PHYSICS — 9749

SUGGESTED MARK SCHEME
Maximum Mark: 190

October/November 2018

Paper 1
Multiple Choice

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

Notes:
Candidates found **Questions 1**, **2**, **5**, **9**, **11**, **18**, **24**, **26** and **27** relatively challenging.

Question 1
Percentage uncertainty in *L* needed to be subtracted from, rather than added to, the percentage uncertainty in *g*.

Question 2
Distance is the total magnitudes of the areas of the triangles defined by the graph lines and the time axes.

Question 9
Those who chose option **C** confused between angular displacement and linear displacement.

Question 11
Those who chose option **D** assumed wrongly that the spacecraft must start from rest.

Question 17
Those who chose **B** found the centre-to-fringe distance instead of fringe-fringe distance. This requires a doubling of the new centre-fringe distance.

Question 23
Those who chose either **B** or **C** assumed wrongly that current must split equally at the junction

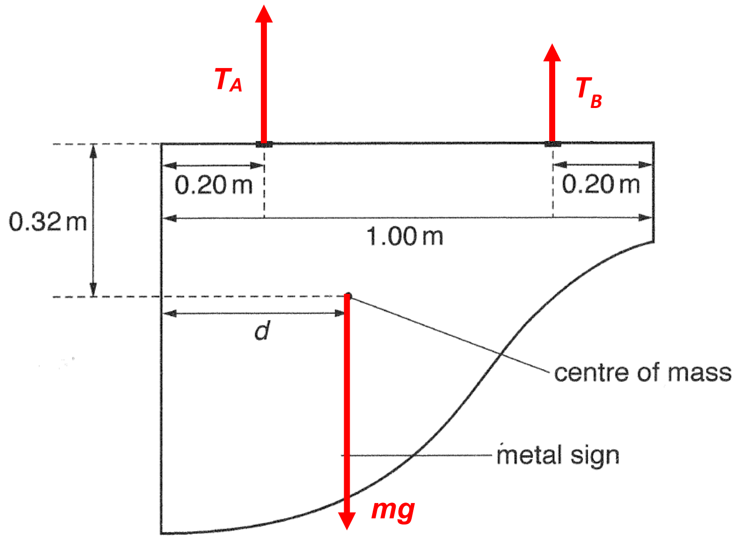
Question 24
Those who chose option **B**, omitted a factor of 2 either from omitting the sin 30° factor or from missing that the magnetic force is exerted on the coil at double the distance away from the pivot as is the weight.
Those who chose option **D** treated the coil as consisting of a single turn rather than 50.

Question 27
Those who chose option **D** neglected to consider the effect of half-wave rectification.

Paper 2
Structured Questions

Qns		Marks
1(a)	when a body is in rotational equilibrium, the sum of clockwise moments about any point must be equal to the sum of anticlockwise moments about the same point.	B1

1(b)(i)



As metal sign is in translational equilibrium,

$T_A + T_B = mg$

$= (4.5)(9.81)$

$T_A + T_B = 44.145$ ---- (1)

Since the perpendicular distance of T_A is smaller than that of T_B from the centre of mass, $T_A > T_B$

therefore $\frac{T_B}{T_A} = \frac{3}{7}$ ---- (2) **M1**

Solving (1) and (2):

$T_A = 31$ N

$T_B = 13$ N **A1**

Notes: Be careful not to get the $\frac{T_B}{T_A} = \frac{3}{7}$ values the wrong way around.

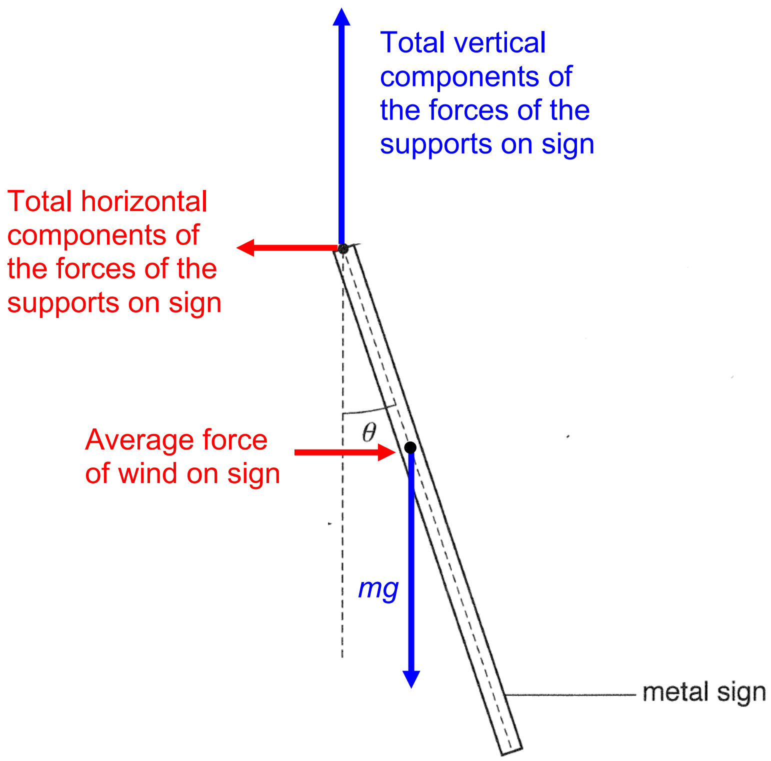
1(b)(ii) Taking moments about the centre of mass,

$T_A (d - 0.20) = T_B (1.00 - d - 0.20)$ **C1**

$31 (d - 0.20) = 13 (1.00 - d - 0.20)$

$d = 0.38$ m **A1**

Qns	Marks
1(c)	

