UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2011 question paper

for the guidance of teachers

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.

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1 **(a)**	scalar has only magnitude	B1	
	vector has magnitude and direction	B1	[2]
(b)	kinetic energy, mass, power all three underlined	B1	[1]
(c) **(i)**	$s = ut + ½ at^2$		
	$15 = 0.5 \times 9.81 \times t^2$	C1	
	$T = 1.7$ s	A1	[2]
	if g = 10 is used then –1 but only once on paper		
(ii)	vertical component v_v:		
	$v_v^2 = u^2 + 2as = 0 + 2 \times 9.81 \times 15$ or $v_v = u + at = 9.81 \times 1.7(5)$		
	$v_v = 17.16$	C1	
	resultant velocity: $v^2 = (17.16)^2 + (20)^2$	C1	
	$v = 26$ m s^{-1}	A1	[3]
	If u = 20 is used instead of u = 0 then 0/3 Allow the solution using: initial (potential energy + kinetic energy) = final kinetic energy		
(iii)	distance is the actual path travelled	B1	
	displacement is the straight line distance between start and finish points (in that direction) / minimum distance	B1	[2]
2 **(a)** **(i)**	base units of D:		
	force: kg m s^{-2}	B1	
	radius: m velocity: m s^{-1}	B1	
	base units of D: [F / ($R \times v$)] kg m s^{-2} / (m × m s^{-1})	M1	
	= kg m^{-1} s^{-1}	A0	[3]
(ii) **1.**	$F = 6\pi \times D \times R \times v = [6\pi \times 6.6 \times 10^{-4} \times 1.5 \times 10^{-3} \times 3.7]$		
	$= 6.9 \times 10^{-5}$ N	A1	[1]
2.	$mg - F = ma$ hence $a = g - [F / m]$		
	$m = \rho \times V = \rho \times 4/3\ \pi R^3 = (1.4 \times 10^{-5})$	C1	
	$a = 9.81 - [6.9 \times 10^{-5}] / \rho \times 4/3\ \pi \times (1.5 \times 10^{-3})^3$ (9.81 – 4.88)	M1	
	$a = 4.9(3)$ m s^{-2}	A1	[3]
(b) **(i)**	$a = g$ at time $t = 0$	B1	
	a decreases (as time increases)	B1	
	a goes to zero	B1	[3]
(ii)	Correct shape below original line	M1	
	sketch goes to terminal velocity earlier	A1	[2]

3 (a) (i)	work done equals force × distance moved / displacement in the direction of the force		B1	[1]
(ii)	power is the rate of doing work / work done per unit time		B1	[1]
(b) (i)	kinetic energy	$= ½\ mv^2$	C1	
		$= 0.5 \times 600\ (9.5)^2$	C1	
		= 27075 (J) = 27 kJ	A1	[3]
(ii)	potential energy	$= mgh$		
		= 600 × 9.81 × 4.1	M1	
		= 24132 (J)	A1	
		= 24 kJ	A0	[2]
(iii)	work done = 27 – 24 = 3.0 kJ		A1	[1]
(iv)	resistive force = 3000 / 8.2 (distance along slope = 4.1 / sin 30°)		C1	
	= 366 N		A1	[2]

4 (a)	clamped horizontal wire over pulley or vertical wire attached to ceiling with mass attached	B1	
	details: reference mark on wire with fixed scale alongside	B1	[2]
(b)	measure original length of wire to reference mark with metre ruler / tape	(B1)	
	measure diameter with micrometer / digital calipers	(B1)	
	measure initial and final reading (for extension) with metre ruler or other suitable scale	(B1)	
	measure / record mass or weight used for the extension	(B1)	
	good physics method: measure diameter in several places / remove load and check wire returns to original length / take several readings with different loads	(B1)	
	MAX of 4 points	B4	[4]
(c)	determine extension from final and initial readings	(B1)	
	plot a graph of force against extension	(B1)	
	determine gradient of graph for F / e	(B1)	
	calculate area from $\pi d^2 / 4$	(B1)	
	calculate E from $E = F\,l / e\,A$ or gradient × l / A	(B1)	
	MAX of 4 points	B4	[4]

5	**(a)**	**(i)**	energy converted from chemical to electrical when charge flows through cell or round complete circuit	B1	
		(ii)	(resistance of the cell) causing loss of voltage or energy loss in cell	B1	[2]
	(b)	**(i)**	$E_B - E_A = I(R + r_B + r_A)$		
			$12 - 3 = I(3.3 + 0.1 + 0.2)$	C1	
			$I = 2.5$ A	A1	[2]
		(ii)	Power $= E \times I$		
			$= 12 \times 2.5$	C1	
			$= 30$ W	A1	[2]
		(iii)	$P = I^2 \times R$ or $P = V^2 / R$ or $P = VI$		
			$= (2.5)^2 \times 3$; $= 9^2 / 3.6$; $= 9 \times 2.5$	C1	
			$= 22.5\ \mathrm{J\,s^{-1}}$	A1	[2]
	(c)		power supplied from cell B is greater than energy lost per second in circuit	B1	[1]
6	**(a)**	**(i)**	to produce coherent sources or constant phase difference	B1	[1]
		(ii)	**1.** 360° / 2π rad allow n × 360° or n × 2π (unit missing –1)	B1	[1]
			2. 180° / π rad allow (n × 360°) – 180° or (n × 2π) – π	B1	[1]
		(iii)	**1.** waves overlap / meet	B1	
			(resultant) displacement is sum of displacements of each wave	B1	[2]
			2. at P crest on trough (OWTTE)	B1	[1]
	(b)		$\lambda = ax / D$	C1	
			$= 2 \times 2.3 \times 10^{-3} \times 0.25 \times 10^{-3} / 1.8$	C1	
			$= 639$ nm	A1	[3]