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PHYSICS

9702/22

Paper 2 AS Structured Questions

October/November 2016

MARK SCHEME

Maximum Mark: 60

Published

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- 1 (a) (i) force / area (normal to the force) B1 [1]
- (ii) ($p = F/A$ so) units: $\text{kg m s}^{-2} / \text{m}^2 = \text{kg m}^{-1} \text{s}^{-2}$ A1 [1]
- allow use of other correct equations:
 e.g. ($\Delta p = \rho g \Delta h$ so) $\text{kg m}^{-3} \text{m s}^{-2} \text{m} = \text{kg m}^{-1} \text{s}^{-2}$
 e.g. ($p = W/\Delta V$ so) $\text{kg m s}^{-2} \text{m} / \text{m}^3 = \text{kg m}^{-1} \text{s}^{-2}$
- (b) units for m : kg, t : s and ρ : kg m^{-3} C1
- units of C : kg/s ($\text{kg m}^{-3} \text{kg m}^{-1} \text{s}^{-2}$)^{1/2}
 or
 units of C^2 : $\text{kg}^2 / \text{s}^2 \text{kg m}^{-3} \text{kg m}^{-1} \text{s}^{-2}$ C1
- units of C : m^2 A1 [3]
- 2 (a) $\Delta E = mg\Delta h$ C1
- $= 0.030 \times 9.81 \times (-)0.31$
- $= (-)0.091 \text{ J}$ A1 [2]
- (b) $E = \frac{1}{2}mv^2$ C1
- (initial) $E = \frac{1}{2} \times 0.030 \times 1.3^2 (= 0.0254)$ C1
- $0.5 \times 0.030 \times v^2 = (0.5 \times 0.030 \times 1.3^2) + (0.030 \times 9.81 \times 0.31)$ so $v = 2.8 \text{ m s}^{-1}$
 or
 $0.5 \times 0.030 \times v^2 = (0.0254) + (0.091)$ so $v = 2.8 \text{ m s}^{-1}$ A1 [3]
- (c) (i) $0.096 = 0.030(v + 2.8)$ C1
- $v = 0.40 \text{ m s}^{-1}$ A1 [2]
- (ii) $F = \Delta p / (\Delta)t$ or $F = ma$
 $= 0.096 / 20 \times 10^{-3}$ or $0.030 (0.40 + 2.8) / 20 \times 10^{-3}$ C1
- $= 4.8 \text{ N}$ A1 [2]
- (d) kinetic energy (of ball and wall) decreases/changes/not conserved, so inelastic
 or
 (relative) speed of approach (of ball and wall) not equal to/greater than (relative) speed of separation, so inelastic. B1 [1]
- (e) force = work done / distance moved C1
- $= (0.091 - 0.076) / 0.60$
- $= 0.025 \text{ N}$ A1 [2]

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- 3 (a)** resultant force (in any direction) is zero B1
 resultant moment/torque (about any point) is zero B1 [2]
- (b) (i)** force = $33 \sin 52^\circ$ or $33 \cos 38^\circ$
 = 26 N A1 [1]
- (ii)** 26×0.30 or $W \times 0.20$ or 12×0.40 C1
 $26 \times 0.30 = (W \times 0.20) + (12 \times 0.40)$ C1
 $W = 15 \text{ N}$ A1 [3]
- (c) (i)** $E = \Delta\sigma / \Delta\varepsilon$ or $E = \sigma / \varepsilon$ C1
 $\Delta\sigma = 2.0 \times 10^{11} \times 7.5 \times 10^{-4}$
 $= 1.5 \times 10^8 \text{ Pa}$ A1 [2]
- (ii)** $\Delta\sigma = \Delta F / A$ or $\sigma = F / A$ C1
 $A = 78 / 1.5 \times 10^8 (= 5.2 \times 10^{-7} \text{ m}^2)$ C1
 $5.2 \times 10^{-7} = \pi d^2 / 4$
 $d = 8.1 \times 10^{-4} \text{ m}$ A1 [3]
- 4 (a)** wave incident on/passes by or through an aperture/edge B1
 wave spreads (into geometrical shadow) B1 [2]
- (b) (i)** waves (from slits) overlap (at point X) B1
 path difference (from slits to X) is zero/
 phase difference (between the two waves) is zero
 (so constructive interference gives bright fringe) B1 [2]
- (ii)** difference in distances = $\lambda / 2 = 580 / 2$
 = 290 nm A1 [1]
- (iii)** $\lambda = ax / D$ C1
 $D = [0.41 \times 10^{-3} \times (2 \times 2.0 \times 10^{-3})] / 580 \times 10^{-9}$ C1
 = 2.8 m A1 [3]
- (iv)** same separation/fringe width/number of fringes
 bright fringe(s)/central bright fringe/(fringe at) X less bright
 dark fringe(s)/(fringe at) Y/(fringe at) Z brighter
 contrast between fringes decreases
 Any two of the above four points, 1 mark each B2 [2]

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- 5 (a) total/sum of electromotive forces or e.m.f.s
 = total/sum of potential differences or p.d.s
 around a loop/(closed) circuit M1
 A1 [2]
- (b) (i) (current in battery =) current in A + current in B or $I_A + I_B$ C1
 $(I =) 0.14 + 0.26 = 0.40 \text{ A}$ A1 [2]
- (ii) $E = V + Ir$
 $6.8 = 6.0 + 0.40r$ or $6.8 = 0.40(15 + r)$ C1
 $r = 2.0 \Omega$ A1 [2]
- (iii) $R = V/I$ C1
 ratio $(= R_A/R_B) = (6.0/0.14)/(6.0/0.26)$
 $= 42.9/23.1$ or $0.26/0.14$
 $= 1.9 (1.86)$ A1 [2]
- (iv) 1. $P = EI$ or VI or $P = I^2 R$ or $P = V^2/R$ C1
 $= 6.8 \times 0.40$ $= 0.40^2 \times 17$ $= 6.8^2/17$
 $= 2.7 \text{ W} (2.72 \text{ W})$ A1 [2]
2. output power $= VI$
 $= 6.0 \times 0.40 (= 2.40 \text{ W})$ C1
 efficiency $= (6.0 \times 0.40)/(6.8 \times 0.40) = 2.40/2.72$
 $= 0.88$ or 88% (allow 0.89 or 89%) A1 [2]

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- 6 (a) hadron not a fundamental particle/lepton is fundamental particle
or
hadron made of quarks/lepton not made of quarks
or
strong force/interaction acts on hadrons/does not act on leptons B1 [1]
- (b) (i) ${}^0_1\text{e}^{(+)}$ or ${}^0_1\beta^{(+)}$ B1
- ${}^0_0\nu_{(\text{e})}$ B1 [2]
- (ii) weak (nuclear force /interaction) B1 [1]
- (iii) • mass-energy
• momentum
• proton number
• nucleon number
• charge
- Any three of the above quantities, 1 mark each* B3 [3]
- (c) (quark structure of proton is) up, up, down or uud B1
- up/u (quark charge) is $(+)\frac{2}{3}(e)$, down/d (quark charge) is $-\frac{1}{3}(e)$ C1
- $\frac{2}{3}e + \frac{2}{3}e - \frac{1}{3}e = (+)e$ A1 [3]