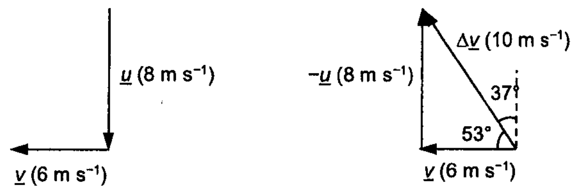
Answers to JC2 Prelim Exam Paper 1 (H2 Physics)

1	C	6	C	11	A	16	C	21	D	26	A
2	C	7	B	12	A	17	C	22	A	27	C
3	D	8	D	13	A	18	B	23	D	28	A
4	D	9	D	14	C	19	B	24	B	29	A
5	D	10	D	15	A	20	B	25	C	30	B

Suggested Solutions:

1 Change in velocity, $\Delta\vec{v} = \vec{v} - \vec{u}$
$= \vec{v} + (-\vec{u})$



Answer: C

2 The gradient of the displacement-time graph is velocity. At one particular instant before t_1, the gradient of tangent of B at that point is equal to gradient of A.

Answer: C

3 Average force on the wall = average force on the balls according to Newton's 3rd law.

average force on the balls =

$$\langle F \rangle = \left(\frac{dp}{dt}\right)_{balls}$$
$$= \frac{300\times10^{-3}\left(10-(-7)\right)}{5}$$
$$= 1.0 \text{ N}$$

Answer: D

4 The couple due to P and Q is anti-clockwise with a magnitude of 10d Nm where d is the diameter of the ring. For equilibrium, the moment due to T must be clockwise and of the same magnitude.

Answer: D

[Turn over

5 Mass of water sends back per sec, $m = (vol)\rho = (\pi r^2 v)\rho$
power of motor = 2 times gain in K.E. of water per sec

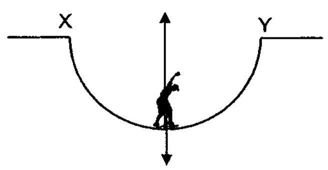
$$= 2\left(\frac{1}{2}mv^2\right)$$
$$= 2\left(\frac{1}{2}\left((\pi r^2 v)\rho\right)v^2\right) = 31.4 \text{ kW}$$

Answer: D

6 The skateboarder will experience the maximum force by the half-pipe at the most bottom point, as the speed will be maximum at that point. Let the radius of the half-pipe be r.

By conservation of energy,
Gain in kinetic energy = loss in gravitational potential energy
$\frac{1}{2}mv^2 - 0 = mgr$
$v^2 = 2gr$

The normal contact force and the gravitational force on the skateboarder contributes to the centripetal force acting on him.



$F_C = N - W$
$N = \frac{mv^2}{r} + mg$
$= m\left(\frac{2gr}{r} + g\right)$
$= 3mg$

Answer: C

7 The gravitational field strength at a point at a distance r away from the point mass decreases with increasing r. Hence the spacing between the equipotential line should increase with increasing r, as $g = -\frac{d\phi}{dr}$.

Answer: B

8 $E_T = \frac{1}{2}m\omega^2 x_0^{\ 2}$

When particle is mid-way between the equilibrium position and an amplitude position

$E_P = \frac{1}{2}m\omega^2\left(\frac{x_0}{2}\right)^2 = \frac{1}{4}\left(\frac{1}{2}m\omega^2 x_0^{\ 2}\right) = \frac{1}{4}E_T$

$E_P : E_T = 1:4$

$E_K = \frac{1}{2}m\omega^2\left(x_0^{\ 2} - \left(\frac{x_0}{2}\right)^2\right) = \frac{3}{4}\left(\frac{1}{2}m\omega^2 x_0^{\ 2}\right) = \frac{3}{4}E_T$

$E_K : E_T = 3:4$

Answer: D

9 The number of carbon dioxide molecules in one mole of carbon dioxide is the Avogadro number N_A.

Since there are two oxygen atoms per molecule of carbon dioxide, the number of oxygen atoms is $2N_A$.

Answer: D

10 Heat supplied to system by heater = heat gained by water + heat gained by tank

$P \times t = mc\Delta\theta + ml_v + C\Delta\theta$

$5.2\times10^3 \times t = [14\times4200\times(100-30)] + (14\times2.26\times10^6) + [6500\times(100-30)]$

$t \approx 7000$ s

Answer: D

11 $pV = nRT$

$\frac{p}{T} = \text{constant}$

Pressure is zero at $T = 0$ K.

p-T graph is a straight line graph through the origin if the temperature is in kelvin.

p-T graph is a straight line graph intercepting the T-axis at −273.15°C if the temperature is in degrees Celsius.

Answer: A

12 Determining the phase angle at d = 5.0 cm,

$y = y_0 \sin\theta$

$1.5 = 3.0\sin\theta$

$\theta = \sin^{-1}\left(\frac{1.5}{3.0}\right) = \frac{\pi}{6}$

Since d = 5.0 cm is in the second quarter of the second wavelength,

phase angle $\phi = 3\pi - \frac{\pi}{6} = 2\frac{5}{6}\pi$

Hence,

$\frac{\Delta\phi}{2\pi} = \frac{\Delta d}{\lambda}$

$\frac{2\frac{5}{6}\pi}{2\pi} = \frac{5.0}{\lambda}$

$\lambda = 3.5$ cm

Answer: A

13 Let the intensities of light after passing through X and Y be I_X and I_Y respectively.

By Malus Law,

$I_Y = I_X\cos^2\theta$

$I = I_Y\cos^2\theta$

$= I_X\cos^4\theta$

Hence, the magnitude of I is the largest when θ is the smallest.

Answer: A

14

$\sin\theta = \frac{\lambda}{b} \Rightarrow \sin\theta = \frac{600\times10^{-9}}{0.1\times10^{-3}} \Rightarrow \theta = 0.34378°$

$\tan\theta = \frac{x}{3.0} \Rightarrow x = 3.0\times\tan(0.34378°) \approx 0.018$

width = $2(0.018) = 0.036$ m

Answer: C

15

$d\sin\theta = n\lambda \Rightarrow d\sin(50°) = 3\lambda \Rightarrow \frac{d}{\lambda} \approx 3.9162$

For highest order,

$\sin\theta < 1$

$\frac{n\lambda}{d} < 1 \Rightarrow n < 3.9162$

highest order = 3

Answer: A

16 Work done needed is the total electrical potential energy at the centre of the square.

$$= \frac{Q}{4\pi\varepsilon_o\left(\frac{a}{\sqrt{2}}\right)} + \frac{-2Q}{4\pi\varepsilon_o\left(\frac{a}{\sqrt{2}}\right)} + \frac{3Q}{4\pi\varepsilon_o\left(\frac{a}{\sqrt{2}}\right)} + \frac{-4Q}{4\pi\varepsilon_o\left(\frac{a}{\sqrt{2}}\right)}$$

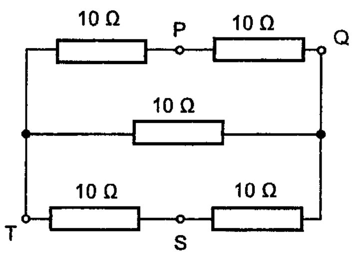
$$= \frac{-\sqrt{2}Q}{2\pi\varepsilon_o a}$$

Answer: C

17 Electric field points in the direction of decreasing potential. Electric potential energy is given by $U = qV$ and thus, for a positive charge moving in the direction of the electric field, its electric potential energy will decrease.

Answer: C

18 The given circuit is similar to the circuit below.



Thus, calculating the effective resistance across QT,

$$R_{QT} = \left(\frac{1}{10+10} + \frac{1}{10} + \frac{1}{10+10}\right)^{-1} = 5.0\ \Omega$$

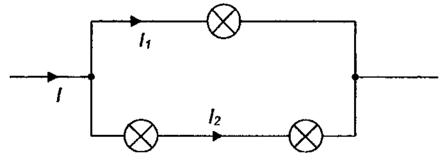
Answer: B

19 Before X blows, p.d across X and Z < p.d. across Y.
After X blows, p.d across Z = p.d. across Y.
i.e., p.d. across Z increases and p.d. across Y decreases.