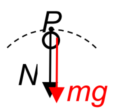


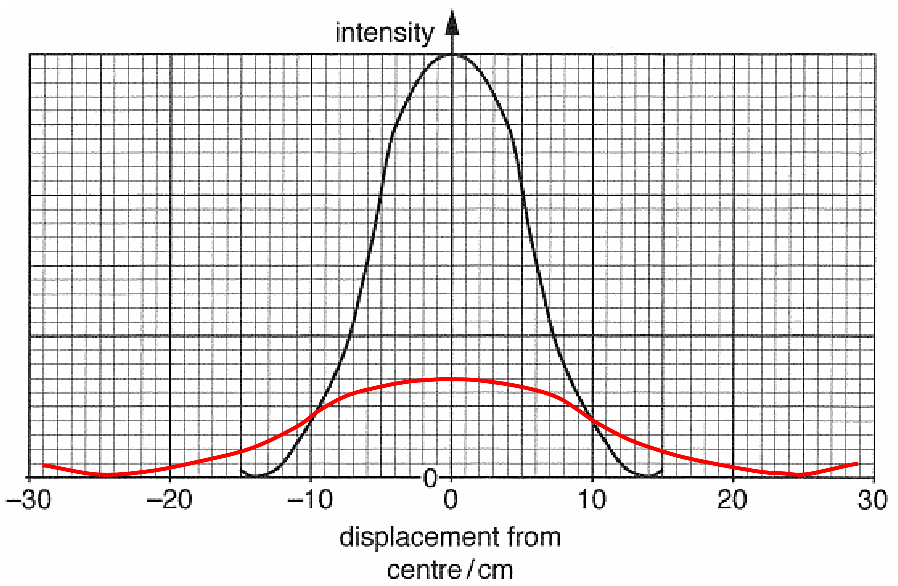
<u>wind exerts a horizontal force on the sign</u> to the right

to maintain translational <u>equilibrium</u> of the metal sign, <u>force that each support provides on the sign must have a horizontal component to balance the rightward force.</u> **B1**

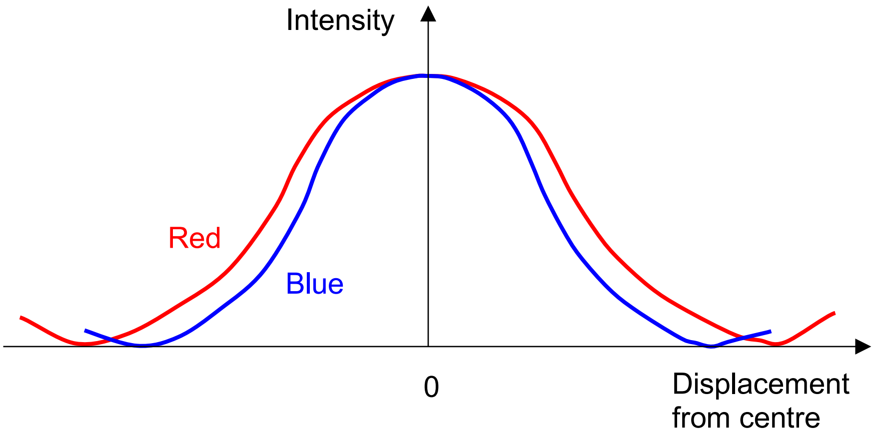
Notes: Do not simply state that a horizontal force is needed as wind is horizontal. Remember to state explicitly that this force is to maintain translational equilibrium.

Common misconception: Some may attribute the horizontal force as resulting from N3L applied to the wind force. From N3L, the sign is the one exerting an equal and opposite force on the wind, this force is not a force acting on the sign by the support.

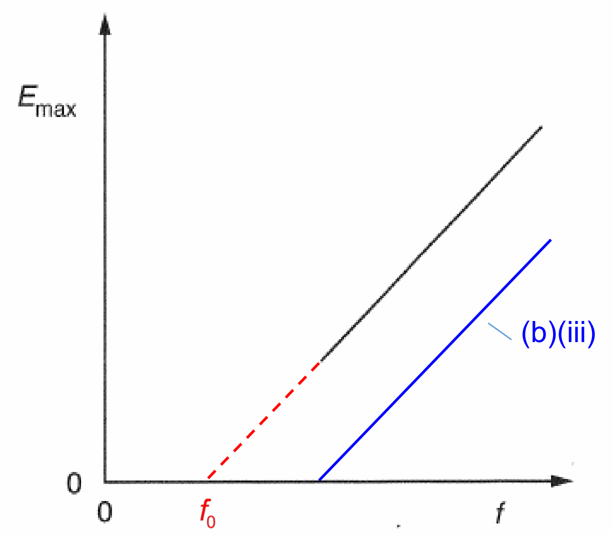
Qns		Marks
2(a)	the change in length of a material is directly proportional to the force applied on it, provided that the limit of proportionality is not exceeded.	B1
2(b)	elastic potential energy stored = area under load-compression graph	M1
	$=\frac{1}{2}(85\times10^{-3})(6.8)$	
	$=0.29$ J	A1
2(c)	loss in elastic PE = gain in KE and gravitational PE	B1
	$EPE_i - 0 = \left(\frac{1}{2}mv^2 - 0\right) + mgh$	M1
	$0.29 - 0 = \frac{1}{2}(42\times10^{-3})v^2 + (42\times10^{-3})(9.81)(0.40)$	
	$= 2.4\ \text{ms}^{-1}$	A1
	Notes: Be careful not to forget the GPE too.	
2(d)(i)	 $N + mg = \frac{mv^2}{r}$	
	At minimum speed, normal contact force $N = 0$, Hence weight provides centripetal force.	B1
	Thus $mg = \frac{m{v_{min}}^2}{r}$	M1
	$v_{min} = \sqrt{rg}$	
	$= \sqrt{(0.20)(9.81)}$	
	$= 1.4\ \text{m s}^{-1}$	
	v_{min} = 1.4 m s^{-1}	A1
2(d)(ii)	$v_{min} = \sqrt{rg}$	
	v_{min} is independent of mass and hence does not change	B1

Qns		Marks
3(a)	a wave spreads out after passing through a slit or around the edge of an obstacle [do not accept spreading "*through*" an obstacle, "*bending*" of waves, "*splitting*" of waves]	B1
3(b)	$\sin\theta = \frac{\lambda}{b}$ For very small angle θ, $\sin\theta \approx \tan\theta = \frac{0.14}{2.7}$ $\frac{0.14}{2.7} = \frac{\lambda}{12 \times 10^{-6}}$ $\lambda = 6.2 \times 10^{-7}$ m	M1 M1 A1
3(c)	 $\sin\theta = \frac{\lambda}{b}$, a narrower slit (smaller b) means a larger θ. more spreading of the waves. broader central maxima. less light passes through, lower overall intensity	B1 B1
3(d)(i)	$\sin\theta = \frac{\lambda}{b}$, a longer wavelength λ would mean a larger θ for the angular positions of the first minima. The central maximum would be broader.	B1 B1

Qns		Marks
3(d)(ii)	white light spectrum consists of wavelengths spanning 400 – 700 nm.	
	$\sin\theta = \frac{\lambda}{b}$, amount of spreading depends on wavelength λ of the incident light.	B1
	longer wavelengths at the red end spreads more as compared to shorter wavelengths, hence the edges are red	
	at the central region, the different wavelengths overlap to produce white	B1



Notes: Remember to use scientific terms such as interference/ overlapping. Common misconception: There is white light at centre as there is no diffraction at the centre.

