H2 PHYSICS

9646

SUGGESTED SOLUTIONS

November 2015

Paper 1
Multiple Choice

Question	*Key*	*Question*	*Key*
1	**A**	21	**C**
2	**D**	22	**D**
3	**C**	23	**B**
4	**A**	24	**B**
5	**C**	25	**A**
6	**A**	26	**B**
7	**D**	27	**B**
8	**C**	28	**B**
9	**A**	29	**D**
10	**C**	30	**B**
11	**B**	31	**B**
12	**A**	32	**D**
13	**D**	33	**B**
14	**A**	34	**C**
15	**A**	35	**C**
16	**A**	36	**A**
17	**C**	37	**C**
18	**C**	38	**A**
19	**C**	39	**D**
20	**B**	40	**B**

Notes
Q4: mass of tanker and water is decreasing.
Q11: the minute hand completes a revolution in 1 hour, not 1 minute *(that's the second hand)
Q18: there has to be a 180 degree phase change after reflection.
Q20: RS wave will always have a component in that direction and will not be stationary.
Q28: ammeter is only reading half the current output from cell.
Q36: need to determine initial uncertainties.

Paper 2
Structured Questions

Question		Marks
	Notes Qns is not straightforward because force acting on mass is not same as time progresses. Must be reminded that force is directly proportional to extension and not the full length of spring. The types of energy involved are GPE, KE and EPE.	
1(a)	natural length $x_0 = 40$ cm	
	when M = 300 g, equilibrium length x = 60 cm	
	$F = k\left(x - x_0\right) = Mg$	
	$k = \dfrac{Mg}{x - x_0}$	M1
	$\left[= \dfrac{(0.300)(9.81)}{(60-40)\times 10^{-2}} = 14.715 \text{ Nm}^{-1} \right]$	
	elastic potential energy = $\dfrac{1}{2}k\left(x - x_0\right)^2 = \dfrac{1}{2}(14.715)\left[(70-40)\times 10^{-2}\right]^2$	
	$= 0.662$ J	A1
	Notes Cannot assume constant force from spring, and to work in terms of extension.	
1(b)(i)	on release, before passing through equilibrium position GPE is converted to KE + Elastic PE	B1
	After passing through equilibrium position as mass reaches lowest point, GPE + KE is converted to Elastic PE	B1
	Notes Markers noted confusion between zero GPE vs minimum GPE at lower point.	
1(b)(ii)	By PCE, decrease in GPE is gain in KE and gain in Elastic PE	B1
	$mg\Delta h = \dfrac{1}{2}mv^2 + \text{Elastic PE}$	M1
	$v = \sqrt{\dfrac{2\left(mg\Delta h - \text{Elastic PE}\right)}{m}}$	C1
	$= \sqrt{\dfrac{2\left((0.3)(9.81)(0.3) - 0.662\right)}{0.3}}$	
	$= 1.21 \text{ ms}^{-1}$	A1
	Notes Do not ignore lose in GPE. KE must be positive.	

Question		Marks
1(b)(iii)	By PCE, decrease in GPE is gain in Elastic PE	B1
	$mg\Delta h = \frac{1}{2}k(\Delta h)^2$	M1
	$\Delta h = \frac{2mg}{k}$	
	$= \frac{2(0.300)(9.81)}{14.715}$	
	$= 0.400$ m	A1
	Notes: Do not use kinematics equations (they only work for constant acceleration).	
2(a)	$\text{gradient} = \frac{y_1 - y_2}{x_1 - x_2}$	
	$= \frac{2.5 - 1.25}{12 - 6}$	M1
	$\left[= 0.208\ I\text{V}^{-1}\right]$	
	to find y-intercept c:	
	$\frac{y_1 - c}{x_1 - 0} = \frac{2.5 - 1.25}{12 - 6}$	
	$c = 1.25 - (6)\left(\frac{2.5 - 1.25}{12 - 6}\right)$	
	$= 0$	A1
	plot of I against V is a straight line with uniform gradient 0.208 and passes through origin, I is proportional to V	A0
2(b)(i)	resistance	
	$R = \frac{V}{I}$	
	$= \frac{12}{2.5} = 4.8\ \Omega$	A1
2(b)(ii)1.	$I_\text{A} = \frac{V}{R_A + R_5}$	
	$= \frac{12}{4+5} = 1.3$ A	A1
2(b)(ii)2.	$I_X = \frac{V}{R_X + R_Y}$	
	$= \frac{12}{4.8 + 2.7} = 1.6$ A	A1
2(b)(iii)	$\Delta V_\text{AC} = (I_A)\left[\left(\frac{75}{100}\right)R_{AB}\right]$	
	$= (1.3)\left(\frac{75}{100}\right)(4) = 3.9$ V	M1

