

**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  $30^\circ$  to  $40^\circ$  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)  $\text{m s}^{-1}$  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) J A1 [2]
- 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  $\frac{1}{2}Fx$  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  $4000 \times 1.4$  or  $500 \times 0.7$  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) 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 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  $350\ \Omega$  resistor =  $0.24 \times 350$   
 or p.d. across  $550\ \Omega$  resistor =  $0.16 \times 550$  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) 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  $\lambda$  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  $\alpha$ -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  $>90^\circ$  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]