Hence Z's brightness increases and that of Y decreases.

Answer: B

20 Maximum power for circuit can be attained when the single bulb is at maximum power.



$I_2 = ½ I_1$
Hence the power for each bulb on the lower branch will be ¼ maximum power, which is 2.5 W.
Maximum power for circuit = 10 + 2.5 + 2.5 = 15 W

Note: If each bulb on lower branch produces maximum power, the bulb on the upper branch will blow (more than max. power produced).

Answer: B

21 Current flowing in opposite direction repel and so Force by M on N is towards the right.
By Fleming's left hand rule, magnetic force by external field on N is towards the left.
Since magnitude of current and external flux density is unknown, the net force will be either left or right.

Answer: D

22 Magnitude of average induced e.m.f.

$$= \left|\frac{0 - BA}{\Delta t}\right| = \frac{BA}{\Delta t}$$

Magnitude of average induced current

$$= \frac{BA}{(\Delta t)(R)}$$

Magnitude of charge

$$= \left[\frac{BA}{(\Delta t)(R)}\right]\Delta t = \frac{BA}{R}$$

Answer: A

23 For the magnet to fall slower, the induced upward magnetic force on the magnet has to increase, or the resultant downward force on the magnet has to decrease.

Option A: Releasing the magnet from a smaller height will cause the rate of change of magnetic flux through the pipe to decrease since the magnet enters the pipe with a lower speed. Hence, the induced e.m.f. in the pipe will be of a smaller magnitude, which will result in a smaller current and smaller induced magnetic force.

Option B: A pipe with a higher resistivity will cause the induced current to be of a smaller magnitude, which will result in a smaller induced magnetic force.

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Option C: A weaker magnet will cause the induced e.m.f. to be of a smaller magnitude, since the rate of change of magnetic flux through the pipe will decrease.

Option D: The induced magnetic force is the same and the resultant downward force will decrease due to the smaller weight of the magnet.

Answer: D

24 $I_{rms} = \sqrt{\dfrac{(5.0)^2(1)+(3.0)^2(1)}{2}} = 4.1 \text{ A}$

Answer: B

25 $P_s = 0.9P_p$

$P_s = 0.9(2300)(10)$

$\dfrac{V_s}{V_p} = \dfrac{N_s}{N_p} = \dfrac{1}{40} \Rightarrow V_s = \left(\dfrac{1}{40}\right)2300$

$I_s = \dfrac{P_s}{V_s} = \dfrac{0.9(2300)(10)}{\left(\dfrac{1}{40}\right)2300} = 360 \text{ A}$

Answer: C

26 $KE = \dfrac{1}{2}mv^2 = \dfrac{p^2}{2m}$

Loss in EPE = Gain in KE

$eV = \dfrac{p^2}{2m} \Rightarrow p = \sqrt{2meV}$

$\lambda_{deBroglie} = \dfrac{h}{p} = \dfrac{h}{\sqrt{2meV}}$

$c = f_{photon}\lambda_{photon} \Rightarrow \lambda_{photon} = \dfrac{c}{f_{photon}}$

For photon, $\lambda_{photon} = \lambda_{deBroglie}$

$\dfrac{c}{f_{photon}} = \dfrac{h}{\sqrt{2meV}} \Rightarrow f_{photon} = \dfrac{c\sqrt{2meV}}{h}$

Answer: A

[Turn over

27 When the atoms of the cool vapour absorbs a photon, it becomes excited and is unstable. It will de-excite and re-radiate a photon uniformly in any direction.

Answer: C

28 The potential energy gained by the electron = $qV = 3.20 \times 10^{-15}$ J

$\dfrac{hc}{\lambda} = 3.20 \times 10^{-15} \text{ J}$

$\lambda = 6.22 \times 10^{-11} \text{ m}$

Answer: A

29 ${}^{111}_{47}\text{Ag} \rightarrow {}^{111}_{48}\text{Cd} + {}^{0}_{-1}\beta$

Answer: A

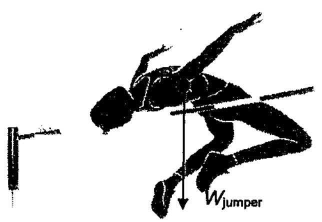
30 Lead plate will remove the count rate due to α-source.

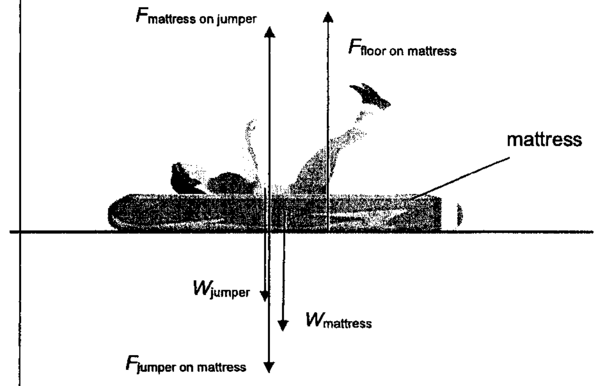
After one half-life, count rate decreased by 70 counts. This implies the α-source provided an original count of 140.

Answer: B

Answers to 2022 JC2 H2 Preliminary Examinations Paper 2

Suggested Solutions:

No.	Solution	Remarks
1(a)	Base units of ρ = Base units of $\frac{Mr^n}{L}$ $\text{kg m}^{-3} = \frac{\text{kg m}^n}{\text{m}}$ $\text{m}^{-3} = \text{m}^{n-1}$ $\Rightarrow n = -2$	[1] for correct workings
1(b)(i)	$\frac{\Delta r}{r} = \frac{1}{2}\left(\frac{\Delta\rho}{\rho} + \frac{\Delta M}{M} + \frac{\Delta L}{L}\right)$ $= \frac{1}{2}\left(\frac{50}{2340} + \frac{0.18}{100} + \frac{0.0002}{0.1242}\right)$ $= 0.012389$ ≈ 0.012	[1] for correct equation [1] for answer
1(b)(ii)	$\rho = \frac{Mr^{-2}}{kL}$ $2340 = \frac{(1.072)r^{-2}}{2.094(0.1242)}$ $r = 0.041970$ $\frac{\Delta r}{r} = 0.012389$ $\Delta r = 0.012389 \times 0.041970 \approx 0.0005$ $\therefore r = 0.0420 \pm 0.0005$	[1] for r [1] for correct expression
2(a)	Newton's third law of motion states that if body A exerts a force on body B, body B will exert the same type of force of equal magnitude but opposite in direction on body A.	[1]
2(b)(i)		[1] W_{jumper} only

No.	Solution	Remarks
2(b)(ii)	 $F_{mattress\ on\ jumper}$ and $F_{jumper\ on\ mattress}$ are action-reaction pairs.	[1] for 2 labelled forces on jumper, length of $F_{mattress\ on\ jumper}$ is greater than W_{jumper}. [1] for 3 labelled forces on mattress, length of $F_{floor\ on\ mattress}$ is greatest [1] for showing that $F_{mattress\ on\ jumper}$ and $F_{jumper\ on\ mattress}$ is the action-reaction pair
2(c)(i)	Area under $F - t$ graph gives change in momentum. $\lvert\Delta p\rvert = \frac{1}{2}(1.2)(375)$ $\lvert 0-(50)(u)\rvert = 225$ $u = 4.5\ \text{m s}^{-1}$	[1] correct substitution [1] correct answer
2(c)(ii)	By principle of conservation of momentum: $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ $(50)(1.5) + 0 = (50)v_1 + (3.0)v_2$ ---- (1) For elastic collision, relative speed of approach ($u_1 - u_2$) before collision is equal to the relative speed of separation ($v_2 - v_1$) after collision. $u_1 - u_2 = v_2 - v_1$ $1.5 - 0 = v_2 - v_1$ ---- (2) $v_1 = v_2 - 1.5$ Substituting (2) into (1) $(50)(1.5) + 0 = (50)(v_2 - 1.5) + (3.0)v_2$ $v_2 = 2.8\ \text{m s}^{-1}$	[1] correct momentum equation [1] correct substitution [1] correct answer
3(a)	The gravitational potential at a point is the work done per unit mass required in moving a small test mass from infinity to that point.	[2] or 0

