

**MARK SCHEME for the October/November 2010 question paper
for the guidance of teachers**

9702 PHYSICS

9702/43

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

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Section A

- 1 (a) (i) rate of change of angle / angular displacement swept out by radius M1
A1 [2]
- (ii) $\omega \times T = 2\pi$ B1 [1]
- (b) centripetal force is provided by the gravitational force B1
either $mr(2\pi/T)^2 = GMm/r^2$ or $mr\omega^2 = GMm/r^2$ M1
 $r^3 \times 4\pi^2 = GM \times T^2$ A1
 $GM/4\pi^2$ is a constant (c) A1
 $T^2 = cr^3$ A0 [4]
- (c) (i) either $T^2 = (45/1.08)^3 \times 0.615^2$ or $T^2 = 0.30 \times 45^3$ C1
 $T = 165$ years A1 [2]
- (ii) speed = $(2\pi \times 1.08 \times 10^8) / (0.615 \times 365 \times 24 \times 3600)$ C1
= 35 km s^{-1} A1 [2]
- 2 (a) atoms / molecules / particles behave as elastic (identical) spheres (1)
volume of atoms / molecules negligible compared to volume of containing vessel (1)
time of collision negligible to time between collisions (1)
no forces of attraction or repulsion between atoms / molecules (1)
atoms / molecules / particles are in (continuous) random motion (1)
(any four, 1 each) B4 [4]
- (b) $pV = \frac{1}{3} Nm\langle c^2 \rangle$ and $pV = nRT$ or $pV = NkT$ B1
 $\frac{1}{3} Nm\langle c^2 \rangle = nRT$ or $= NkT$ and $\langle E_K \rangle = \frac{1}{2} m\langle c^2 \rangle$ B1
 $n = N/N_A$ or $k = R/N_A$ B1
 $\langle E_K \rangle = \frac{3}{2} \times R/N_A \times T$ A0 [3]
- (c) (i) reaction represents either build-up of nucleus from light nuclei M1
or build-up of heavy nucleus from nuclei A1 [2]
so fusion reaction
- (ii) proton and deuterium nucleus will have equal kinetic energies B1
 $1.2 \times 10^{-14} = \frac{3}{2} \times 8.31 / (6.02 \times 10^{23}) \times T$ C1
 $T = 5.8 \times 10^8 \text{ K}$ A1 [3]
(use of $E = 2.4 \times 10^{-14}$ giving $1.16 \times 10^9 \text{ K}$ scores 1 mark)
- (iii) either inter-molecular / atomic / nuclear forces exist B1
or proton and deuterium nucleus are positively charged / repel A1 [1]

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- 3 (a) (i) 8.0 cm A1 [1]
- (ii) $2\pi f = 220$
 $f = 35$ (condone unit) C1
A1 [2]
- (iii) line drawn mid-way between AB and CD (allow ± 2 mm) B1 [1]
- (iv) $v = \omega a$
 $= 220 \times 4.0$
 $= 880 \text{ cm s}^{-1}$ C1
A1 [2]
- (b) (i) 1. line drawn 3 cm above AB (allow ± 2 mm) B1 [1]
2. arrow pointing upwards B1 [1]
- (ii) 1. line drawn 3 cm above AB (allow ± 2 mm) B1 [1]
2. arrow pointing downwards B1 [1]
- (iii) $v = \omega\sqrt{a^2 - x^2}$
 $= 220 \times \sqrt{4.0^2 - 2.0^2}$
 $= 760 \text{ cm s}^{-1}$
(incorrect value for x, 0/2 marks) C1
A1 [2]
- 4 (a) (i) work done moving unit positive charge from infinity to the point M1
A1 [2]
- (ii) charge / potential (difference) (ratio must be clear) B1 [1]
- (b) (i) capacitance = $(2.7 \times 10^{-6}) / (150 \times 10^3)$ C1
(allow any appropriate values)
capacitance = 1.8×10^{-11} (allow 1.8 ± 0.05) A1 [2]
- (ii) either energy = $\frac{1}{2}CV^2$ or energy = $\frac{1}{2}QV$ and $Q = CV$ C1
energy = $\frac{1}{2} \times 1.8 \times 10^{-11} \times (150 \times 10^3)^2$ or $\frac{1}{2} \times 2.7 \times 10^{-6} \times 150 \times 10^3$
= 0.20 J A1 [2]
- (c) either since energy $\propto V^2$, capacitor has $(\frac{1}{2})^2$ of its energy left
or full formula treatment C1
energy lost = 0.15 J A1 [2]

