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PHYSICS **9702/41**

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

MARK SCHEME

Maximum Mark: 100

Published

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Question	Answer	Marks
1(a)(i)	direction or rate of transfer of (thermal) energy **or** (if different,) not in thermal equilibrium/energy is transferred	**B1**
1(a)(ii)	uses a property (of a substance) that changes with temperature	**B1**
1(b)	• temperature scale assumes linear change of property with temperature • physical properties may not vary linearly with temperature • agrees only at fixed points *Any 2 points.*	**B2**
1(c)(i)	$Pt = mc(\Delta)\theta$	**C1**
	$95 \times 6 \times 60 = 0.670 \times 910 \times \Delta\theta$	**M1**
	$\Delta\theta$ = 56 °C so final temperature = 56 + 24 = 80 °C	**A1**
	or	
	$95 \times 6 \times 60 = 0.67 \times 910 \times (\theta - 24)$	**(M1)**
	so final temperature or θ = 80 °C	**(A1)**

Question	Answer	Marks
1(c)(ii)	**1.** sketch: straight line from (0,24) to (6,80)	**B1**
	2. temperature drop due to energy loss = (80 – 64) = 16 °C	**C1**
	energy loss = 0.670 × 910 × (80 – 64) = 9800 J	**A1**
	or	
	energy to raise temperature to 64 °C = 0.670 × 910 × (64 – 24)	**(C1)**
	= 24400 J loss = (95 × 6 × 60) – 24400 = 9800 J	**(A1)**

Question	Answer	Marks
2(a)	(angular frequency =) 2π × frequency **or** 2π / period	**B1**
2(b)(i)	**1.** displacement = 2.0 cm	**A1**
	2. amplitude = 1.5 cm	**A1**
2(b)(ii)	reference to displacement of oscillations **or** displacement from equilibrium position **or** displacement from 2.0 cm	**B1**
	straight line indicates acceleration ∝ displacement	**B1**
	negative gradient shows acceleration and displacement are in opposite directions	**B1**

Question	Answer	Marks
2(b)(iii)	ω^2 = (–)1 / gradient **or** ω^2 = (–)$\Delta a / \Delta s$ **or** a = (–)$\omega^2 x$ <u>and</u> correct value of x	**C1**
	= e.g. (1.8 / 0.03) or (0.9 / 0.015) or (1.2 / 0.02) etc. **or** 0.9 = $\omega^2 \times 0.015$ = 60	**C1**
	f = √60 / 2π = 1.2 Hz	**A1**

Question	Answer	Marks
3(a)	force per unit mass	**B1**
3(b)	changes in height <u>much</u> less than radius of Earth	**M1**
	so (radial) field lines are almost parallel **or** $g = GM / R^2 \approx GM / (R + h)^2$	**A1**

Question	Answer	Marks
3(c)	gravitational force provides/is centripetal force	B1
	$GMm/r^2 = mv^2/r$	C1
	$v = (2\pi \times 1.5 \times 10^{11})/(3600 \times 24 \times 365) = 2.99 \times 10^4$ (m s^{-1})	C1
	$6.67 \times 10^{-11}M = 1.5 \times 10^{11} \times (2.99 \times 10^4)^2$	C1
	$M = 2.0 \times 10^{30}$ kg	A1
	or	
	$GMm/r^2 = mr\omega^2$	(C1)
	$\omega = 2\pi/(3600 \times 24 \times 365) = 1.99 \times 10^{-7}$ (rad s^{-1})	(C1)
	$6.67 \times 10^{-11}M = (1.5 \times 10^{11})^3 \times (1.99 \times 10^{-7})^2$	(C1)
	$M = 2.0 \times 10^{30}$ kg	(A1)
	or	
	$T^2 = 4\pi^2 r^3/GM$	(C2)
	$M = 4\pi^2 \times (1.5 \times 10^{11})^3 / (\{3600 \times 24 \times 365\}^2 \times 6.67 \times 10^{-11})$	(C1)
	$= 2.0 \times 10^{30}$ kg	(A1)

Question	Answer	Marks
4(a)	• acts as 'return' (conductor) for signal • shielding from noise/crosstalk/interference *Two sensible suggestions, 1 mark each.*	**B2**
4(b)	• small bandwidth • (there is) noise/interference/crosstalk • large attenuation/energy loss • reflections due to poor impedance matching *Two sensible suggestions, 1 mark each.*	**B2**
4(c)	attenuation = $190 \times 14 \times 10^{-3}$ (= 2.66 dB)	**C1**
	ratio / dB = $(–)10\ \lg(P_2 / P_1)$	**C1**
	$2.66 = –10\ \lg(P_{OUT} / P_{IN})$ $P_{OUT} / P_{IN} = 0.54$	**C1**
	fractional loss $= 1 – (P_{OUT} / P_{IN}) = 1 – 0.54$ $= 0.46$	**A1**
	or	
	$2.66 = 10\ \lg(P_{IN} / P_{OUT})$ $P_{IN} / P_{OUT} = 1.85$	**(C1)**
	fractional loss $= (P_{IN} – P_{OUT}) / P_{IN} = (1.85 – 1) / 1.85$ $= 0.46$	**(A1)**

Question	Answer	Marks
5(a)(i)	force proportional to product of charges and inversely proportional to square of separation	**A1**
5(a)(ii)	curve starting at (R, F_C)	**B1**
	passing through ($2R$, $0.25F_C$)	**B1**
	passing through ($4R$, $0.06F_C$)	**B1**
5(b)	graph: E = 0 when current constant (0 to t_1, t_2 to t_3, t_4 to t_5)	**B1**
	stepped from t_1 to t_2 and t_3 to t_4	**B1**
	(steps) in opposite directions	**B1**
	later one larger in magnitude	**B1**