Qns		Marks
4(a)	minimum frequency of electromagnetic radiation for electrons to be emitted from metal surface.	**B1**
	at this frequency, electrons are emitted with zero kinetic energy	**B1**
4(b)		**B1** (f_0) **B1** **(b)(iii)**
4(b)(ii)	gradient is equal to the Planck constant h	**B1**
	$hf = \Phi + E_{K,\max} \quad \rightarrow \quad E_{K,\max} = hf - \Phi$	
4(c)(i)	$\frac{hc}{\lambda} = \Phi + \frac{1}{2}mv_{\max}^2$	**M1**
	$\frac{(6.63\times10^{-34})(3.00\times10^{8})}{(490\times10^{-9})} = 2.5(1.60\times10^{-19}) + \frac{1}{2}(9.11\times10^{-31})v_{\max}^2$	**C2**
	$v_{\max} = 1.1\times10^{5}\ \text{m s}^{-1}$	**A1**
4(c)(ii)1	blue light has frequency higher than threshold frequency of europium, hence photoelectric effect occurs.	
	electrons are emitted from the electroscope, gold leaf and rod become less charged and hence smaller electrostatic repulsion.	**B1**
	frequency of red light is below threshold frequency of europium so no electrons are emitted	
4(c)(ii)2	gold leaf rises due to electrostatic repulsion due to net lack of electrons.	**B1**
	even if photoelectric effect occurs, electrons emitted from europium surface will only make the gold leaf and rod more positively charged and hence larger repulsion	**B1**
	Notes: Remember that only electrons are free to move and do not use terms like positive charge cannot be emitted.	

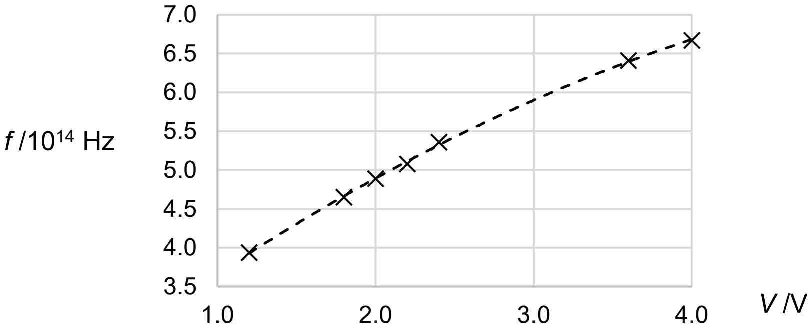
Qns		Marks
5(a)	volume of 1 mole $= \dfrac{\text{mass of 1 mole}}{\text{density}}$	
	$= \dfrac{63.5\times10^{-3}}{8960}$	C1
	$= 7.087\times10^{-6}\ \text{m}^3$	
	number density of copper atoms $= \dfrac{N_A}{\text{volume of 1 mole}}$	
	$= \dfrac{6.02\times10^{23}}{7.087\times10^{-6}\ \text{m}^3}$	C1
	$= 8.49\times10^{28}\text{m}^{-3}$	
		B1
	each atom has 1 conduction electron, so number density of charge carriers is $8.49\times10^{28}\ \text{m}^{-3}$.	
5(b)	$P = I^2R$	
	$5.0 = I^2(30)$	C1
	$I = 0.41\ \text{A}$	C1
	$I = Anvq$	
	$0.41 = \left[\dfrac{\pi(0.36\times10^{-3})^2}{4}\right](3.4\times10^{28})(v)(1.60\times10^{-19})$	C1
	$v = 7.4\times10^{-4}\ \text{m s}^{-1}$	A1
5(c)	$V = IR = (nAqv)(\dfrac{\rho L}{A}) = nev\rho L$	
	same material, so number density of charge carriers n is the same same temperature and material, so resistivity ρ is same	M1
		B1
	Hence drift velocity is inversely proportional to length	
		A1
	Since length is doubled, drift velocity v is halved	
	[do not accept quantities *increased* or *decreased*]	

Qns		Marks
6(a)(i)	$V_Q = I_Q R_Q$ $V_{out} = V_Q$ $= (27 \times 10^{-3})(90)$ $= 2.4$ V	A1
6(a)(ii)	before connecting thermistor, $V_P = I_P R_P$ $R_P = \frac{V_P}{I_P} = \frac{\text{e.m.f.} - V_Q}{I}$ $= \frac{9.0 - 2.4}{27 \times 10^{-3}}$ $R_P = 240\ \Omega$	C1
	after connecting thermistor, resistance of parallel branch with Q $R_{//} = (\frac{1}{120} + \frac{1}{90})^{-1}$ $= 51\ \Omega$	C1
	by potential divider rule, $V_{out} = \frac{51}{51 + 240}(9.0)$ $= 1.6$ V	A1
	Note: Current in the circuit does not remain at 27 mA when the thermistor is connected as the total resistance of the circuit has changed.	
6(a)(iii)	When the temperature of the NTC thermistor is increased, its resistance would decrease.	B1
	The total resistance of the thermistor in parallel with Q is thus reduced.	M1
	By the potential divider rule, V_{out} would also decrease.	A1
	OR	
	(The total resistance increases.)	(M1)
	(P.d. across P increases, hence V_{out} decreases)	(A1)

