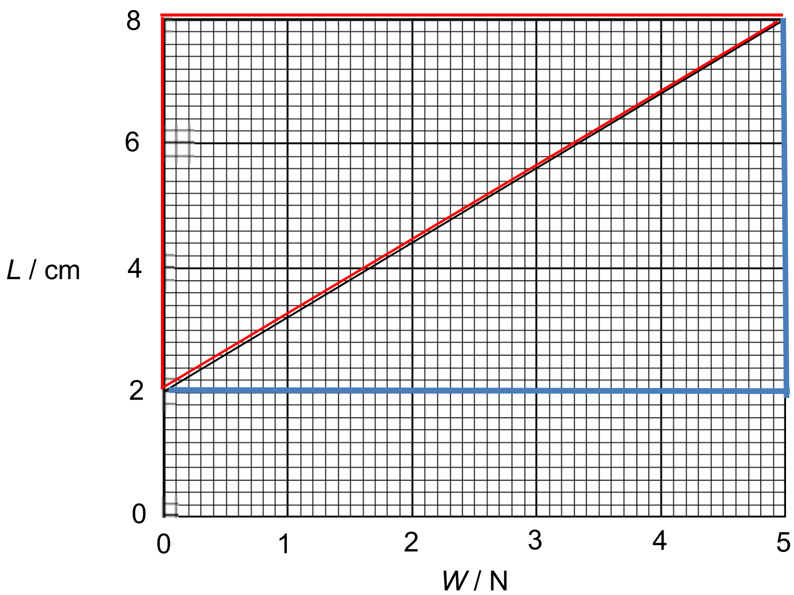


Fig. 3.2

(a) On Fig. 3.2, shade the area in the graph that represents the energy stored in the spring when the weight on the spring is increased from zero to 5.0 N. [1]

The area bounded by the red lines

(b) A mass of weight 4.0 N is suspended from the spring.

When the mass is stationary, a force is then applied to pull the mass downwards through a distance of 1.0 cm and held stationary.

At this position,

(i) Determine the total length of the spring.

When 4.0 N is suspended, the length of the spring = 6.8 cm
Hence total length = 6.8 + 1.0 = 7.8 cm

length = ... cm [1]

.

(ii) Determine the total elastic potential energy of the spring.

$$\text{spring constant} = \frac{\text{force}}{\text{extension}}$$
$$= \frac{5}{(0.08 - 0.02)} = 83.333 \text{ N m}^{-1} \quad [1]$$

$$\text{elastic potential energy} = \frac{1}{2} k x^2$$
$$= \frac{1}{2}(83.333)(0.078 - 0.02)^2 \quad [1]$$
$$= 0.14 \text{ J}$$

elastic potential energy = ... J [2]

(iii) Determine the force required to hold the mass stationary.

$$T = k x$$
$$= (83.333)(0.078 - 0.02) \quad [1]$$
$$= 4.8333 \text{ N}$$

$$T = W + F_{applied}$$
$$4.8333 = 4.0 + F_{applied} \quad [1]$$
$$F_{applied} = 0.833 \text{ N}$$

Force = ... N [2]

4 A common game in carnivals is the "high striker" whereby a player uses a hammer to hit a target pad at one end of a lever in order to launch a puck at the other end. The player wins if the puck hits the bell at the top of a tower. This is illustrated in Fig. 4.1.

In one such carnival, the hammer and puck weigh 9.00 kg and 0.40 kg respectively. The bell is located 5.00 m above the puck.

A student plays the game and just manages to ring the bell.

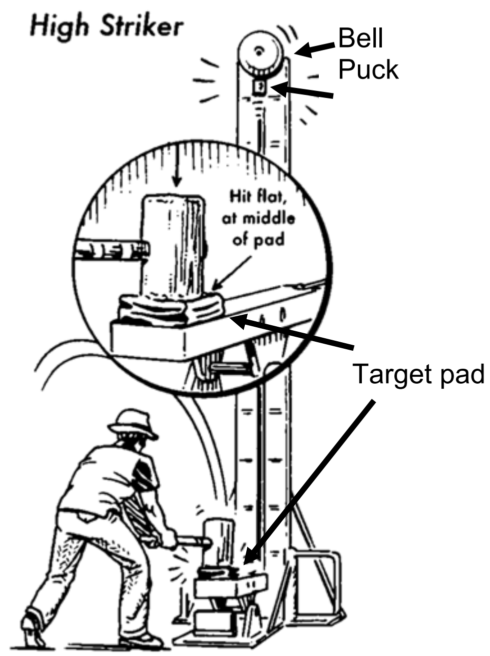


Fig. 4.1

(a) Determine the gain in gravitational potential energy of the puck.

