H2 PHYSICS

SUGGESTED SOLUTIONS

9749

November 2017

Paper 1
Multiple Choice

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

Notes:

Questions that candidates found more challenging were **Questions 5**, **12**, **14**, **15, 16, 17**, **21**, **22** and **26**.

Question 5
Option A - a momentum change of less than *p* would result in the ball continuing to move in the same direction.
Option D – an elastic bounce will result in a change of momentum of 2*p*

Question 12
Note that work is done on the system.

Question 14
Those who chose option **B** did not realise that one full cycle corresponds to a rotation of 2π radians.

Question 15
Those who chose option **A** did not realise that frequency is constant as a wave moves from one medium to another.

Question 16
Those who chose option **A** did not recognise that the relationship between ϴ and order *n* of maxima is not proportional.

Question 22
Those who chose option **B** did not realise that the 2 A current is added to the 4 A current to give 6 A through the bottom 30 Ω resistor.

Question 26
Those who chose option **C** did not recall that the mean power in a resistive load is half the peak power for a sinusoidal alternating current.

Paper 2
Structured Questions

Notes: Ensure that all steps in a 'show that' question are clearly presented and that all assumptions made are declared. As a logic check, final numerical answers should be realistic.

Question		Marks
1(a)	$F = kx$	
	$k = \frac{F}{x} = \frac{mg}{L - L_0} = \frac{(140 \times 10^{-3})(9.81)}{(10.8 - 8.0) \times 10^{-2}}$	**M1**
	$= 49.1 \text{ N m}^{-1}$	**A1**
1(b)(i)	$k = \frac{mg}{L - L_0}$	
	$\frac{\Delta k}{k} = \frac{\Delta m}{m} + \frac{\Delta(L - L_0)}{(L - L_0)} = \frac{\Delta m}{m} + \frac{\Delta L + \Delta L_0}{(L - L_0)}$	
	$= \frac{1}{100} + \frac{2}{108 - 80}$	**M1**
	$\left[\begin{aligned} \Delta k &= k\left(\frac{1}{100} + \frac{2}{108 - 80}\right) \\ &= 49.1\left(\frac{1}{100} + \frac{2}{108 - 80}\right) \\ &= 4.0 \text{ Nm}^{-1} \ (2 \text{ s.f.}) \end{aligned} \right]$	
	Notes: Portion in square bracket not necessary but as a reminder, if need to evaluate absolute uncertainty, give to more than 1 s.f..	
	$\frac{\Delta k}{k} \times 100\% = \left(\frac{1}{100} + \frac{2}{108 - 80}\right) \times 100\%$	
	$= 8.1\%$	**A1**
1(b)(ii)	$\frac{\Delta k}{k} \times k = \Delta k = \frac{8.1}{100}(49.1)$	
	$= \pm 4 \text{ N m}^{-1} \ (1 \text{ s.f.})$	
	$k = 49 \pm 4 \text{ N m}^{-1}$	**B1**
	Notes: When presented in this form, the absolute uncertainty is 1 s.f. and the precision of the quantity follows that of the absolute uncertainty (i.e. in this case, *k* must be quoted to the nearest '1')	

Question		Marks
1(c)(i)	magnitude of upthrust is equivalent to reduction of elastic force for (10.8 - 10.3 =) 0.5 cm of extension	**C1**
	$U = kx_{0.5\text{ cm}} \approx (49)(0.5 \times 10^{-2})$	**C1**
	$= 0.25\text{ N}$	**A0**
1(c)(ii)	volume of block, $V = \dfrac{m_{block}}{\rho_{block}} = \dfrac{140 \times 10^{-3}}{7750}$	**M1**
	$\left(= 1.81 \times 10^{-5}\text{ m}^3\right)$	
	Notes: This is not the final answer, so in your calculator/working work with more s.f.'s.	
	Upthrust is the weight of liquid displaced $U = m_{liquid}g = V\rho_{liquid}g$ $\rho_{liquid} = \dfrac{U}{Vg} = \dfrac{0.25}{\left(\dfrac{140 \times 10^{-3}}{7750}\right)(9.81)}$	**M1**
	$= 1410\text{ kg m}^{-3}$	**A1**
	Notes: Remember to distinguish between *mass* and *weight*.	