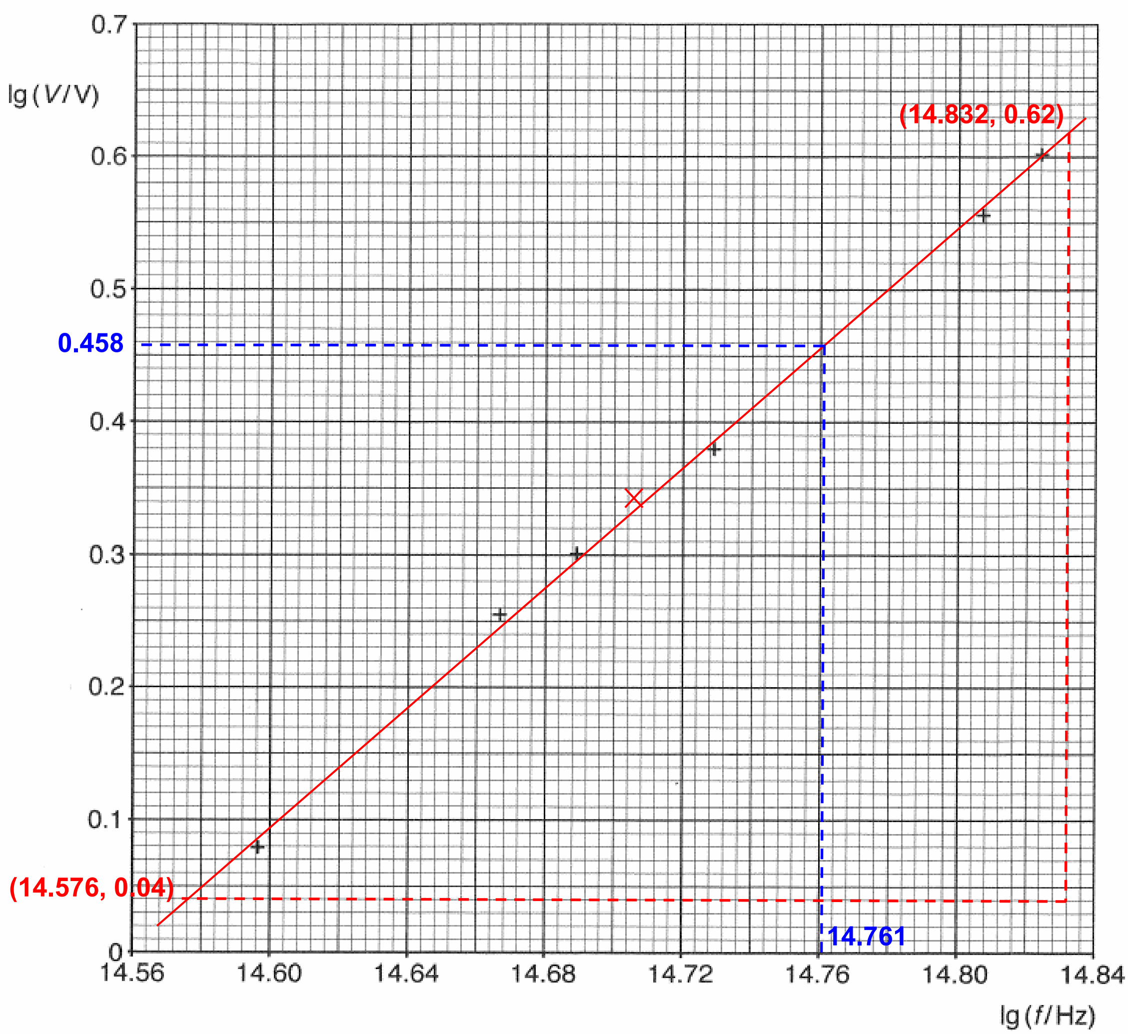
Qns		Marks
6(b)	Arc AB $= r\theta$	
	$= (1.2 \times 10^{-2})(\frac{92}{180}\pi)$	C1
	= 0.01927 m	
	By the potential divider rule,	
	$V_{out} = \frac{0.01927}{6.5 \times 10^{-2}} \times 9.0$	C1
	$= 2.7$ V	A1
	Note: The resistance wire is not a full circle hence its length is not the circumference of the circle (length of resistance wire is already given so there is no need to calculate).	

Qns		Marks
7(a)	As the p.d. *V* across the LED increases, the frequency *f* of the emitted photons increases (at a decreasing rate).	B1

Note:
This is not a proportional relationship: when *V* is doubled from 2.0 V to 4.0 V, *f* is not doubled.



7(b)(i), (ii)



- Plot accurate to ½ smallest square. **B1**
- Best fit line drawn. **B1**

Qns		Marks
7(b)(iii)	$V = kf^n$	
	$\lg V = n \lg f + \lg k$	M1
	gradient $= \dfrac{y_1 - y_2}{x_1 - x_2} = \dfrac{0.620 - 0.040}{14.832 - 14.576}$ $= \dfrac{0.580}{0.256} = 2.27$	
	n = gradient = 2.27	A1
7(c)(i)	$\lg f = \lg(\dfrac{c}{\lambda})$ $= \lg(\dfrac{3.00 \times 10^8}{520 \times 10^{-9}}) = 14.761$	M1
	From graph, when lg f = 14.761, lg V = 0.458	M1
	Thus, V = 2.87 V	A1
7(c)(ii)	$Pt = N$(photon energy)	
	$(10)(60) = N(3.8 \times 10^{-19})$	C1
	$N = 1.6 \times 10^{21}$	A1
7(c)(iii)	$V = IR$	
	$(4.5 - 2.87) = (20 \times 10^{-3})R$	C1
	$R = 82\ \Omega$	A1
	Notes: *V* is not the potential difference of the power supply but the potential difference across the series resistor.	
7(d)	$Q = It = (730 \times 10^{-3}\ \text{A})(60 \times 60\ \text{s})$ $= 2.63 \times 10^3\ \text{C}$	
	The total amount of charge available from the power supply is 730 mAh or 2.63×10^3 C.	B1
	The power supply can provide a current of 730 mAh for 1 hour. For a varying current, the product of the average current and time = 730 mAh.	B1
	Note: Candidates need to state that 730 mAh is the total amount of charge available from the supply.	

Qns		Marks
7(e)	$\frac{e_{LED}}{e_{lamp}} = \left(\frac{P_{out}}{P_{in}}\right)_{LED} \div \left(\frac{P_{out}}{P_{in}}\right)_{lamp}$ $= \frac{800}{10} \div \frac{840}{60}$ $= 5.7$	C1 A1
7(f)(i)	For roughly the same brightness, LEDs and CFLs require $\frac{10}{60} \times 100\% = 17\%$ and $\frac{14}{60} \times 100\% = 23\%$ of the power input required by incandescent lamps respectively. This means that the power sources of appliances using these lamps (e.g. torches) do not have to be recharged or replaced as often as compared to incandescent lamps.	B1 B1
7(f)(ii)	Consider 50k hours of operation:	

Cost	LED	CFL
Electricity	(10 W)(50kh)($0.22 / kWh) = $110.00	(14 W)(50kh)($0.22 / kWh) = $154.00
Lamps	1×($35.95) = $35.95	5×($3.95) = $19.75
Total Cost	$145.95	$173.75