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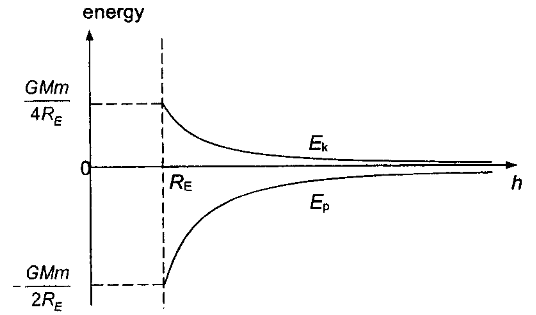
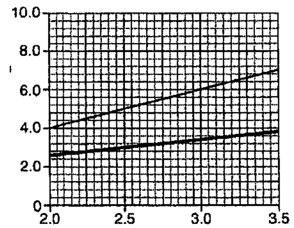
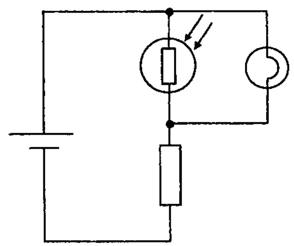
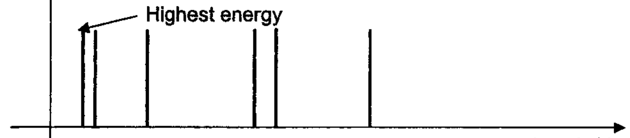
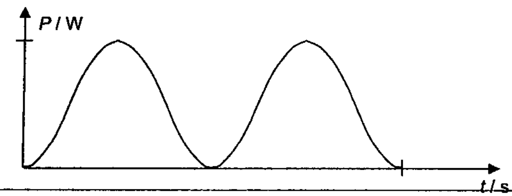
3(b)(i)		[1] for E_p [1] for E_k -1 if y-axis not labelled
3(b)(ii)	The gravitational force on the satellite provides for the centripetal force required to move it in a circular path. $F_G = F_C$ $\frac{GMm}{R^2} = mR\omega^2$ $\frac{(6.67\times10^{-11})(6.0\times10^{24})}{R^3} = \left(\frac{2\pi}{12\times60\times60}\right)^2$ $R = 2.66\times10^7$ m $h = 2.66\times10^7 - 6.4\times10^6$ $= 2.02\times10^7$ m $\approx 2.0\times10^7$ m	[1] [1] for correct substitution for $F_G = F_C$ [1] for h
3(b)(iii)	In order for the satellite to orbit at a larger h and orbital radius, the total energy required in the satellite is larger as it is equals to $-\frac{GMm}{2r}$. Hence the work done required on the satellite is positive.	[1] [1]
4(a)(i)	The waves reaching at AB will have different path length. When path difference is $n\lambda$, the waves will arrive at a point in phase, superpose and have constructive interference to form maxima. When path difference is $(n+0.5)\lambda$, the wave will arrive anti-phase at a point, superpose and have destructive interference to form minima.	[1] for path difference [1] for phase difference

[Turn over

4(a)(ii)	$I \propto A^2$ $\frac{I_1}{I_R} = \left(\frac{A_1}{A_R}\right)^2$ $\frac{I}{3I} = \left(\frac{1.5}{A_R}\right)^2 \Rightarrow A_R = 2.5981$ cm $A_Q = 2.5981 - 1.5 = 1.0981 \approx 1.1$ cm	[1] for A_R [1] for answer
4(b)(i)	$ax = \lambda D \Rightarrow x = \frac{\lambda}{a}D$ Gradient of graph = $\frac{\lambda}{a}$ $\frac{(4.0-7.0)\times10^{-3}}{(2.0-3.5)} = \frac{\lambda}{0.34\times10^{-3}}$ $\Rightarrow \lambda = 6.8\times10^{-7}$ m = 680 nm	[1] for gradient relationship [1] for correct gradient [1] for answer
4(b)(ii)	 When a increases, gradient decreases, Lower intercept with vertical axis; smaller gradient	[1]
5(a)(i)	Voltmeter reading, $V = \frac{5.00}{5.00+1.25}(9.00) = 7.20\text{ V}$	[1] ans
(a)(ii)		[1] LDR in series with the resistor [1] LDR // with the lamp

(b)(i)	Potential difference across 100 Ω resistor = potential difference across balanced length 400 mm. Potential difference across 100 Ω + R Ω resistor = potential difference across balanced length 588 mm. $\Rightarrow \frac{400}{588}=\frac{100}{100+R}$ $R = 47\ \Omega$	[1] sub [1] ans
(b)(ii)	Terminal potential for the 6.00 V source $=\frac{147}{147+r}(6.00)$ Potential difference across balanced length of 588 mm $=\frac{588}{1000}(9.00)$ $\Rightarrow \frac{588}{1000}(9.00)=\frac{147}{147+r}(6.00)$ $r \approx 19.7\ \Omega$	[1] sub [1] ans
6(a)	Work function energy refers to the minimum amount of energy needed to liberate an electron from its surface.	[1]
(b)	Energy of photon $E=\frac{hc}{\lambda}=(6.63\times10^{-34})(3\times10^{8})/(540\times10^{-9})$ $=3.683\times10^{-19}\text{ J}=2.3\text{ eV}$ Since the energy of the incident photon is lower than work function of metal, no electrons are emitted from surface.	[1] for substitution [1] for answer [1] for conclusion
(c)	If the wavelength of the radiation remains unchanged, changes in intensity only changes the number of photons incident on metal surface per unit time per unit area. Thus photon energy is still lower than work function, no photoelectrons will be emitted.	[1] [1]
(d)(i)	13.6 eV	[1]
(ii)	−13.6 +12.8 = −0.80 eV Hence highest energy level that electrons can be excited to is −0.85 eV	[1] Must show working to get - 0.80 eV

[Turn over

	Number of wavelengths = number of discrete transitions $={}^{4}C_{2}$ $=6$	[1] for correct answer
(iii)		[1] correct highest energy spectral line [1] three sections of spectral lines seen
(iv)	$\frac{hc}{\lambda}=(-0.85-(-13.6))\times1.6\times10^{-19}$ $\lambda=9.75\times10^{-8}\text{ m}$	[1] correct answer
7(a)	The root-mean-square (r.m.s.) value of an alternating current is defined as the value of steady direct current which would produce the same mean power as the alternating current in a given resistance.	[2] or zero
(b)	$\frac{N_s}{N_p}=\frac{V_s}{V_p}$ $\frac{N_s}{3000}=\frac{\frac{14}{\sqrt{2}}}{250}$ $N_s = 119$ turns Assumption: the transformer is ideal, with no power loss in the stepping down process.	[1] for correct substitution [1] for correct answer [1]
(c)(i)	$\langle P\rangle=\frac{V_{rms}^{2}}{R}\le 340$ $R\ge\frac{\left(\frac{14}{\sqrt{2}}\right)^{2}}{340}=0.29\ \Omega$	[1] for correct substitution [1] for correct answer
(ii)		[1] correct shape [1] correct number of cycles