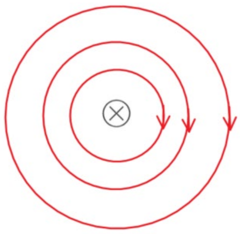
Question		Marks
2(a)(i)	$v_C = r_C\omega_C = r_C\left(\frac{2\pi}{T_C}\right)$	
	$T_C = r_C\left(\frac{2\pi}{v_C}\right) = (1.75\times10^4\times10^3)\left(\frac{2\pi}{0.200\times10^3}\right)$ = 5.498×10^5 s	M1
	number of days = $\frac{5.498\times10^5}{24\times60\times60}$	M1
	$= 6.36$ days	A0
	Notes: Remember to (show how to) convert the number of seconds into days.	
2(a)(ii)1.	Charon hovers over the same position in the sky all the time	B1
2(a)(ii)2.	same side of Charon observed all the time	B1
2(b)	$g_P = G\frac{M_P}{R_P^2} = (6.67\times10^{-11})\frac{1.31\times10^{22}}{(1.20\times10^6)^2}$	M1
	$= 0.607$ kg m^{-3}	A1
	Notes: Be careful with the power-of-ten, and to square the radius.	
2(c)(i)	Loss in Gravitational E_p of rock = Gain in E_K of rock	B1
	$U_{initial} - U_{final} = KE_{final} - KE_{initial}$	
	$0 - \frac{GM_{Pluto}M}{r} = \frac{1}{2}Mv^2 - 0$	
	$v = \sqrt{\frac{2GM_{Pluto}}{r}}$	M1
	$v = \sqrt{2\left(\frac{GM_{Pluto}}{r^2}\right)r}$	
	Since $g_P = \frac{GM_{Pluto}}{r^2}$,	M1
	$v = \sqrt{2g_P r}$	A0
	Notes: Need to explicitly show the (i) conservation of energy and (ii) algebra and substitution clearly.	
2(c)(ii)	$v_{min} = \sqrt{2g_P r} = \sqrt{2(0.607)(1.20\times10^6)} = 1210$ m s^{-1}	B1
	Notes: Be careful with the power-of-ten	

Question		Marks
3(a)	Oscillations in one direction,	B1
	in a plane normal to the direction of transfer of energy.	B1
	Notes: not asking for definition of transverse wave and need to mention either "oscillation" or "vibration".	
3(b)	speed, v, is the rate of change of distance (s) with time taken (t)	
	$v = \frac{s}{t}$	M1
	for a progressive wave, it travels one wavelength (λ) in a period T:	M1
	$v = \frac{s}{t} = \frac{\lambda}{T}$	
	Since $f = \frac{1}{T}$, $v = \lambda\left(\frac{1}{T}\right) = \lambda f$	A0
	Notes: Start with the definition of speed	
3(c)(i)	Path difference BP – AP = $\sqrt{12^2 + 5.0^2} - 12 = 1.0$ km	
	Number of wavelengths within path difference:	
	$\frac{BP - AP}{\lambda} = \frac{BP - AP}{c \div f} = \frac{1.0 \times 10^3}{(3.00 \times 10^8) \div (1200 \times 10^3)} = 4$	M1
	since waves are emitted at source in phase and meet with path difference of integer multiple of wavelengths at P,	M1
	waves reach in phase, undergo constructive interference, a maximum is detected	A1
	Notes: It is not sufficient to just *state* the conditions for constructive/destructive interference. To *explain*, data needs to be used, such as the relationship between wavelength and the path difference.	
3(c)(ii)	resultant amplitude varies between maxima and minima with constant frequency (OR at a constant rate)	B1
3(c)(iii)	use polarisers at both A and B	B1
	axis of polarisation is aligned perpendicularly to each other	B1
	Notes: both sources need to be polarised 90deg relative to each other.	

Question		Marks
3(d)	assuming point source transmitters	
	$I = \frac{P}{4\pi r^2} \quad \rightarrow I \propto \frac{1}{r^2}$	C1
	$\frac{I_A}{I_B} = \frac{r_B^2}{r_A^2} = \left(\frac{13}{12}\right)^2$	M1
	= 1.2 (*do not accept fraction*)	A1

Notes: *cannot* leave as 169/144. Do not confuse *A* for amplitude/area.