Question		Marks
	$\Delta V_{AD} = (I_X)(R_X)$ $= (1.6)(4.8) = 7.7\text{ V}$	M1
	$\Delta V_{CD} = 7.7 - 3.9 = 3.8\text{ V}$	A1
	Notes Need to be clear between p.d. across resistor vs potential at a point.	
	Notes The explanations for Q3 were challenging to some candidates. A learning point here is that explanations in terms of **energy** is important.	
3(a)	a single discrete packet of energy of electromagnetic radiation is absorbed by an electron at the surface of M.	B1
	if the energy absorbed is at least the work function of M, electron will be emitted with minimum amount of kinetic energy	B1
	Notes Examiners were on the look-out for explanations that discuss energy changes. It was insufficient to refer to EM radiation or threshold frequency.	
3(b)(i)	electrons with the most kinetic energy loses all their kinetic energy as electric potential energy in the electric field between M and C. Zero current as no electrons reach C.	B1
	Notes Insufficient to explain the meaning of stopping potential in genera. Need to apply to the situation and discuss the energy changes from max KE to EPE.	
3(b)(ii)	Positive plate is collecting all emitted electrons giving rise to maximum current value. Rate of emission of electrons at M is limited by the number of photons reaching M.	B1
	Notes Need to answer question in terms of why current is constant despite p.d. becoming positive.	
3(c)	$KE_{max} = hf - \Phi$	
	$f = \dfrac{KE_{max} + \Phi}{h} = \dfrac{eV_s + \Phi}{h}$	M1
	$= \dfrac{2.2e + 1.8e}{6.63 \times 10^{-34}} = \dfrac{4(1.6 \times 10^{-19})}{6.63 \times 10^{-34}}$ $= 9.65 \times 10^{14}\text{ Hz}$	A1

Question		Marks
3(d)	graph stretched vertically upwards by factor of 2	B1
	same V_s	B1
4(a)	$a_c = r\omega^2 = r\left(\frac{2\pi}{T}\right)^2$	
	$= \left(4.22\times10^5\times10^3\right)\left(\frac{2\pi}{1.53\times10^5}\right)^2$	M1
	$= 0.712\ \text{m s}^{-2}$	A1
4(b)(i)	Only force acting on Amalthea is the gravitational force by Jupiter and acts in same direction as the centripetal force. Gravitational field strength g is gravitational force per unit pass so the net force $F_{\text{net}} = mg$	B1
	By N2L, the gravitational force results in the rate of change of momentum of Amalthea that takes place in the direction of the gravitational force. Amalthea's mass is constant so net centripetal acceleration a_c is net force per unit mass: $F_{\text{net}} = \frac{dp}{dt} = m\frac{dv}{dt} = ma_c$	B1
4(b)(ii)	gravitational field strength provides centripetal acceleration	
	$\frac{GM_{\text{Jupiter}}}{r^2} = g = a_c$	M1
	$r = \sqrt{\frac{GM_{\text{Jupiter}}}{a_c}}$	
	$\frac{r_{\text{Io}}}{r_{\text{Amalthea}}} = \sqrt{\frac{a_{\text{Amalthea}}}{a_{\text{Io}}}} = \sqrt{\frac{3.87}{0.712}} = 2.33$	A1
5(a)(i)	$F_E = qE = (2e)E$	
	$= (2)(1.60\times10^{-19})(1.5\times10^5)$	
	$= 4.8\times10^{-14}\ \text{N}$	A1