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8(a)(i)	Read-off from Fig. 8.1, Speed of P-wave = 8.4 km s^{-1} Speed of S-wave = 4.8 km s^{-1} Distance travelled by P-wave = Distance travelled by S-wave $(t-170)\times 8.4 = t\times 4.8$ $\Rightarrow t = 396.76 \approx 397$ s	[1] for both correct speeds [1] for correct workings [1] for correct answer
8(a)(ii)	distance = $396.76\times 4.8 = 1904.4 \approx 1900$ km	[1]
8(a)(iii)	S-wave has <u>no velocity</u> in outer core; It cannot travel through outer core as <u>outer core is liquid</u>	[1] [1]
8(b)(i)	amplitude = 0.014 m frequency = $\frac{12}{2\pi} = 1.9098 \approx 1.9$ Hz	[1] [1]
8(b)(ii)1	$v = \frac{ds}{dt} = -(0.014\times 12)\sin(12t) \approx -0.17\sin(12t)$	[1]
8(b)(ii)2	$a = \frac{dv}{dt} = -(0.14\times 12^2)\cos(12t) \approx -2.0\cos(12t)$	[1]
8(b)(iii)1	SHM $\Rightarrow a_o = \lvert -\omega^2 x_o \rvert$; $v_o = \omega x_o$; $\omega = 2\pi f$ $\therefore a_o = \omega(\omega x_o) = \omega v_o = 2\pi f v_o$ $PGA = 2\pi f v_o$	[1] for correct expression of a_o, v_o and ω [1] for correct working
8(b)(iii)2	$PGA = 0.90$ m s^{-2} ; $v_o = 0.081$ m s^{-1} $f = \frac{PGA}{2\pi v_o} = \frac{0.90}{2\pi(0.081)} = 1.7684 \approx 1.8$ Hz Using $v_o = \omega x_o$, $\Rightarrow 0.081 = 2\pi(1.7684)x_o$ $\Rightarrow x_o = 0.0072901 \approx 0.0073$ m	[1] [1] [1]
8(b)(iii)3	<u>Resonance</u> takes place when the <u>external driving frequency</u> of <u>the wave from earthquake</u> is the same as its <u>natural frequency of the buildings</u>, Hence there is <u>maximum transfer of energy</u>, causng large amplitude	[1] [1]

8(b)(v)	Suitable test explained: $PGA \propto \frac{1}{r} \Rightarrow PGA = k\frac{1}{r}$, where k is a constant. $k_1 = 56\times 1.2 \approx 67$ $k_2 = 120\times 0.53 \approx 64$ $k_3 = 220\times 0.3 = 66$ Since k_1, k_2 and k_3 are similar, the equation is valid.	[1] [1] for three values of k. [1] for conclusion

Answers to 2022 JC2 H2 Preliminary Examinations Paper 3

Suggested Solutions:

<table>
<tr><th>No.</th><th>Solution</th><th>Remarks</th></tr>
<tr><td>1(a)(i)</td><td>The gradient of the graph represents the acceleration, which is changing in value.

Thus resultant force is changing. This suggested the presence of air resistance, since weight cannot be the only force acting on the ball.</td><td>[1]

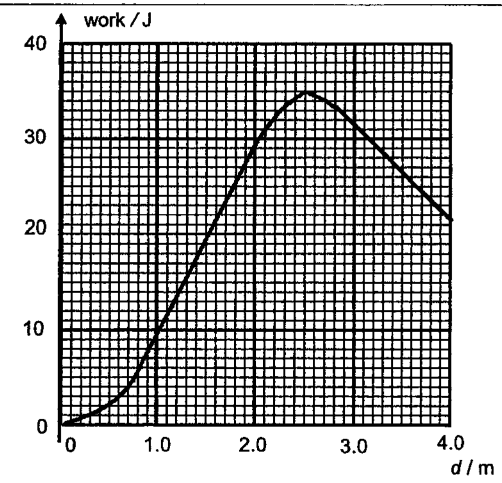
[1]</td></tr>
<tr><td>1(a)(ii)</td><td>The magnitude of acceleration due to free fall can be determined from the gradient of the graph at 1.75 s.

At this time, velocity is zero which means there is no air resistance and the only force (net force) experienced by the ball is its own weight.</td><td>[1]

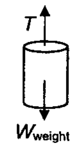
[1]</td></tr>
<tr><td>1(b)</td><td>At $t = 0$ s, the ball is moving with the largest speed and hence experiences the greatest air resistance.
Gradient of tangent at $t = 0$ s,
$= \frac{25}{1.2}$
$= 20.8$
Since $W + F_{air} = ma$,
$(0.010 \times 9.81) + F_{air} = 0.010 \times \frac{25}{1.2}$
$F_{air} \approx 0.110$ N (±10%)</td><td>[1] expl

[1] for gradient at $t = 0$ s

[1] ans</td></tr>
<tr><td>2(a)</td><td>Work done is area under the F-d graph.
<table><tr><th>d / m</th><th>work done / J</th></tr><tr><td>1.0</td><td>10</td></tr><tr><td>2.0</td><td>30</td></tr><tr><td>2.5</td><td>35</td></tr><tr><td>4.0</td><td>35 – 13.5 = 21.5</td></tr></table>Note that work done is cumulative.</td><td>[1]
[1]
[1]
[1]
One mark each for the correct shape and value corresponding to each d value.</td></tr>
</table>

<table>
<tr><td></td><td>
Fig. 2.2</td><td></td></tr>
<tr><td>2(b)(i)</td><td>$\sin 30° = \frac{h}{d}$
$mgh = mgd \sin 30° = (0.50)(9.81)(2.0)\sin 30° = 4.9$ J</td><td>[1] answer</td></tr>
<tr><td>2(b)(ii)</td><td>Gain in K.E. = W.D. on mass – W.D. against friction – gain in G.P.E.
Gain in K.E. = 30 – (3.0)(2.0) – 4.9
= 19.1 J</td><td>[1] correct energy equation

[1] correct W.D. again friction

[1] correct answer</td></tr>
<tr><td>3(a)</td><td>Acceleration is a rate of change of velocity.
Since the direction of moving bob is changing, hence there is a change in velocity of the bob and hence there is acceleration.</td><td>[1]
[1]</td></tr>
<tr><td>3(b)</td><td>Since the weight remain stationary to the tube, there is no net force acting on the weight, i.e.
$T = W_{weight}$
$= (0.400)(9.81)$
$= 3.924$ N
</td><td>[1] explain T = weight of brass weight</td></tr>
</table>

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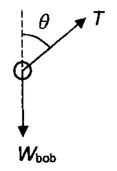
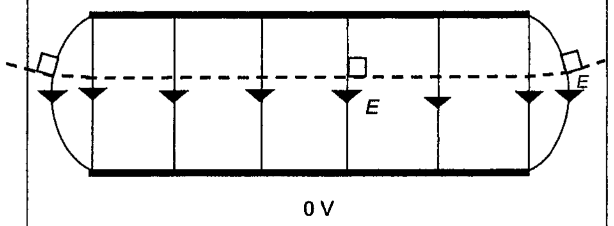
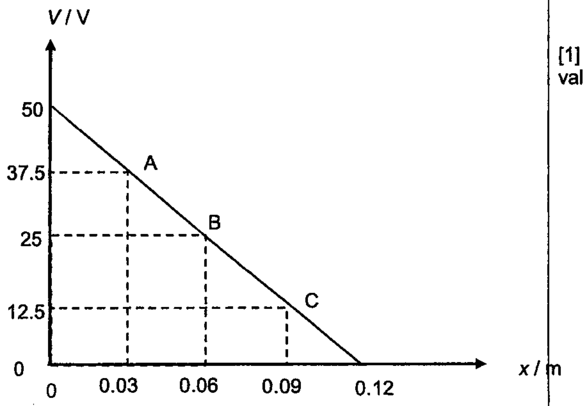
	Considering the forces acting on the bob, since the circular motion of the bob is in the horizontal plane, the vertical component of the tension T must balance the weight of the bob, i.e.  $T\cos\theta = W_{bob}$ $\cos\theta = \frac{W_{bob}}{T}$ $= \frac{(0.100)(9.81)}{(0.400)(9.81)}$ $= 0.25$ Hence, $\theta = 75.52°$ $\approx 76°$	[1] explain $T\cos\theta = W_{bob}$ [1] correct answer
3(c)	The horizontal component of the tension T provides for centripetal force. $T\sin\theta = F_c$ $= \frac{mv^2}{r}$ $(0.400)(9.81)\sin 76° = \frac{(0.100)v^2}{(0.30)\sin 76°}$ $v = \sqrt{\frac{(0.400)(9.81)(0.30)\sin^2 76°}{(0.100)}}$ $= 3.33$ $\approx 3.3 \text{ m s}^{-1}$	[1] equation and substitution [1] correct answer
4(a)	The internal energy of a gas is the sum of a random distribution of kinetic and potential energies associated with the molecules of the gas.	[1]
4(b)(i)	$N = \frac{(3.3\times10^5)(1.8\times10^{-3})}{(1.38\times10^{-23})(37+273.15)}$ $N = 1.39\times10^{23}$ molecules $N \approx 1.4\times10^{23}$ molecules	[1] for correct substitution and showing 1.39×10^{23}
4(b)(ii)1	$\Delta U = \frac{3}{2}Nk\Delta T$ $\Delta U = \frac{3}{2}(1.4\times10^{23})(1.38\times10^{-23})(15-37)$ $\Delta U = -63.756$ J $\Delta U \approx -64$ J (Accept −63 J for using 3/2 pV)	[1] for correct substitution [1] for correct answer Minus one mark if there is no negative" sign