4(a)	at least 3 concentric circles with increasing distance from each other	B1
	each circle labelled with clockwise arrows	B1



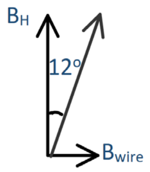
Notes: best to bring your compass (alongside geometry set) for exams.

4(b)	magnetic flux density due to long straight wire:	
	$B = \frac{\mu_0 I}{2\pi d} = \frac{(4\pi \times 10^{-7})(8.5)}{2\pi(19 \times 10^{-2})}$	M1
	$= 9.0 \times 10^{-6}$ T	A1

Notes: Be careful when converting cm to m.

Question		Marks

4(c)(i)



$$\tan(12°) = \frac{B_{wire}}{B_H}$$

$$B_H = \frac{B_{wire}}{\tan(12°)} = \frac{9.0 \times 10^{-6}}{\tan(12°)}$$ **M1**

$$= 4.2 \times 10^{-5} \text{ T}$$ **A1**

Notes: The examiners were looking out for (at least) a vector diagram showing how the 2 magnetic fields combined to form the resultant field with the angle.

4(c)(ii)

(*if more marks allocated / if more numerical accuracy required*)
Find the distance from wire that will result in same magnitude of flux as with Earth's field:

$$B_H = \frac{\mu_0 I}{2\pi d} = \frac{(4\pi \times 10^{-7})(8.5)}{2\pi d}$$

$$d = \frac{(4\pi \times 10^{-7})(8.5)}{2\pi(4.21 \times 10^{-5})} = 0.0404 \text{ m}$$

X to be marked 4.04 cm (about 1/5 distance between wire and compass) from wire at the 3 o'clock position.

Magnetic flux density is a vector quantity.

At X, the magnetic flux density due to wire is pointing downwards, opposite to the upward Earth's magnetic field. **B1**

The point is nearer to the wire than the compass in Fig. 4.3 so that the magnitude matches that of the Earth's.

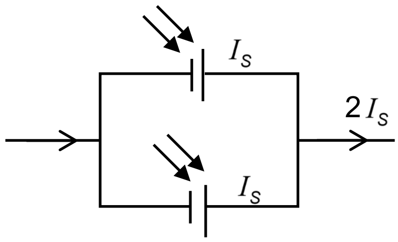
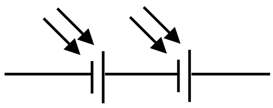
A1

Notes: Need to *explain* how the 2 fields cancel out (magnitude and direction).

Question		Marks
5(a)(i)	$R = \frac{\rho L}{A} = \frac{\rho L}{\pi r^2} = \frac{\rho L}{\pi \left(\frac{d}{2}\right)^2}$	C1
	$= \frac{4\rho L}{\pi d^2} = \frac{4(1.7\times10^{-8})(96)}{\pi(0.18\times10^{-3})^2}$	M1
	$= 64\ \Omega$	A1
5(a)(ii)	Since volume = *L* x *A*, increased length causes reduced <u>cross-sectional area</u>, Since $R = \frac{\rho L}{A}$, resistance increases.	B1
	Notes: Need to consider the reduction in cross-sectional area as a result of stretching.	
5(a)(iii)	16 resistors in parallel: $\frac{1}{R_{\text{effective}}} = \frac{16}{R}$	
	$R_{\text{effective}} = \frac{R}{16} = \frac{64.1}{16} = 4.0\ \Omega$	A1
5(b)(i)	$P = I^2R = (2.5)^2(4.0)$	M1
	$= 25\ \text{W}$	A1
5(b)(ii)	current of 2.5 A is split equally across 16 strands	
	$I = Anvq = \pi\left(\frac{d}{2}\right)^2 nvq_e$	
	$v = \frac{4I}{\pi d^2 nq_e} = \frac{4I}{\pi d^2 nq_e} = \frac{4\left(\frac{2.5}{16}\right)}{\pi(0.18\times10^{-3})^2(8.5\times10^{28})(1.6\times10^{-19})}$	M1
	$= 4.5\times10^{-4}\ \text{m s}^{-1}$	A1