M1

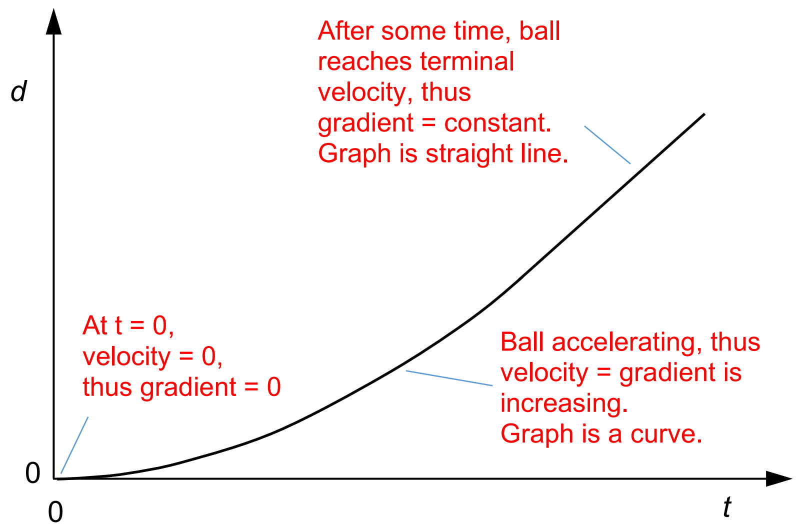
M1

Thus, LED lamps are more cost effective and LTA should proceed with the replacement of all CFLs. A1

7(f)(iii) Incandescent lamps are less efficient and much of the input power is given off as heat. This could melt the snow that would otherwise cover the traffic lights. B1

Paper 3
Longer Structured Questions

Qns	Marks
1(a)	

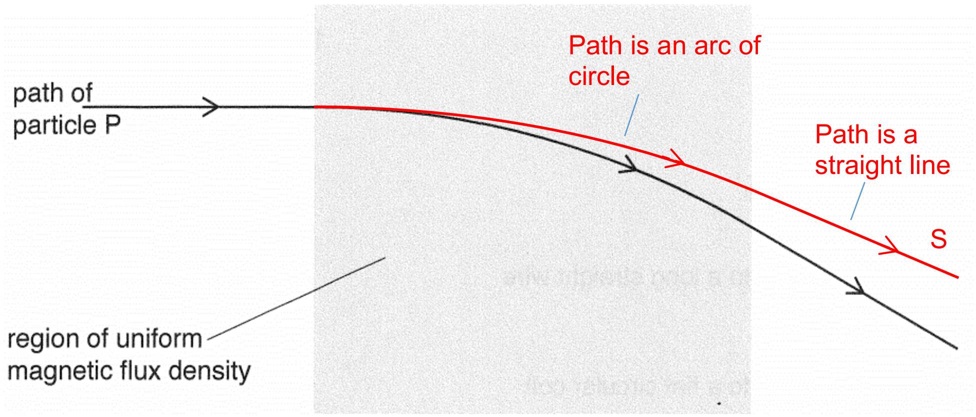


B2

[all 3 correct: 2 m. Any 1 missing: 1 m. Else 0 m.]

Note:
The question explicitly stated that the ball is falling through air, thus air resistance is not negligible. After some time, the ball would have reached terminal velocity.

1(b)

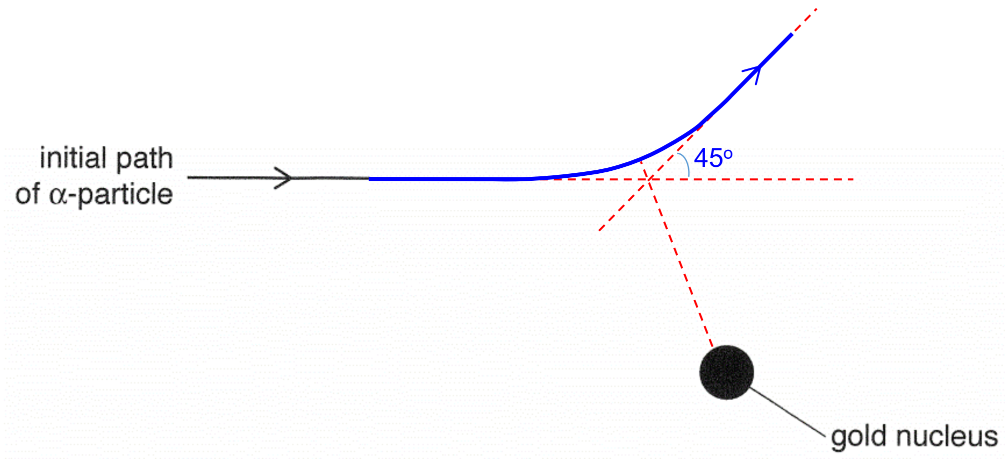


B2

[1 mark for each key part of path]

Note:
In the magnetic field, we have $Bqv = m\frac{v^2}{r} \rightarrow r = \frac{mv}{Bq}$. Thus with twice the speed, particle S would have a path that is an arc of a circle with a larger radius. Once P leaves the magnetic field, its path would be a straight line as there is no longer a magnetic force acting on it.
Candidates are strongly advised to label the different parts of the path with appropriate description.

Qns		Marks
1(c)		

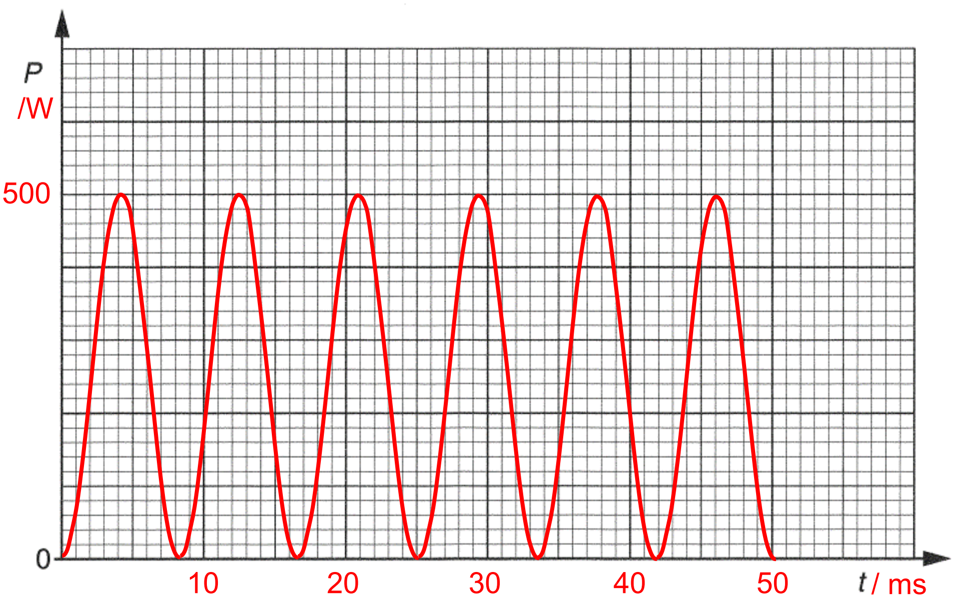


- drawing 2 straight lines joined by a curve in between **B1**
- appropriate positioning of the point of closest approach **B1**

