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PHYSICS **9702/42**

Paper 4 A Level Structured Questions **October/November 2019**

MARK SCHEME

Maximum Mark: 100

Published

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Question	Answer	Marks
2(a)(i)	specks of light moving haphazardly	**B1**
2(a)(ii)	(gas) molecules collide with (smoke) particles **or** random motion of the (gas) molecules	**M1**
	causes the (haphazard) motion of the smoke particles **or** causes the smoke particles to change direction	**A1**
2(b)(i)	$pV = nRT$	**C1**
	$n = (3.51 \times 10^5 \times 2.40 \times 10^{-3}) / (8.31 \times 290)$ **or** $n = (3.75 \times 10^5 \times 2.40 \times 10^{-3}) / (8.31 \times 310)$	**C1**
	or	
	$pV = NkT$	**(C1)**
	$n = (3.51 \times 10^5 \times 2.40 \times 10^{-3}) / (1.38 \times 10^{-23} \times 6.02 \times 10^{23} \times 290)$ **or** $n = (3.75 \times 10^5 \times 2.40 \times 10^{-3}) / (1.38 \times 10^{-23} \times 6.02 \times 10^{23} \times 310)$	**(C1)**
	$n = 0.350$ mol **or** 0.349 mol	**A1**
2(b)(ii)	energy transfer $= (0.349$ **or** $0.35) \times 12.5 \times (310 - 290)$	**C1**
	$= 87.3$ J **or** 87.5 J	**A1**
2(c)(i)	zero	**A1**
2(c)(ii)	87.3 J **or** 87.5 J	**A1**
	increase	**B1**

Question	Answer	Marks
3(a)	(thermal) energy per unit mass (to change state)	**B1**
	change of state without any change of temperature	**B1**
3(b)(i)	140 g	**A1**
3(b)(ii)	temperature difference (between apparatus and surroundings) does not change	**B1**
3(b)(iii)	$VIt = mL$	**C1**
	$(\{15.1 \times 3.6\} + R) \times 600 = 140 \times L$ **or** $(\{7.3 \times 1.8\} + R) \times 600 = 65 \times L$	**C1**
	$41.22 \times 600 = 75 \times L$	**C1**
	$L = 330\ \text{J g}^{-1}$	**A1**
3(b)(iv)	$15.1 \times 3.6 \times 600 = (140 \times 330) - H$ **or** $7.3 \times 1.8 \times 600 = (65 \times 330) - H$	**C1**
	$H = 13\,600$ rate of gain = 13 600 / 600 = 23 W	**A1**

Question	Answer	Marks
4(a)(i)	loss of energy	**B1**
4(a)(ii)	amplitude (of oscillations) decreases (with time)	**B1**
4(b)(i)	$\omega = 2\pi / T$	**C1**
	$T = 0.80$ s, so $\omega = 2\pi / 0.80$ $\omega = 7.9$ rad s^{-1}	**A1**
4(b)(ii)	$\omega^2 = 2k / M$	**C1**
	$7.9^2 = 2k / 1.2$ $k = 37$ N m^{-1}	**A1**
4(c)(i)	(one) smooth curve, not touching the *f*-axis, with two concave sides meeting at a peak in between them	**B1**
	(one) peak at 1.0ω	**B1**
4(c)(ii)	• lower peak/(whole) line is lower • flatter peak/peak is less sharp • peak at (slightly) lower angular frequency/peak moves to left *any two points, one mark each*	**B2**

Question	Answer	Marks
5(a)(i)	product of density and speed	**M1**
	speed of sound in the medium	**A1**
5(a)(ii)	$Z_B = 1.8 \times 10^3 \times 4.1 \times 10^3$ $= 7.4 \times 10^6$ kg m^2 s^{-1}	**A1**
5(b)	$\alpha = (1.7 - 1.3)^2 / (1.7 + 1.3)^2 = 0.018$ fraction = 0.98	**A1**
5(c)(i)	reduction in power/intensity (of wave)	**M1**
	as the wave passes through the medium	**A1**
5(c)(ii)	**1.** ratio $= e^{-\mu x}$	**C1**
	$= 0.90$	**A1**
	2. ratio $= 0.62$	**A1**
5(d)	fraction $= 0.898 \times 0.617 \times 0.98$ $= 0.54$	**A1**

Question	Answer	Marks
6(a)	period = 5.0 μs, so frequency = 2.0×10^5 Hz	**A1**
6(b)	sketch: three equally spaced vertical lines sitting on *f*-axis	**B1**
	two outer vertical lines of equal length and central line longer	**B1**
	three vertical lines (and no others) shown at frequencies 190 kHz, 200 kHz and 210 kHz	**B1**