Question		Marks
6(a)	the de Broglie wavelength of the electrons is of same order of magnitude as inter-atomic spacing between carbon atoms in the graphite film. <u>Diffraction of electrons occurred at the graphite film</u> **Notes:** Common misconceptions: > photons produced when electrons collided with graphite > photons emitted due to electrons de-exciting from atomic energy levels	**B1**
6(b)	the kinetic energy of the electrons increased the momentum of the electrons increased $p = \frac{h}{\lambda}$ so the de Broglie wavelength decreased $d \sin\theta = \lambda$; angle of diffraction decreased diameters of the concentric circles decreased	**M1** **M1** **A1**
6(c)	Loss in Electric E_p = Gain in E_k $Q\Delta V = \frac{p^2}{2m}$ $p = \sqrt{2me\Delta V}$ Using $\lambda = \frac{h}{p}$, $\lambda = \frac{h}{\sqrt{2me\Delta V}}$ $= \frac{6.63 \times 10^{-34}}{\sqrt{2(9.11 \times 10^{-31})(1.6 \times 10^{-19})(1200)}}$ $= 3.5 \times 10^{-11}$ m	**B1** **C1** **C1** **A1**

Question		Marks
7(a)(i)	$glide\ ratio = \dfrac{Horizontal\ distance}{Vertical\ distance}$ $40 = \dfrac{Horizontal\ distance}{8500 - 1500}$ $Horizontal\ distance = 2.8 \times 10^5\ \text{m}$	A1
7(a)(ii)	Maximise lift through the long wing span of 71.9m	B1
	Small mass of 2300 kg for a long wing span plane	B1
	Streamlined aircraft body to reduce drag	(B1)
	Notes: Data concerning aircraft features need to be linked to the good glide ratio.	
7(a)(iii)	During horizontal flight, lift = weight $\text{glide ratio } = 40 = \dfrac{\text{lift}}{\text{drag}} = \dfrac{mg}{\text{drag}}$	M1
	$\text{drag } = \dfrac{(2300)(9.81)}{40}$ $= 560\ \text{N}$	A1
7(b)(i)	amount of stored energy per unit mass	B1
	Notes: Do not mix *quantities* and *units* e.g. *energy* per *kg*.	
7(b)(ii)	amount of energy stored in four batteries: $= (4)(41\ \text{kWh}) = (164 \times 10^3)(60)(60)$ $= 5.9 \times 10^8\ \text{J}$	A1
7(b)(iii)	During horizontal flight of constant speed, forward force = drag force	
	Energy stored = Work done by forward force $5.9 \times 10^8 = F \times s$	M1
	$s = \dfrac{5.9 \times 10^8}{560}$ $= 1.1 \times 10^6\ \text{m}$	A1

Question		Marks
7(c)	Light energy is absorbed as it passes through atmosphere. The more it passes through, the more of it is being absorbed. **Notes:** Common mistakes included not noting that light energy is lost when travelling through atmosphere. Some proposed the non-logical idea that aircraft would be nearer the Sun (change in distance is insignificant compared to distance from the Earth to the Sun).	B1
7(d)	It needs to collect energy to store for use during night flight	B1
7(e)	1. in parallel  2. in series 	B1 B1
7(f)(i)	power collected is <u>directly proportional</u> to the area of photovoltaic cells	B1
7(f)(ii)	$\text{intensity} = \dfrac{\text{power}}{\text{area}}$ represents intensity of sunlight captured/collected	B1
7(f)(iii)	$gradient = \dfrac{73.0 - 0.0}{300 - 0}$ $= 0.243 \text{ kW m}^{-2}$ $= 243 \text{ Wm}^{-2}$	M1 A1
7(g)(i)	M = 1.556, I_1 = 0.836 kW m^{-2}	B1
7(g)(iii)	**Even distribution of points on both sides of the curve** **Notes:** Quality of curves were poor when the curve did not pass through points or did not reach final point. Some force-fitted a straight line through mistakenly.	B1
7(g)(iv)	I_1 = 0.895 kW m^{-2}	B1

Question		Marks
7(g)(v)	efficiency $= \frac{I}{I_1} \times 100\% = \frac{0.243}{0.895} \times 100\% = 27.2\%$	B1
	Notes: Common mistake was to use a value from table (max value of 0.947 was common) instead of own value for the required point above Japan. Need to ensure that the units for both intensity values are the same.	
7(h)	1. can only transport passengers during day time and fair weather conditions so that there is available solar energy	B1
	2. efficiency of collection of solar power by current generation of solar cells at 27.2% is too low to support high volume air travel	B1
	3. more passengers means more mass and more lift force required. The wingspan necessary may be too long to be practical	
	Notes: Responses need to be specific to *passenger air craft* – many were over-general that will affect all types of solar aircraft.	

