

---

**PHYSICS**

**9702/41**

Paper 4 A Level Structured Questions

**October/November 2017**

MARK SCHEME

Maximum Mark: 100

---

**Published**

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2017 series for most Cambridge IGCSE<sup>®</sup>, Cambridge International A and AS Level components and some Cambridge O Level components.

Question	Answer	Marks
1(a)(i)	direction or rate of transfer of (thermal) energy <b>or</b> (if different,) not in thermal equilibrium/energy is transferred	<b>B1</b>
1(a)(ii)	uses a property (of a substance) that changes with temperature	<b>B1</b>
1(b)	<ul style="list-style-type: none"> <li>• temperature scale assumes linear change of property with temperature</li> <li>• physical properties may not vary linearly with temperature</li> <li>• agrees only at fixed points</li> </ul> <i>Any 2 points.</i>	<b>B2</b>
1(c)(i)	$Pt = mc(\Delta)\theta$	<b>C1</b>
	$95 \times 6 \times 60 = 0.670 \times 910 \times \Delta\theta$	<b>M1</b>
	$\Delta\theta = 56^\circ\text{C}$ so final temperature = $56 + 24 = 80^\circ\text{C}$	<b>A1</b>
	<b>or</b>	
	$95 \times 6 \times 60 = 0.67 \times 910 \times (\theta - 24)$	<b>(M1)</b>
	so final temperature or $\theta = 80^\circ\text{C}$	<b>(A1)</b>

Question	Answer	Marks
1(c)(ii)	1. sketch: straight line from (0,24) to (6,80)	<b>B1</b>
	2. temperature drop due to energy loss = $(80 - 64) = 16^{\circ}\text{C}$	<b>C1</b>
	energy loss = $0.670 \times 910 \times (80 - 64) = 9800 \text{ J}$	<b>A1</b>
	<b>or</b>	
	energy to raise temperature to $64^{\circ}\text{C} = 0.670 \times 910 \times (64 - 24)$	<b>(C1)</b>
	$= 24400 \text{ J}$ loss = $(95 \times 6 \times 60) - 24400 = 9800 \text{ J}$	<b>(A1)</b>

Question	Answer	Marks
2(a)	(angular frequency =) $2\pi \times \text{frequency}$ <b>or</b> $2\pi/\text{period}$	<b>B1</b>
2(b)(i)	1. displacement = 2.0 cm	<b>A1</b>
	2. amplitude = 1.5 cm	<b>A1</b>
2(b)(ii)	reference to displacement of oscillations <b>or</b> displacement from equilibrium position <b>or</b> displacement from 2.0 cm	<b>B1</b>
	straight line indicates acceleration $\propto$ displacement	<b>B1</b>
	negative gradient shows acceleration and displacement are in opposite directions	<b>B1</b>

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

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

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

Question	Answer	Marks
4(a)	<ul style="list-style-type: none"> <li>• acts as 'return' (conductor) for signal</li> <li>• shielding from noise/crosstalk/interference</li> </ul> <i>Two sensible suggestions, 1 mark each.</i>	<b>B2</b>
4(b)	<ul style="list-style-type: none"> <li>• small bandwidth</li> <li>• (there is) noise/interference/crosstalk</li> <li>• large attenuation/energy loss</li> <li>• reflections due to poor impedance matching</li> </ul> <i>Two sensible suggestions, 1 mark each.</i>	<b>B2</b>
4(c)	attenuation = $190 \times 14 \times 10^{-3}$ (= 2.66 dB)	<b>C1</b>
	ratio/dB = $(-10 \lg(P_2/P_1))$	<b>C1</b>
	2.66 = $-10 \lg(P_{OUT}/P_{IN})$	<b>C1</b>
	$P_{OUT}/P_{IN} = 0.54$	
	fractional loss = $1 - (P_{OUT}/P_{IN}) = 1 - 0.54$ = 0.46	<b>A1</b>
	<b>or</b>	
	2.66 = $10 \lg(P_{IN}/P_{OUT})$ $P_{IN}/P_{OUT} = 1.85$	<b>(C1)</b>
fractional loss = $(P_{IN} - P_{OUT})/P_{IN} = (1.85 - 1)/1.85$ = 0.46	<b>(A1)</b>	

Question	Answer	Marks
5(a)(i)	force proportional to <u>product</u> of charges and inversely proportional to <u>square</u> 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
	$T = \frac{2}{3}C$ 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 3.0V)	B1
	to zero	B1
	Q: p.d. will increase (from 6.0V)	B1
	to 9.0V	B1

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



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

Question	Answer	Marks			
9(a)	image of one slice/section	<b>(B1)</b>			
	images (of one slice) taken from different angles	<b>(M1)</b>			
	to give 2D image (of one slice)	<b>(A1)</b>			
	(repeated for) many slices	<b>(M1)</b>			
	to build up 3D image (of whole body/structure)	<b>(A1)</b>			
	<i>Max. 4 marks total</i>	<b>4</b>			
9(b)	evidence of subtraction of background (–26)	<b>C1</b>			
	evidence of division by three	<b>C1</b>			
	<table border="1" data-bbox="322 740 624 842"> <tbody> <tr> <td data-bbox="322 740 472 790">7</td> <td data-bbox="472 740 624 790">11</td> </tr> <tr> <td data-bbox="322 790 472 842">6</td> <td data-bbox="472 790 624 842">2</td> </tr> </tbody> </table>	7	11	6	2
7	11				
6	2				

Question	Answer	Marks
10(a)	heating depends on current <sup>2</sup> / $I^2$	<b>B1</b>
	and current <sup>2</sup> / $I^2$ is always positive	<b>B1</b>
	<b>or</b>	
	a.c. changes direction (every half cycle)	<b>(B1)</b>
	but heating effect is independent of current direction	<b>(B1)</b>
	<b>or</b>	
	voltage and current are always in phase in a resistor	<b>(B1)</b>
	so $V \times I$ is always positive	<b>(B1)</b>
	<b>or</b>	
	sketch graph drawn showing power against time	<b>(B1)</b>
comment that power is always positive	<b>(B1)</b>	
10(b)(i)	for same power (transmission, higher voltage) → lower current	<b>B1</b>
	lower current → less power loss in (transmission) cables	<b>B1</b>
10(b)(ii)	<ul style="list-style-type: none"> <li>• voltage can be (easily) stepped up/down</li> <li>• transformers only work with a.c.</li> <li>• generators produce a.c.</li> <li>• easier to rectify than invert</li> </ul> <p><i>Two sensible suggestions, 1 mark each.</i></p>	<b>B2</b>

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

Question	Answer	Marks
12(a)	<ul style="list-style-type: none"> <li>• emission from radioactive daughter products</li> <li>• self-absorption in source</li> <li>• absorption in air before reaching detector</li> <li>• detector not sensitive to all radiations</li> <li>• window of detector may absorb some radiation</li> <li>• dead-time of counter</li> <li>• background radiation</li> </ul> <p><i>Any two points.</i></p>	<b>B2</b>
12(b)(i)	<p>curve is not smooth <b>or</b> curve fluctuates/curve is jagged</p>	<b>B1</b>
12(b)(ii)	clear evidence of allowance for background	<b>B1</b>
	half-life determined at least twice	<b>B1</b>
	half-life = 1.5 hours <i>(1 mark if in range 1.7–2.0; 2 marks if in range 1.4–1.6)</i>	<b>A2</b>
12(c)	<b>1.</b> half-life: no change	<b>M1</b>
	because decay is spontaneous/independent of environment	<b>A1</b>
	<b>2.</b> count rate (likely to be or could be) different/is random/cannot be predicted	<b>B1</b>