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MARK SCHEME

Maximum Mark: 100

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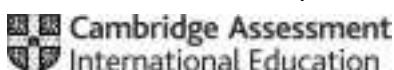
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Question	Answer	Marks
1(a)	<u>force</u> proportional to <u>product</u> of masses and inversely proportional to square of separation	B1
	idea of <u>force</u> between <u>point</u> masses	B1
1(b)	mass of Jupiter (M) = $(4/3)\pi R^3 \rho$	B1
	$\omega = 2\pi/T$ or $v = 2\pi nR/T$	B1
	$(m)\omega^2 x = GM(m)/x^2$ or $(m)v^2/x = GM(m)/x^2$	M1
	substitution and correct algebra leading to $\rho T^2 = 3\pi n^3/G$	A1
1(c)(i)	$n = (4.32 \times 10^5)/(7.15 \times 10^4)$ or $n = 6.04$	C1
	$\rho \times (42.5 \times 3600)^2 = (3\pi \times 6.04^3)/(6.67 \times 10^{-11})$	C1
	$\rho = 1.33 \times 10^3 \text{ kg m}^{-3}$	A1
1(c)(ii)	Jupiter likely to be a gas/liquid (at high pressure) [allow other sensible suggestions]	B1

Question	Answer	Marks
2(a)	(thermal) energy <u>per</u> (unit) mass (to cause change of state)	B1
	(energy required to cause/released in) change of state at constant temperature	B1
2(b)(i)	1. (work done on/against) the <u>atmosphere</u>	B1
	2. <u>water</u> as it turns from liquid to vapour	M1
	as potential energy of <u>molecules</u> increases	A1
	or	
	<u>surroundings</u> as its temperature rises	(M1)
	as energy is lost/transferred to surroundings	(A1)
2(b)(ii)	$VI - h = M/t \times L$ (where h = power loss) or $L = (VI t - Q)/M$ (where Q = energy loss)	C1
	$(14.2 \times 6.4) - (11.5 \times 5.2) = (9.1 - 5.0) \times L/300$ or $L = [(14.2 \times 6.4) - (11.5 \times 5.2)] \times 300 / (9.1 - 5.0)$	C1
	$L = 2300 \text{ J g}^{-1}$	A1

Question	Answer	Marks
3(a)(i)	angle (subtended) where arc (length) is equal to radius	M1
	(angle subtended) at the centre of a circle	A1
3(a)(ii)	angular frequency = $2\pi \times$ frequency or 2π / period	B1
3(b)(i)	c/ML^3 is a constant so acceleration is proportional to displacement	B1
	minus sign shows that acceleration and displacement are in opposite <u>directions</u>	B1
3(b)(ii)	$c/ML^3 = (2\pi f)^2$	C1
	$c = 4\pi^2 \times 3.2^2 \times 0.24 \times 0.65^3$	C1
	$= 27 \text{ kg m}^3 \text{ s}^{-2}$	A1

Question	Answer	Marks
4(a)	quartz/piezo-electric and crystal/transducer	B1
	p.d. across crystal causes it to distort	B1
	applying <u>alternating</u> p.d. causes oscillations/vibrations	B1
	when applied frequency is natural frequency, crystal resonates	B1
	natural frequency of crystal is in ultrasound range	B1
4(b)	small(er) structures can be resolved/observed/identified	B1

Question	Answer							Marks														
5(a)	<table><tr><td>(0.2 ms)</td><td>8.0 (mV)</td><td colspan="5">1000</td></tr></table>							(0.2 ms)	8.0 (mV)	1000					B1							
	(0.2 ms)	8.0 (mV)	1000																			
<table><tr><td>(0.8 ms)</td><td>5.8 (mV)</td><td colspan="5">0101</td></tr></table>							(0.8 ms)	5.8 (mV)	0101					B1								
(0.8 ms)	5.8 (mV)	0101																				
5(b)	series of steps							B1														
	all (step) changes are at 0.2 ms intervals							B1														
	steps with correct levels at correct times (1 mark if five levels correct; 2 marks if all levels correct)							B2														
	<table><tr><td>level</td><td>0</td><td>8</td><td>10</td><td>15</td><td>5</td><td>8</td></tr><tr><td>time / ms</td><td>0–0.2</td><td>0.2–0.4</td><td>0.4–0.6</td><td>0.6–0.8</td><td>0.8–1.0</td><td>1.0–1.2</td></tr></table>								level	0	8	10	15	5	8	time / ms	0–0.2	0.2–0.4	0.4–0.6	0.6–0.8	0.8–1.0	1.0–1.2
	level	0	8	10	15	5	8															
time / ms	0–0.2	0.2–0.4	0.4–0.6	0.6–0.8	0.8–1.0	1.0–1.2																
5(c)	smaller step heights (possible)							B1														
	smaller changes (in input signal) can be seen/reproduced/represented or (allows) more accurate <u>reproduction</u> (of the input signal)							B1														