Paper 3
Longer Structured Questions

Question		Marks
1(a)	air resistance increases with speed	B1
	resultant force = weight – air resistance → so resultant force decreases	B1
	weight = air resistance → no resultant force and acceleration.	B1
	Hence constant velocity	
1(b)(i)	$F_{net} = ma$	B1
	$mg - kv = ma$	
	$g - a = \dfrac{kv}{m}$	B1 A0
1(b)(ii)	v = 0 m s^{-1} a = 9.81 m s^{-2} $(g - a)$ = 0 m s^{-2} v = 30 m s^{-1} a = 5.8 m s^{-2} $(g - a)$ = 4.0 m s^{-2} v = 40 m s^{-1} a = 0 m s^{-2} $(g - a)$ = 9.81 m s^{-2}	
	Correct values of a for v = 0 m s^{-1}	A1
	Correct values of a for v = 40 m s^{-1}	A1
	v = 30 ms^{-1} , $a \approx$ gradient of tangent to graph at that point	
	gradient = $\dfrac{y_1 - y_2}{x_1 - x_2} = \dfrac{44 - 20}{6 - 1.8}$	
	5.7 ms^{-2} [accept 5.8 ± 0.2 ms^{-2}]	A1
	For $(g – a)$ column, all three entries to be calculated correctly from 9.8 – a	A1
	Notes: Should recognise immediately that gradient of graph at t = 0 is a = 9.8 immediately.	
1(b)(iii)	since $(g - a) = \dfrac{kv}{m}$, $\dfrac{(g-a)}{v} = \dfrac{k}{m}$ should be constant	
	v = 20 ms^{-1} , $\left(\dfrac{k}{m}\right)_1 = \dfrac{(g-a)}{v}$ = 0.080 s^{-1} v = 30 ms^{-1} , $\left(\dfrac{k}{m}\right)_2 = \dfrac{(g-a)}{v}$ = 0.14 s^{-1}	M1
	The values of $\dfrac{k}{m}$ are not close to each other, hence the student's suggestion is not justified	A1

Question		Marks
2(a)(i)	Total momentum of A and B is not zero before collision By Principle of Conservation of Linear Momentum, total momentum must not be zero throughout.	M1
	So both are never stationary at the same time	A1
2(a)(ii)	magnitude of average force $\lvert F\rvert = \left\lvert\frac{\Delta P_A}{\Delta t}\right\rvert = \frac{(1.5)(0.90-(-0.70))}{0.3}$	C1
	$= 8.0$ N	A1
	Notes: Do not confuse the change in momentum of A, with the difference in momentum between A and B.	
2(b)(i)	According to Newton's 3rd Law, the force on B = force on A	
	$F\Delta t = m_B(2.2 - v_B)$ $(8.0)(0.3) = 1.2(2.2 - v_B)$	C1
	$v_B = 0.20$ ms^{-1}	A1
2(b)(ii)	answer to 2(b)(i) is a vector quantity. Having the same positive sign as the initial velocity of B implies that B's direction continues to be to the left.	B1
2(c)	relative speed of approach = 0.90 – (– 2.2) = 3.1 ms^{-1} relative speed of separation = – 0.20 – (– 0.70) = 0.5 ms^{-1}	M1
	relative speed of approach not equal relative speed of separation so inelastic (*comparisons using E_K not given credit*)	A1
	Notes: Common mistake was to give the relative speed of approach as 1.3 instead.	

Question		Marks
3(a)	a region of space	B1
	where a mass experiences a force	B1

3(b)(i)

