CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the October/November 2015 series

9702 PHYSICS

9702/21 Paper 2 (AS Structured Questions), maximum raw mark 60

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1 **(a)** temperature — B1
current — B1 [2]
(allow amount of substance, luminous intensity)

(b) **(i)** **1.** E = (stress / strain =) [force / area] / [extension / original length]

units of stress: $kg\,m\,s^{-2} / m^2$ and no units for strain — B1

units of E: $kg\,m^{-1}\,s^{-2}$ — A0 [1]

2. units for T: s, l: m and M: kg

$K^2 = T^2 E / M l^3$ hence units: $s^2\,kg\,m^{-1}\,s^{-2} / kg^3$ (= m^{-4}) — C1

units of K: m^{-2} — A1 [2]

(ii) % uncertainty in E = 4% (for T^2) + 0.6% (for l^3) + 0.1% (for M) + 3% (for K^2)
= 7.7% — B1

$E = [(1.48 \times 10^5)^2 \times 0.2068 \times (0.892)^3] / (0.45)^2$
$= 1.588 \times 10^{10}$ — C1

7.7% of $E = 1.22 \times 10^9$ — C1

$E = (1.6 \pm 0.1) \times 10^{10}\,kg\,m^{-1}\,s^{-2}$ — A1 [4]

2 **(a)** ps = 10^{-12} (s) **or** $T = 4 \times 50 \times 10^{-12}$ (s) — B1

$v = f\lambda$ **or** $v = \lambda / T$ — C1

$\lambda = 3.0 \times 10^8 \times 4 \times 50 \times 10^{-12}$ — C1

= 0.06(0) m — A1 [4]

(b) $1500 = 3.0 \times 10^8 \times 4 \times$ time-base setting **or** $T = 5 \times 10^{-6}$ s — C1

time-base setting = 1.3 (1.25) $\mu s\,cm^{-1}$ — A1 [2]

3 **(a)** work done is force × distance moved in direction of force
or
no work done along PQ as no displacement/distance moved in direction of force — B1

work done is same in vertical direction as same distance moved in direction of force — B1 [2]

(b) (i)	at maximum height $t = 1.5$ (s) **or** $s = ½(u + v)t$, $s = 11$ m and $t = 1.5$ s	C1	
	$V_v = 0 + 9.81 \times 1.5$ $\quad$ $V_v = (11 \times 2) / 1.5$		
	$= 15$ (14.7) m s^{-1}	A1	[2]
(ii)	straight line from (0,0) to (3.00, 25.5)	B1	[1]
(iii)	at maximum height $V_h = 25.5 / 3$ (= 8.5 m s^{-1})	B1	
	ratio $= mgh / ½mv^2$	C1	
	$= (2 \times 9.81 \times 11.0) / (8.5)^2$		
	= 3.0 (2.99)	A1	[3]
(iv)	deceleration is greater/resultant force (weight and friction force) is greater	M1	
	time is less	A1	[2]
4 (a)	density = mass / volume	C1	
	mass = $7900 \times 4.5 \times 24 \times 10^{-6}$ = 0.85 (0.853) kg	M1	[2]
(b)	pressure = force / area	C1	
	force = $W \cos 40°$	C1	
	pressure $= (0.85 \times 9.81 \cos 40°) / 24 \times 10^{-4}$		
	$= 2.7$ (2.66) $\times 10^3$ Pa	A1	[3]
(c)	$F = ma$	C1	
	$W \sin 40° - f = ma$	C1	
	$0.85 \times 9.81 \times \sin 40° - f = 0.85 \times 3.8$		
	f (= 5.36 – 3.23) = 2.1 N [5.38 – 3.242 if 0.8532 kg is used for the mass]	A1	[3]

5	(a)		progressive: all particles have same amplitude stationary: no nodes or antinodes or maximum to minimum/zero amplitude	B1	
			progressive: adjacent particles are not in phase stationary: waves particles are in phase (between adjacent nodes)	B1	[2]
	(b)	(i)	wavelength 1.2 m (zero displacement at 0.0, 0.60 m, 1.2 m, 1.8 m, 2.4 m)		
			either peaks at 0.30 m and 1.5 m and troughs at 0.90 m and 2.1 m or vice versa (but not both)	B1	
			maximum amplitude 5.0 mm	B1	[2]
		(ii)	180° or π rad	A1	[1]
		(iii)	at t = 0 particle has kinetic energy as particle is moving	B1	
			at t = 5.0 ms no kinetic energy as particle is stationary so decrease in kinetic energy (between t = 0 and t = 5.0 ms)	B1	[2]
6	(a)		energy converted from chemical to electrical per unit charge	B1	[1]
	(b)	(i)	current $= E/(R + r)$	C1	
			$= 6.0/(16 + 0.5)$ $= 0.36\ (0.364)$ A	A1	[2]
		(ii)	terminal p.d. = $(0.36 \times 16) = 5.8$ V **or** $(6 - 0.36 \times 0.5)$ = 5.8 V	A1	[1]
	(c)	(i)	use of $R = \rho l/A$ or proportionality with length and inverse proportionality with area or d^2	C1	
			$d/2$ and $l/2$ gives resistance of Z = $2R_Y$ = 24 (Ω)	C1	
			R = resistance of parallel combination = $[1/24 + 1/12]^{-1}$ = 8(.0) (Ω)	A1	[3]
		(ii)	resistance of circuit less therefore current larger	B1	
			lost volts greater therefore terminal p.d. less	B1	[2]
	(d)		power = I^2R **or** VI **or** V^2/R	C1	
			current in second circuit (= 6.0 / 12.5) = 0.48 (A)	B1	
			ratio = $[(0.36)^2 \times 16] / [(0.48)^2 \times 12] = 0.75$ [0.77 if full s.f. used]	B1	[3]

7 **(a)** **(i)** curved path towards negative (–) plate (right-hand side) B1 [1]

(ii) range of α-particle is only few cm in air/loss of energy of the α-particles due to collision with air molecules/ionisation of the air molecules B1 [1]

(iii) $V = E \times d$ C1

$= 140 \times 10^{6} \times 12 \times 10^{-3} = 1.7\ (1.68)\,\text{MV}$ A1 [2]

(b) β have opposite charge to α therefore deflection in opposite direction B1

β has a range of velocities/energies hence number of different deflections B1

β have less mass or q/m is larger hence deflection is greater
or
β with (very) high speed (may) have less deflection B1 [3]

(c)

emitted particle	change in *Z*	change in *A*
α-particle	–2	–4
β-particle	+1	0

A1 [1]