UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2010 question paper

for the guidance of teachers

9702 PHYSICS

9702/41 Paper 4 (A2 Structured Questions), maximum raw mark 100

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UNIVERSITY of CAMBRIDGE
International Examinations

Section A

1	**(a)**		angle (subtended) at centre of circle	B1	
			(by) arc equal in length to radius	B1	[2]
	(b)	**(i)**	point S shown below C	B1	[1]
		(ii)	(max) force / tension = weight + centripetal force	C1	
			centripetal force = $mr\omega^2$	C1	
			$15 = 3.0/9.8 \times 0.85 \times \omega^2$	C1	
			$\omega = 7.6 \text{ rad s}^{-1}$	A1	[4]
2	**(a)**	**(i)**	27.2 + 273.15 or 27.2 + 273.2	C1	
			300.4 K	A1	[2]
		(ii)	11.6 K	A1	[1]
	(b)	**(i)**	($<c^2>$ is the) mean / average square speed	B1	[1]
		(ii)	$\rho = Nm/V$ with N explained	B1	
			so, $pV = 1/3\ Nm<c^2>$	B1	
			and $pV = NkT$ with k explained	B1	
			so mean kinetic energy / $<E_K> = ½m<c^2> = 3/2\ kT$	B1	[4]
	(c)	**(i)**	$pV = nRT$		
			$2.1 \times 10^7 \times 7.8 \times 10^{-3} = n \times 8.3 \times 290$	C1	
			$n = 68$ mol	A1	[2]
		(ii)	mean kinetic energy $= 3/2\ kT$		
			$= 3/2 \times 1.38 \times 10^{-23} \times 290$	C1	
			$= 6.0 \times 10^{-21}$ J	A1	[2]
		(iii)	realisation that total internal energy is the total kinetic energy	C1	
			energy $= 6.0 \times 10^{-21} \times 68 \times 6.02 \times 10^{23}$	C1	
			$= 2.46 \times 10^5$ J	A1	[3]
3	**(a)**	**(i)**	to-and-fro / backward and forward motion (between two limits)	B1	[1]
		(ii)	no energy loss or gain / no external force acting / constant energy / constant amplitude	B1	[1]
		(iii)	acceleration directed towards a fixed point	B1	
			acceleration proportional to distance from the fixed point / displacement	B1	[2]
	(b)		acceleration is constant (magnitude)	M1	
			so cannot be s.h.m.	A1	[2]

4	**(a)**		ability to do work		B1	
			as a result of the position/shape, etc. of an object		B1	[2]
	(b)	**(i)**	**1**	$\Delta E_{gpe} = GMm / r$	C1	
				$= (6.67 \times 10^{-11} \times \{2 \times 1.66 \times 10^{-27}\}^2) / (3.8 \times 10^{-15})$	C1	
				$= 1.93 \times 10^{-49}$ J	A1	[3]
			2	$\Delta E_{epe} = Qq / 4\pi\varepsilon_0 r$	C1	
				$= (1.6 \times 10^{-19})^2 / (4\pi \times 8.85 \times 10^{-12} \times 3.8 \times 10^{-15})$	C1	
				$= 6.06 \times 10^{-14}$ J	A1	[3]
		(ii)	idea that $2E_K = \Delta E_{epe} - \Delta E_{gpe}$		B1	
			$E_K = 3.03 \times 10^{-14}$ J			
			$= (3.03 \times 10^{-14}) / 1.6 \times 10^{-13}$		M1	
			= 0.19 MeV		A0	[2]
		(iii)	fusion may occur / may break into sub-nuclear particles		B1	[1]
5	**(a)**	**(i)**	V_H depends on angle between (plane of) probe and *B*-field		B1	
			either V_H max when plane and *B*-field are normal to each other			
			or V_H zero when plane and *B*-field are parallel			
			or V_H depends on sine of angle between plane and *B*-field		B1	[2]
		(ii)	**1**	calculates $V_H r$ at least three times	M1	
				to 1 s.f. constant so valid or approx constant so valid		
				or to 2 s.f., not constant so invalid	A1	[2]
			2	straight line passes through origin	B1	[1]
	(b)	**(i)**	e.m.f. induced is proportional / equal to		M1	
			rate of change of (magnetic) flux (linkage)		A1	
			constant field in <u>coil</u> / flux (linkage) of <u>coil</u> does not change		B1	[3]
		(ii)	e.g. vary current (in wire) / switch current on or off / use a.c. current			
			rotate coil			
			move coil <u>towards</u> / <u>away</u> from wire (1 mark each, max 3)		B3	[3]
6	**(a)**		all four diodes correct to give output, regardless of polarity		M1	
			connected for correct polarity		A1	[2]
	(b)		$N_S / N_P = V_S / V_P$		C1	
			$V_0 = \sqrt{2} \times V_{rms}$		C1	
			ratio $= 9.0 / (\sqrt{2} \times 240)$			
			$= 1/38$ or $1/37$ or 0.027		A1	[3]