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- 5 (a) magnetic flux = BA
 $= 89 \times 10^{-3} \times 5.0 \times 10^{-2} \times 2.4 \times 10^{-2}$
 $= 1.07 \times 10^{-4} \text{ Wb}$ C1
A1 [2]
- (b) (i) e.m.f. = $\Delta\phi / \Delta t$ C1
(for $\Delta\phi = 1.07 \times 10^{-4} \text{ Wb}$), $\Delta t = 2.4 \times 10^{-2} / 1.8 = 1.33 \times 10^{-2} \text{ s}$ C1
e.m.f. = $(1.07 \times 10^{-4}) / (1.33 \times 10^{-2})$
 $= 8.0 \times 10^{-3} \text{ V}$ A1 [3]
- (ii) current = $8.0 \times 10^{-3} / 0.12$ M1
 $\approx 70 \text{ mA}$ A0 [1]
- (c) force on wire = BIL
 $= 89 \times 10^{-3} \times 70 \times 10^{-3} \times 5.0 \times 10^{-2}$ C1
 $\approx 3 \times 10^{-4} \text{ (N)}$ M1
suitable comment e.g. this force is too / very small (to be felt) A1 [3]
- 6 (a) power / heating depends on I^2 M1
so independent of current direction A1 [2]
- (b) *either* maximum power = $I_0^2 R$ or average power = $I_{\text{RMS}}^2 R$ M1
 $I_0 = \sqrt{2} \times I_{\text{RMS}}$ M1
maximum power = $2 \times$ average power
ratio = 0.5 A1 [3]
- 7 (a) force due to E -field is equal and opposite to force due to B -field B1
 $Eq = Bqv$ B1
 $v = E/B$ B1 [3]
- (b) *either* charge and mass are not involved in the equation in (a)
or F_E and F_B are both doubled
or E , B and v do not change M1
so no deviation A1 [2]
- 8 (a) minimum frequency for electron to be emitted (from surface) M1
of electromagnetic radiation / light / photons A1 [2]
- (b) $E = hc / \lambda$ or $E = hf$ and $c = f\lambda$ C1
either threshold wavelength = $(6.63 \times 10^{-34} \times 3.0 \times 10^8) / (5.8 \times 10^{-19})$
 $= 340 \text{ nm}$
or energy of 340 nm photon = $4.4 \times 10^{-19} \text{ J}$
or threshold frequency = $8.7 \times 10^{14} \text{ Hz}$
or 450 nm $\rightarrow 6.7 \times 10^{14} \text{ Hz}$ A1
appropriate comment comparing wavelengths / energies / frequencies B1
so no effect on photo-electric current B1 [4]

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Section B

- 9 (a) (i) edges can be (clearly) distinguished B1 [1]
- (ii) e.g. size of X-ray source / anode / target / aperture
scattering of X-ray beam
pixel size
(any two, 1 each) B2
further detail e.g. use of lead grid B1 [3]
- (b) X-ray image involves a single exposure B1
CT scan: exposure of a slice from many different angles M1
repeated for different slices A1
CT scan involves a (much) greater exposure B1 [4]
- 10 (a) e.g. infinite input impedance / resistance
zero output impedance / resistance
infinite gain
infinite bandwidth
infinite slew rate
(any three, 1 each) B3 [3]
- (b) (i) with switch open, V^- is less (positive) than V^+ M1
output is positive A1
with switch closed, V^- is more (positive) than V^+ so output is negative A1 [3]
(allow similar scheme if V^- more positive than V^+ treated first)
- (ii) 1. diodes connected correctly between output and earth M1
2. green identified correctly A1 [2]
(do not allow this mark if not argued in (i))
- 11 (a) (i) $I / I_0 = \exp(-1.5 \times 2.9)$ C1
 $= 0.013$ A1 [2]
- (ii) $I / I_0 = \exp(-4.6 \times 0.95)$
 $= 0.013$ A1 [1]
- (b) attenuation (coefficients) in muscle and in fat are similar B1
attenuation (coefficients) in bone and muscle / fat are different B1
contrast depends on difference in attenuation B1 [3]

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- 12 (a) (i) 1. signal has same variation (with time) as the data B1
2. consists of (a series of) 'highs' and 'lows' B1
either analogue is continuously variable (between limits)
or digital has no intermediate values B1 [3]
- (ii) e.g. can be regenerated / noise can be eliminated
extra data can be added to check / correct transmitted signal
(*any two reasonable suggestions, 1 each*) B2 [2]
- (b) (i) analogue signal is sampled at (regular time) intervals B1
sampled signal is converted into a binary number B1 [2]
- (ii) one channel is required for each bit (of the digital number) B1 [1]