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

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.

CAMBRIDGE
International Examinations

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) × 360° or (n + ½) × 2π rad or path difference of (n + ½)λ 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 2πn 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.	$s = ut + ½at^2$		
	$192 = ½ \times 9.81 \times t^2$	C1	
	t = 6.3 (6.26) s	A1	[2]
2.	max E_k (= mgh) = 0.27 × 9.81 × 192	C1	
	or		
	calculation of v (= 61.4) and use of E_K (= ½ mv^2) = ½ × 0.27 × $(61.4)^2$	(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 $E = ½mv^2$ to give v = 61(.4) m 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 m s^{-1}, R = 0.6 (N)	C1	
	0.27 × 9.8 – 0.6 = 0.27 × a		
	a = 7.6 (7.58) m s^{-2}	A1	[2]
(iii)	R = weight for terminal velocity	B1	
	either weight requires velocity to be about 80 m s^{-1} *or* at 60 m 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 $= 0.5/(4.4 \times 10^{-3})$

$= 110\ (114)\ \Omega$ A1 [2]

(b) **(i)** current $(= 1.2/375) = 3.2 \times 10^{-3}$ A A1 [1]

(ii) current in diode $= 4.4 \times 10^{-3}$ (A)
total resistance $= 1.2/4.4 \times 10^{-3} = 272.7\ (\Omega)$ C1

resistance of $R_1 = 272.7 - 113.6 = 160\ (159)\ \Omega$ A1

or

p.d. across diode = 0.5 V and p.d. across R_1 = 0.7 V (C1)

resistance of $R_1 = 0.7/4.4 \times 10^{-3}$
$= 160\ (159)\ \Omega$ (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 A1
0.85 m 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 × A = 4.5 × 10^8 × 15 × 10^{-6} = 6800 (6750) N A1 [2]

(b) $\rho = m/V$ C1

weight = $mg = \rho Vg = \rho ALg$
6750 = 7.8 × 10^3 × 15 × 10^{-6} × L × 9.81 C1

L = 5.9 (5.88) × 10^3 m A1

or

maximum mass = 6750 / 9.81 = 688 kg (C1)
mass per unit length = ρA = 0.117 kg m^{-1} (C1)
L = 688 / 0.117 = 5.9 × 10^3 m (A1)

or

maximum mass = 6750 / 9.81 = 688 kg (C1)
volume = m/ρ = 0.0882 m^3 = LA (C1)
L = 0.0882 / 15 × 10^{-6} = 5.9 × 10^3 m (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 $E_k = \frac{1}{2}m^2v^2/m$ or $\frac{1}{2}m(p/m)^2$]
to $E_k = \dfrac{p^2}{2m}$ B1 [1]

(ii) $p = (2E_km)^{½}$ hence $(2[E_km]_\alpha)^{½} = (2[E_km]_{Th})^{½}$ C1

2 × $[E_k]_{Th}$ × 234 = 2 × 6.69 × 10^{-13} × 4 C1

$[E_k]_{Th}$ = 1.14 × 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 (C1)
= 71(.5) keV (A1) [3]