CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the October/November 2015 series

9702 PHYSICS

9702/23 Paper 2 (AS Structured Questions), maximum raw mark 60

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1	**(a)** energy or W: kg m^2 s^{-2} **or** power or P: kg m^2 s^{-3}	M1	
	intensity or I: kg m^2 s^{-2} m^{-2} s^{-1} (from use of energy expression) **or** kg m^2 s^{-3} m^{-2} (from use of power expression)		
	indication of simplification to kg s^{-3}	A1	[2]
	(b) (i) ρ: kg m^{-3}, c: m s^{-1}, f: s^{-1}, x_0: m	M1	
	substitution of terms in an appropriate equation and simplification to show K has no units	A1	[2]
	(ii) $I = 20 \times 1.2 \times 330 \times (260)^2 \times (0.24 \times 10^{-9})^2$	C1	
	$= 3.1 \times 10^{-11}$ (W m^{-2})	C1	
	$= 31$ (30.8) pW m^{-2}	A1	[3]
2	**(a) (i)** (the loudspeakers) are connected to the same signal generator	B1	[1]
	(ii) 1. the waves (that overlap) have phase difference of zero or path difference of zero and so *either* constructive interference *or* displacement larger	B1	[1]
	2. the waves (that overlap) have phase difference of $(n + ½) \times 360°$ or $(n + ½) \times 2\pi$ rad or path difference of $(n + ½)\lambda$ and so *either* destructive interference *or* displacements cancel/smaller	B1	[1]
	3. the waves (that overlap) are in phase or have phase difference of $n360°$ or $2\pi n$ rad or path difference of $n\lambda$ and so *either* constructive interference *or* displacement larger	B1	[1]
	(b) time period = 0.002 s or 2 ms	C1	
	wave drawn is half time period	B1	
	amplitude 1.0 cm (same as Fig. 2.2)	B1	[3]

3 (a) (i) 1.	$s = ut + \frac{1}{2}at^2$		
	$192 = \frac{1}{2} \times 9.81 \times t^2$	C1	
	$t = 6.3\ (6.26)\,\text{s}$	A1	[2]
2.	max E_k (= mgh) = $0.27 \times 9.81 \times 192$	C1	
	or		
	calculation of v (= 61.4) and use of E_K (= $\frac{1}{2}mv^2$) = $\frac{1}{2} \times 0.27 \times (61.4)^2$	(C1)	
	max E_k = 510 (509) J	A1	[2]
(ii)	velocity is proportional to time **or** velocity increases at a constant rate		
	as acceleration is constant or resultant force is constant	B1	[1]
(iii)	use of $v = at$ or $v^2 = 2as$ or $E = \frac{1}{2}mv^2$ to give $v = 61(.4)\,\text{m}\,\text{s}^{-1}$	B1	[1]
(b) (i)	R increases with velocity	B1	
	resultant force is $mg - R$ **or** resultant force decreases	B1	
	acceleration decreases	B1	[3]
(ii)	at $v = 40\,\text{m}\,\text{s}^{-1}$, $R = 0.6$ (N)	C1	
	$0.27 \times 9.8 - 0.6 = 0.27 \times a$		
	$a = 7.6\ (7.58)\,\text{m}\,\text{s}^{-2}$	A1	[2]
(iii)	R = weight for terminal velocity	B1	
	either weight requires velocity to be about $80\,\text{m}\,\text{s}^{-1}$ *or* at $60\,\text{m}\,\text{s}^{-1}$, R is less than weight		
	so does not reach terminal velocity	B1	[2]
4 (a) (i)	reaction/vertical force = weight – P cos 60°	C1	
	= 180 – 35 cos 60°		
	= 160 (163) N	A1	[2]
(ii)	work done = 35 sin 60° × 20	C1	
	= 610 (606) J	A1	[2]