Qns		Marks
2(a)	a region of space where a mass experiences a gravitational force.	B1 B1
2(b)(i)	The diameters of the Sun and Proxima Centauri are about $10^6/10^{13} = 10^{-7}$ and $10^5/10^{13} = 10^{-8}$ times of their separation respectively the two stars can be treated as point masses since their diameters are negligible when compared to their separation **Note:** Newton's law of gravitation applies to point masses. Thus, the need to justify why the two stars can be considered as point masses. Where possible, candidates should quantify their claims in their explanation. For example, finding the ratio of 2 quantities to show that one is very much larger or smaller than the other.	B1
2(b)(ii)	$F = \frac{Gm_1m_2}{r^2}$ $= \frac{(6.67\times10^{-11})(2.0\times10^{30})(2.4\times10^{29})}{(4.0\times10^{13}\times10^{3})^2}$ $= 2.0\times10^{16}$ N	M1 A1
2(c)	$a = \frac{F}{m} = \frac{2.0\times10^{16}}{2.0\times10^{30}} = 1.0\times10^{-14}$ m s^{-2}. Although F is very large, but because the mass of the Sun is also very large, the resulting acceleration of the Sun is negligible. **Note:** By motion, we can mean velocity and/or acceleration. Since the effect of a force on a body is given by Newton's 2nd Law, we discuss acceleration which needs to be worked out.	M1 A1

Qns		Marks
3(a)(i)	$E=(\frac{\Delta V}{d})$	M1
	(where E is Electric field strength, ΔV is the p.d. between the plates, and d is the plate separation.)	
	$F=qE$	
	$=q(\frac{\Delta V}{d})$	
	$=(3.2\times10^{-19})(\frac{900}{3.6\times10^{-2}})$	M1
	$=8.0\times10^{-15}$ N	A0
3(a)(ii)	$a=\frac{F}{m}$	
	$=\frac{8.0\times10^{-15}}{6.6\times10^{-27}}$	M1
	$=1.2\times10^{12}$ m s^{-2}	A1
3(b)	$+\rightarrow$: $s_x=u_xt$	
	$t=\frac{s_x}{u_x}$	
	$=\frac{7.5\times10^{-2}}{4.1\times10^{5}}=1.8\times10^{-7}$ s	C1
	$+\downarrow$: $s_y=u_yt+\frac{1}{2}a_yt^2$	
	$=0+\frac{1}{2}(1.2\times10^{12})(1.8\times10^{-7})^2$	
	$=1.9\times10^{-2}$ m	C1
	The particle could have a vertical displacement of 1.9 cm downwards. This is more than 3.6/ 2 = 1.8 cm, the vertical distance to the lower plate. Thus, the particle would collide with the lower plate.	A1

Qns		Marks
4(a)(i)	the force per unit length per unit current	B1
	acting on a conductor carrying a current	B1
	placed at right angle to the magnetic field.	B1
4(a)(ii)	product of the magnetic flux density normal to the loop, the area of the loop	B1
	and the number of turns of wire in the loop.	B1
	Note: It is not acceptable to just write that magnetic flux linkage is the "product of magnetic flux and number of turns", without defining magnetic flux.	
4(b)	When the switch is closed, a direct current (dc) flows in the coil and increases from zero to a steady value. Current sets up increasing magnetic flux through the aluminium ring.	B1
	By Faraday's Law, the increasing flux linkage through the ring induces e.m.f. in the ring.	B1
	The ring is a closed conducting path, induced current flows in the ring.	B1
	By Lenz's Law, the induced current produces a magnetic field opposite in direction to the coil's field to oppose the increasing flux. This results in a repulsive force causing the ring to jump up vertically.	B1
	Note: It is the induced current and not the induced e.m.f. that gives rise to the opposing magnetic field in the ring. Therefore, it must first be established that there is induced current flow, else there would only be induced e.m.f. but no repulsive force.	
4(c)	When the switch is closed, the same e.m.f. is induced in the ring. However, since the ring is an insulator, there is no induced current in the ring to set up the opposing magnetic field. Thus, there is no repulsive force on the ring.	M1
	The ring will not move.	A1
	Note: There is still induced e.m.f. even though the ring is an insulator.	

Qns		Marks
5(a)	the value of a steady direct current that will dissipate heat at the same average rate in a given resistor	B1 B1
	Note: It is the rate of heating/ energy dissipation that must be considered and that the heating takes place in a resistor.	
5(b)(i)	$V_{rms} = \frac{V_o}{\sqrt{2}} = \frac{170}{\sqrt{2}} = 120 \text{ V}$	B1
5(b)(ii)	$f = \frac{\omega}{2\pi} = \frac{377}{2\pi}$ $= 60.0 \text{ Hz}$	M1 A1
5(b)(iii)	$\langle P \rangle = \frac{(V_{rms})^2}{R}$ $= \frac{120^2}{58} = 250 \text{ W}$	M1 A1
5(c)		
	$P_o = 2\langle P \rangle = 2(2.5 \times 10^2) = 500 \text{ W}$ Period for alternating p.d., $T = \frac{1}{f} = \frac{1}{60.0} = 16.7 \text{ ms}$	
	• Correct shape (smooth sine-squared graph) • axes clearly labelled correctly with units and values • At least 4 cycles of power curve drawn	B1 B1 B1

