Cambridge International AS & A Level

**Cambridge Assessment International Education**
Cambridge International Advanced Subsidiary and Advanced Level

**PHYSICS** **9702/43**

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<br>**or**<br>(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<br>• physical properties may not vary linearly with temperature<br>• agrees only at fixed points<br>*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** |
| | $\Delta\theta = 56\,°\text{C}$ 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 $\theta = 80\,°\text{C}$ | **(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<br>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) | $\omega^2$ = (–)1 / gradient **or** $\omega^2$ = (–)$\Delta a / \Delta s$ **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 = $\omega^2$ × 0.015<br>= 60 | **C1** |
| | $f$ = √60 / 2π<br>= 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<br>**or**<br>$g = GM / R^2 \approx GM / (R + h)^2$ | **A1** |

| Question | Answer | Marks |
|---|---|---|
| 3(c) | gravitational force provides/is centripetal force | **B1** |
| | $GMm / r^2 = mv^2 / r$ | **C1** |
| | $v = (2\pi \times 1.5 \times 10^{11}) / (3600 \times 24 \times 365) = 2.99 \times 10^4$ ($\text{m s}^{-1}$) | **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)** |
| | $\omega = 2\pi / (3600 \times 24 \times 365) = 1.99 \times 10^{-7}$ ($\text{rad s}^{-1}$) | **(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<br>• shielding from noise/crosstalk/interference<br>*Two sensible suggestions, 1 mark each.* | **B2** |
| 4(b) | • small bandwidth<br>• (there is) noise/interference/crosstalk<br>• large attenuation/energy loss<br>• reflections due to poor impedance matching<br>*Two sensible suggestions, 1 mark each.* | **B2** |
| 4(c) | attenuation = 190 × 14 × $10^{-3}$ (= 2.66 dB) | **C1** |
| | ratio / dB = (–)10 lg($P_2$ / $P_1$) | **C1** |
| | 2.66 = –10 lg ($P_{OUT}$ / $P_{IN}$)<br><br>$P_{OUT}$ / $P_{IN}$ = 0.54 | **C1** |
| | fractional loss = 1 – ($P_{OUT}$ / $P_{IN}$) = 1 – 0.54<br><br>= 0.46 | **A1** |
| | **or** | |
| | 2.66 = 10 lg ($P_{IN}$ / $P_{OUT}$)<br><br>$P_{IN}$ / $P_{OUT}$ = 1.85 | **(C1)** |
| | fractional loss = ($P_{IN}$ – $P_{OUT}$) / $P_{IN}$ = (1.85 – 1) / 1.85<br><br>= 0.46 | **(A1)** |

| 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** |
| | $T = ⅔C$ **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<br>**or**<br>$Bqv = Eq$<br>**or**<br>$v = E/B$ | **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** |

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

| Question | Answer | Marks |
|---|---|---|
| 10(a) | heating depends on current²/$I^2$ | **B1** |
| | and current²/$I^2$ 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) $\rightarrow$ lower current | **B1** |
| | lower current $\rightarrow$ less power loss in (transmission) cables | **B1** |
| 10(b)(ii) | • voltage can be (easily) stepped up/down<br>• transformers only work with a.c.<br>• generators produce a.c.<br>• easier to rectify than invert<br>*Two sensible suggestions, 1 mark each.* | **B2** |

| Question | Answer | Marks |
|---|---|---|
| 11(a) | packet/quantum of energy of electromagnetic/EM radiation | **B1** |
| 11(b)(i) | $E = hf$<br><br>$1.1 \times 10^{6} \times 1.60 \times 10^{-19} = 6.63 \times 10^{-34} \times f$ | **C1** |
| | $f = 2.7 \times 10^{20}$ ($2.65 \times 10^{20}$) Hz | **A1** |
| 11(b)(ii) | $p = h / \lambda = hf / c$<br><br>$= (6.63 \times 10^{-34} \times 2.65 \times 10^{20}) / (3.00 \times 10^{8})$<br><br>**or**<br><br>$p = E / c$<br><br>$= (1.1 \times 1.60 \times 10^{-13}) / (3.00 \times 10^{8})$ | **C1** |
| | $p = 5.9 \times 10^{-22}$ ($5.87 \times 10^{-22}$) 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<br>• self-absorption in source<br>• absorption in air before reaching detector<br>• detector not sensitive to all radiations<br>• window of detector may absorb some radiation<br>• dead-time of counter<br>• background radiation<br>*Any two points.* | **B2** |
| 12(b)(i) | curve is not smooth<br>**or**<br>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<br>(*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** |