

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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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 = $m\omega^2 r$ 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) $\langle c^2 \rangle$ is the) mean / average square speed B1 [1]
- (ii) $\rho = Nm/V$ with N explained B1
so, $pV = 1/3 Nm\langle c^2 \rangle$ B1
and $pV = NkT$ with k explained B1
so mean kinetic energy / $\langle E_k \rangle = 1/2 m\langle c^2 \rangle = 3/2 kT$ B1 [4]
- (c) (i) $pV = nRT$
 $2.1 \times 10^7 \times 7.8 \times 10^3 = n \times 8.3 \times 290$ C1
 $n = 68 \text{ mol}$ A1 [2]
- (ii) mean kinetic energy = $3/2 kT$
= $3/2 \times 1.38 \times 10^{-23} \times 290$ C1
= $6.0 \times 10^{-21} \text{ J}$ 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
= $2.46 \times 10^5 \text{ J}$ 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]

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- 4 (a) ability to do work as a result of the position/shape, etc. of an object B1 B1 [2]
- (b) (i) 1 $\Delta E_{\text{gpe}} = GMm/r$
 $= (6.67 \times 10^{-11} \times \{2 \times 1.66 \times 10^{27}\}^2) / (3.8 \times 10^{15})$
 $= 1.93 \times 10^{49} \text{ J}$ C1 C1 A1 [3]
- 2 $\Delta E_{\text{epe}} = Qq / 4\pi\epsilon_0 r$
 $= (1.6 \times 10^{19})^2 / (4\pi \times 8.85 \times 10^{-12} \times 3.8 \times 10^{15})$
 $= 6.06 \times 10^{14} \text{ J}$ C1 C1 A1 [3]
- (ii) idea that $2E_K = \Delta E_{\text{epe}} - \Delta E_{\text{gpe}}$
 $E_K = 3.03 \times 10^{14} \text{ J}$
 $= (3.03 \times 10^{14}) / 1.6 \times 10^{13}$
 $= 0.19 \text{ MeV}$ B1 M1 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
 $V_0 = \sqrt{2} \times V_{\text{rms}}$ C1
ratio $= 9.0 / (\sqrt{2} \times 240)$
 $= 1/38$ or $1/37$ or 0.027 A1 [3]

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- 7 (a) arrow pointing up the page B1 [1]
- (b) (i) $Eq = Bqv$ C1
 $v = (12 \times 10^3) / (930 \times 10^6)$ C1
 $= 1.3 \times 10^7 \text{ m s}^{-1}$ 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
 $= 1.8 \times 10^{11} \text{ C kg}^{-1}$ 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
 $= 1.2 \times 10^{28} \times (3.0 \times 10^8)^2$
 $= 1.08 \times 10^{11} \text{ J}$ A1 [2]
- (ii) $E = hc / \lambda$
 $\lambda = (6.63 \times 10^{-34} \times 3.0 \times 10^8) / (1.08 \times 10^{11})$ C1
 $= 1.84 \times 10^{-14} \text{ m}$ A1 [2]
- (iii) $\lambda = h / p$
 $p = (6.63 \times 10^{-34}) / (1.84 \times 10^{-14})$ C1
 $= 3.6 \times 10^{-20} \text{ N s}$ 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 k Ω 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]

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- 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 to give C1
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 = $1.8 \times 10^{15} \text{ W}$ 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]