Question	Answer	Marks
7	X-rays are used	**B1**
	section (of object) is scanned	**B1**
	scans/images taken at many angles/directions **or** images of each section are 2-dimensional	**B1**
	images of (many) sections are combined	**B1**
	(to give) 3-dimensional image of (whole) structure	**B1**

Question	Answer	Marks
8(a)	magnitude: (force =) Bqv	**B1**
	direction: P→Q **or** E→F **or** S→R **or** H→G	**B1**
8(b)(i)	EHSP and FGRQ	**B1**
8(b)(ii)	PE **or** QF **or** RG **or** SH	**B1**
8(c)(i)	*any one correct starting point from:* • (mass of 1 atom =) $27 \times 1.66 \times 10^{-27}$ • (amount of substance per unit volume =) 2.7 / 27 • 27 g (of substance) contains 6.02×10^{23} atoms • (2.7 g mass contains) 0.1 mol • (1 cm^3 volume contains) 0.1 mol • (1 m^3 volume contains) 10^5 mol	**C1**
	$n = (2.7 \times 10^3) / (27 \times 1.66 \times 10^{-27}) = 6.0 \times 10^{28}$ **or** $n = (2.7 / 27) \times 10^6 \times 6.02 \times 10^{23} = 6.0 \times 10^{28}$	**A1**
8(c)(ii)	$V_H = (0.15 \times 4.6) / (6.0 \times 10^{28} \times 0.090 \times 10^{-3} \times 1.60 \times 10^{-19})$	**C1**
	$= 8.0 \times 10^{-7}$ V	**A1**

Question	Answer	Marks
9(a)	work done per unit charge	**B1**
	(work done) moving positive charge from infinity	**B1**
9(b)(i)	energy $= 4.8 \times 1.60 \times 10^{-13}$ $= 7.7 \times 10^{-13}$ J	**A1**
9(b)(ii)	$E_P = Qq / 4\pi\varepsilon_0 d$	**C1**
	$Q = 79e$ **and** $q = 2e$	**C1**
	$7.68 \times 10^{-13} = (79 \times 2 \times \{1.60 \times 10^{-19}\}^2 / (4\pi \times 8.85 \times 10^{-12} \times d)$	**C1**
	$d = 4.7 \times 10^{-14}$ m	**A1**
9(c)	(diameter must be) less than/equal to 10^{-13} or 10^{-14} m	**B1**

Question	Answer	Marks
10(a)	(as temperature rises) electrons in valence band gain energy	**B1**
	electrons jump to conduction band	**B1**
	holes are left in the valence band	**B1**
	increased <u>number</u> (density) of charge carriers causes lower resistance	**B1**
10(b)(i)	$V^- = V^+$	**C1**
	$1.50 / 1.20 = R_T / 1.76$	**C1**
	$R_T = 2.2$ (kΩ)	**C1**
	temperature = 14 °C	**A1**
10(b)(ii)	(For LED to conduct,) V_{OUT} must be negative	**B1**
	$V^- > V^+$	**B1**
	R_T must be lower so temperature must be above **(b)(i)** value	**B1**

Question	Answer	Marks
11(a)	(induced) e.m.f. proportional to rate	**M1**
	of change of (magnetic) flux (linkage)	**A1**
11(b)(i)	any two from t_1, t_3, t_5, t_7	**A1**
11(b)(ii)	t_2 **and** t_4 **or** t_4 **and** t_6	**A1**
11(c)	e.m.f. = $N\Delta\Phi / \Delta t$	**C1**
	$= (2 \times 9.4 \times 10^{-4} \times 5.0 \times \pi \times (1.8 \times 10^{-2})^2 \times 63) / (6.0 \times 10^{-3})$	**C1**
	= 0.10 V	**A1**

Question	Answer	Marks
12(a)(i)	(decay is) unpredictable/cannot be predicted	**B1**
12(a)(ii)	probability of decay (of a nucleus)	**M1**
	per unit time	**A1**
12(b)	$A = \lambda N$	**C1**
	(for 1.00 m^3) $A = 0.600 / 4.80 \times 10^{-3}$ (= 125 Bq)	**C1**
	$N = 125 / ([7.55 \times 10^{-3}] / 3600)$ (= 5.96×10^7)	**C1**
	so ratio = $(2.52 \times 10^{25}) / (5.96 \times 10^7)$	**C1**
	or	
	(for 4.80×10^{-3} m^3) N for air = $2.52 \times 10^{25} \times 4.80 \times 10^{-3}$ (= 1.21×10^{23})	**(C1)**
	N for radon = $0.600 / ([7.55 \times 10^{-3}] / 3600)$ (= 2.86×10^5)	**(C1)**
	so ratio = $(1.21 \times 10^{23}) / (2.86 \times 10^5)$	**(C1)**
	ratio = 4.2×10^{17}	**A1**