[Turn over

4(b)(ii)2	$\Delta U = Q + W$ $-64 = Q - 85$ $Q = 21$ J	[1] for correct substitution [1] for correct answer
4(b)(ii)3	r.m.s. speed $\propto \sqrt{T}$ Ratio $= \frac{\sqrt{15+273.15}}{\sqrt{37+273.15}}$ $= 0.9639$ ≈ 0.96	[1] for correct substitution [1] for correct answer Allow other method.
5(a)	Progressive: There is a net transmission of energy from the wave source to points away from the source. Transverse: The direction of the oscillation of the particles in the wave is <u>perpendicular to that of the wave propagation</u>.	[1] [1]
5(b)(i)	intensity $I = \frac{P}{4\pi r^2}$ $= \frac{30}{4\pi(3.0)^2}$ $= 0.265$ $\approx 0.27 \text{ W m}^{-2}$	[1] substitution [1] answer
5(b)(ii)	intensity $I \propto (\text{amplitude } A)^2 \propto \frac{1}{r^2}$ $A \propto \frac{1}{r}$ $\frac{A_2}{A_3} = \frac{r_3}{r_2}$ $= \frac{3.0}{2.0}$ $= 1.5$	[1] substitution [1] answer in decimal
5(b)(iii)	The concave mirror redirects the light, such that all the <u>energy from the bulb is concentrated onto a smaller area</u>. This will lead to a light from the torchlight having a <u>larger intensity</u> than that in (b)(i).	[1] [1]

6(a)		[1] equally spaced electric field lines field lines cuts equipotential lines perpendicularly
6(b)		[1] straight line [1] correct values
6(c)	$F = qE = q\frac{V}{d} = (1.60\times10^{-19})\left(\frac{50}{0.12}\right) = 6.7\times10^{-17}$ N	[1] correct electric field *E* [1] correct answer
6(d)	loss in electric potential energy = gain in K.E. $q(V_A - 0) = \frac{1}{2}mv^2 - \frac{1}{2}m(2\times10^4)^2$ $1.60\times10^{-19}(37.5-0) = \frac{1}{2}(1.67\times10^{-27})\left(v^2 - (2\times10^4)^2\right)$ $v = 8.7\times10^4$ m s^{-1}	[1] correct substitution [1] correct answer

[Turn over

7(a)(i)	$0.52 = \frac{N}{t}(1.6\times10^{-19})$ $\frac{N}{t} = \frac{0.52}{1.6\times10^{-19}}$ $\frac{N}{t} = 3.25\times10^{18}$ s^{-1} $\approx 3.3\times10^{18}$ s^{-1}	[1] sub Must show $\frac{N}{t} = 3.25\times10^{18}$
7(a)(ii)	$v = \frac{0.52}{(5.9\times10^{28})(\pi)(0.18\times10^{-3})^2(1.60\times10^{-19})}$ $= 5.4\times10^{-4}$ m s^{-1}	[1] sub [1] ans
7(a)(iii)	Upon the closing of the switch, the <u>electric field is established almost instantaneously</u>, causing all electrons to move in the circuit. Although the drift velocity of the electrons is low, there is <u>a large number of electrons in the circuit moving together once the switch is closed.</u> Therefore, current in the circuit flows almost immediately.	[1] [1]
7(b)	Potential difference across wire X = 2.8 V Potential difference across NTC thermistor = 5.7 V $9.0 = 2.8 + 5.7 + 0.52r$ $r = 0.96\ \Omega$	[1] correct p.d for both wire X and NTC thermistor [1] ans
8(a)(i)	A = 94, Z = 35	[1] both correct
8(a)(ii)	Mass defect of U-235, *m* = (143)(1.00866) + (92)(1.00728) – (235.044) = 1.864 *u* Binding energy of U-235 = mc^2 = $(1.864)(1.66\times10^{-27})(3.00\times10^8)^2$ = 2.785×10^{-10} J = 1741 MeV **OR** Binding energy of U-235 = 1.864 (934) = 1741 MeV	[1] value for *m* [1] sub [1] ans [1] sub [1] ans
8(a)(iii)	Neutron(s) is/are produced	[1] ans
8(b)(i)	<u>High energy</u> electron	[1] ans

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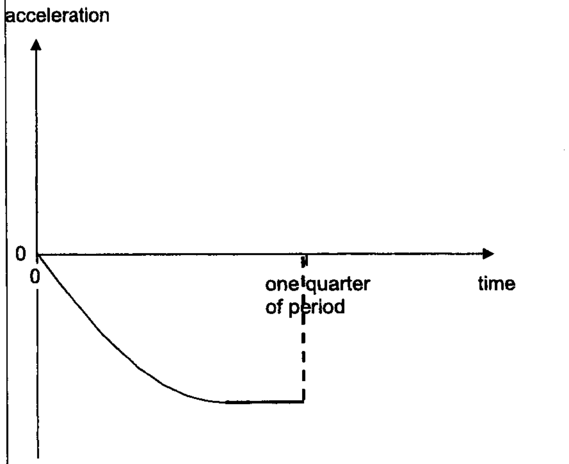
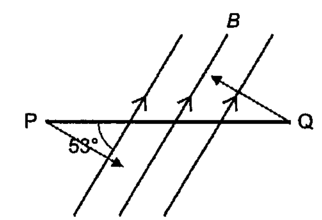
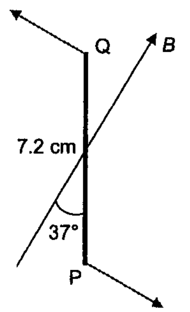
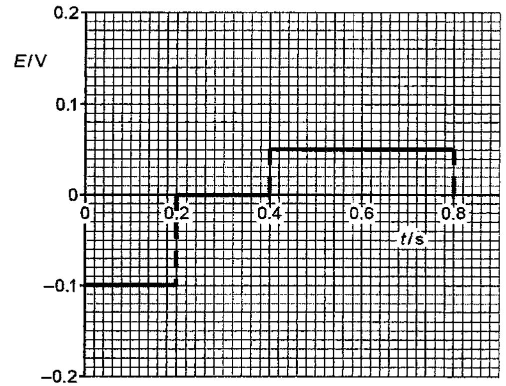
8(b)(ii)	$\lambda = \frac{\ln 2}{28(365)(24)(3600)} = 7.85 \times 10^{-10}\ s^{-1}$ $A = \lambda N = \lambda N_o e^{-\lambda t} = (7.85 \times 10^{-10})(2.36 \times 10^{13})\ e^{-\frac{\ln 2}{28}(100)}$ $= 1.56 \times 10^3$ Bq	[1] value for λ [1] ans
9(a)	Simple harmonic motion is defined as an oscillatory motion in which the acceleration of an object is directly proportional to the displacement of the object from its equilibrium position, and the acceleration is always directed towards that position.	[1] [1]
(b)(i)	-9.81 m s^{-2} When the plate is accelerating downward at 9.81 m s^{-2}, the sand will be undergoing acceleration of free fall. At this acceleration, the gravitational force acting on the sand particle is just sufficient to cause the acceleration of the sand particle and thus normal contact force equals zero.	[1] only accept negative answer [1] [1]
(b)(ii)1.	Gradient of graph = $-\omega^2$ $-\frac{12.5}{2.5 \times 10^{-2}} = -\omega^2$ $-\frac{12.5}{2.5 \times 10^{-2}} = -(2\pi f)^2$ $f = 3.56$ Hz	[1] correct gradient [1] correct link from gradient to f [1] correct answer
(b)(ii)2.	$KE = \frac{1}{2}mv^2$ $= \frac{1}{2}m\left(\omega\sqrt{x_0^2 - x^2}\right)^2$ $= \frac{1}{2}(1.2 \times 10^{-5})(500)(0.025^2 - 0.010^2)$ $= 1.58 \times 10^{-6}$ J	[1] correct substitution [1] correct answer
(b)(ii)3.	$x = x_0 \sin(2\pi f t)$ $2.0 = 2.5\sin(2\pi(3.56)t)$ $t = 0.0415$ s	[1] for substitution [1] for answer Can accept if use $x = 1.95$

