

MARK SCHEME for the May/June 2011 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) (i) force proportional to product of masses B1
force inversely proportional to square of separation B1 [2]
- (ii) separation much greater than radius / diameter of Sun / planet B1 [1]
- (b) (i) e.g. force or field strength $\propto 1 / r^2$
potential $\propto 1 / r$ B1 [1]
- (ii) e.g. gravitational force (always) attractive B1
electric force attractive or repulsive B1 [2]
- 2 (a) number of atoms of carbon-12 M1
in 0.012 kg of carbon-12 A1 [2]
- (b) $pV = NkT$ or $pV = nRT$ C1
substitutes temperature as 298 K C1
either $1.1 \times 10^5 \times 6.5 \times 10^{-2} = N \times 1.38 \times 10^{-23} \times 298$
or $1.1 \times 10^5 \times 6.5 \times 10^{-2} = n \times 8.31 \times 298$ and $n = N / 6.02 \times 10^{23}$ C1
 $N = 1.7 \times 10^{24}$ A1 [4]
- 3 (a) acceleration / force proportional to displacement from a fixed point M1
acceleration / force (always) directed towards that fixed point / in opposite
direction to displacement A1 [2]
- (b) (i) $A\rho g / m$ is a constant and so acceleration proportional to x B1
negative sign shows acceleration towards a fixed point / in opposite
direction to displacement B1 [2]
- (ii) $\omega^2 = (A\rho g / m)$ C1
 $\omega = 2\pi f$ C1
 $(2 \times \pi \times 1.5)^2 = ((4.5 \times 10^{-4} \times 1.0 \times 10^3 \times 9.81) / m)$ C1
 $m = 50\text{g}$ A1 [4]
- 4 (a) work done in bringing unit positive charge M1
from infinity (to that point) A1 [2]
- (b) (i) field strength is potential gradient B1 [1]
- (ii) field strength proportional to force (on particle Q) B1
potential gradient proportional to gradient of (potential energy) graph B1
so force is proportional to the gradient of the graph A0 [2]

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(c)	energy = $5.1 \times 1.6 \times 10^{-19}$ (J)	C1	
	potential energy = $Q_1Q_2 / 4\pi\epsilon_0r$	C1	
	$5.1 \times 1.6 \times 10^{-19} = (1.6 \times 10^{-19})^2 / 4\pi \times 8.85 \times 10^{-12} \times r$	C1	
	$r = 2.8 \times 10^{-10}$ m	A1	[4]
(d) (i)	work is got out as x decreases so opposite sign	M1 A1	[2]
(ii)	energy would be doubled gradient would be increased	B1 B1	[2]
5 (a)	region (of space) where there is a force <i>either</i> on / produced by magnetic pole <i>or</i> on / produced by current carrying conductor / moving charge	M1 A1	[2]
(b) (i)	force on particle is (always) normal to velocity / direction of travel speed of particle is constant	B1 B1	[2]
(ii)	magnetic force provides the centripetal force $mv^2 / r = Bqv$ $r = mv / Bq$	B1 M1 A0	[2]
(c) (i)	direction from 'bottom to top' of diagram	B1	[1]
(ii)	radius proportional to momentum ratio = $5.7 / 7.4$ = 0.77 <i>(answer must be consistent with direction given in (c)(i))</i>	C1 A1	[2]
6 (a) (i)	to concentrate the (magnetic) flux / reduce flux losses	B1	[1]
(ii)	changing flux (in core) induces current in core currents in core give rise to a heating effect	M1 A1	[2]
(b) (i)	e.m.f. induced proportional to rate of change of (magnetic) flux (linkage)	M1 A1	[2]
(ii)	magnetic flux in phase with / proportional to e.m.f. / current in primary coil e.m.f. / p.d. across secondary proportional to rate of change of flux so e.m.f. of supply not in phase with p.d. across secondary	M1 M1 A0	[2]
(c) (i)	for same power (transmission), high voltage with low current with low current, less energy losses in transmission cables	B1 B1	[2]
(ii)	voltage is easily / efficiently changed	B1	[1]

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- 7 (a) for a wave, electron can 'collect' energy continuously B1
for a wave, electron will always be emitted /
electron will be emitted at all frequencies..... M1
after a sufficiently long delay A1 [3]
- (b) (i) *either* wavelength is longer than threshold wavelength
or frequency is below the threshold frequency
or photon energy is less than work function B1 [1]
- (ii) $hc / \lambda = \phi + E_{\text{MAX}}$ C1
 $(6.63 \times 10^{-34} \times 3.0 \times 10^8) / (240 \times 10^{-9}) = \phi + 4.44 \times 10^{-19}$ C1
 $\phi = 3.8 \times 10^{-19} \text{ J (allow } 3.9 \times 10^{-19} \text{ J)}$ A1 [3]
- (c) (i) photon energy larger M1
so (maximum) kinetic energy is larger A1 [2]
- (ii) fewer photons (per unit time) M1
so (maximum) current is smaller A1 [2]
- 8 (a) (i) Fe shown near peak A1 [1]
(ii) Zr shown about half-way along plateau A1 [1]
(iii) H shown at less than 0.4 of maximum height A1 [1]
- (b) (i) heavy / large nucleus breaks up / splits M1
into two nuclei / fragments of approximately equal mass A1 [2]
- (ii) binding energy of nucleus = $B_E \times A$ B1
binding energy of parent nucleus is less than sum of binding energies
of fragments B1 [2]

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Section B

- 9 (a) to compare two potentials / voltages
output depends upon which is greater M1 A1 [2]
- (b) (i) resistance of thermistor = 2.5 k Ω
resistance of X = 2.5 k Ω C1 A1 [2]
- (ii) at 5 °C / at < 10 °C, $V^- > V^+$
so V_{OUT} is –9V M1 A1
at 20 °C / at > 10 °C, $V^- < V^+$ and V_{OUT} is +9V B1
 V_{OUT} switches between negative and positive at 10 °C B1 [4]
(allow similar scheme if 20 °C treated first)
- 10 (a) product of density (of medium) and speed of sound (in the medium) B1 [1]
- (b) α would be nearly equal to 1 M1
either reflected intensity would be nearly equal to incident intensity
or coefficient for transmitted intensity = $(1 - \alpha)$ M1
transmitted intensity would be small A1 [3]
- (c) (i) $\alpha = (1.7 - 1.3)^2 / (1.7 + 1.3)^2$ C1
 $= 0.018$ A1 [2]
- (ii) attenuation in fat = $\exp(-48 \times 2x \times 10^{-2})$ C1
 $0.012 = 0.018 \exp(-48 \times 2x \times 10^{-2})$ C1
 $x = 0.42$ cm A1 [3]
- 11 (a) frequency of carrier wave varies M1
(in synchrony) with the displacement of the information signal A1 [2]
- (b) (i) 5.0V A1 [1]
(ii) 640 kHz A1 [1]
(iii) 560 kHz A1 [1]
(iv) 7000 (*condone unit*) A1 [1]
- 12 (a) e.g. acts as 'return' for the signal M1
shields inner core from noise / interference / cross-talk A1 [2]
(any two sensible answers, 1 each, max 2) B2 [2]
- (b) e.g. greater bandwidth
less attenuation (per unit length)
less noise / interference
(any two sensible answers, 1 each, max 2) B2 [2]
- (c) attenuation is 2.4 dB C1
attenuation = $10 \lg(P_1/P_2)$ C1
ratio = 1.7 A1 [3]