Question		Marks
5(a)(ii)	$\left\|F_E\right\| = \dfrac{1}{4\pi\varepsilon_0}\dfrac{\left\|Q_A Q_B\right\|}{r^2} = \dfrac{1}{4\pi\varepsilon_0}\dfrac{\left\|(+2e)(-2e)\right\|}{r^2}$	M1
	$= \dfrac{1}{4\pi(8.85\times10^{-12})}\dfrac{(2)(1.60\times10^{-19})(2)(1.60\times10^{-19})}{(4.0\times10^{-12})^2}$	M1
	$= 5.8\times10^{-5}$ N	A1
	Notes Common mistake was to leave out the square for the separation.	
5(b)	[from (a)(i)] A and B have same amount of charge in opposite polarities. They each experience an electric force that is equal in magnitude but opposite in direction when subject to the same external uniform electric field.	M1
	[from (a)(ii)] By N3L, the electrostatic forces between A and B are equal and opposite. The forces are internal within the molecule.	M1
	vector sum of forces acting *within* and *on* molecule AB is zero	A0
	Notes Need to take the hint from the earlier part of the question and discuss forces within (internal to the) molecule as well as external forces acting on the moledule.	
5(c)	$\tau = Fd_{\perp} = F\left(d\sin60°\right)$	M1
	$= (4.8\times10^{-14})\left[(4.0\times10^{-12})(\sin60°)\right]$	
	$= 1.7\times10^{-25}$ N m	A1
6(a)	${}^{128}_{53}\mathrm{I} \rightarrow {}^{0}_{-1}\beta + {}^{128}_{54}\mathrm{D}$	
6(b)	Assume no background count,	
	$C = C_0 e^{-\lambda t}$	M1
	$\dfrac{175}{28} = \dfrac{e^{-\lambda(2000)}}{e^{-\lambda(6000)}}$	
	$\left(\ln\left(\dfrac{28}{175}\right)\right) = -4000\lambda = -4000\left(\dfrac{\ln 2}{t_{\text{half}}}\right)$	
	$t_{\text{half}} = \dfrac{-4000(\ln 2)}{\ln\left(\dfrac{28}{175}\right)}$	M1
	$= 1510$ s	A1

Question	**Marks**

7(a)

$$y = kMgl^r b^{-1} d^s$$

$$\frac{y_1}{y_2} = \left(\frac{d_1}{d_2}\right)^s$$

$$\ln\left(\frac{y_1}{y_2}\right) = s\left[\ln\left(\frac{d_1}{d_2}\right)\right]$$

$$= s\left[\ln\left(\frac{5.00\times10^{-3}}{6.00\times10^{-3}}\right)\right] = -s\left[\ln(1.2)\right]$$

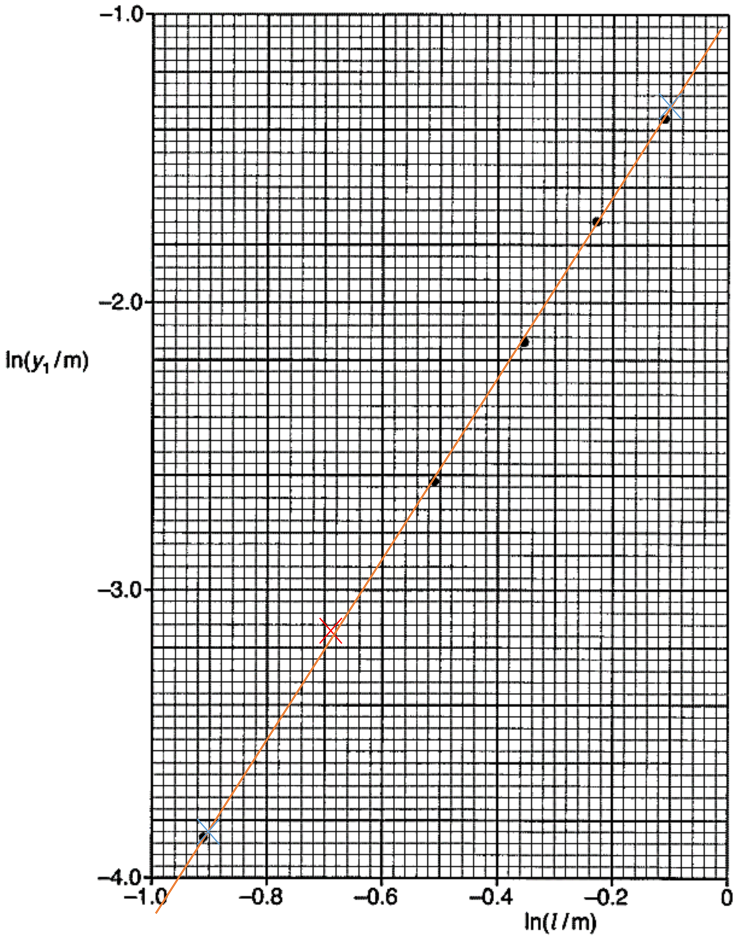
$$s = -\frac{\ln\left(\frac{y_1}{y_2}\right)}{\ln(1.2)}$$

