

**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 / M1  
electron will be emitted at all frequencies..... A1 [3]  
after a sufficiently long delay
- (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 $\Omega$   
resistance of X = 2.5 k $\Omega$  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)  $\alpha$  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)  $\alpha = (1.7 - 1.3)^2 / (1.7 + 1.3)^2$   
 $= 0.018$  C1 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]