[Turn over

(b)(iii)		[1] correct shape [1] negative
(c)(i)	At the equilibrium position, the upward tension force is equal to the downward weight. When the pendulum is displaced leftwards along a circular arc, the component of the weight tangent to the arc acts towards the right and is parallel to its displacement. This component provides the restoring force At equilibrium position, the upthrust equals to weight. As the block is displaced downwards from its equilibrium position, the volume of water displaced increases and hence, upthrust increases. The restoring force for the floating block is the resultant force due to the upthrust on the block by the water and the block's weight.	[1] [1] [1] [1]
(c)(ii)	Resonance Driving frequency of the water waves is equal to the natural frequency of the oscillation of the block.	[1] [1]
10(a)(i)	$6.0 \times 10^{-3} = B(4.2)(7.2 \times 10^{-2})\sin 53°$ $B = 0.0248$ T $B \approx 0.025$ T	[1] for correct substitution [1] for correct answer
10(a)(ii)	The change in reading is a decrease. The magnetic force acting on SR is upwards in Fig. 10.1. *OR* The magnetic force acting on SR is out of the plane of the paper in Fig. 10.2.	[1] [1]

10(a)(iii) 1		[1] for correct direction of arrow drawn at P, perpendicular to *B* [1] for correct direction of arrow drawn at Q, (perpendicular to *B*)
10(a)(iii) 2	 Magnitude of torque = magnetic force × perpendicular distance $=\left[(0.025)(4.2)(8.7\times10^{-2})\sin 90°\right]\left[(7.2\times10^{-2})\cos 37°\right]$ $=5.253\times10^{-4}$ N m $\approx 5.3\times10^{-4}$ N m	[1] for correct substitution for magnetic force [1] for correct substitution for perpendicular distance [1] for correct answer
10(a)(iii) 3	The frame will rotate until it is <u>perpendicular to the magnetic field.</u>	[1]
10(b)(i)	Magnetic flux linkage in smaller solenoid $=(320)1.4\times10^{-3}B$ $=0.448B$ Magnetic flux linkage in larger solenoid $=(40)4.2\times10^{-3}B$ $=0.168B$ The <u>smaller solenoid</u> has a <u>larger magnetic flux linkage</u>.	[1] for correct substitution [1] correct conclusion

10(b)(ii) 1	Magnitude of e.m.f. induced $=(320)(1.4\times10^{-3})\left(\dfrac{45\times10^{-3}}{0.20}\right)$ $=0.1008$ V ≈ 0.10 V	[1] for correct substitution [1] for correct answer
10(b)(ii) 2		[1] for horizontal line at −0.10 V from 0 to 0.20 s [1] for horizontal line at zero from 0.20 s to 0.40 s [1] for horizontal line at 0.05 V from 0.40 s to 0.80 s
10(b)(iii)	As the smaller solenoid is removed, the <u>flux linkage</u> in the smaller solenoid is <u>decreasing</u>. According to Faraday's Law of electromagnetic induction, this causes an <u>induced e.m.f.</u> in the smaller solenoid. The induced e.m.f. causes an <u>induced current</u> to flow in the smaller solenoid. The induced current causes an <u>induced magnetic field</u> around the smaller solenoid according to Lenz's Law. The two magnetic fields interact to create an <u>attractive force between the solenoids</u> to oppose the change which is the smaller coil being removed.	[1] [1] [1]

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Apparatus List

Odd bench
Question 1

- 1.5 V dry cell with holder
- Switch
- Resistor Y (10 Ω resistor with value hidden)
- 80 cm of 34 swg constantan wire fixed at 10 cm and 90 cm marks of rule
- 200 cm of 34 swg constantan wire (wound round a card of dimension 21 cm x 15 cm)
- 5 wires
- Ammeter (400 mA d.c.) (nearest 0.1 mA)
- Voltmeter (40 V d.c.) (nearest 0.01 V)
- Rheostat (22 Ω)

Question 2

- 2 x retort stands, bosses, clamps
- 3 x identical springs attached to a ring (diameter 3 cm)
- 1 x 100 g mass hanger
- 3 x 100 g slotted masses
- 1 x set square
- 1 x 30 cm rule
- 2 counterweights

Even bench
Question 3

- 2 × retort stands
- 2 × bosses
- 2 × clamps
- 2 × half-metre rules
- 2 × shorter string loops
- 2 × longer string loops
- 1 × metre rule
- 1 × stopwatch
- 1 × metre rule

Apparatus List (For Students)

Odd bench
Question 1

- 1.5 V dry cell with holder
- Switch
- Resistor Y
- Wire on metre rule (from 10 cm to 90 cm marks)
- Wire wound round a card (do not cut this wire)
- 9 wires
- Ammeter (400 mA d.c.)
- Voltmeter (40 V d.c.)
- Rheostat

Question 2

- 2 x retort stands, bosses, clamps
- 3 x identical springs attached to a ring (diameter 3 cm)
- 1 x 100 g mass hanger
- 3 x 100 g slotted masses
- 1 x set square
- 1 x 30 cm rule
- 2 counterweights

Even bench
Question 3

- 2 × retort stands
- 2 × bosses
- 2 × clamps
- 2 × half-metre rules
- 2 × shorter string loops
- 2 × longer string loops
- 1 × metre rule
- 1 × stopwatch
- 1 × metre rule

Suggested Solutions

<table>
<tr><th>No.</th><th>Solution</th><th>Remark</th></tr>
<tr><td>1(a)(iv)</td><td>V_0 = 0.27 V</td><td>[1] 2 d.p. in V</td></tr>
<tr><td>1(a)(v)</td><td>first ammeter reading = 92.8 mA
second ammeter reading = 87.1 mA</td><td>[1] 1 d.p. in mA</td></tr>
<tr><td>1(b)(iii)</td><td>x = 30.0 cm
I = 108.2 mA</td><td>[1]
- d.p. and units
- 29.0 cm <x< 31.0 cm</td></tr>
<tr><td>1(c)</td><td><table>
<tr><th>x / cm</th><th>I / mA</th><th>$\frac{1}{x}$ / cm^{-1}</th></tr>
<tr><td>20.0</td><td>153.8</td><td>0.0500</td></tr>
<tr><td>30.0</td><td>108.2</td><td>0.0333</td></tr>
<tr><td>40.0</td><td>90.4</td><td>0.0250</td></tr>
<tr><td>50.0</td><td>78.4</td><td>0.0200</td></tr>
<tr><td>60.0</td><td>69.9</td><td>0.0167</td></tr>
<tr><td>70.0</td><td>62.9</td><td>0.0143</td></tr>
</table></td><td>[1] headings and units

