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Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS 9702/22

Paper 2 AS Structured Questions

October/November 2016

MARK SCHEME
Maximum Mark: 60

Published

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(ii) $(p = F/A \operatorname{so})$ units: $\operatorname{kgms}^{-2}/\operatorname{m}^2 = \operatorname{kgm}^{-1} \operatorname{s}^{-2}$ A1 [1 allow use of other correct equations: e.g. $(Ap = pg/h \operatorname{so}) \operatorname{kgm}^{-2} \operatorname{ms}^{-2} \operatorname{m} = \operatorname{kgm}^{-1} \operatorname{s}^{-2}$ e.g. $(p = W/A V \operatorname{so}) \operatorname{kgm}^{-2} \operatorname{m/m}^3 = \operatorname{kgm}^{-1} \operatorname{s}^{-2}$ e.g. $(p = W/A V \operatorname{so}) \operatorname{kgm}^{-3} \operatorname{kgm}^{-3} = \operatorname{kgm}^{-1} \operatorname{s}^{-2}$ C1 units of C : $\operatorname{kg/s} (\operatorname{kgm}^{-3} \operatorname{kgm}^{-3} \operatorname{kgm}^{-3} \operatorname{sgm}^{-1} \operatorname{s}^{-2})^{1/2}$ or units of C : $\operatorname{kg/s} (\operatorname{kgm}^{-3} \operatorname{kgm}^{-3} \operatorname{kgm}^{-1} \operatorname{s}^{-2})^{1/2}$ or units of C : m^2 A1 [3 and C A2 C A3 C A4 C A5 C A6 C A7 C A7 C A7 C A7 C A8 C A8 C A8 C A8 C A8 C A9 C	P	age 2		Pape)r
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allow use of other correct equations: e.g. $(\Delta p = \rho g \Delta h s 0) \log m^3 ms^2 m = \log m^{-1} s^{-2}$ e.g. $(p = W/\Delta V s 0) \log ms^{-3} m/m^3 = \log m^{-1} s^{-2}$ e.g. $(p = W/\Delta V s 0) \log ms^{-2} m/m^3 = \log m^{-1} s^{-2}$ (b) units for m : $\log k$; $\log m^3 \log m^{-1} s^{-2}$ $\log m$ units of \mathbb{C} : $\log k \log m^3 \log m^{-1} s^{-2}$ $\log m$ units of \mathbb{C} : $\log k \log m^3 \log m^{-1} s^{-2}$ $\log m$ units of \mathbb{C} : $\log k \log m^3 \log m^{-1} s^{-2}$ $\log m$ units of \mathbb{C} : $\log k \log m^3 \log m^{-1} s^{-2}$ $\log m$ units of \mathbb{C} : $\log k \log m^3 \log m^{-1} s^{-2}$ $\log m$ units of \mathbb{C} : $\log k \log m^3 \log m^{-1} s^{-2}$ $\log m$ units of \mathbb{C} : $\log k \log m^{-3} \log m^{-1} s^{-2}$ $\log m$ units of \mathbb{C} : $\log k \log m^{-3} \log m^{-1} s^{-2}$ $\log m$ units of \mathbb{C} : $\log k \log m $	1	(a)	(i) force/area (normal to the force)	B1	[1]
e.g. $(\Delta p = \rho g \Delta h \text{ so}) \text{ kg m}^{-3} \text{ m} = ^{k} \text{ g m}^{-1} \text{ s}^{-2}$ e.g. $(p = W/\Delta V \text{ so}) \text{ kg ms}^{-2} \text{ m} - ^{k} \text{ kg m}^{-1} \text{ s}^{-2}$ (b) units of C : kg/s (kg m $^{-3}$ kg m $^{-1}$ s $^{-2}$) ^{1/2} or units of C : kg/s (kg m $^{-3}$ kg m $^{-1}$ s $^{-2}$) ^{1/2} 10 units of C : kg/s/s kg m $^{-3}$ kg m $^{-1}$ s $^{-2}$ 11 units of C : kg/s/s kg m $^{-3}$ kg m $^{-1}$ s $^{-2}$ 12 (a) $\Delta E = mg\Delta h$ $= 0.030 \times 9.81 \times (-)0.31$ $= (-)0.091 \text{ J}$ 13 (b) $E = \frac{1}{2}mv^2$ $= (-)0.091 \text{ J}$ 14 (c) (initial) $E = \frac{1}{2} \times 0.030 \times 1.3^2 (= 0.0254)$ $= 0.5 \times 0.030 \times v^2 = (0.5 \times 0.030 \times 1.3^2) + (0.030 \times 9.81 \times 0.31) \text{ so } v = 2.8 \text{ms}^{-1}$ or $= 0.5 \times 0.030 \times v^2 = (0.0254) + (0.091) \text{ so } v = 2.8 \text{ms}^{-1}$ 15 (c) (i) $0.096 = 0.030 (v + 2.8)$ $= 0.096/20 \times 10^{-3} \text{ or } 0.030 (0.40 + 2.8)/20 \times 10^{-3}$ $= 4.8 \text{ N}$ 16 (d) $\frac{\text{kinetic}}{\text{energy}}$ (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. 17 (e) force = work done/distance moved $= (0.091 - 0.076)/0.60$			(ii) $(p = F/A \text{ so}) \text{ units: } \text{kg m s}^{-2}/\text{m}^2 = \text{kg m}^{-1} \text{ s}^{-2}$	A1	[1]
units of $C: kg/s (kg m^{-3} kg m^{-1} s^{-2})^{1/2}$ or units of $C^2: kg^2/s^2 kg m^{-3} kg m^{-1} s^{-2}$ 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 $0.5 \times 0.030 \times v^2 = (0.5 \times 0.030 \times 1.3^2) + (0.030 \times 9.81 \times 0.31) \text{ so } v = 2.8 \text{ms}^{-1}$ or $0.5 \times 0.030 \times v^2 = (0.0254) + (0.091) \text{ so } v = 2.8 \text{ms}^{-1}$ A1 [3 (c) (i) $0.096 = 0.030 (v + 2.8)$ C1 $v = 0.40 \text{ms}^{-1}$ A1 [2 (ii) $F = \frac{\Delta p}{(\Delta)} (\Delta) t$ or $F = ma$ $= 0.096/20 \times 10^{-3} \text{ or } 0.030 (0.40 + 2.8)/20 \times 10^{-3}$ C1 $= 4.8 \text{N}$ A1 [2 (d) $\frac{k \text{inetic}}{(\text{relative})} speed of approach (of ball and wall) not equal to/greater than (relative) speed of separation, so inelastic. (e) force = work done/distance moved = (0.091 - 0.076)/0.60 C1$			e.g. $(\Delta p = \rho g \Delta h \text{ so}) \text{ kg m}^{-3} \text{ m s}^{-2} \text{ m} = \text{kg m}^{-1} \text{ s}^{-2}$		
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(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) 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 $= (0.091 - 0.076)/0.60$ C1		(c)	(i) $0.096 = 0.030 (v + 2.8)$	C1	
= 0.096/20×10 ⁻³ or 0.030 (0.40 + 2.8)/20×10 ⁻³ C1 = 4.8 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. (e) force = work done/distance moved = (0.091 - 0.076)/0.60 C1			$v = 0.40 \mathrm{m s^{-1}}$	A1	[2]
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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			= 4.8 N	A1	[2]
(relative) speed of approach (of ball and wall) not equal to/greater than (relative) speed of separation, so inelastic. (e) force = work done/distance moved = (0.091 - 0.076)/0.60 C1		(d)			
= (0.091 - 0.076)/0.60 C1			(relative) speed of approach (of ball and wall) not equal to/greater than (relative)	B1	[1]
= 0.025 N A1 [2		(e)		C1	
			= 0.025 N	A1	[2]

