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PHYSICS **9702/42**

Paper 4 A Level Structured Questions **October/November 2017**

MARK SCHEME

Maximum Mark: 100

Published

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Question	Answer	Marks
1(a)	force proportional to product of masses and inversely proportional to square of separation	**B1**
	idea of force between point 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**
	$\rho = 1.33 \times 10^3\,\text{kg}\,\text{m}^{-3}$	**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 per (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 atmosphere	**B1**
	2. water as it turns from liquid to vapour	**M1**
	as potential energy of molecules increases	**A1**
	or	
	surroundings 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** $L = (VIt - Q)/M$ (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**
	$L = 2300\,\text{J}\,\text{g}^{-1}$	**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 directions	**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 alternating 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)	(0.2 ms)	8.0 (mV)	1000	**B1**
	(0.8 ms)	5.8 (mV)	0101	**B1**
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**
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**

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

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**
	$E = 9.0 \times 10^4\,\mathrm{N\,C^{-1}}$ (*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 $V = q/4\pi\varepsilon_0 x$	**(C1)**
	to give $q = 3.6 \times 10^{-8}\,\mathrm{C}$	**(C1)**
	(then $E = q/4\pi\varepsilon_0 x^2$ and x = 6 cm gives) $E = 9.0 \times 10^4\,\mathrm{N\,C^{-1}}$	**(A1)**
	or	
	($E = q/4\pi\varepsilon_0 x^2$ and $V = q/4\pi\varepsilon_0 x$ and so) $E = V/x$	**(C1)**
	giving $E = 5.4 \times 10^3/0.060$	**(C1)**
	$= 9.0 \times 10^4\,\mathrm{N\,C^{-1}}$	**(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) *Any 2 points.*	**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 × 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**

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**
	forces are equal 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 $E_{MAX} = 0$ 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**

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)	$V_{r.m.s.}$ (= 5.6 / √2) = 4.0 V	**A1**
11(b)(ii)	380 = 2π*f* **or** *f* = 60.5 Hz	**C1**
	number (= 2*f*) = 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 candidate's 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)	mean p.d. is higher **or** r.m.s. p.d. is higher **or** capacitor supplies energy to resistor	**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 $= (1.2 \times 10^{-3} \times 10^{-9}) / (131 \times 1.66 \times 10^{-27})$ $(= 5.51 \times 10^{12})$	**C1**
	$A = \lambda N$	**C1**
	$= [0.086 / (24 \times 3600)] \times 5.51 \times 10^{12}$ $= 5.5 \times 10^{6}$ Bq	**A1**
12(c)(ii)	$1 / 50 = \exp(-0.086t)$ **or** $1 / 50 = 0.5^{n}$	**C1**
	$t = 45$ days	**A1**