[1] 6 sets of data
(min range of 50cm)

[1] d.p.and units of raw data

[1] s.f. of processed data

[1] correct calculation</td></tr>
<tr><td>1(d)</td><td>Refer to attached graph.</td><td>[1] axes: units, scale

[1] plotted points accurate to half of smallest division

[1] best fit line</td></tr>
<tr><td>1(d)</td><td>$gradient = \frac{140 - 74}{0.045 - 0.0185} = 2490$
P=2490 mA cm

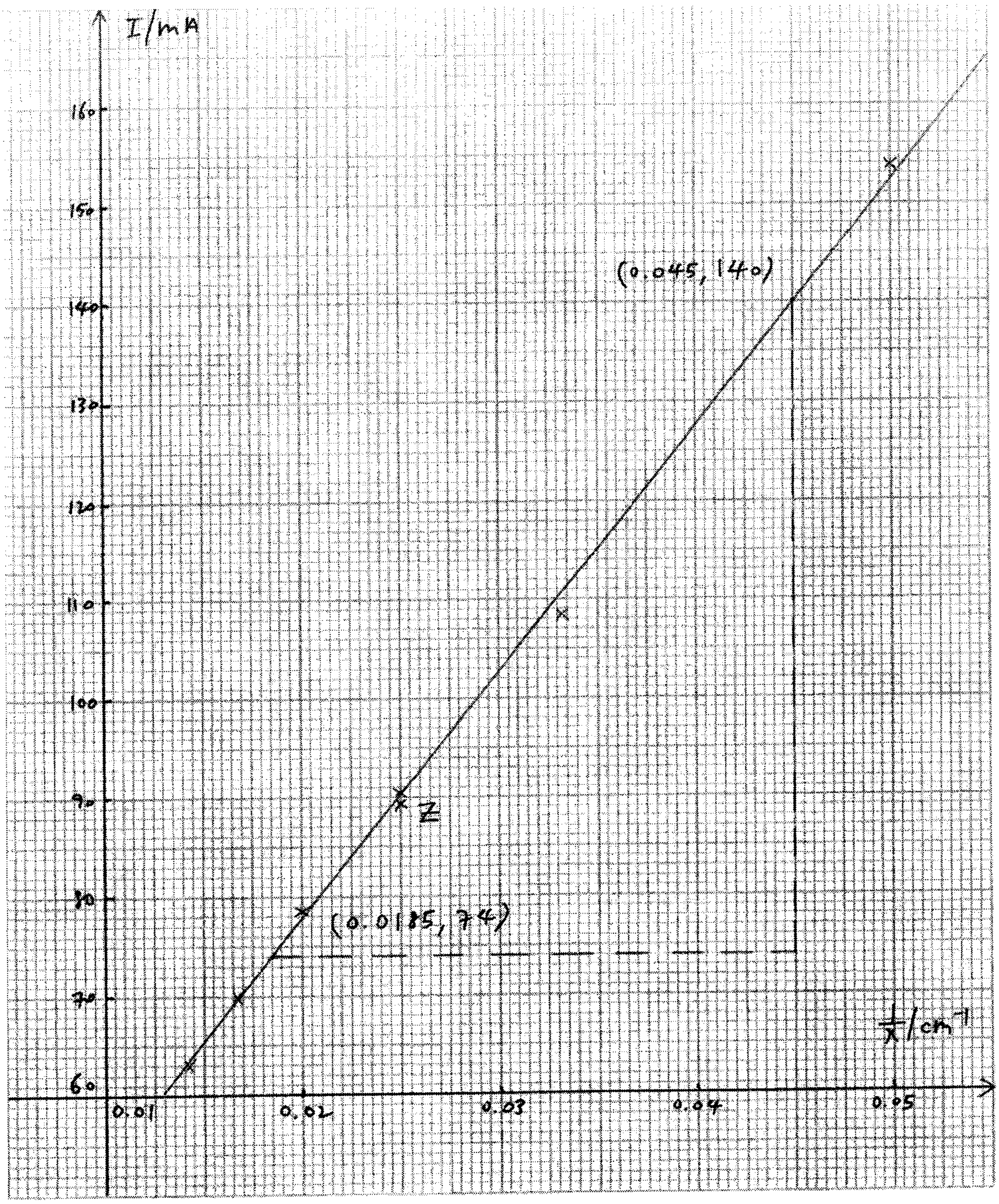
Substitute $(0.045, 140)$ into the equation,
$140 = (2490)(0.045) + Q$
$Q = 27.9$ mA</td><td>[1] - Big triangle
- substitution of gradient coordinates

[1] P with units

[1] Q with units</td></tr>
<tr><td>1(e)</td><td>$L = \frac{2490 \text{ mA cm}}{27.9 \text{ mA}} = 89.2$ cm</td><td>[1] L with units
(0 m < L < 2 m)</td></tr>
<tr><td>1(f)(ii)</td><td>x = 40.0 cm
I = 89.3 mA</td><td>39 cm < x < 41 cm</td></tr>
<tr><td>1(f)(iv)</td><td>Z agrees with the pattern set by the other points on the graph as it is very close to the best fit line.

Comparing with (a)(v),</td><td>[1] for (f)(ii), f(iii) and statement based on scatter of Z from best fit line</td></tr>
</table>

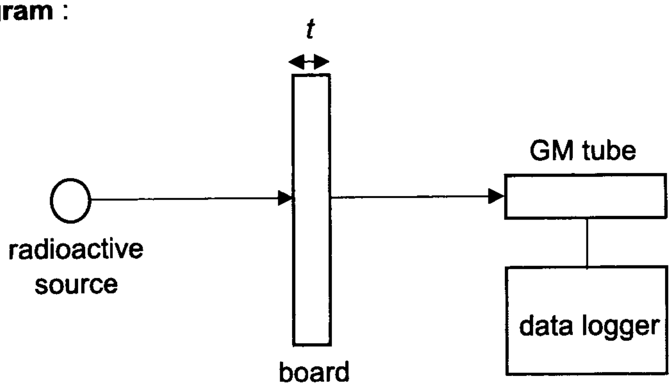
	error in values of $I = \frac{92.8 - 87.1}{2} = 3$ mA Point Z is within ±1 mA from the BFL in the graph and thus it is within ±3 mA above.	[1] for valid justification using (a)(v). Accept any logical reasoning.



No.	Solution	Remarks
2(a)	S = 5.0 cm	
2(b)(i)	S_1 = 27.8 cm S_2 = 17.6 cm	[1] for correct measurements with units Range : 23.0 cm < S_1 < 34.0 cm 14.0 cm < S_2 < 22.0 cm
2(b)(ii)	p = 17.8 cm q = 12.6 cm	[1] for correct calculation with units
2(c)(i)	k = 25.4 N m^{-1}	[1] for correct calculation
2(c)(ii)	$m^2g^2 = \frac{k^2p^2}{4} + k^2q^2$ $\left(\frac{p^2}{4} + q^2\right) = \frac{g^2}{k^2}m^2$ Plot $\left(\frac{p^2}{4} + q^2\right)$ vs m^2, gradient is $\frac{g^2}{k^2}$ so k can be determined.	[1] for correct linearization [1] for correct gradient