y_1/m	y_2/m	l/m	$\ln(y_1/\text{m})$	$\ln(l/\text{m})$	s
0.257	0.148	0.900	−1.359	−0.105	-3.0269
0.178	0.103	0.800	−1.726	−0.223	-3.0004
0.118	0.068	0.700	−2.137	−0.357	-3.0231
0.073	0.042	0.600	−2.617	−0.511	-3.0319
0.042	0.024	0.500			-3.0693
0.021	0.012	0.400	−3.863	−0.916	-3.0693

s is -3 to 1 s.f.

7(a)(ii) $\ln(y_1 / \text{m}) = -3.170$ $\ln(l / \text{m}) = -0.693$

7(a)(iii)



Question		Marks
7(a)(iv)	gradient $= \dfrac{y_1 - y_2}{x_1 - x_2}$ $= \dfrac{-1.4-(-3.8)}{-0.1-(-0.9)}$ $= 3.00$	M1 A1
7(a)(v)	k, M, g, d, and b are constant, $y = kMgl^{r}b^{-1}d^{s}$ $\ln y_1 = r\ln l + \ln\left(\dfrac{kMgd^{s}}{b}\right)$ plot of y_1 against l is a straight line with gradient r, y-intercept $\ln\left(\dfrac{kMgd^{s}}{b}\right)$ graph supports the expression. **Notes** Answers need to go beyond what is to be expected after taking log on both side of the given equation, and to compare with the graph that drawn.	
7(a)(vi)	r is gradient of graph, is integer value of 3	
7(b)	gradient $= \dfrac{y_1 - y_2}{x_1 - x_2} = \dfrac{y_1 - c}{x_1 - 0}$ $\dfrac{-1.4-(-3.8)}{-0.1-(-0.9)} = \dfrac{-1.4-c}{-0.1}$ $c = -1.1$ y-intercept c = -1.1= $\ln\left(\dfrac{kMgd^{s}}{b}\right)$ $k = \dfrac{e^{c}b}{Mgd^{s}}$ $= \dfrac{e^{-1.1}(3\times10^{-2})}{(0.5)(9.81)(5\times10^{-3})^{-3}}$ $= 2.54\times10^{-10} \approx 3\times10^{-10}$	
7(c)(i)	$\dfrac{b}{kMgd^{s}}$ is constant acceleration a is directly proportional to displacement from equilibrium x negative sign implies that direction of acceleration a is opposite to displacement x	A1

Question		Marks
7(c)(ii)	$a = -\omega^2 x = -\dfrac{b}{kMd^s l^r}x$	
	$\omega = \sqrt{\dfrac{b}{kMd^s l^r}} = \dfrac{2\pi}{T}$	
	$T = \dfrac{2\pi}{\sqrt{\dfrac{b}{kMgd^s l^r}}}$	
	$= \dfrac{2\pi}{\sqrt{\dfrac{3\times10^{-2}}{(3\times10^{-10})(0.5)(5\times10^{-3})^{-3}0.6^3}}}$	M1 A1
	$= 0.584$ s	
8	bulb of lamp fully submerged into beaker of water, thermometer held in place by retort stand, boss and clamp [can be written or drawn in well-labelled diagram]	P1
	voltmeter in parallel with lamp power source and ammeter in series with lamp method to vary p.d. across lamp (eg benchtop power supply, potentiometer with rheostat [can be written or drawn in well-labelled diagram]	P2
	measure time *t* from time when power is supplied, record current *I* and p.d. *V*	V1
	measure mass of water *m* using weighing balance measure initial and final leading to change in temperature of water Δ*T* using thermometer	V2
	Repeat experiment at least 5 other times varying *V*	P3
	calculate thermal energy *Q* = *mc*Δ*T* calculate electrical energy *E* = *IVt* calculate $\eta = 1 - \dfrac{Q}{E}$	D1
	linearization and appropriate graph (eg $\ln\eta = b\ln V + \ln a$ so $\ln\eta$ against $\ln V$)	D2
	finding constants *a* and *b* (eg *b* = gradient and ln *a* from y-intercept)	D3
	keep set up at thermal equilibrium with surroundings by leaving set up to cool for long time after each heating run suitable measure/method to keep supplied power constant (any 1)	K1
	use glove / pair of tongs to handle hot filament lamp suitable measure to prevent water touching electrical circuit (any 1)	X1