Let m_{Sun} be mass of the Sun

Gravitational force provides the centripetal force — **B1**

$$\frac{GMm_{Sun}}{r^2} = \frac{m_{Sun}v^2}{r}$$ **M1**

$$v = \sqrt{\frac{GM}{r}}$$ **A0**

3(b)(ii)

$$v = \sqrt{\frac{GM}{r}}$$

$$M_{galaxy} = \frac{v^2 r}{G}$$

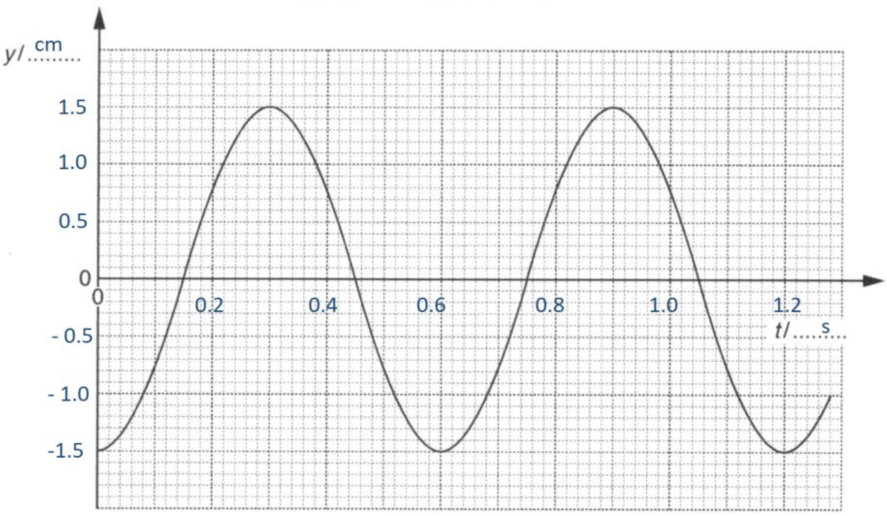
$$M = \frac{(230\times10^3)^2(2.4\times10^{20})}{6.67\times10^{-11}}$$ **C1**

$= 1.9\times10^{41}$ kg — **C1**

$$\frac{M}{m_{Sun}} = \frac{1.9\times10^{41}}{2.0\times10^{30}} = 9.5\times10^{10}$$ **A1**

Notes: Need to square the velocity.

4(a)



Vertical axis: — **B1**

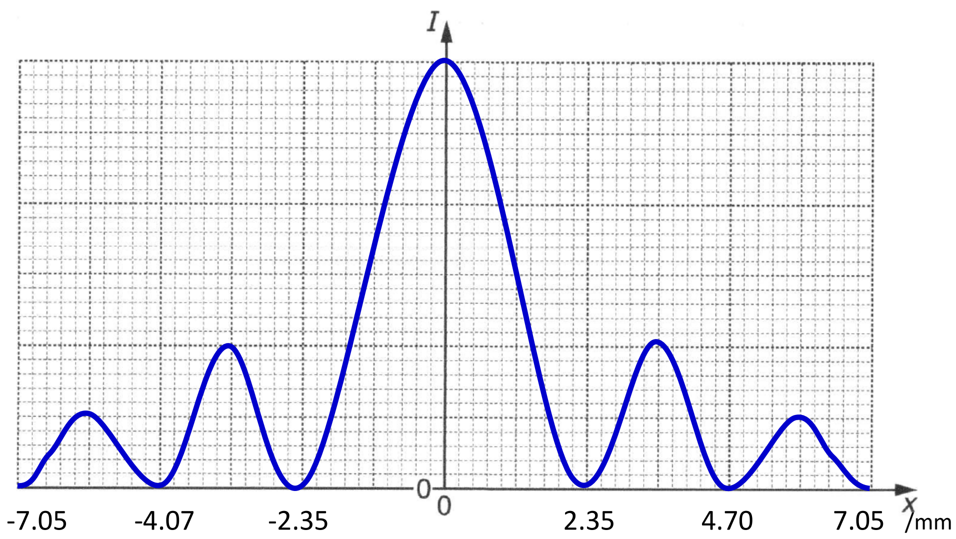
y / cm ; 1.0 for every large grid

Horizontal axis: — **B1**

t / s ; 0.2 for every large grid

Notes: Need to label the axes with values

Question		Marks
4(b)(i)	$y = -y_0 \cos(\omega t) = -y_0 \cos\left(\frac{2\pi}{T}t\right) = -1.5\cos\left(\frac{2\pi}{0.60}t\right)$	C1
	$y = +0.20\ cm,$ $+0.20 = -1.5\cos\left(\frac{2\pi}{0.60}t\right)$ $t_1 = 0.163$ s	C1
	$y = -0.20\ cm,$ $-0.20 = -1.5\cos\left(\frac{2\pi}{0.60}t\right)$ $t_2 = 0.137$ s	
	Shortest time from -2.0mm to +2.0 mm = $t_2 - t_1 = 0.163 - 0.137$= 0.026 s By symmetry, shortest time from +2.0mm to -2.0 mm = 0.026 s	A1
4(b)(ii)	time = $t_2 - t_1 \approx 0.65 - 0.55$ (read to half small square) $= 0.10$ s	A1
4(c)	for oscillation moving through same total distance of 4mm duration of 0.026 s near zero displacement is much shorter than duration of 0.10 s at maximum displacement	M1
	determination of cube at its zero displacement position is more certain and accurate	A1