Qns		Marks
6(a)	a discrete packet of energy of electromagnetic radiation energy of each photon = *Planck constant* × *frequency*	M1 A1
6(b)(i)	$E = \frac{hc}{\lambda} = \frac{(6.63\times10^{-34})(3.00\times10^{8})}{(680\times10^{-9})}$ $= 2.9\times10^{-19}$ J	M1 A1
6(b)(ii)	Intensity $I = \frac{P}{A} = \frac{NE}{tA}$ $\frac{N}{t} = \frac{IA}{E}$ $= \frac{(3.1\times10^{3})\left[\pi\left(\frac{1.2\times10^{-3}}{2}\right)^{2}\right]}{2.9\times10^{-19}}$ $= 1.2\times10^{16}$ s^{-1}	M1 M1 A0
6(c)	Momentum of each photon, $p = \frac{h}{\lambda} = \frac{6.63\times10^{-34}}{680\times10^{-9}} = 9.75\times10^{-28}$ N s Take upward direction as positive. In the normal direction, we have: By Newton's 2nd Law, Force = $\frac{N}{t}(p_f - p_i)$ Force of surface on reflected photons = $0.55\left(\frac{N}{t}\right)\left[(+p\cos52^o)-(-p\cos52^o)\right] = 1.10\left(\frac{N}{t}\right)p\cos52^o$ N Force of surface on absorbed photons = $0.45\left(\frac{N}{t}\right)\left[0-(-p\cos52^o)\right] = 0.45\left(\frac{N}{t}\right)p\cos52^o$ N Total force of surface on photons $= 1.10\left(\frac{N}{t}\right)p\cos52^o + 0.45\left(\frac{N}{t}\right)p\cos52^o$ $= 1.55\left(\frac{N}{t}\right)p\cos52^o$ $= 1.55(1.2\times10^{16})(9.75\times10^{-28})\cos52^o$ $= 1.1\times10^{-11}$ N By Newton's 3rd Law, |Force of photons on surface| = |force of surface on photons| = 1.1×10^{-11} N	M1 M1 M1 M1 M1 A1

Qns		Marks
7(a)(i)	When the ***activity* of a radioactive sample is measured** (e.g. using a GM counter) under constant external conditions at any instant in time, the count rate always fluctuates (rise and fall irregularly).	B1
	Note: The answer requires an experimental observation, not a definition.	
7(a)(ii)	The ***half-lives*** of similar radioactive samples of the same nuclei measured under different external conditions such as pressure and temperature are the same.	B1
	Note: The answer requires an experimental observation, not a definition.	
7(b)(i)	From graph, activity dropped from 5.8×10^5 s^{-1} to 0.9×10^5 s^{-1} in first 40 days	M1
	$A = A_o e^{-\lambda t}$ $0.9\times10^5 = 5.8\times10^5 e^{-\lambda(40\times24\times60\times60)}$	M1
	$\lambda = 5.39\times10^{-7}\ \text{s}^{-1} \approx 5.3\times10^{-7}\ \text{s}^{-1}$	A1
	OR	
	After 2 half-lives, A = $\dfrac{5.8\times10^5}{4} = 1.45\times10^5\ \text{s}^{-1}$	(M1)
	From the graph, *t* = 30 days Half-life = 30/2 = 15 days	(M1)
	$\lambda = \dfrac{\ln 2}{15\times24\times60\times60} = 5.34\times10^{-7}\ \text{s}^{-1} \approx 5.3\times10^{-7}\ \text{s}^{-1}$	(A1)
7(b)(ii)	$A_o = \lambda N_o$ $5.8\times10^5 = 5.3\times10^{-7} N_o$ $N_o = 1.094\times10^{12}$	M1
	$M = N_o \times 32u$ $= (1.094\times10^{12})(32\times1.66\times10^{-27})$ $= 5.8\times10^{-14}\ \text{kg} = 5.8\times10^{-11}\ \text{g}$	A1
	OR	
	$M = \dfrac{M_m}{N_A} N_o$ $= \dfrac{32}{6.02\times10^{23}}(1.094\times10^{12})$ $= 5.8\times10^{-11}\ \text{g}$	(A1)

Qns		Marks
8(a)(i)	sum of the kinetic energy due to the random motion of a distribution of molecules	B1
	and potential energy due to intermolecular forces between the molecules	B1
8(a)(ii)	$+q$ heat supplied to a system	B1
	$+W$ work done on a system	B1
8(b)(i)	A gas that obeys the equation of state $PV = nRT$	B1
	at all values of pressure p, volume V, amount of gas in moles n, and thermodynamic temperature T.	B1
	Note: All symbols used must be defined.	
8(b)(ii)1	$pV = NkT$	M1
	$(5.4\times10^{5})(1.2\times10^{4}\times10^{-6}) = N(1.38\times10^{-23})(57+273.15)$	M1
	$N = 1.4\times10^{24}$	A1
8(b)(ii)2	$\langle KE\rangle_{molecule} = \frac{3}{2}kT$	
	$= \frac{3}{2}(1.38\times10^{-23})(57+273.15)$	M1
	$= 6.8\times10^{-21}$ J	A1
8(b)(ii)3	For an ideal gas, there is no potential energy for the molecules. Thus,	M1
	$U = N\langle KE\rangle_{molecule}$	
	$= (1.4\times10^{24})(6.8\times10^{-21})$	
	$= 9.5\times10^{3}$ J	A1
8(c)(i)	$\Delta U = N\Delta\langle KE\rangle_{molecule} = N(\frac{3}{2}k\Delta T)$	M1
	$= (1.4\times10^{24})\frac{3}{2}(1.38\times10^{-23})(155-57)$	C1
	$= 2.8\times10^{3}$ J	A1
8(c)(ii)1	Since increase in internal energy = (+q) + (+w), (+w) must be zero.	B1
	So the volume of the gas must be constant.	B1

Qns		Marks
8(c)(ii)2	From **8(c)(i)** and **8(c)(ii)1**, 2.8×10^3 J of thermal energy is required to increase the temperature of *n* moles of the gas from 57 °C to 155 °C.	
	From **8(b)(ii)1**, $n = \frac{N}{N_A} = \frac{1.4 \times 10^{24}}{6.02 \times 10^{23}} = 2.33$	
	$C = \frac{q}{n\Delta T}$	**M1**
	$= \frac{2.8 \times 10^3}{(2.33)(155 - 57)} = 12.3 \text{ J mol}^{-1} \text{ K}^{-1}$	**A1**
	OR	
	$C = \frac{q}{n\Delta T}$	
	$= \frac{\Delta U}{n\Delta T}$ (since $\Delta U = q$ from **8(c)(ii)1**.)	
	$= \frac{\left(\frac{3}{2} nR\Delta T\right)}{n\Delta T} = \frac{3}{2}R$	**(M1)**
	$= \frac{3}{2}(8.31) = 12.5 \text{ J mol}^{-1} \text{ K}^{-1}$	**(A1)**

Qns | **Marks**

9(a)(i) acceleration (of an object) is always directed opposite to the direction of the displacement (**OR** directed towards equilibrium point) and **B1**

directly proportional to its displacement from the equilibrium position. **B1**

9(a)(ii)1 There are both positive and negative displacements. **B1**

Note:
The question expects candidates to use the features of the graph in their explanation.