Question		Marks
	Details (any 2) Stirring of water to prevent localized heating Electrical circuit is switched on for a sufficiently long duration to ensure a measurable change in temperature (Δθ). Any suitable method to monitor and obtain an average value for current (I) and potential difference (V). Records the highest temperature attained after the circuit is opened to account for residual heating. Reducing heat transfer to the surrounding by ensuring that final temperature is not too high or using suitable heat insulation. Any suitable method to account for or reduce evaporation loss.	Q2

Notes

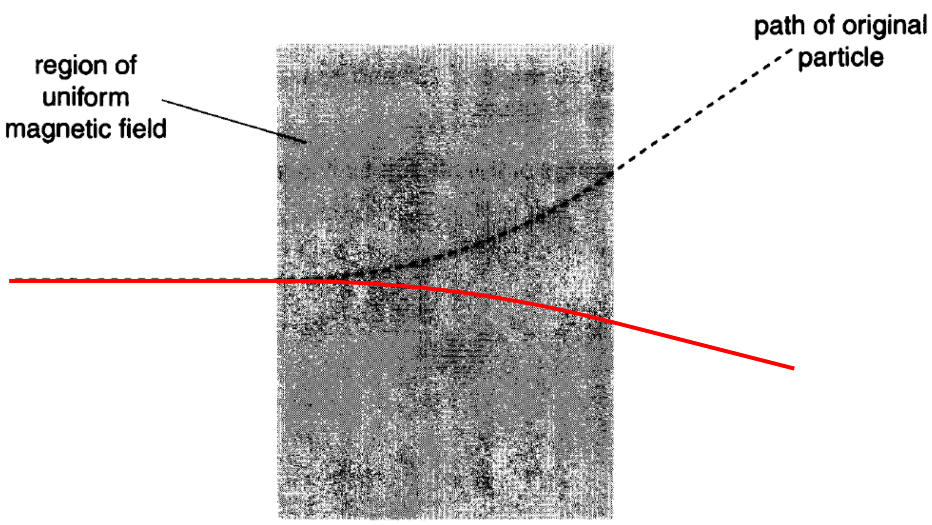
Need to draw proper circuit diagram that involved ammeter and voltmeter.
Most were able to discuss measuring p.d. and current but many failed to measure mass of water; measuring the mass is preferred over measuring the volume.

The time elapsed is necessary to find out the total energy supplied.

The main safety that examiners were looking out for were the use of safety gloves or tongs when adjusting/moving the heated container of liquid. If candidates used batteries, it would be irrelevant to discuss the risk of electrocution.

Paper 3
Longer Structured Questions

Question		Marks
1(a)	no resultant force acting on body in any direction	B1
	no resultant moment acting on body about any point	B1
	Notes	
	Need to handle both translational and rotational equilibrium. Also need to mention either ‘resultant’ or ‘net’	
1(b)(i)	constant speed therefore zero acceleration	M1
	by N2L, rate of change of momentum of a body is directly proportional to resultant force acting on body.	M1
	for a body of constant mass, net force is directly proportional to acceleration and is zero	
	no net force so ball is in translational equilibrium	A0
1(b)(ii)	gravitational force of Earth on satellite provides centripetal force	M1
	centripetal force is net force, causing acceleration of satellite towards centre of Earth continuously	M1
	satellite experiences net force so not in translational equilibrium	A0
	Notes	
	need to start off with grav force providing centripetal force	
2(a)	$\lambda = \frac{ax}{D}$	
	$= \frac{(0.95\times10^{-3})(1.4\times10^{-3})}{2.1}$	
	$= 6.33\times10^{-7}$ m	
2(b)	same fringe separation	B1
	bright fringe less bright	M1
	dark fringes brighter	M1
	contrast between fringes decreases	A0
	Notes	
	need to treat the changes in separation, bright fringes and dark fringes separately	
2(c)	reduced spreading of waves due to diffraction	M1
	waves from both slits no longer overlap on screen	A1

