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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: $\text{kg} / \text{s} (\text{kg m}^{-3} \text{ kg m}^{-1} \text{ s}^{-2})^{1/2}$
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

$= 0.030 \times 9.81 \times (-)0.31$

$= (-)0.091$ 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

$= 4.8$ N A1 [2]

(d) <u>kinetic</u> 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
$= (0.091 - 0.076) / 0.60$ C1

$= 0.025$ N A1 [2]

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° *or* 33 cos 38°
= 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

$W = 15$ N A1 [3]

(c) **(i)** $E = \Delta\sigma / \Delta\varepsilon$ *or* $E = \sigma / \varepsilon$ C1

$\Delta\sigma = 2.0 \times 10^{11} \times 7.5 \times 10^{-4}$
$= 1.5 \times 10^{8}$ 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

$5.2 \times 10^{-7} = \pi d^2 / 4$

$d = 8.1 \times 10^{-4}$ 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]

5 **(a)** total/sum of electromotive forces or e.m.f.s
= total/sum of potential differences or p.d.s M1
around a loop/(closed) circuit 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 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* $P = I^2R$ *or* $P = V^2/R$ C1

$= 6.8 \times 0.40$ $= 0.40^2 \times 17$ $= 6.8^2/17$

= 2.7 W (2.72 W) A1 [2]

2. output power $= VI$
$= 6.0 \times 0.40$ (= 2.40 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]

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)** ${}^{0}_{1}e^{(+)}$ or ${}^{0}_{1}\beta^{(+)}$ B1

${}^{0}_{0}\nu_{(e)}$ 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 (+)⅔(*e*), down/d (quark charge) is –⅓(*e*) C1

⅔*e* + ⅔*e* – ⅓*e* = (+)*e* A1 [3]