Question	Answer	Marks
6(a)(i)	$1/T = 1/(2C) + 1/C$	**C1**
	$T = ⅔C$ **or** $0.67C$	**A1**
6(a)(ii)	same charge on Q as on combination	**B1**
	so p.d. is 6.0 V	**B1**
6(b)	P: p.d. will decrease (from 3.0 V)	**B1**
	to zero	**B1**
	Q: p.d. will increase (from 6.0 V)	**B1**
	to 9.0 V	**B1**

Question	Answer	Marks
7(a)(i)	gain of amplifier is very large	**B1**
	V^+ is at earth (potential)	**B1**
	for amplifier not to saturate	**M1**
	difference between V^- and V^+ must be very small **or** V^- must be equal to V^+	**A1**
	or	
	if $V^- \neq V^+$ then feedback voltage	**(M1)**
	acts to reduce gap until $V^- = V^+$ when stable	**(A1)**
7(a)(ii)	input impedance is infinite	**B1**
	(so) current in R_1 = current in R_2	**B1**
	$(V_{IN} - 0) / R_1 = (0 - V_{OUT}) / R_2$	**B1**
	(gain =) $V_{OUT} / V_{IN} = - R_2 / R_1$	**B1**
7(b)	graph: correct inverted shape (straight diagonal line from (0,0) to a negative potential, then a horizontal line, then a straight diagonal line back to the *t*-axis at the point where $V_{IN} = 0$)	**B1**
	horizontal line at correct potential of (–)9.0 V	**B1**
	both ends of horizontal line occur at correct times (coinciding with when V_{IN} = 2.0 V)	**B1**

Question	Answer	Marks
8(a)	DERQ and CFSP	**B1**
8(b)(i)	force (on charge) due to magnetic field = force due to electric field **or** $Bqv = Eq$ **or** $v = E/B$	**B1**
	$E = V_H/d$	**B1**
	$V_H = Bvd$	**B1**
8(b)(ii)	use of $I = nAqv$ **and** $A = dt$	**M1**
	algebra clear leading to $V_H = BI/ntq$	**A1**
8(c)	(in metal,) n is very large	**M1**
	(therefore) V_H is small	**A1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td rowspan="6">9(a)</td><td>image of one slice/section</td><td>(B1)</td></tr>
<tr><td>images (of one slice) taken from different angles</td><td>(M1)</td></tr>
<tr><td>to give 2D image (of one slice)</td><td>(A1)</td></tr>
<tr><td>(repeated for) many slices</td><td>(M1)</td></tr>
<tr><td>to build up 3D image (of whole body/structure)</td><td>(A1)</td></tr>
<tr><td>Max. 4 marks total</td><td>4</td></tr>
<tr><td rowspan="3">9(b)</td><td>evidence of subtraction of background (–26)</td><td>C1</td></tr>
<tr><td>evidence of division by three</td><td>C1</td></tr>
<tr><td><table><tr><td>7</td><td>11</td></tr><tr><td>6</td><td>2</td></tr></table></td><td>A1</td></tr>
</table>

Question	Answer	Marks
10(a)	heating depends on current^2/I^2	**B1**
	and current^2/I^2 is always positive	**B1**
	or	
	a.c. changes direction (every half cycle)	**(B1)**
	but heating effect is independent of current direction	**(B1)**
	or	
	voltage and current are always in phase in a resistor	**(B1)**
	so $V \times I$ is always positive	**(B1)**
	or	
	sketch graph drawn showing power against time	**(B1)**
	comment that power is always positive	**(B1)**
10(b)(i)	for same power (transmission, higher voltage) → lower current	**B1**
	lower current → less power loss in (transmission) cables	**B1**
10(b)(ii)	• voltage can be (easily) stepped up/down • transformers only work with a.c. • generators produce a.c. • easier to rectify than invert *Two sensible suggestions, 1 mark each.*	**B2**

Question	Answer	Marks
11(a)	packet/quantum of energy of electromagnetic/EM radiation	**B1**
11(b)(i)	$E = hf$ $1.1 \times 10^{6} \times 1.60 \times 10^{-19} = 6.63 \times 10^{-34} \times f$	**C1**
	$f = 2.7 \times 10^{20}$ (2.65×10^{20}) Hz	**A1**
11(b)(ii)	$p = h/\lambda = hf/c$ $= (6.63 \times 10^{-34} \times 2.65 \times 10^{20})/(3.00 \times 10^{8})$ **or** $p = E/c$ $= (1.1 \times 1.60 \times 10^{-13})/(3.00 \times 10^{8})$	**C1**
	$p = 5.9 \times 10^{-22}$ (5.87×10^{-22}) N s	**A1**
11(c)	$123 \times 1.66 \times 10^{-27} \times v = 5.87 \times 10^{-22}$	**C1**
	$v = 2.9 \times 10^{3}$ m s^{-1}	**A1**

Question	Answer	Marks
12(a)	• emission from radioactive daughter products • self-absorption in source • absorption in air before reaching detector • detector not sensitive to all radiations • window of detector may absorb some radiation • dead-time of counter • background radiation *Any two points.*	**B2**
12(b)(i)	curve is not smooth **or** curve fluctuates/curve is jagged	**B1**
12(b)(ii)	clear evidence of allowance for background	**B1**
	half-life determined at least twice	**B1**
	half-life = 1.5 hours (*1 mark if in range 1.7–2.0; 2 marks if in range 1.4–1.6*)	**A2**
12(c)	**1.** half-life: no change	**M1**
	because decay is spontaneous/independent of environment	**A1**
	2. count rate (likely to be or could be) different/is random/cannot be predicted	**B1**