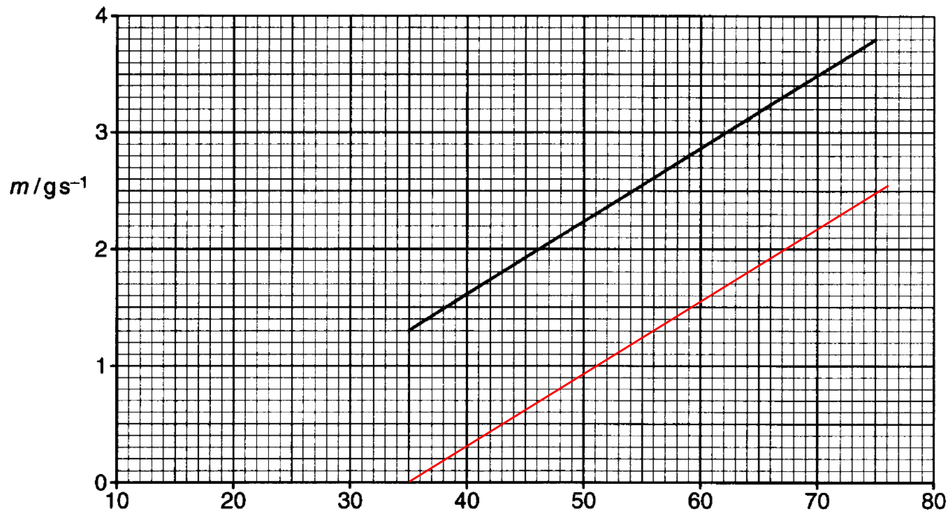
Question		Marks
3(a)	$R_{\text{total}} = \frac{V}{I} = \frac{6}{1.6\times10^{-3}} = 3750\ \Omega$ $R_{\text{thermistor}} = 3750 - 1.5\times10^{3} = 2250\ \Omega$ $\theta = 14°\text{C}$	
3(b)	resistance of thermistor decreases as temperature rises, total circuit resistance decreases so current increases heating effect due to increased current, causing greater rise in temperature of thermistor and resulting in exponential increase in current and heating	M1 A1
4(a)	when a long straight wire carrying a current of 1A is placed normal to a uniform magnetic flux experiences a force per unit length of 1 N m^{-1}	M1 A1
4(b)(i)	magnetic force always normal to velocity constant momentum, KE constant, speed constant, magnitude of magnetic force constant so magnetic force provides centripetal force	M1 M1 A0
4(b)(ii)	magnetic force provides centripetal force $Bqv = \frac{mv^2}{r}$ $r = \frac{mv}{Bq} = \frac{p}{Bq}$ $p = rBq = \left(6.2\times10^{-2}\right)\left(0.24\right)\left(1.6\times10^{-19}\right)$ $= 2.38\times10^{-21}$ N s	M1 M1 A1
4(c)	 deflection direction reversed larger radius / less deflection curvature only within magnetic field, straight lines outside field	B1 B1

Question		Marks
5(a)	a discrete packet of electromagnetic radiation energy given by $E = hf$	B1
5(b)(i)	$E = hf = \dfrac{hc}{\lambda}$ $\Delta E = hc\left(\dfrac{1}{\lambda_{\text{final}}} - \dfrac{1}{\lambda_{\text{initial}}}\right)$ $= (6.63\times10^{-34})(3\times10^{8})\left(\dfrac{1}{966.8\times10^{-12}} - \dfrac{1}{965.0\times10^{-12}}\right)$ $= -3.84\times10^{-19}$ J	
5(b)(ii)	by PCE, loss in photon energy = gain in KE of electron	M1
	$E_K = \dfrac{p^2}{2m}$ $p = \sqrt{2m_eE_K} = \sqrt{2(9.11\times10^{-31})(3.84\times10^{-19})}$	M1
	$= 8.36\times10^{-25}$ N s	A0
	Notes This is a “show question. The final answer is already provided. So presentation is very important. Need to write out the statement in full involving energy change – cannot represent merely using symbols. Full substitution expected.	

