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

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the October/November 2015 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.

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 × 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 of trolley/T (and block) changes to EPE/strain energy/elastic energy of spring	B1	
			EPE changes to KE of trolley/T and KE of block **or** to give lower 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	
			$0.24(350 + R) = 240$		
			$R = 650\,\Omega$	A1	[2]
		(iii)	power = IV **or** I^2R **or** V^2/R	C1	
			ratio = $(84 \times 0.24)/(88 \times 0.16)$ **or** $[(0.24)^2 \times 350]/[(0.16)^2 \times 550]$ **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 $2 \times 3.2\,\text{mm}$	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]