Gain in g.p.e.= $m\,g\,h$
= 0.4 × 9.81 × 5.00 [1]
= 19.6 J

gain in gravitational potential energy = ………… J [1]

(b) Suppose that 75% of the final kinetic energy of the hammer is transformed into thermal and sound energy, calculate the speed of impact of the student's hammer with the lever.

0.25 × Loss in k.e. = 19.6 [1]
$\Rightarrow$ 0.5 m v^2 = 78.4 [1]
$\Rightarrow$ v = 4.2 m/s [1]

speed of impact = ……………. m s^{-1} [3]

(c) Suggest and explain one modification in which the game can be made more difficult to win.

Any reasonable answer.
The mass of the puck could be increased. [1]
More energy is required to launch the puck to the top of the tower. [1] [2]

5 (a) When a circuit is connected using an e.m.f. cell with an internal resistor, the following equation is used:

$$V = E - Ir$$

. whereby E is the e.m.f., r the internal resistance and I the mains current. State what V represents.

The potential difference (p.d.) across the cell's terminals or p.d. across the resistor ....[1]

(b) A voltmeter connected across the terminals of a cell reads 1.61 V. The reading drops to 1.34 V when a 3.0 Ω resistor is connected in parallel with the voltmeter as shown in Fig. 5.1.

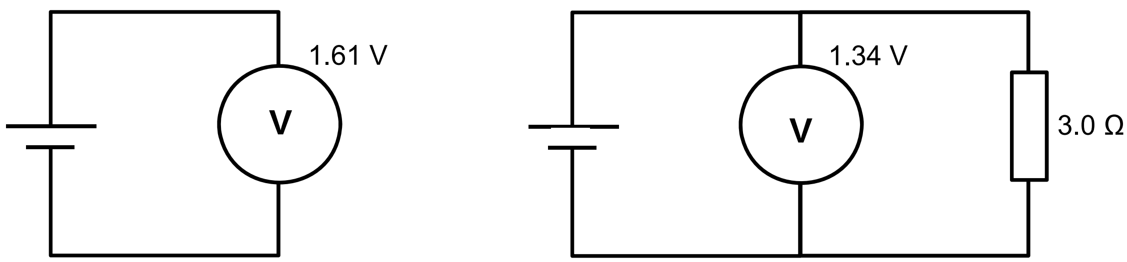


Fig. 5.1

(i) Calculate the internal resistance of the cell.

Since E = 1.61 V and V = 1.34 V, we have $I\,r$ = 0.27 V [1]

Given that $V = I$ (3) = 1.34 V, we have I = 0.4467 A [1]

Thus, (0.4467) r = 0.27 ⇒ r = 0.60 Ω [1]

internal resistance = ... Ω [3]

(ii) A second resistor is connected in parallel with the 3.0 Ω resistor. Without doing any calculations, state and explain how V changes.

Effective external resistance decreases [1]

⇒ Draws more current from cell

⇒ “P.d. across r” increases, thus V decreases [1]

[2]

6 Einstein’s photoelectric equation appears in several forms, one of which is shown below

$$E_{k\,max} = h\,f - \phi$$

Monochromatic light of frequency 7.40×10^{14} Hz is irradiated onto a caesium surface, and $E_{k\ max}$ is measured. The procedure is repeated for three other frequencies, enabling four points to be plotted on the graph grid of Fig. 6.1 below.