Question		Marks
5(c)(i)	By PCLM, sum of final vertical momenta = initial = 0	B1
	$\left\|p_{\text{deflected photon}} \sin 75°\right\| = \left\|p \sin\alpha\right\|$ ... (1)	M1
	By PCLM, sum of final horizontal momenta = initial	B1
	$p_{\text{incident photon}} = p_{\text{deflected photon}} \cos 75° + p\cos\alpha$	
	$p\cos\alpha = p_{\text{incident photon}} - p_{\text{deflected photon}} \cos 75°$ ... (2)	M1
	$\tan\alpha = \frac{(1)}{(2)} = \frac{p_{\text{deflected photon}} \sin 75°}{p_{\text{incident photon}} - p_{\text{deflected photon}} \cos 75°}$	
	$\alpha = \tan^{-1}\left(\frac{p_{\text{deflected photon}} \sin 75°}{p_{\text{incident photon}} - p_{\text{deflected photon}} \cos 75°}\right)$	
	$= \tan^{-1}\left(\frac{\frac{h}{\lambda_{\text{final}}}\sin 75°}{\frac{h}{\lambda_{\text{initial}}} - \frac{h}{\lambda_{\text{final}}}\cos 75°}\right) = \tan^{-1}\left(\frac{\frac{1}{966.8}\sin 75°}{\frac{1}{965} - \frac{1}{966.8}\cos 75°}\right)$	
	$= 52.4°$	A1
	Notes need to state that momentum is conserved (i) 90 degree to and (ii) along direction of the incoming photon	
6(a)(i)	rate of change of velocity with respect to time takes place in the direction of change in velocity	B1
6(a)(ii)	Earth's gravitational field lines are radial from centre of Earth height above Earth's surface is small compared to Earth's large radius so at surface, field lines are approximately parallel implying constant field strength By N2L, force per unit mass is directly proportional to acceleration of unit mass $F = mg = ma$	
6(b)(i)	steel ball is much denser than air so <u>cross-sectional area</u> of ball is very small	B1
6(b)(ii)1.	$s = ut + \frac{1}{2}at^2 = 0 + \frac{g}{2}t^2$	
	$t = \sqrt{\frac{2s}{g}}$	
	$= \sqrt{\frac{2(44.1\times10^{-2})}{9.81}}$	M1
	$= 0.300$ s	A1

Question		Marks
6(b)(ii)2.	accounting for diameter, distance fallen from top = 56.6 – 1.2 = 55.4 cm time taken to fall 55.4 cm: $t=\sqrt{\frac{2s}{g}}$ $=\sqrt{\frac{2\left(55.4\times10^{-2}\right)}{9.81}}$ $=0.336$ s time interval = 0.336 – 0.300 = 0.036 s **Note**: the common mistake was to not account for diameter	
6(c)	$\Delta T=\lvert 0.036-0.033\rvert=0.003$ s %-tage uncertainty $=\frac{\Delta T}{T_{\text{stated}}}\times100\%=\frac{0.003}{0.033}\times100\%$ $=9.1\%\ (2\text{ s.f.})$ **Note:** the common mistake was to use previous answer as denominator	M1 A1
6(d)(i)	there is a systemic error in the vertical displacement read off the scale that is always less than the actual the new calculated time of fall will be less than that in **(b)(ii)1.**	M1 A1
6(d)(ii)	magnitude of downward acceleration for ball is less than $g=9.81\text{ m s}^{-2}$ for a short distance after release due vector sum of upward-acting magnetic force of attraction and downward acting weight the rate of increase of velocity initially is less so less vertical displacement for same time period shortly after release more time elapsed to cover same vertical displacement of 44.1 cm as than **(b)(ii)1.** **Note:** need to make clear that <u>**only** initial</u> acceleration is less than 9.81	M1 M1 A1
6(e)	[nature of drag] magnitude of air resistance increases as relative velocity between ball and air increases [vector sum of forces] net downward force decreases due to vector sum of upward-acting air resistance and downward-acting weight [effect on acceleration] By N2L, for constant mass, net acceleration decreases until zero, then ball reaches state of constant downward velocity	B1 B1 B1

