

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the October/November 2015 series

9702 PHYSICS

9702/23

Paper 2 (AS Structured Questions), maximum raw mark 60

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- 1 (a) energy or W : $\text{kg m}^2 \text{s}^{-2}$
or
power or P : $\text{kg m}^2 \text{s}^{-3}$ M1
- intensity or I : $\text{kg m}^2 \text{s}^{-2} \text{m}^{-2} \text{s}^{-1}$ (from use of energy expression)
or
 $\text{kg m}^2 \text{s}^{-3} \text{m}^{-2}$ (from use of power expression)
- indication of simplification to kg s^{-3} A1 [2]
- (b) (i) ρ : kg m^{-3} , c : m s^{-1} , f : s^{-1} , x_0 : m M1
- substitution of terms in an appropriate equation and simplification to show K has no units A1 [2]
- (ii) $I = 20 \times 1.2 \times 330 \times (260)^2 \times (0.24 \times 10^{-9})^2$ C1
- $= 3.1 \times 10^{-11} (\text{W m}^{-2})$ C1
- $= 31 (30.8) \text{ pW m}^{-2}$ A1 [3]
- 2 (a) (i) (the loudspeakers) are connected to the same signal generator B1 [1]
- (ii) 1. the waves (that overlap) have phase difference of zero or path difference of zero and so
either constructive interference
or displacement larger B1 [1]
2. the waves (that overlap) have phase difference of $(n + \frac{1}{2}) \times 360^\circ$ or $(n + \frac{1}{2}) \times 2\pi$ rad or path difference of $(n + \frac{1}{2})\lambda$ and so
either destructive interference
or displacements cancel/smaller B1 [1]
3. the waves (that overlap) are in phase or have phase difference of $n360^\circ$ or $2\pi n$ rad or path difference of $n\lambda$ and so
either constructive interference
or displacement larger B1 [1]
- (b) time period = 0.002 s or 2 ms C1
- wave drawn is half time period B1
- amplitude 1.0 cm (same as Fig. 2.2) B1 [3]

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- 3 (a) (i) 1. $s = ut + \frac{1}{2}at^2$
- $192 = \frac{1}{2} \times 9.81 \times t^2$ C1
- $t = 6.3$ (6.26) s A1 [2]
2. $\max E_k (= mgh) = 0.27 \times 9.81 \times 192$ C1
- or**
- calculation of v ($= 61.4$) and use of $E_k (= \frac{1}{2}mv^2) = \frac{1}{2} \times 0.27 \times (61.4)^2$ (C1)
- $\max E_k = 510$ (509) J A1 [2]
- (ii) velocity is proportional to time **or** velocity increases at a constant rate
as acceleration is constant **or** resultant force is constant B1 [1]
- (iii) use of $v = at$ **or** $v^2 = 2as$ **or** $E = \frac{1}{2}mv^2$ to give $v = 61(.4)\text{ms}^{-1}$ B1 [1]
- (b) (i) R increases with velocity B1
resultant force is $mg - R$ **or** resultant force decreases B1
acceleration decreases B1 [3]
- (ii) at $v = 40\text{ms}^{-1}$, $R = 0.6$ (N) C1
- $0.27 \times 9.8 - 0.6 = 0.27 \times a$
- $a = 7.6$ (7.58) ms^{-2} A1 [2]
- (iii) $R =$ weight for terminal velocity B1
- either* weight requires velocity to be about 80ms^{-1}
or at 60ms^{-1} , R is less than weight
- so does not reach terminal velocity B1 [2]
- 4 (a) (i) reaction/vertical force = weight $- P \cos 60^\circ$ C1
- $= 180 - 35 \cos 60^\circ$
- $= 160$ (163) N A1 [2]
- (ii) work done = $35 \sin 60^\circ \times 20$ C1
- $= 610$ (606) J A1 [2]

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- (b) (i) work done by force P = work done against frictional force B1 [1]
- (ii) horizontal component of P is equal and opposite to frictional force B1
- vertical component of P + normal reaction force equal and opposite to weight B1 [2]
- 5 (a) (i) resistance = V/I B1
- very high/infinite resistance at low voltages B1
- resistance decreases as V increases B1 [3]
- (ii) p.d. from graph 0.50 (V) C1
- resistance = $0.5/(4.4 \times 10^{-3})$
- = 110 (114) Ω A1 [2]
- (b) (i) current (= $1.2/375$) = 3.2×10^{-3} A A1 [1]
- (ii) current in diode = 4.4×10^{-3} (A)
- total resistance = $1.2/4.4 \times 10^{-3} = 272.7$ (Ω) C1
- resistance of $R_1 = 272.7 - 113.6 = 160$ (159) Ω A1
- or
- p.d. across diode = 0.5 V and p.d. across $R_1 = 0.7$ V (C1)
- resistance of $R_1 = 0.7/4.4 \times 10^{-3}$
- = 160 (159) Ω (A1) [2]
- (iii) power = IV or I^2R or V^2/R C1
- ratio = $(4.4 \times 0.5)/(3.2 \times 1.2)$
- or $[(4.4)^2 \times 114]/[(3.2)^2 \times 375]$
- or $[(0.5)^2 \times 375]/[114 \times (1.2)^2]$
- = 0.57 A1 [2]
- 6 (a) waves from loudspeaker (travel down tube and) are reflected at closed end B1
- two waves (travelling) in opposite directions with same frequency/wavelength overlap B1 [2]
- (b) (i) 0.51 m A1
- 0.85 m A1 [2]
- (ii) A at open end, N at closed end, with an N and A in between, equally spaced (by eye) B1 [1]

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- 7 (a) stress or $\sigma = F/A$ C1
max. tension = UTS $\times A = 4.5 \times 10^8 \times 15 \times 10^{-6} = 6800$ (6750) N A1 [2]
- (b) $\rho = m/V$ C1
weight = $mg = \rho Vg = \rho ALg$
 $6750 = 7.8 \times 10^3 \times 15 \times 10^{-6} \times L \times 9.81$ C1
 $L = 5.9$ (5.88) $\times 10^3$ m A1
- or
maximum mass = $6750/9.81 = 688$ kg (C1)
mass per unit length = $\rho A = 0.117$ kg m⁻¹ (C1)
 $L = 688/0.117 = 5.9 \times 10^3$ m (A1)
- or
maximum mass = $6750/9.81 = 688$ kg (C1)
volume = $m/\rho = 0.0882$ m³ = LA (C1)
 $L = 0.0882/15 \times 10^{-6} = 5.9 \times 10^3$ m (A1) [3]
- 8 (a) mass-energy
proton number or charge
nucleon number B2 [2]
- (b) (i) $E_k = \frac{1}{2} mv^2$ and $p = mv$ with working leading to
[via $E_k = \frac{1}{2} m^2 v^2 / m$ or $\frac{1}{2} m(p/m)^2$]
to $E_k = \frac{p^2}{2m}$ B1 [1]
- (ii) $p = (2E_k m)^{1/2}$ hence $(2[E_k m]_\alpha)^{1/2} = (2[E_k m]_{Th})^{1/2}$ C1
 $2 \times [E_k]_{Th} \times 234 = 2 \times 6.69 \times 10^{-13} \times 4$ C1
 $[E_k]_{Th} = 1.14 \times 10^{-14}$ J
= 71(.5) keV A1
- or
calculation of speed of α -particle = 1.42×10^7 m s⁻¹
calculation of momentum of α -particle/nucleus = 9.43×10^{-20} N s (C1)
 $[E_k]_{Th} = 1.14 \times 10^{-14}$ J (C1)
= 71(.5) keV (A1) [3]