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

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 must be read in conjunction with the question papers and the report on the examination.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the May/June 2010 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

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	
			$\omega = 7.6$ 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 coil / flux (linkage) of coil 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 towards / away 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 <u>very large</u> / 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 <u>carrier</u> wave <u>varies</u> (in synchrony) with signal — M1
(in synchrony) with <u>displacement</u> of signal — A1 [2]

(b) advantages e.g. <u>less</u> noise / <u>less</u> interference
<u>greater</u> 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 × 10^3 / P_2)
or –190 = 10 lg P_2 / 18 × 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]