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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International Examinations

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 C1
e.g. $[14^2 + 8.0^2 - 2(14)(8.0)\cos 60°]^{1/2}$
or $[(14 - 8.0\cos 60°)^2 + (8.0\sin 60°)^2]^{1/2}$

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 A1 [1]
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

(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	
			$= 2.3\ (2.27)\ \text{J}$	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	
			$= 0.25\ (0.75 + 1.2) = 0.49\ (0.488)\ \text{N s}$	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	
			$4000 \times 2.8 \times \sin 30° + 500 \times 1.4 \times \sin 30° = T \times 2.8$	M1	
			hence $T = 2100$ (2125) N	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 2×3.2 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]