7 **(a)**	arrow pointing up the page	B1	[1]
(b) **(i)**	$Eq = Bqv$	C1	
	$v = (12 \times 10^3) / (930 \times 10^{-6})$	C1	
	$= 1.3 \times 10^7$ m s^{-1}	A1	[3]
(ii)	$Bqv = mv^2 / r$	C1	
	$q/m = (1.3 \times 10^7) / (7.9 \times 10^{-2} \times 930 \times 10^{-6})$	C1	
	$= 1.8 \times 10^{11}$ C kg^{-1}	A1	[3]
8 **(a)**	momentum conservation hence momenta of photons are equal (but opposite)	M1	
	same momentum so same energy	A1	[2]
(b) **(i)**	$(\Delta)E = (\Delta)mc^2$	C1	
	$= 1.2 \times 10^{-28} \times (3.0 \times 10^8)^2$		
	$= 1.08 \times 10^{-11}$ J	A1	[2]
(ii)	$E = hc / \lambda$		
	$\lambda = (6.63 \times 10^{-34} \times 3.0 \times 10^8) / (1.08 \times 10^{-11})$	C1	
	$= 1.84 \times 10^{-14}$ m	A1	[2]
(iii)	$\lambda = h / p$		
	$p = (6.63 \times 10^{-34}) / (1.84 \times 10^{-14})$	C1	
	$= 3.6 \times 10^{-20}$ N s	A1	[2]

Section B

9 **(a)** **(i)**	point X shown correctly	B1	[1]
(ii)	op-amp has very large / infinite gain	M1	
	non-inverting input is at earth (potential) / earthed / at 0 V	M1	
	if amplifier is not to saturate, inverting input must be (almost) at earth potential / 0 (V) same potential as inverting input	A1	[3]
(b) **(i)**	total input resistance = 1.2 kΩ	C1	
	(amplifier) gain (= –4.2 / 1.2) = –3.5	C1	
	(voltmeter) reading = –3.5 × –1.5		
	= 5.25 V	A1	[3]
	(total disregard of signs or incorrect sign in answer, max 2 marks)		
(ii)	(less bright so) resistance of LDR increases	M1	
	(amplifier) gain decreases	M1	
	(voltmeter) reading decreases	A1	[3]

10 **(a)** X-ray taken of slice / plane / section B1
repeated at different angles B1
images / data is processed B1
combined / added to give (2-D) image of slice B1
repeated for successive slices B1
to build up a 3-D image B1
image can be viewed from different angles / rotated B1
max 6 [6]

(b) **(i)** 16 A1 [1]

(ii) evidence of deducting 16 then dividing by 3 C1
to give A1 [2]

3	2
6	5

11 **(a)** frequency of carrier wave varies (in synchrony) with signal M1
(in synchrony) with displacement of signal A1 [2]

(b) advantages e.g. less noise / less interference
greater bandwidth / better quality
(1 each, max 2)
disadvantages e.g. short range / more transmitters / line of sight
more complex circuitry
greater expense
(1 each, max 2) B4 [4]

12 **(a)** gain / loss/dB = 10 $\lg(P_1/P_2)$ C1
$190 = 10 \lg(18 \times 10^3 / P_2)$
or $-190 = 10 \lg P_2 / 18 \times 10^3)$ C1
power = 1.8×10^{-15} W A1 [3]

(b) **(i)** 11 GHz / 12 GHz B1 [1]

(ii) e.g. so that input signal to satellite will not be 'swamped'
to avoid interference of uplink with / by downlink B1 [1]