Question		Marks
5(a)(i)	position of first minima: $\sin\theta = \frac{\lambda}{d}$	C1
	since θ is small, $\theta \approx \sin\theta \approx \tan\theta = \dfrac{\frac{1}{2}\text{width}}{2.4}$	
	width $\approx (2)(2.4)\left(\frac{\lambda}{d}\right)$	
	$= (2)(2.4)\left(\frac{590\times10^{-9}}{0.60\times10^{-3}}\right)$	C1
	= 4.7 mm	A1
	Notes: Need to see that the distance between centre and first minimum ,s half the width of the central maximum	
5(a)(ii)		
	Reasonably smooth curve, 1 central maxima and 4 minima	M1
	at least 2 maximas of decreasing intensity on both sides of central maxima	A1
	Central fringe at least twice the width of subsequent fringes	A1
5(b)(i)	When two objects are just resolved, they can be distinguished.	B1
	This happens when the first minimum of the diffraction pattern of one source coincides with the central maximum of the diffraction pattern of the other source	B1
5(b)(ii)	$\theta = \frac{\lambda}{b} = \frac{590\times10^{-9}}{0.60\times10^{-3}}$	M1
	$= 9.8\times10^{-4}$ rad	A1
	Notes: *b* is *not* the distance between screen and slit	

Question		Marks
6(a)	Energy gained = work done by electric force = electric force × s = q(field strength) × s	
	$= q\dfrac{\Delta V}{d}s$	M1
	$= q\dfrac{\Delta V}{d}\left(\dfrac{2d}{3} - \dfrac{d}{3}\right)$	M1
	$= \dfrac{1}{3}q\Delta V$	
	where s is the displacement q is the charge of the α-particle ΔV is potential difference between the plates	
	Since the expression does not contain d, work done is independent of d.	A0
	Notes: need to explain all symbols introduced, especially since E can mean either energy or field strength.	

Question		Marks
6(b)	change in kinetic energy = final E_k – initial E_k = $\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$	
	From plate B to $x = \frac{d}{3}$	
	$\frac{1}{3}q\Delta V = \frac{1}{2}mv^2 - 0$	C1
	$v = \sqrt{\frac{2}{3}\left(\frac{2e}{4u}\right)\Delta V} = \sqrt{\left(\frac{1}{3}\right)\left(\frac{1.60\times10^{-19}}{1.66\times10^{-27}}\right)(750-0)}$	
	$= 1.55\times10^{5}$ ms^{-1}	C1
	From plate B to $x = \frac{2d}{3}$	
	$\frac{2}{3}q\Delta V = \frac{1}{2}mv^2 - 0$	C1
	Velocity at $x = \frac{2d}{3}$:	
	$v = \sqrt{\frac{4}{3}\left(\frac{2q_e}{4u}\right)\Delta V} = \sqrt{\left(\frac{2}{3}\right)\left(\frac{1.60\times10^{-19}}{1.66\times10^{-27}}\right)(750-0)}$	
	$= 2.20\times10^{5}$ ms^{-1}	C1
	Change in speed = $2.20\times10^{5} - 1.55\times10^{5} = 6.4\times10^{4}$ ms^{-1}	A1
	Notes: $\frac{1}{2}mv^2 - \frac{1}{2}mu^2 \neq \frac{1}{2}m(\Delta v)^2$	

Question		Marks
7(a)	to eject an electron, energy of photon must be more than work function energy of metal	B1
	energy of a UV photon energy is more than work function energy energy of a red light photon energy is less than work function energy	B1
	Notes: need to bring in idea of individual photons.	
7(b)	β-particles have are high speeds / energy electrons	B1
	when charged particle is accelerated	M1
	electromagnetic radiation produced	A1
	β-particles stopped in lead produce X-ray radiation which escapes	B1
7(c)	mass is concentrated in very small nucleus compared to atom hence only small proportion of particles approach nucleus closely	B1
	atom contains positively charged nucleus	B1
	electrostatic repulsion between atom and alpha particle can result in large deflections	B1

