CAMBRIDGE INTERNATIONAL EXAMINATIONS
GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2014 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.

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1	(a)	power = energy / time *or* work done / time force: kg m s^{-2} (including from *mg* in *mgh* or *Fv*)	B1	
		or kinetic energy ($\frac{1}{2}mv^2$): kg (m s^{-1})^2	B1	
		(distance: m and (time)$^{-1}$: s^{-1}) and hence power: kg m s^{-2} m s^{-1} = kg m^2 s^{-3}	B1	[3]
	(b)	Q/t : kg m^2 s^{-3}	C1	
		A: m^2 and *x*: m and *T*: K	C1	
		correct substitution into $C = (Qx)/tAT$ or equivalent, or with cancellation	C1	
		units of *C* : kg m s^{-3} K^{-1}	A1	[4]
2	(a)	$\rho = m/V$	C1	
		$V = (\pi d^2/4) \times t = 7.67 \times 10^{-7}$ m^3		
		$\rho = (9.6 \times 10^{-3})/[\pi(22.1/2 \times 10^{-3})^2 \times 2.00 \times 10^{-3}]$	C1	
		ρ = 12513 kg m^{-3} (allow 2 or more s.f.)	A1	[3]
	(b) (i)	$\Delta\rho/\rho = \Delta m/m + \Delta t/t + 2\Delta d/d$	C1	
		= 5.21% + 0.50% + 0.905% [or correct fractional uncertainties]	C1	
		= 6.6% (6.61%)	A1	[3]
	(ii)	ρ = 12 500 ± 800 kg m^{-3}	A1	[1]
3	(a)	a body / mass / object continues (at rest or) at constant / uniform velocity unless acted on by a <u>resultant</u> force	B1	[1]
	(b) (i)	weight <u>vertically</u> down	B1	
		normal / reaction / contact (force) perpendicular / normal <u>to the slope</u>	B1	[2]
	(ii) 1.	acceleration = gradient *or* $(v - u)/t$ *or* $\Delta v/t$	C1	
		= (6.0 – 0.8) / (2.0 – 0.0) = 2.6 m s^{-2}	M1	[2]
	2.	$F = ma$ = 65 × 2.6 = 169 N (allow to 2 or 3 s.f.)	A1	[1]
	3.	weight component seen: mg sinθ (218 N)	C1	
		218 – *R* = 169	C1	
		R = 49 N (require 2 s.f.)	A1	[3]

4	**(a)**	GPE: energy of a <u>mass</u> due to its position in a <u>gravitational field</u>	B1	
		KE: energy (a mass has) due to its motion / speed / velocity	B1	[2]
	(b) (i) 1.	KE $= \frac{1}{2}mv^2$	C1	
		$= \frac{1}{2} \times 0.4 \times (30)^2$	C1	
		= 180 J	A1	[3]
	2.	$s = 0 + \frac{1}{2} \times 9.81 \times (2.16)^2$ *or* $s = (30\sin 45°)^2 / (2 \times 9.81)$	C1	
		= 22.88 (22.9) m = 22.94 (22.9) m	A1	[2]
	3.	GPE $= mgh$	C1	
		$= 0.4 \times 9.81 \times 22.88 = 89.8$ (90) J	A1	[2]
	(ii) 1.	KE = initial KE – GPE = 180 – 90 = 90 J	A1	[1]
	2.	(horizontal) velocity is not zero / (object) is still moving / answer explained in terms of conservation of energy	B1	[1]
5	**(a)**	(Young modulus / E =) stress / strain	B1	[1]
	(b) (i)	stress $= F/A$ *or* $= F/(\pi d^2/4)$ *or* $= F/(\pi d^2)$	M1	
		ratio = 4 (or 4:1)	A1	[2]
	(ii)	E is the same for both wires (as same material) [e.g. $E_P = E_Q$]	M1	
		strain = stress / E		
		ratio = 4 (or 4:1) [*must be same as* ***(i)***]	A1	[2]
6	**(a)**	there are no lost volts / energy lost in the battery *or* there are no lost volts / energy lost in the internal resistance	B1	[1]
	(b)	the current / I decreases (as R increases)	M1	
		p.d. decreases (as R increases)	A1	
		or		
		the parallel resistance (of X and R) increases	M1	
		p.d. across parallel resistors increases, so p.d. (across Y) decreases	A1	[2]

(c)	**(i)**	current = 2.4 (A)	C1	
		p.d. across AB = 24 – 2.4 × 6 = 9.6 V	M1	
		or		
		total resistance = 10 Ω (= 24 V / 2.4 A)	C1	
		(parallel resistance = 4 Ω), p.d. = 24 × (4 / 10) = 9.6 V	M1	[2]
	(ii)	*R* (AB) = 9.6 / 2.4 = 4.0 Ω	C1	
		1 / 6 + 1 / *X* = 1 / 4 [must correctly substitute for R]	C1	
		X = 12 Ω	A1	
		or		
		I_R = 9.6 / 6.0 = 1.6 (A)	(C1)	
		I_X = 2.4 – 1.6 = 0.8 (A)	(C1)	
		X (= 9.6 / 0.8) = 12 Ω	(A1)	[3]
	(iii)	power = *VI or EI or* V^2/R *or* E^2/R *or* I^2R	C1	
		= 24 × 2.4 *or* $(24)^2/10$ *or* $(2.4)^2 \times 10$		
		= 57.6 W (allow 2 or more s.f.)	A1	[2]
(d)		power decreases	M0	
		e.m.f. constant or power = 24 × current, and current decreases *or* e.m.f. constant or power = 24^2 / resistance, and resistance increases	A1	[1]

7	**(a)**	waves from the double slit are coherent / constant phase difference	B1	
		waves (from each slit) overlap / superpose / meet (**not** interfere)	B1	
		maximum / bright fringe where path difference is $n\lambda$ *or* phase difference is *n*360° / 2π*n* rad *or* minimum / dark fringe where path difference is $(n + \frac{1}{2})\lambda$ *or* phase difference is (2*n* + 1) 180° / (2*n* + 1)π rad	B1	[3]
	(b)	$v = f\lambda$	C1	
		$\lambda = (3 \times 10^8) / 670 \times 10^{12}$ = 448 (or 450) (nm)	M1	[2]
	(c)	*w* = 12 / 9	C1	
		a (= $D\lambda/w$) = $(2.8 \times 450 \times 10^{-9}) / (12 / 9 \times 10^{-3})$ [allow nm, mm]	C1	
		= 9.5×10^{-4} m [9.4×10^{-4} m using λ = 448 nm]	A1	[3]
	(d)	(red light has) larger / higher / longer wavelength (must be comparison)	M1	
		fringes further apart / larger separation	A1	[2]