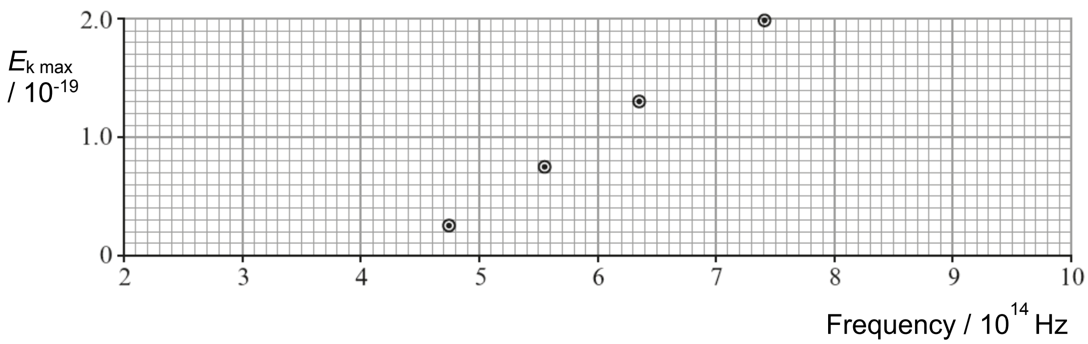


Fig. 6.1

(a) By showing your working, determine from Fig. 6.1

(i) a value for the Planck constant,

Gradient of graph gives Planck constant, h [C1]

Value = 6.6 [± 0.3] × 10^{-34} J s [A1]

Planck constant = ……………….. J s [2]

(ii) the threshold frequency of caesium.

Read off x-intercept = 4.4 [± 0.1] × 10^{14} Hz [1]

threshold frequency = ……………… Hz [1]

(b) When a lithium surface is used instead of a caesium surface, $E_{k\,max}$ is found to be 0.40 × 10^{-19} J for light of frequency 7.40 × 10^{14} Hz.

(i) Draw the expected line of $E_{k\,max}$ against frequency on the same grid in Fig. 6.1. [1]

(ii) This line cannot be checked satisfactorily by experiment if visible light is used. Name the region of the electromagnetic spectrum which is required.

Ultraviolet region [1]
…………………………………………………………………………………[1]

(iii) State what is different about lithium, as compared to caesium, which makes it necessary to use the region stated in (b)(ii).

The workfunction [threshold frequency] of lithium is larger. [1]
…………………………………………………………………………………[1]

Section B

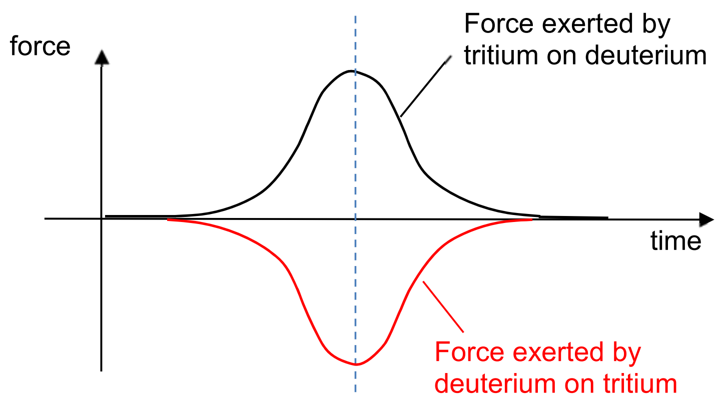
Answer **two** questions in this section.

7 **(a)** A tritium nucleus moves towards a deuterium nucleus at a large distance from deuterium nucleus as illustrated in Fig. 7.1.

Fig. 7.1

The nuclei initially have the same speed *v*. The tritium nucleus consists of two nucleons and a proton. The deuterium nucleus consists of a neutron and a proton. The proton and neutron have the same mass *m*.

(i) Fig. 7.2 shows the electric force exerted by tritium nucleus on deuterium nucleus. Draw the electric force exerted by deuterium nucleus on tritium nucleus in Fig. 7.2.



[1]

Fig. 7.2

(ii) Explain your answer to **(i)**.

According to Newton's third law, when tritium nucleus exerts a force on deuterium nucleus, deuterium nucleus will also exert a force of an equal magnitude but in opposite direction on tritium nucleus. [1]

…………………………………………………………………………………………

…………………………………………………………………………………… [1]

(iii) Explain how your answer to **(i)** is consistent with the principle of conservation of momentum.