Question		Marks
8(a)(i)	two bodies are at <u>same/equal</u> (*NOT constant) temperature	B1
8(a)(ii)	no <u>net</u> transfer	A1
	of thermal energy from one body to another	M1
8(b)(i)	Ice is at a lower temperature than its surroundings.	B1
	Net thermal energy is transferred <u>from</u> surrounding <u>to</u> ice	
	not in thermal equilibrium	A0
8(b)(ii)	Heat gained by ice = thermal energy from heater and from atmosphere	
	$m_{water}L = IVt + Rt$	C1
	$(114.0 - 32.4)(330) = (6.3)(12.0)(5.0 \times 60) + R(5.0 \times 60)$	M1
	R = 14 W	A1
8(c)(i)	internal energy = sum of kinetic energy and potential energy	B1
	no intermolecular forces present between ideal gas molecules	
	potential energy is zero	B1
	Internal energy is solely kinetic energy	B1
	kinetic energy is <u>directly proportional to</u> thermodynamic temperature	B1
8(c)(ii)1.	$pV = nRT \rightarrow \quad n = \dfrac{pV}{RT}$	
	Initial $n = \dfrac{(1.0 \times 10^5)(2.0 \times 10^{-2})}{(8.31)(25 + 273.15)} = 0.807$ mol	M1
	Final $n = \dfrac{p}{T} = \dfrac{(1.5 \times 10^5)(2.0 \times 10^{-2})}{(8.31)(174 + 273.15)} = 0.807$ mol	M1
	Since amount of gas n *is* constant, and $n \propto$ mass, mass remains constant	A1
8(c)(ii)2.	mass of gas = 20n = 20(0.807) = 16.14 g	
	$Q = mc\Delta T = mc\Delta\left(T_{final} - T_{initial}\right)$	C1
	$1220 = (16.14)c\left(174 - 25\right)$	C1
	c = 0.51 J g^{-1} K^{-1}	A1
8(c)(iii)	Since the increase in temperature is the same in both instances,	B1
	<u>increase in internal energy is same</u> for both cases	
	when gas expands, work is done <u>by</u> gas against atmospheric pressure	M1
	additional thermal energy has to be supplied	A1

Question		Marks
9(a)	the value of the <u>steady direct current</u>	B1
	which would <u>dissipate heat</u> at the <u>same average rate in a given resistor</u>	B1
9(b)(i)	By comparing $V = 240\sin(377t)$ with $x = x_0 \sin(\omega t)$	
	$\omega = 2\pi f$	C1
	$f = \frac{377}{2\pi} = 60.0$ Hz	A1
9(b)(ii)	$P_{rms} = \frac{V_{rms}^2}{R} = \frac{\left(V_0/\sqrt{2}\right)^2}{R}$	C1
	$= \frac{1}{2}\frac{V_0^2}{R} = \frac{1}{2}\left(\frac{240^2}{38}\right)$	C1
	= 760 W	A1
9(c)(i)1.	induced e.m.f. in a conductor is <u>proportional</u> to	B1
	the <u>rate of change</u> of magnetic <u>flux linkage</u>	B1
9(c)(i)2.	alternating current gives rise to changing flux in core	B1
	flux links the secondary coil	B1
	by Faraday's law, changing flux induces e.m.f. in secondary coil	B1
	the induced e.m.f. is continuously switching polarity as flux is continuously increasing and decreasing and reversing.	B1
9(c)(ii)1.	no power loss in transformer so <u>input power equals output power</u>	B1
9(c)(ii)2.	$\frac{N_s}{N_p} = \frac{V_{rms,s}}{V_{rms,p}}$	
	$\frac{N_s}{5000} = \frac{12}{\left(240/\sqrt{2}\right)}$	M1
	N_p = 350	A1
9(c)(iii)1.	increase flux linkage	B1
	reduce flux loss	B1
	low hysteresis	(B1)
9(c)(iii)2.	reduces eddy currents	M1
	so reduce thermal energy/heat losses in the core	A1
	(do not allow '<u>prevent</u> energy losses'')	