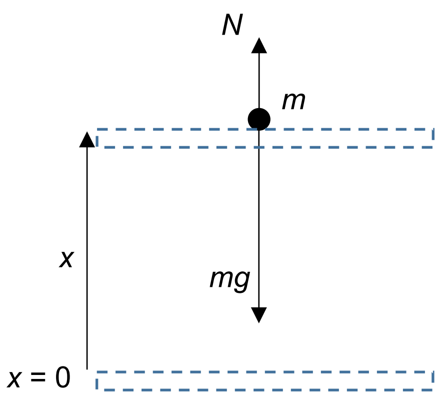
9(a)(ii)2 The graph is curved and not a straight-line graph passing through the origin, thus a is not proportional to x. **B1**

Note:
Use the features of the graph in the explanation.

9(b)(i)1 Amplitude at the upper position (or Maximum height). **A1**

Note:
"At maximum amplitude" is not acceptable. There are 2 possible maximum amplitude positions hence the need to be specific.

9(b)(i)2



F = ma

$mg - N = ma$

$= m(\omega^2 x)$ **M1**

When contact is lost,

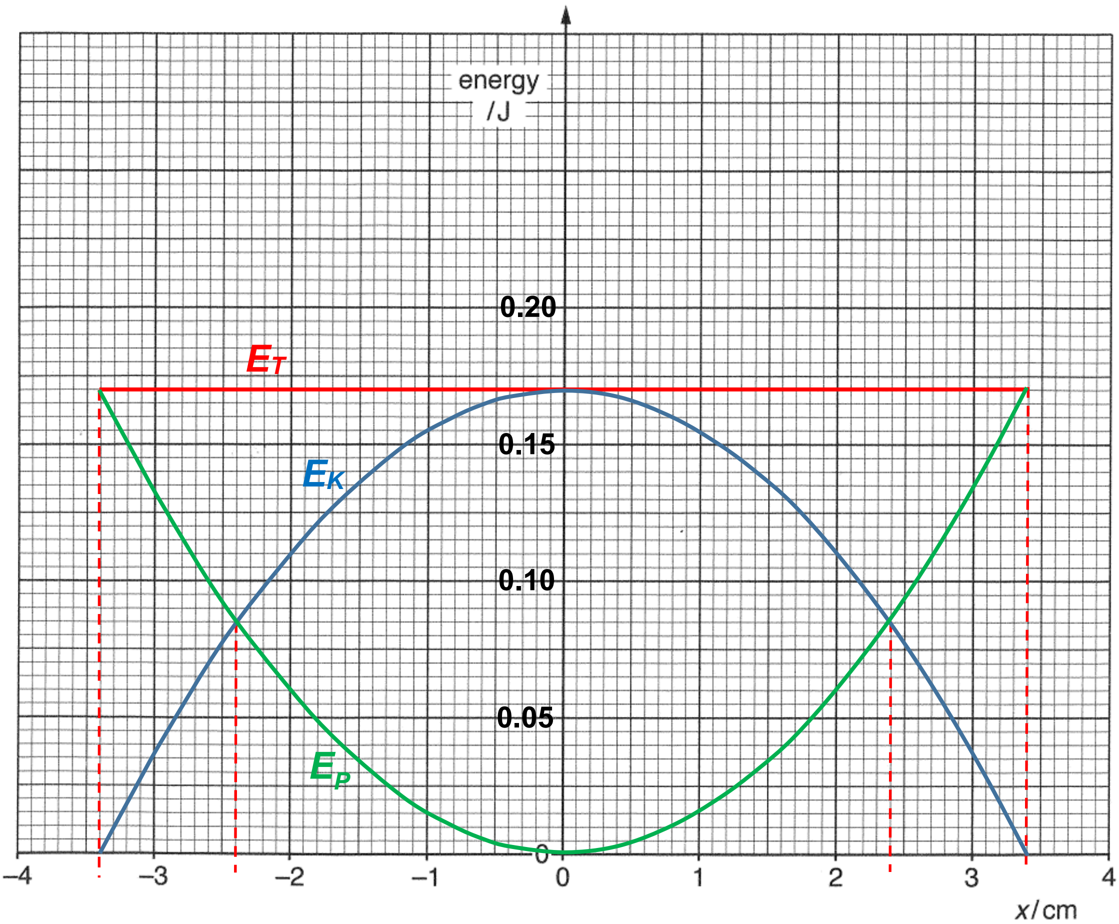
$N = 0 \rightarrow x = \frac{g}{\omega^2}$ **M1**

When ω is constant and x_o increased gradually, contact would first be lost when

$x_o = \frac{g}{\omega^2} = \frac{9.81}{(2\pi \times 13)^2}$

$= 1.47 \times 10^{-3}$ m $= 1.47$ mm **A1**

9(b)(ii) A pebble has a larger mass m. However, the minimum amplitude x_o for which the pebble loses contact with the platform is given by $x_o = \frac{g}{\omega^2}$ which is independent of m. Thus, x_o would be the same. **M1** **A1**

Qns		Marks
9(c)(i)1	$E_T = (E_K)_{max}$	
	$= \frac{1}{2}mv_o^2 = \frac{1}{2}m\omega^2 x_o^2$	M1
	$= \frac{1}{2}(1.2)(2\pi \times 2.5)^2(3.4 \times 10^{-2})^2$	
	$= 0.17$ J	A1
9(c)(i)2	When $E_K = E_P$,	
	$E_T = E_P + E_K = 2E_K$	
	$(E_K)_{max} = 2E_K$	
	$\frac{1}{2}m\omega^2 x_o^2 = 2\left(\frac{1}{2}m\omega^2(x_o^2 - d^2)\right)$	M1
	$d = \frac{x_o}{\sqrt{2}} = \frac{3.4}{\sqrt{2}} = 2.4$ cm	A1
9(c)(ii) 1,2,3		

- Energy axis clearly labelled — B1
- Shape of *KE* and *PE* graphs quadratic, smooth curve — B2
- *KE* and *PE* graphs intercept at $x = \pm 2.4$ cm — B1
- *TE* at 0.17 J — B1
- All graphs from x = –3.4 cm to +3.4 cm — B1