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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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) pm	A1	[3]
	(b)	$t = (8.5 \times 10^{16}) / (3.0 \times 10^{8})$	C1	
		$(= 2.83 \times 10^{8} =)$ 0.28(3) Gs	A1	[2]
	(c)	mass, power and temperature all underlined and no others	B1	[1]
	(d) (i)	arrow in the direction 30° to 40° south of east	B1	[1]
	(ii)	triangle of velocities completed (i.e. correct scale diagram) or correct working given e.g. $[14^2 + 8.0^2 - 2(14)(8.0) \cos 60°]^{1/2}$ **or** $[(14 - 8.0 \cos 60°)^2 + (8.0 \sin 60°)^2]^{1/2}$	C1	
		resultant velocity = 12(.2) (or 12.0 to 12.4 from scale diagram) m s^{-1}	A1	[2]
2	**(a) (i)**	$v = u + at$	C1	
		$0 = 3.6 - 3.0t$		
		t (= 3.6 / 3.0) = 1.2 s	A1	[2]
	(ii)	(distance to rest from P = $(3.6 \times 1.2) / 2$ =) 2.2 (2.16) m **or** $[0 - (3.6)^2] / [2 \times (-3.0)]$ = 2.2 (2.16) m **or** $3.6 \times 1.2 - ½ \times 3.0 \times (1.2)^2$ = 2.2 (2.16) m **or** $0 + ½ \times 3.0 \times (1.2)^2$ = 2.2 (2.16) m	A1	[1]
	(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 s from Q to R)		
		$v = 4.8\ \text{m s}^{-1}$	A0	[2]

	(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 $= ½m(v^2 - u^2)$ $= 0.5 \times 0.45\ (4.8^2 - 3.6^2)$ [= 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) N m^{-1}	A1	[2]
		(ii)	work done = area under line **or** $½Fx$ **or** $½kx^2$	C1	
			(= $0.5 \times 4.4 \times 5.4 \times 10^{-2}$ =) 0.12 (0.119) J	A1	[2]
	(b)	**(i)**	kinetic energy/E_k <u>of trolley/T</u> (and block) changes to EPE/strain energy/elastic energy <u>of spring</u>	B1	
			EPE changes to KE <u>of trolley/T</u> and KE <u>of block</u> **or** to give <u>lower</u> KE to trolley	B1	[2]
		(ii)	change in momentum $= m(v + u)$	C1	
			= 0.25 (0.75 + 1.2) = 0.49 (0.488) N s	A1	[2]
4	**(a)**		product of the force and the perpendicular distance to/from a point/pivot	B1	[1]
	(b)	**(i)**	$4000 \times 2.8 \times \sin 30°$ **or** $500 \times 1.4 \times \sin 30°$ **or** $T \times 2.8$ **or** 4000×1.4 **or** 500×0.7	B1	
			$4000 \times 2.8 \times \sin 30° + 500 \times 1.4 \times \sin 30° = T \times 2.8$ hence $T = 2100$ (2125) N	M1 A0	[2]
		(ii)	($T_v = 2100 \cos 60°$ =) 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]

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 Ω	A1	[2]
		(iii)	power = IV **or** I^2R **or** V^2/R	C1	
			ratio = (84 × 0.24) / (88 × 0.16) **or** [(0.24)^2 × 350] / [(0.16)^2 × 550] **or** (84^2/350) / (88^2/ 550) **or** 20.16 / 14.08		
			= 1.4(3)	A1	[2]
	(b)	(i)	p.d. across 350 Ω resistor = 0.24 × 350 **or** p.d. across 550 Ω resistor = 0.16 × 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 <u>in lamp</u> 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]

(c)	**(i)**	path difference is λ	B1	
		water vibrates/oscillates with amplitude about 2×3.2 mm	B1	[2]
	(ii)	path difference is $\lambda/2$ so little/no motion/displacement/amplitude	B1	[1]

8	**(a)**	result: majority / most (of the α-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° 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]