	(b)	**(i)**	work done by force P = work done against frictional force	B1	[1]
		(ii)	horizontal component of P is equal and opposite to frictional force	B1	
			vertical component of P + normal reaction force equal and opposite to weight	B1	[2]
5	**(a)**	**(i)**	resistance = V/I	B1	
			very high/infinite resistance at low voltages	B1	
			resistance decreases as V increases	B1	[3]
		(ii)	p.d. from graph 0.50 (V)	C1	
			resistance = $0.5/(4.4 \times 10^{-3})$		
			= 110 (114) Ω	A1	[2]
	(b)	**(i)**	current (= 1.2 / 375) = 3.2×10^{-3} A	A1	[1]
		(ii)	current in diode = 4.4×10^{-3} (A) total resistance = $1.2/4.4 \times 10^{-3}$ = 272.7 (Ω)	C1	
			resistance of R_1 = 272.7 – 113.6 = 160 (159) Ω	A1	
			or		
			p.d. across diode = 0.5 V and p.d. across R_1 = 0.7 V	(C1)	
			resistance of R_1 = $0.7/4.4 \times 10^{-3}$ = 160 (159) Ω	(A1)	[2]
		(iii)	power = IV **or** I^2R **or** V^2/R	C1	
			ratio = $(4.4 \times 0.5)/(3.2 \times 1.2)$ **or** $[(4.4)^2 \times 114]/[(3.2)^2 \times 375]$ **or** $[(0.5)^2 \times 375]/[114 \times (1.2)^2]$ = 0.57	A1	[2]
6	**(a)**		waves from loudspeaker (travel down tube and) are reflected at closed end	B1	
			two waves (travelling) in opposite directions with same frequency/wavelength overlap	B1	[2]
	(b)	**(i)**	0.51 m 0.85 m	A1 A1	[2]
		(ii)	A at open end, N at closed end, with an N and A in between, equally spaced (by eye)	B1	[1]

7	(a)	stress or $\sigma = F / A$	C1	
		max. tension = UTS $\times$ A = $4.5 \times 10^8 \times 15 \times 10^{-6}$ = 6800 (6750) N	A1	[2]
	(b)	$\rho = m / V$	C1	
		weight = $mg = \rho Vg = \rho ALg$ $6750 = 7.8 \times 10^3 \times 15 \times 10^{-6} \times L \times 9.81$	C1	
		$L = 5.9\ (5.88) \times 10^3$ m	A1	
		or		
		maximum mass = 6750 / 9.81 = 688 kg mass per unit length = ρA = 0.117 kg m^{-1} L = 688 / 0.117 = 5.9×10^3 m	(C1) (C1) (A1)	
		or		
		maximum mass = 6750 / 9.81 = 688 kg volume = m / ρ = 0.0882 m^3 = LA L = 0.0882 / 15×10^{-6} = 5.9×10^3 m	(C1) (C1) (A1)	[3]
8	(a)	mass-energy proton number or charge nucleon number	B2	[2]
	(b) (i)	$E_k = \frac{1}{2} mv^2$ and $p = mv$ with working leading to [via $E_k = \frac{1}{2} m^2 v^2 / m$ or $\frac{1}{2} m (p / m)^2$] to $E_k = \dfrac{p^2}{2m}$	B1	[1]
	(ii)	$p = (2E_k m)^{½}$ hence $(2[E_k m]_\alpha)^{½} = (2[E_k m]_{Th})^{½}$	C1	
		$2 \times [E_k]_{Th} \times 234 = 2 \times 6.69 \times 10^{-13} \times 4$	C1	
		$[E_k]_{Th} = 1.14 \times 10^{-14}$ J = 71(.5) keV	A1	
		or		
		calculation of speed of α-particle = 1.42×10^7 m s^{-1} calculation of momentum of α-particle/nucleus = 9.43×10^{-20} N s	(C1)	
		$[E_k]_{Th}$ = 1.14×10^{-14} J = 71(.5) keV	(C1) (A1)	[3]