Principle of conservation of momentum states that the total momentum of a system will be constant if the total net external force acting on the system is zero. [1]
Area under force –time graph gives the change in momentum. [1]
Since the areas under force –time graph for tritium and deuterium nuclei have the same magnitude but are of opposite sign, [1]
the sum of the change in momentum of tritium and deuterium nuclei is equal to zero.
Hence the total momentum of tritium and deuterium nuclei remains constant.

…………………………………………………………………………………………

…………………………………………………………………………………… [3]

(iv) Determine the final speed of tritium nucleus in terms of *v*.

Applying Conservation of momentum:

Total momentum before = Total momentum after

$(3m)v + (2m)(-v) = (3m)v_T + (2m)v_D$

$v = 3v_T + 2v_D$ …………………(1) [1]

Relative speed of approach = Relative speed of separation

$v - (-v) = v_D - v_T$ [1]

$v_D = v_T + 2v$ ……………….. (2)

Substitute (2) into (1) to solve for v_T:

$v = 3v_T + 2(v_T + 2v)$

$v_T = -0.6v$ [1]

final speed = …………………………… [3]

(b) State Newton's second law of motion.

The rate of change of momentum is directly proportional to the net external force

and takes place in the same direction as the net external force.

…………………………………………………………………………………… [1]

(c) A car of mass 750 kg is travelling at 30 m s^{-1} along a horizontal road. The brakes are applied and the car is brought to rest by an average resistive force *F*. The average deceleration of the car is 5.0 m s^{-2}.

(i) Show that the resistive force, *F* is 3750 N.

$F_{net} = m\,a$ = 750 x 5.0 = 3750 N

[1]

(ii) Calculate the change in momentum of the car.

change in momentum = $m\,v_f - m\,v_i$ = 0 – (750)(30) = 22500 N s

change in momentum = ……………………….. N s [1]

(iii) Hence, using the answer in **(i)** and **(ii)**, calculate the time taken for the car to be brought to rest after the brake is applied.

Impulse = change in momentum

$F_{net}\, t = \Delta$ p

3750 t = 22500

t = 6.0 s

time = ……………………………… s [1]

Describe, in terms of Newton's third law, the horizontal forces acting on the tyres and on the road with relation to the motion of the car.

The ground will exert frictional force which is opposite to the motion of car on the car' tyre. [1]

By Newton's third law, the car's tyre will exert frictional force which is equal in magnitude but opposite in direction on the ground. [1]

Hence, the direction of frictional force from the car' tyre on the ground is in the same direction as the car motion.

……………………………………………………………………………………..[2]

(d) The car in **(c)** now travels at 30 m s^{-1} down a slope where the angle to the horizontal is 10°. The car is brought to rest by applying the brakes. The same resistive force, *F* of 3750 N acts on the car.

(i) In Fig. 7.3, draw all the forces acting on the car as it is decelerating. Label the forces clearly. [1]

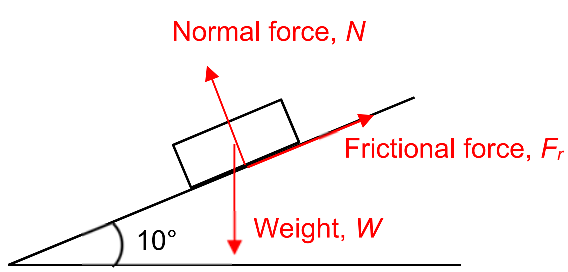


Fig. 7.3

(ii) Explain why the distance that the car travels before coming to rest is greater than that in **(c)**.

The component of weight which is parallel to the slope is downslope in direction. Hence the net force in upslope direction is reduced and the deceleration is reduced. [1] .... [1]

(iii) Calculate the deceleration of the car.

$F_{net} = m\,a$

3750 – (750) (9.81) (sin10°) = (750) (a) [1]

a = 3.30 m s^{-2} (marks not awarded for –ve sign)

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

(iv) The mass of the car is increased from 750 kg to 1000 kg. State and explain what would happen to the deceleration of the car.