No.	Solution	Remarks
3(a)(i)	$d = 40.0$ cm	[1] correct to nearest 0.1 cm
3(a)(ii)	percentage uncertainty in $d = \dfrac{0.2}{40.0} \times 100\% = 0.5\%$	[1] for correct percentage uncertainty (1 or 2 s.f.) – abs uncertainty 0.2~0.3 cm
3(a)(iii)	$l_1 = 26.6$ cm $l_2 = 26.5$ cm $l = 26.6$ cm	[1] - repeated readings - correct to 0.1 cm
3(a)(iv)	percentage uncertainty in $l = \dfrac{0.2}{26.6} \times 100\% = 0.75\% \approx 0.8\%$	[1] for correct percentage uncertainty (1 or 2 s.f.) – abs uncertainty 0.2~0.3 cm
3(b)	$N = 40$ $t_1 = 29.9$ s $t_2 = 29.8$ s $T = \dfrac{t_1 + t_2}{2N} = \dfrac{29.8 + 29.9}{2(40)} = 0.746$ s	[1] - repeated t readings - t_1 and t_2 recorded to 0.1 s, at least 20.0 s - T correct to 3 s.f.
3(c)	$d = 30.0$ cm $l_1 = 41.7$ cm $l_2 = 41.7$ cm $l = 41.7$ cm $N = 20$ $t_1 = 24.8$ s $t_2 = 24.9$ s $T = \dfrac{t_1 + t_2}{2N} = \dfrac{24.8 + 24.9}{2(20)} = 1.24$ s	[1] for d and l - repeated l readings - correct to 0.1 cm [1] for T - repeated t readings - t_1 and t_2 recorded to 0.1 s, at least 20.0 s - T correct to 3 s.f. E.c.f. applies from 3(a) and 3(b)
3(d)(i)	$k_1 = \dfrac{0.746^2 \times 0.400^2}{0.266} = 0.335$ s^{2}m $k_2 = \dfrac{1.24^2 \times 0.300^2}{0.417} = 0.332$ s^{2}m	[1] [1] Ignore units

3(d)(ii)	percentage difference $= \frac{0.335-0.332}{0.332} = 0.9\%$ The percentage difference of 0.9% between the two k values are very close to the percentage uncertainties of *d* and *l*, at 0.5% and 0.8% respectively. As such, the results of my experiment supports the suggested relationship. Tutors to exercise professional judgement for acceptable variation.	[1] valid evaluation based on comparing percentage difference with both percentage uncertainties of *d* and *l*
3(e)	Without masses <table><tr><td>*d* / cm</td><td>N</td><td>t_1 / s</td><td>t_2 / s</td><td>*T* / s</td></tr><tr><td>35.0</td><td>25</td><td>26.7</td><td>26.5</td><td>1.06</td></tr><tr><td>**30.0**</td><td>20</td><td>24.8</td><td>24.9</td><td>**1.24**</td></tr><tr><td>**25.0**</td><td>15</td><td>22.5</td><td>22.4</td><td>**1.50**</td></tr><tr><td>20.0</td><td>15</td><td>27.7</td><td>27.5</td><td>1.84</td></tr></table> With masses <table><tr><td>*d* / cm</td><td>N</td><td>t_1 / s</td><td>t_2 / s</td><td>*T* / s</td></tr><tr><td>35.0</td><td>20</td><td>24.4</td><td>24.4</td><td>1.22</td></tr><tr><td>**30.0**</td><td>20</td><td>25.3</td><td>25.3</td><td>**1.27**</td></tr><tr><td>**25.0**</td><td>20</td><td>26.8</td><td>26.9</td><td>**1.34**</td></tr><tr><td>20.0</td><td>20</td><td>29.6</td><td>29.7</td><td>1.48</td></tr></table> *d* should have a value between 25.0 and 30.0 cm for the value of *T* to be the same for both cases.	[1] presentation of data for experiment without masses [1] presentation of data for experiment with masses [1] correct evaluation for *d*, with explanation.
3(f)	<table><tr><td>*m* / g</td><td>N</td><td>t_1 / s</td><td>t_2 / s</td><td>*T* / s</td></tr><tr><td>0</td><td>20</td><td>26.8</td><td>26.9</td><td>1.34</td></tr><tr><td>50</td><td>20</td><td>23.2</td><td>23.4</td><td>1.17</td></tr><tr><td>100</td><td>20</td><td>20.8</td><td>20.9</td><td>1.04</td></tr><tr><td>150</td><td>25</td><td>23.9</td><td>23.9</td><td>0.956</td></tr><tr><td>200</td><td>25</td><td>22.1</td><td>22.1</td><td>0.884</td></tr></table> When the mass at the centre, that equivalent to more children seated at middle, *m* increases, the period *T* decreases.	[1] presentation of data for experiment [1] correct *T* values [1] correct evaluation
3(g)	• Set up the apparatus as per Fig. 3.1. Measure the length of the bottom plank L using a metre rule. Repeat **(a)(i)**, **(a)(iii)**, and **(b)** to achieve a set of readings for *L*, *d*, *T* and *l*. • Keep *d* and *l* constant, and repeat the steps **(a)(i)**, **(a)(iii)**, and **(b)** to get 5 additional sets of data while varying *L*. Vary *L* by using planks of different *L* values to be used in the set up. • Based on the equation *T* = *kL*, plot a graph of *T* against *L*, where *k* is the gradient. • If the plotted data follow a clear linear trend, with the best fit line cutting the origin, the results show direct proportionality between *T* and *L*. • With *d* fixed, using planks of very small lengths and very large lengths will lead to unstable oscillations, and cause the period readings to be very small and large respectively. There is also a limit to the length of ruler allowed between the retort stands.	[1] step for taking data [1] control of variables [1] plot graph [1] showing direct proportionality [1]difficulty

No.	Solution	Remarks
4	**Aim** : To determine the values of n and m, based on the equation $C = k\rho^n t^m$ **Experiment 1** – determine n **Independent variable** : density of material ρ, calculated using $\rho = \frac{\text{mass}}{\text{length} \times \text{width} \times \text{thickness}}$ of the boards. This is done using boards of different materials. **Dependent variable:** count rate C, measured using a Geiger-Muller (GM) tube **Controlled variables**: thickness of board t, radioactive source, distance between board and source, and between board and GM tube	[1] correct variables for Expt 1
	Diagram :  	[1] feasibile setup [1] labelled diagram
	Procedure : a) Measure the mass of a board using a digital mass balance. Measure the length and width of the board using a meter rule, and the thickness of the board using a pair of vernier calipers. b) Calculate the density of the board $\rho = \frac{\text{mass}}{\text{length} \times \text{width} \times \text{thickness}}$. c) Set up the apparatus as shown above. d) Determine the count rate of the radioactive source through the board by reading data logger connected to the GM tube. e) Repeat steps (a) to (d) while using boards of different materials and same thickness, to get 5 additional sets of readings of ρ and C. f) Based on the equation $\lg C = n \lg \rho + \lg(kt^m)$, plot a graph of lg C against lg ρ, where n is the gradient.	[1] calculation of density [1] detail - for measuring thickness, length and width using proper instruments [1] detail - for correct and detailed procedure to obtain first set of readings [1] using boards of different materials to vary density [1] correct graph plotted

	Experiment 2 – determine *m* **Independent variable** : thickness of board *t*, measured using Vernier calipers **Dependent variable:** count rate *C*, measured using a Geiger-Muller (GM) tube **Controlled variables** : material of board (density of board ρ), radioactive source, distance between board and source, and between board and GM tube	[1] Independent variable and controlled variable for Expt 2
	Procedure : g) Repeat steps (a) to (d) by while using boards of varying thickness *t* and of the same material, to get 6 sets of readings of *t* and *C*. This will keep the density of the board ρ constant. h) Based on the equation $\lg C = m\lg t + \lg(k\rho^n)$, plot a graph of lg *C* against lg *t*, where *m* is the gradient.	[1] correct graph plotted
	Precautions for accuracy 1. Take repeated readings of *C* for each set of readings, and determine the average value of *C* for greater accuracy. 2. Ensure that the board is perpendicular to the radiation, and that the board is clamped securely using a retort stand.	[1] at least one accuracy precaution
	Precautions for safety 1. Never point the radioactive source towards another person. When doing the experiment, the source should always be directed towards a direction where there is no people. Ensure that people do not walk in the path of the radiation 2. Wear personal protective equipment to minimise exposure to radiation.	[1] at least one safety precaution