

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
- $(= 6.52 \times 10^{-13} =) 0.65(2) \text{ pm}$ 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) ms^{-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
- $[0 - (3.6)^2] / [2 \times (-3.0)] = 2.2 (2.16) \text{ m}$
- or
- $3.6 \times 1.2 - \frac{1}{2} \times 3.0 \times (1.2)^2 = 2.2 (2.16) \text{ m}$
- or
- $0 + \frac{1}{2} \times 3.0 \times (1.2)^2 = 2.2 (2.16) \text{ m}$
- (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 $x = 1.68 \text{ (m)}$ (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)
- $v = 4.8 \text{ ms}^{-1}$ 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 $= \frac{1}{2}m(v^2 - u^2)$
 $= 0.5 \times 0.45 (4.8^2 - 3.6^2) [= 5.184 - 2.916]$ 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]

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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
 $0.24(350 + R) = 240$
 $R = 650 \Omega$ 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
 $V_{350} = 84$ (V) and $V_{550} = 88$ (V) gives $V_{AB} = 4.0$ V
 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) (i) 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]

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- (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 = $(d_A)^3 / (d_N)^3 = (2.3 \times 10^{-10})^3 / (2.8 \times 10^{-14})^3$
= 5.5×10^{11} A1 [3]