**CAMBRIDGE INTERNATIONAL EXAMINATIONS**

**Cambridge International Advanced Subsidiary and Advanced Level**

# MARK SCHEME for the October/November 2015 series

## 9702 PHYSICS

**9702/22** Paper 2 (AS Structured Questions), maximum raw mark 60

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|---|---|---|---|---|---|
| **1** | **(a)** | $v = f\lambda$ | | C1 | |
| | | $\lambda = (3.0 \times 10^8)/(4.6 \times 10^{20})$ | | C1 | |
| | | $(= 6.52 \times 10^{-13} =)$ 0.65(2) pm | | A1 | [3] |
| | **(b)** | $t = (8.5 \times 10^{16})/(3.0 \times 10^8)$ | | C1 | |
| | | $(= 2.83 \times 10^8 =)$ 0.28(3) Gs | | A1 | [2] |
| | **(c)** | mass, power and temperature all underlined and no others | | B1 | [1] |
| | **(d)** | **(i)** | arrow in the direction 30° to 40° south of east | B1 | [1] |
| | | **(ii)** | triangle of velocities completed (i.e. correct scale diagram) or correct working given<br>e.g. $[14^2 + 8.0^2 - 2(14)(8.0)\cos 60°]^{1/2}$<br>**or** $[(14 - 8.0\cos 60°)^2 + (8.0\sin 60°)^2]^{1/2}$ | C1 | |
| | | | resultant velocity = 12(.2) (or 12.0 to 12.4 from scale diagram) m s$^{-1}$ | A1 | [2] |
| **2** | **(a)** | **(i)** | $v = u + at$ | C1 | |
| | | | $0 = 3.6 - 3.0t$ | | |
| | | | $t$ (= 3.6 / 3.0) = 1.2 s | A1 | [2] |
| | | **(ii)** | (distance to rest from P = (3.6 × 1.2) / 2 =) 2.2 (2.16) m<br>**or**<br>$[0 - (3.6)^2]/[2 \times (-3.0)] = 2.2$ (2.16) m<br>**or**<br>$3.6 \times 1.2 - ½ \times 3.0 \times (1.2)^2 = 2.2$ (2.16) m<br>**or**<br>$0 + ½ \times 3.0 \times (1.2)^2 = 2.2$ (2.16) m | A1 | [1] |
| | **(b)** | distance = 6.0 – 2.16 (= 3.84) | | C1 | |
| | | $v^2 = u^2 + 2as = 2 \times 3.0 \times 3.84$ (= 23.04) | | M1 | |
| | | **or** | | | |
| | | $x + 2 \times 2.16 = 6.0$ gives $x = 1.68$ (m) | | (C1) | |
| | | $v^2 = 3.6^2 + 2 \times 1.68 \times 3.0$ (= 23.04) | | (M1) | |
| | | **or** correct method with intermediate time calculated ($t$ = 1.6 s from Q to R) | | | |
| | | $v = 4.8$ m s$^{-1}$ | | A0 | [2] |

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| (c) | straight line from $v = 3.6\ \text{m s}^{-1}$ to $v = 0$ at $t = 1.2\ \text{s}$ | B1 | |
| | straight line continues with the same gradient as $v$ changes sign | B1 | |
| | straight line from $v = 0$ intercept to $v = -4.8\ \text{m s}^{-1}$ | B1 | [3] |
| (d) | difference in KE $= ½m(v^2 - u^2)$<br>$= 0.5 \times 0.45\ (4.8^2 - 3.6^2)$ [= 5.184 – 2.916] | C1 | |
| | $= 2.3\ (2.27)\ \text{J}$ | A1 | [2] |

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| 3 | (a) | (i) | $k = F / x$ **or** 1 / gradient | C1 | |
| | | | $(k = 4.4 / (5.4 \times 10^{-2}) =)\ 81\ (81.48)\ \text{N m}^{-1}$ | A1 | [2] |
| | | (ii) | work done = area under line **or** $½Fx$ **or** $½kx^2$ | C1 | |
| | | | $(= 0.5 \times 4.4 \times 5.4 \times 10^{-2} =)\ 0.12\ (0.119)\ \text{J}$ | A1 | [2] |
| | (b) | (i) | kinetic energy/$E_k$ <u>of trolley/T</u> (and block) changes to EPE/strain energy/elastic energy <u>of spring</u> | B1 | |
| | | | EPE changes to KE <u>of trolley/T</u> and KE <u>of block</u> **or** to give <u>lower</u> KE to trolley | B1 | [2] |
| | | (ii) | change in momentum $= m(v + u)$ | C1 | |
| | | | $= 0.25\ (0.75 + 1.2) = 0.49\ (0.488)\ \text{N s}$ | A1 | [2] |
| 4 | (a) | | product of the force and the perpendicular distance to/from a point/pivot | B1 | [1] |
| | (b) | (i) | $4000 \times 2.8 \times \sin 30°$ **or** $500 \times 1.4 \times \sin 30°$ **or** $T \times 2.8$<br>**or** $4000 \times 1.4$ **or** $500 \times 0.7$ | B1 | |
| | | | $4000 \times 2.8 \times \sin 30° + 500 \times 1.4 \times \sin 30° = T \times 2.8$<br>hence $T = 2100\ (2125)\ \text{N}$ | M1<br>A0 | <br>[2] |
| | | (ii) | $(T_v = 2100 \cos 60° =)\ 1100\ (1050)\ \text{N}$ | A1 | [1] |
| | | (iii) | there is an upward (vertical component of) force at A | B1 | |
| | | | upward force at A + $T_v$ = sum of downward forces/weight+load/4500 N | B1 | [2] |