Pá	age 3		Mark Scheme	Syllabus	Pap	
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3	(a)		ultant force (in any direction) is zero ultant moment/torque (about any point) is zero		B1 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	
			$W = 15 \mathrm{N}$		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 × 10 ⁸ Pa		A1	[2]
		(ii)	$\Delta \sigma = \Delta F/A$ or $\sigma = F/A$		C1	
			$A = 78/1.5 \times 10^8 \ (= 5.2 \times 10^{-7} \mathrm{m}^2)$		C1	
			$5.2 \times 10^{-7} = \pi d^2/4$			
			$d = 8.1 \times 10^{-4} \mathrm{m}$		A1	[3]
4			ve incident on/passes by or through an aperture/edge ve spreads (into geometrical shadow)		B1 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]

Α1

[2]

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(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 Α1 [2] C1 **(b)** (i) (current in battery =) current in A + current in B or $I_A + I_B$ (I =) 0.14 + 0.26 = 0.40 AΑ1 [2] (ii) E = V + Ir6.8 = 6.0 + 0.40r or 6.8 = 0.40(15 + r)C1 $r = 2.0 \Omega$ Α1 [2] (iii) R = V/IC1 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)Α1 [2] (iv) 1. P = EI or VI $P = I^2R$ or $P = V^2/R$ or C1 $= 0.40^2 \times 17$ $=6.8^2/17$ $= 6.8 \times 0.40$ = 2.7 W (2.72 W)Α1 [2] output power = VIC1 $= 6.0 \times 0.40 (= 2.40 \text{ W})$ efficiency = $(6.0 \times 0.40)/(6.8 \times 0.40) = 2.40/2.72$

= 0.88 or 88% (allow 0.89 or 89%)

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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

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 $(+)^{2/3}(e)$, 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]