The component of weight which is parallel to the slope in downslope direction increases. Hence the net force in upslope direction is reduced [1]. As the mass is increased, the deceleration will be reduced since $F_{net} = m\,a$ [1]

.... [2]

8(a) Explain what is meant by the following terms in italics.

(i) *coherent* sources

....

....[1]

(ii) *phase difference*

....

....[1]

(iii) *diffraction*

....

....[1]

(b) **(i)** State the conditions for a well-defined stationary wave to be formed using two separate sound sources.

....

....

....[2]

(ii) Compare the amplitude, phase and frequency of wave motion between a stationary and progressive wave.

....

....

....

....

....

....

....

....

....

....

....

....

....[5]

(c) In Fig. 8.1, a straight road runs parallel to the line joining two radio transmitting aerials A and B which are 600 m apart. Both aerials radiate signals at a frequency of 50 MHz. The road is 4.8 km from the aerials at its nearest point X.

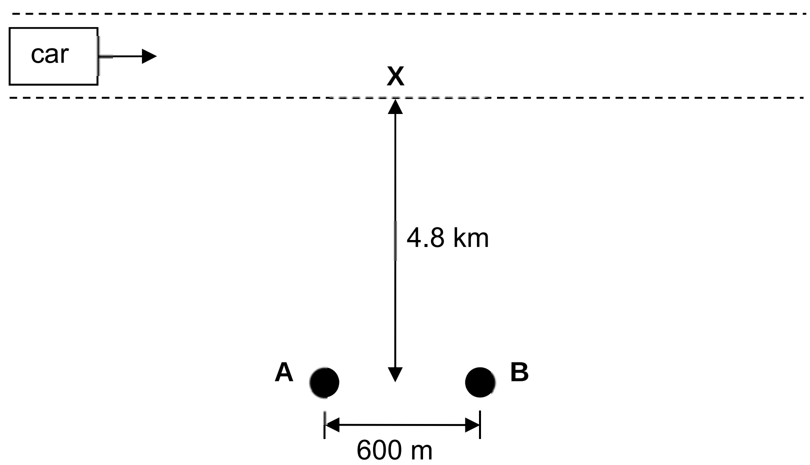


Fig. 8.1

A car travels at a steady speed along the road. As it passes along the road, it receives a radio signal that varies periodically.

(i) Explain why the radio signal varies as described.

....

....

....

....

....[3]

(ii) If the maximum intensity of the radio signal received varies at a frequency of 0.50 Hz, calculate the speed of the car.

speed of car = ... m s^{-1} [3]

(d) In Fig. 8.2, S_1 and S_2 are two coherent point sources placed a distance *d* apart.

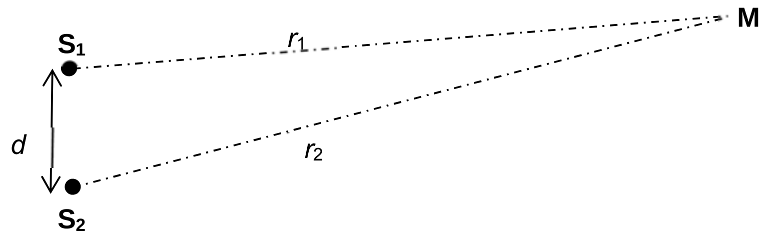


Fig. 8.2

The sources emit waves that are in phase. Each wave has an amplitude *A* and wavelength λ. The distances of M from S_1 and S_2 are r_1 and r_2 respectively.

(i) Deduce the ratios of the intensities and the amplitudes, in terms of r_1 and r_2, of the waves from S_1 and S_2 when they arrive at M. [3]

ratio of intensities = ………………………….

ratio of amplitudes = ………………………….

(ii) Hence or otherwise, explain why there is no complete cancellation of the two waves at M although the waves arrive at M in anti-phase to each other.

………………………………………………………………………………………..............

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

9 (a) (i) Define magnetic flux density.

……………………………………………………………………………………………..

……………………………………………………………………………………..……..