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| **5** | **(a)** | **(i)** | $I = V/R$ | C1 | |
| | | | (= 240 / 1500 =) 0.16 A | A1 | [2] |
| | | **(ii)** | $I_2$ = 0.40 – 0.16 (= 0.24) | C1 | |
| | | | 0.24 (350 + $R$) = 240 | | |
| | | | $R$ = 650 Ω | A1 | [2] |
| | | **(iii)** | power = $IV$ **or** $I^2R$ **or** $V^2/R$ | C1 | |
| | | | ratio = (84 × 0.24) / (88 × 0.16)<br>**or** [(0.24)$^2$ × 350] / [(0.16)$^2$ × 550]<br>**or** (84$^2$/350) / (88$^2$/ 550)<br>**or** 20.16 / 14.08 | | |
| | | | = 1.4(3) | A1 | [2] |
| | **(b)** | **(i)** | p.d. across 350 Ω resistor = 0.24 × 350<br>**or** p.d. across 550 Ω resistor = 0.16 × 550 | C1 | |
| | | | $V_{350}$ = 84 (V) and $V_{550}$ = 88 (V) gives $V_{AB}$ = 4.0 V<br>**or** $V_{950}$ = 152 (V) and $V_R$ = 156 V gives $V_{AB}$ = 4.0 V | A1 | [2] |
| | | **(ii)** | p.d. across $R$ increases **or** potential at B increases **or** $V_{350}$ decreases hence $V_{AB}$ increases | B1 | [1] |
| **6** | **(a)** | | internal resistance causes lost volts | B1 | |
| | | | p.d. across lamp is less than 12 V, power is less than 48 W | B1 | [2] |
| | **(b)** | **(i)** | greater lost volts or p.d. across cell/lamp reduced, less current in lamp | B1 | [1] |
| | | **(ii)** | p.d. across lamp/current <u>in lamp</u> decreases, hence resistance decreases | B1 | [1] |
| **7** | **(a)** | **(i)** | 3.2 mm | A1 | [1] |
| | | **(ii)** | 20 mm | A1 | [1] |
| | **(b)** | **(i)** | energy is transferred/propagated (through the water) or wave profile/wavefronts move (outwards from dipper) so progressive | B1 | [1] |
| | | **(ii)** | to produce waves with constant/zero phase difference/coherent waves | B1 | [1] |

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| **(c) (i)** | path difference is $\lambda$ | B1 | |
| | water vibrates/oscillates with amplitude about $2 \times 3.2$ mm | B1 | [2] |
| **(ii)** | path difference is $\lambda/2$ so little/no motion/displacement/amplitude | B1 | [1] |
| **8 (a)** | result: majority / most (of the $\alpha$-particles) went straight through/were deviated by small angles | M1 | |
| | conclusion: most of the atom is (empty) space **or** size/volume of nucleus very small compared with atom | A1 | |
| | result: a small proportion were deflected through large angles or >90° or came straight back | M1 | |
| | conclusion: the mass or majority of mass is in a (very) small charged volume/region/nucleus | A1 | [4] |
| **(b)** | $\rho = m / V$ | C1 | |
| | mass of atom and mass of nucleus (approx.) equal stated **or** cancelled **or** values given e.g. 63 u or $63 \times 1.66 \times 10^{-27}$ | C1 | |
| | ratio $= (r_A)^3 / (r_N)^3 = (1.15 \times 10^{-10})^3 / (1.4 \times 10^{-14})^3$<br>**or**<br>ratio $= (d_A)^3 / (d_N)^3 = (2.3 \times 10^{-10})^3 / (2.8 \times 10^{-14})^3$<br>$= 5.5 \times 10^{11}$ | A1 | [3] |