Question		Marks
7(a)(i)1.	for sinusoidal A.C.,	
	$V_{\text{r.m.s.}} = \dfrac{V_0}{\sqrt{2}}$	
	$V_0 = \sqrt{2}V_{\text{r.m.s.}} = \sqrt{2}(17)$	M1
	$= 24.0\text{ V}$	A1
7(a)(i)2.	$\omega = 2\pi f$	
	$f = \dfrac{\omega}{2\pi} = \dfrac{380}{2\pi}$	M1
	$= 60.5\text{ Hz}$	A1
7(a)(ii)	a.c. changes direction every half cycle but heating effect is independent of direction of current heating effect is provided by product of resistance and square of current	
7(b)(i)	thermal energy per unit mass required to raise temperature of substance by one degree kelvin	
7(b)(ii)	a constant rate of heat loss to surrounding	
7(b)(iii)	graph is a plot of flow rate $\left(\dfrac{m}{t}\right)$ [denoted by *m* in qns] against power supplied	
	$Pt = mc\Delta T + H_{\text{loss}}$	
	$P = \left(\dfrac{m}{t}\right)c\Delta T + \dfrac{dH_{\text{loss}}}{dt}$	
	$\left(\dfrac{m}{t}\right) = \left(\dfrac{1}{c\Delta T}\right)P - \left(\dfrac{1}{c\Delta T}\right)\left(\dfrac{dH_{\text{loss}}}{dt}\right)$	
	gradient is $\left(\dfrac{1}{c\Delta T}\right)$	M1
	gradient $= \dfrac{y_1 - y_2}{x_1 - x_2} = \dfrac{3.5 - 1.5}{70 - 38} = \left(\dfrac{1}{c\Delta T}\right)$	M1
	gradient is $c = \left(\dfrac{3.5-1.5}{70-38}\right)^{-1}\left(\dfrac{1}{\Delta T}\right) = \left(\dfrac{3.5-1.5}{70-38}\right)^{-1}\dfrac{1}{(38.8-35.0)}$	M1
	$= 4.21\text{ J g}^{-1}\text{ K}^{-1}$	
	$= 4210\text{ J kg}^{-1}\text{ K}^{-1}$	A1

Question		Marks
7(c)		
	experiment conducted at higher temperatures so greater heat loss to surrounding → lower y-intercept experimented conducted with same temperature difference → same gradient	
7(d)(i)	<u>increase</u> in internal energy of a system is sum of heat supplied <u>to</u> system and work done <u>on</u> system	
7(d)(ii)	internal energy of ideal gas has no potential energy due to no intermolecular forces of attraction	(0)
	purely kinetic energy due to random distribution which is directly proportional to thermodynamic temperature	(0)
	per 1 K increase in temperature, the increase in internal energy is same	B1
	for constant volume, no work is done on system	M1
	for constant pressure, gas expands and does work against atmospheric pressure so additional thermal energy has to be supplied	M1
	resulting in a bigger specific heat capacity for constant pressure process	A0
8(a)(i)	oscillatory motion where	
	acceleration of body is directly proportional to displacement from equilibrium point	B1
	and	
	is always directed opposite of displacement towards equilibrium point	B1
8(a)(ii)1.	[graph features] from graph,	B1
	[y-values] motion has both positive and negative displacements	
	[gradient] acceleration *a* is in opposite direction as displacement *x*	
	[infer] force is a restoring force that is directed towards origin	B1
8(a)(ii)2.	[graph feature, gradient] not straight line passing through origin	B1
	[infer] acceleration is not directly proportional to displacement, not SHM	B1

Question		Marks
8(b)(i)1.	displacement of vibrating particles	B1
	<u>parallel</u> to the <u>direction of transfer of energy</u> of the wave	B1
8(b)(i)2.	speed with which energy is transmitted by wave is product of wavelength and frequency $v = f\lambda$	B1
8(b)(ii)1.	$T = \frac{1}{f} = \frac{1}{835}$	M1
	$= 0.00120$ s	A1
8(b)(ii)2.	time interval $t = \frac{T}{2} = 0.000599$ s	A1
8(b)(ii)3.	$v_{\text{max}} = x_0\omega = x_0\left(2\pi f\right) = \left(610 \times 10^{-9}\right)\left(2\pi\right)\left(835\right)$	M1
	$= 0.00320$ m s^{-1}	A1
8(b)(ii)4.	$E_{\text{max}} = \frac{1}{2}mv_{\text{max}}{}^2 = \frac{1}{2}\left(5.3 \times 10^{-26}\right)\left(0.00320\right)^2$	M1
	$= 2.71 \times 10^{-31}$ J	A1
8(b)(iii)	speed of propagation of sound energy is about 5 orders of magnitude larger than maximum speed of oscillation of a particle in the gas medium	B1
	speed of propagation of sound energy does not involve transfer of medium, so can be greater than the maximum speed of vibration of individual particles in the medium	B1
8(c)(i)	a vibration source in the gas medium produces series of compression and rarefactions which are transferred away through the medium	B1
8(c)(ii)	pressure difference acting on the effective cross sectional area of the molecule that has been displaced from mean position	B1
	(due to differential rate of collision from neighbouring particles giving rise to rate of change of momentum along axis of wave energy propagation)	