……………………………………………………………………………………… [2]

(ii) Using the definition of magnetic flux density in **(a)(i)**, express the unit of magnetic flux density in terms of SI base units.

SI base units of magnetic flux density = ………………………… [2]

(b) A square coil ABCD with length 20.0 cm and 100 turns is placed in a region of uniform magnetic field of 0.15 T as seen in Fig. 9.1.

The current in the coil is 5.0 A.

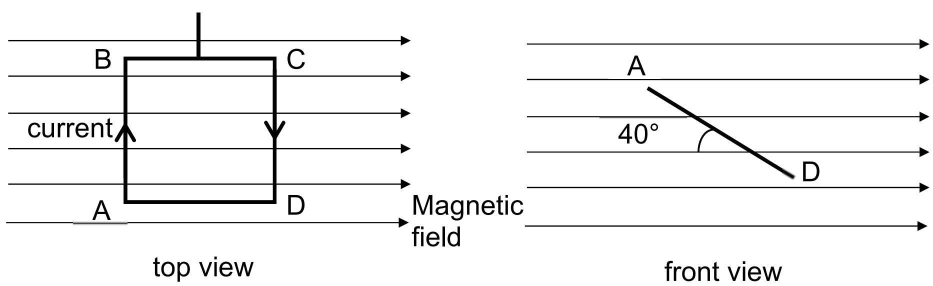


Fig. 9.1

(i) Draw two arrows on the *front* view of Fig. 9.1 to indicate the direction of the magnetic forces acting on wires AB and CD due to the field. [1]

(ii) Calculate the magnetic force acting on side AB of the square coil.

magnetic force = ………………………… N [2]

(iii) Hence determine the torque of the couple acting on the coil at that instant due to the magnetic forces.

torque = ………………………… N m [2]

(c) (i) A simplified *front* view of Fig. 9.1 is shown below in Fig. 9.2.

On Fig. 9.2, sketch the magnetic field lines around the wires AB and CD due to the current flowing in the coil. [2]

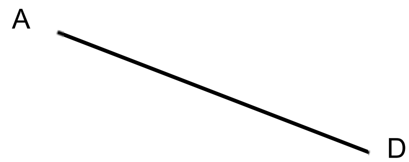


Fig. 9.2

(ii) On Fig. 9.2, draw two arrows to indicate direction of two *other* magnetic forces acting on wires AB and CD due to each other. [1]

(iii) Explain the origin and direction of these two magnetic forces.

…………………………………………………………………………………………...

…………………………………………………………………………………………...

…………………………………………………………………………………………...

……………………………………………………………………………….…… [2]

(d) A light wire frame UVWX is supported on two knife edges A and B so that the section AVWB of the frame lies within a solenoid, as shown in Fig 9.4.