Question	Answer	Marks
6(a)	electric field lines are radial/normal to surface (of sphere)	B1
	electric field lines <u>appear</u> to originate from centre (of sphere)	B1
6(b)(i)	tangent drawn at $x = 6.0$ cm and gradient calculation attempted	C1
	$E = 9.0 \times 10^4 \text{ NC}^{-1}$ (1 mark if in range ± 1.2 ; 2 marks if in range ± 0.6)	A2
	or	
	correct pair of values of V and x read from curved part of graph and substituted into $V = q/4\pi\epsilon_0 x$	(C1)
	to give $q = 3.6 \times 10^{-8} \text{ C}$	(C1)
	(then $E = q/4\pi\epsilon_0 x^2$ and $x = 6$ cm gives) $E = 9.0 \times 10^4 \text{ NC}^{-1}$	(A1)
	or	
	($E = q/4\pi\epsilon_0 x^2$ and $V = q/4\pi\epsilon_0 x$ and so) $E = V/x$	(C1)
	giving $E = 5.4 \times 10^3 / 0.060$	(C1)
	$= 9.0 \times 10^4 \text{ NC}^{-1}$	(A1)
6(b)(ii)	($R =$) 2.5 cm	B1
	potential inside a conductor is constant or field strength inside a conductor zero (so gradient is zero)	B1

Question	Answer	Marks
7(a)(i)	(part of) the output is combined with the input	M1
	reference to potential/voltage/signal	A1
7(a)(ii)	- increased (operating) stability - increased bandwidth/range of frequencies over which gain is constant - less distortion (of output) <i>Any 2 points.</i>	B2
7(b)(i)	1. gain = $3.6 / (48 \times 10^{-3})$	C1
	= 75	A1
	2. gain = $1 + R_F / R$ $75 = 1 + (92.5 \times 10^3) / R$	C1
	$R = 1300 \Omega$	A1
7(b)(ii)	for 68 mV, gain $\times V_{IN} = 5.1$ (V) or output voltage would be greater than the supply voltage	M1
	amplifier would saturate (at 5.0 V) or output voltage = 5.0 (V)	A1

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Question	Answer	Marks
8(a)(i)	DERQ and CFSP	B1
8(a)(ii)	charge carriers moving normal to (magnetic) field	B1
	<u>charge carriers</u> experience a <u>force</u> normal to I (and B)	B1
	charge build-up sets up electric field across the slice or build-up of charges results in a p.d. across the slice	B1
	charge stops building up/ V_H becomes constant when $F_B = F_E$	B1
8(b)	V_H inversely proportional to n /number density of charge carriers	B1
	number density of charge carriers (n) lower in semiconductors so V_H larger for semiconductor slice	B1
	or	
	V_H proportional to v /drift velocity	(B1)
	(for same current) drift velocity (v) higher in semiconductors so V_H larger for semiconductor slice	(B1)

Question	Answer	Marks
9(a)	region (of space)	B1
	where an object/particle experiences a force	B1
9(b)	electric and magnetic fields normal to each other	B1
	velocity of particle normal to both fields	B1
	forces (on particle) due to fields are in opposite directions	B1
	<u>forces are equal</u> for particles with a particular speed/for a selected speed/for speed given by $v = E(q)/B(q)$	B1
9(c)(i)	path labelled Q shown undeviated	B1
9(c)(ii)	reasonable curve in field and no 'kink' on entering, labelled V	B1
	deviated 'upwards'	B1

Question	Answer	Marks
10(a)	λ_0 marked and graph line passing through $E_{\text{MAX}} = 0$ at $\lambda = \lambda_0$	B1
	graph line with λ always $< \lambda_0$	B1
	negative gradient with correct concave curvature	B1
10(b)	curve with negative gradient and correct concave curvature	M1
	not touching either axis	A1

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Question	Answer	Marks
11(a)(i)	circles drawn only around the top left and bottom right diodes	B1
11(a)(ii)	B shown as (+)ve and A shown as (–)ve	B1
11(b)(i)	$V_{\text{r.m.s.}} (= 5.6 / \sqrt{2}) = 4.0 \text{ V}$	A1
11(b)(ii)	$380 = 2\pi f$ or $f = 60.5 \text{ Hz}$	C1
	number ($= 2f$) = 120	A1
11(c)(i)	peak values (all) unchanged	B1
	(all) minima shown at 4.0 V	B1
	three lines from near peak showing concave curves after leaving dotted line not 'kinked' and not cutting the peak reaching <u>candidate's</u> minimum at the point where the decay meets the next dotted line	B1
	three lines drawn along the dotted lines showing rise in voltage from minima back to peak values	B1
11(c)(ii)	<u>mean</u> p.d. is higher or <u>r.m.s.</u> p.d. is higher or capacitor supplies energy <u>to resistor</u>	M1
	so (mean) power increases	A1

Question	Answer	Marks
12(a)(i)	<u>nucleus</u> emits particles/EM radiation/ionising radiation	B1
	emission/release from unstable <u>nucleus</u> or emission from <u>nucleus</u> is random and/or spontaneous	B1
12(a)(ii)	probability of decay (of a nucleus) or fraction of (number of undecayed) nuclei that will decay	M1
	per unit time	A1
12(b)	energy is shared with another particle	B1
	mention of antineutrino	B1
12(c)(i)	number = $[(1.2 \times 10^{-9}) / 131] \times 6.02 \times 10^{23}$ or number = $(1.2 \times 10^{-3} \times 10^{-9}) / (131 \times 1.66 \times 10^{-27})$ (= 5.51×10^{12})	C1
	$A = \lambda N$	C1
	= $[0.086 / (24 \times 3600)] \times 5.51 \times 10^{12}$ = 5.5×10^6 Bq	A1
12(c)(ii)	$1/50 = \exp(-0.086t)$ or $1/50 = 0.5^n$	C1
	$t = 45$ days	A1