

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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Page 2	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2015	9702	22

- 1 (a) $v = f\lambda$** C1
- $\lambda = (3.0 \times 10^8) / (4.6 \times 10^{20})$ C1
- $(= 6.52 \times 10^{-13} =) 0.65(2) \text{ pm}$ A1 [3]
- (b) $t = (8.5 \times 10^{16}) / (3.0 \times 10^8)$** C1
- $(= 2.83 \times 10^8 =) 0.28(3) \text{ Gs}$ 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** C1
- e.g. $[14^2 + 8.0^2 - 2(14)(8.0) \cos 60^\circ]^{1/2}$
or $[(14 - 8.0 \cos 60^\circ)^2 + (8.0 \sin 60^\circ)^2]^{1/2}$
- 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
- $0 = 3.6 - 3.0t$
- $t (= 3.6 / 3.0) = 1.2 \text{ s}$ A1 [2]
- (ii) (distance to rest from P = $(3.6 \times 1.2) / 2 =$) 2.2 (2.16) m** A1 [1]
- or**
 $[0 - (3.6)^2] / [2 \times (-3.0)] = 2.2$ (2.16) m
or
 $3.6 \times 1.2 - \frac{1}{2} \times 3.0 \times (1.2)^2 = 2.2$ (2.16) m
or
 $0 + \frac{1}{2} \times 3.0 \times (1.2)^2 = 2.2$ (2.16) m
- (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 ($t = 1.6 \text{ s}$ from Q to R)**
- $v = 4.8 \text{ m s}^{-1}$ A0 [2]

Page 3	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2015	9702	22

- (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 $= \frac{1}{2}m(v^2 - u^2)$
 $= 0.5 \times 0.45 (4.8^2 - 3.6^2) [= 5.184 - 2.916]$ C1
 $= 2.3 (2.27) \text{ J}$ A1 [2]
- 3 (a) (i) $k = F/x$ or $1/\text{gradient}$ 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 $\frac{1}{2}Fx$ or $\frac{1}{2}kx^2$ 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 of trolley/T (and block) changes to EPE/strain energy/elastic energy of spring B1
EPE changes to KE of trolley/T and KE of block or to give lower 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) $4000 \times 2.8 \times \sin 30^\circ$ or $500 \times 1.4 \times \sin 30^\circ$ or $T \times 2.8$
or 4000×1.4 or 500×0.7 B1
 $4000 \times 2.8 \times \sin 30^\circ + 500 \times 1.4 \times \sin 30^\circ = T \times 2.8$ M1
hence $T = 2100 (2125) \text{ N}$ A0 [2]
- (ii) ($T_v = 2100 \cos 60^\circ =$) $1100 (1050) \text{ N}$ 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]

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2015	9702	22

- 5 (a) (i)** $I = V/R$ C1
 $(= 240/1500 =) 0.16 \text{ A}$ A1 [2]
- (ii)** $I_2 = 0.40 - 0.16 (= 0.24)$ C1
 $0.24(350 + R) = 240$
 $R = 650 \Omega$ A1 [2]
- (iii)** power = IV or I^2R or V^2/R C1
ratio = $(84 \times 0.24)/(88 \times 0.16)$
or $[(0.24)^2 \times 350]/[(0.16)^2 \times 550]$
or $(84^2/350)/(88^2/550)$
or $20.16/14.08$
 $= 1.4(3)$ A1 [2]
- (b) (i)** p.d. across 350Ω resistor = 0.24×350
or p.d. across 550Ω resistor = 0.16×550 C1
 $V_{350} = 84 \text{ (V)}$ and $V_{550} = 88 \text{ (V)}$ gives $V_{AB} = 4.0 \text{ V}$
or $V_{950} = 152 \text{ (V)}$ and $V_R = 156 \text{ V}$ gives $V_{AB} = 4.0 \text{ V}$ 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 in lamp 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]

Page 5	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2015	9702	22

- (c) (i) path difference is λ B1
- water vibrates/oscillates with amplitude about $2 \times 3.2 \text{ mm}$ B1 [2]
- (ii) path difference is $\lambda/2$ so little/no motion/displacement/amplitude B1 [1]

- 8 (a) result: majority/most (of the α -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 $>90^\circ$ 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 = $(r_A)^3 / (r_N)^3 = (1.15 \times 10^{-10})^3 / (1.4 \times 10^{-14})^3$
or
 ratio = $(d_A)^3 / (d_N)^3 = (2.3 \times 10^{-10})^3 / (2.8 \times 10^{-14})^3$
 $= 5.5 \times 10^{11}$ A1 [3]