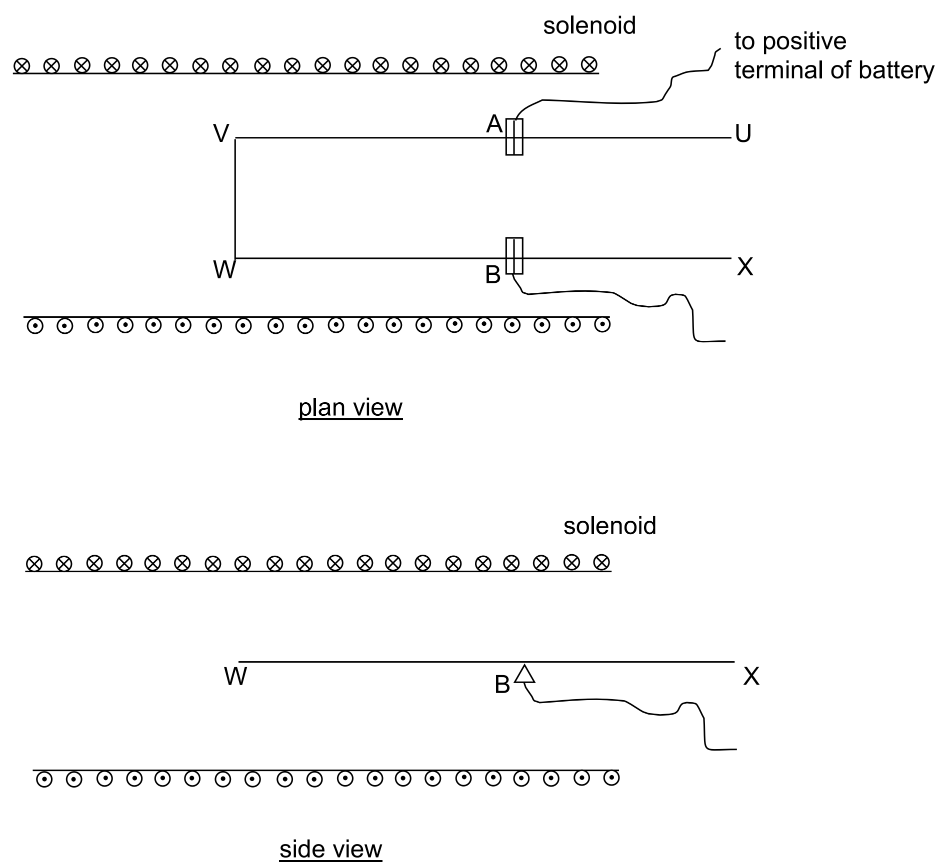


Fig 9.4

Electrical connections are made to the frame through the knife-edges so that AVWB of the frame and solenoid can be connected in series with a battery. When there is no current in the circuit, the frame is horizontal.

(i) The solenoid has 500 turns per metre and carries a current of 3.5 A. Given that the magnetic flux density B inside a long solenoid is $B = \mu_0 nI$, where $\mu_0 = 4\pi \times 10^{-7}$ H m^{-1}, n is the number of turns per metre and I is the current, calculate the magnetic flux density experienced by side VW of the frame.

magnetic flux density = ………………….. T [2]

(ii) Side VW has length 4.0 cm. Calculate the force acting on VW due to the magnetic field in the solenoid.

force on VW = ………………….. N [2]

(iii) A small object of mass 0.10 g is placed on the side BX and positioned so as to keep the frame horizontal. The length of BW is 15.0 cm. Determine the distance from the knife-edge where the object must be positioned.

distance from knife-edge = ………………….. cm [2]

End of Paper

8(a)	(i)	*coherent* refers to sources that produce waves of constant phase difference. [1]
	(ii)	*Phase difference* refers to the difference in the stages of oscillation for one cycle. [1]
	(iii)	*diffraction* refers to the phenomenon of bending or spreading of waves when they pass an obstacle or through an aperture. [1]
(b)	(i)	The waves from the two separate sound sources must have equal amplitude and frequency [1] and travel with the same speed in opposite direction [1]
	(ii)	(see table below)

	Stationary Wave	Progressive Wave
amplitude	varies from zero at the nodes to maximum at the antinodes. [1]	same for all particles. [1]
phase	all particles between 2 adjacent nodes are in phase. Particles between adjacent pairs of nodes are in anti-phase. [1]	all particles within one wavelength have different phases. [1]
frequency	all particles vibrate with same frequency as the wave (except those at the nodes).	all particles vibrate with same frequency as the wave. [1]

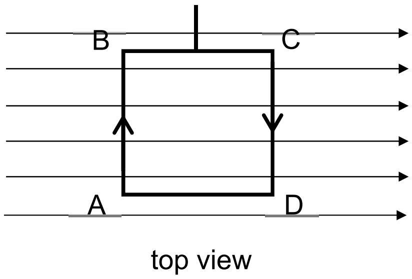
(c)	(i)	Signals emitted from A and B undergo interference at different points along the road. [1] When the phase difference is such that they in phase, constructive interference takes place and the intensity is a maximum. [1] When the phase difference is such that they are anti-phase, destructive interference takes place and the intensity is a minimum. Since the maxima and minima are equally spaced the signal intensity varies periodically along the road. [1] (maximum of 2 marks to be given if the answer is in terms of path difference = nλ for constructive interference or $(n+\frac{1}{2})\lambda$ for destructive interference)
	(ii)	wavelength of signal, $\lambda = \frac{c}{f} = \frac{3 \times 10^8}{50 \times 10^6} = 6\,m$ [1] Using $\lambda = \frac{ax}{D}$: $6 = \frac{600x}{4800} \Rightarrow x = 48\,m$ [1] $v = f\lambda$ = 0.5 x 48 = 24 $m\,s^{-1}$ [1]
(d)	(i)	since $I \propto A^2$ and $I \propto \frac{1}{r^2}$, then $A \propto \frac{1}{r}$ [1] ratio of intensities $\frac{I_1}{I_2} = \left(\frac{r_2}{r_1}\right)^2$ [1] ratio of amplitudes $\frac{A_1}{A_2} = \left(\frac{r_2}{r_1}\right)$ [1]
	(ii)	Since the amplitudes of the two waves arriving at P are not equal, the resultant amplitude at destructive interference is not zero. [1]

9 **(a) (i)** Magnetic flux density is the **force per unit length per unit current** acting on an **infinitely long current carrying conductor placed perpendicularly** to the magnetic field. [1]

(ii) $T = \frac{N}{Am}$ [1]

$T = \frac{kgms^{-2}}{Am} = kgA^{-1}s^{-2}$ [1]

(b) (i) [1]



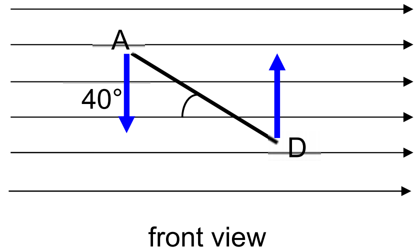


Fig. 9.1

(ii) $F_B = (100)(0.15)(0.2)(5.0)$

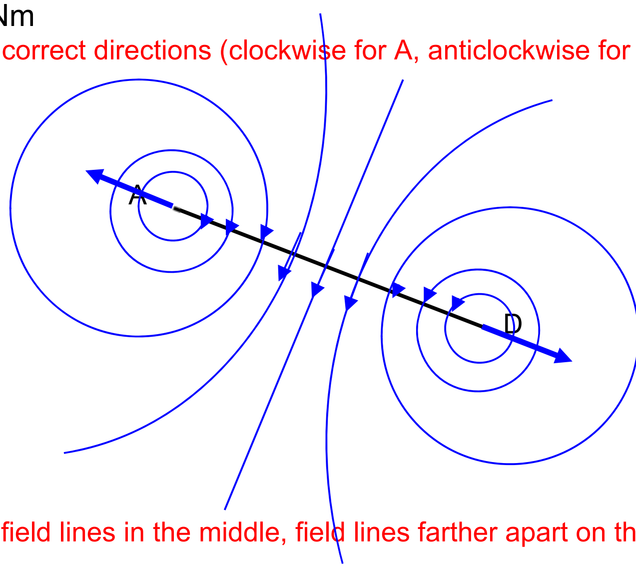
$F_B = 15$ N

(iii) $\tau = 15 \times 0.2 \ \cos 40°$ [1]

$\tau = 2.30$ Nm [1]

(c) (i) correct directions (clockwise for A, anticlockwise for D) [1]

(ii) [1]



closer field lines in the middle, field lines farther apart on the outside [1]

(iii) The current in AB sets up a magnetic field that interacts with the current in CD giving rise to the force acting on CD and vice versa. [1]

The directions of the forces can be found using Fleming's Left Hand Rule. [1]

(d) (i) B = μ_0 nI = (4π x 10^{-7})(500)(3.5) [1]

= 2.20 x 10^{-3} T or Wb m^{-2} [1]

(ii) F = BIl sin θ = (2.2 x 10^{-3})(3.5)(4 x 10^{-2}) [1]

= 3.08 x 10^{-4} N [1]

(iii) Taking pivot about the knife-edge,

Using the principle of moments,

Sum on CW moments = Sum of ACW moments

(0.10 x 10^{-3})g(x) = (3.08 x 10^{-4})(0.15) [1]

$$x = \frac{\left(3.08 \times 10^{-4}\right)(0.15)}{\left(0.10 \times 10^{-3}\right)(9.81)}$$ [1]

x = 0.0471 m

= 4.71 cm