

**MARK SCHEME for the October/November 2011 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) weight =  $GMm/r^2$   
 $= (6.67 \times 10^{-11} \times 6.42 \times 10^{23} \times 1.40)/(1/2 \times 6.79 \times 10^6)^2$   
 $= 5.20 \text{ N}$  C1  
C1  
A1 [3]
- (ii) potential energy =  $-GMm/r$  C1  
 $= -(6.67 \times 10^{-11} \times 6.42 \times 10^{23} \times 1.40)/(1/2 \times 6.79 \times 10^6)$  M1  
 $= -1.77 \times 10^7 \text{ J}$  A0 [2]
- (b) either  $1/2mv^2 = 1.77 \times 10^7$  C1  
 $v^2 = (1.77 \times 10^7 \times 2)/1.40$  C1  
 $v = 5.03 \times 10^3 \text{ m s}^{-1}$  A1  
or  $1/2mv^2 = GMm/r$  (C1)  
 $v^2 = (2 \times 6.67 \times 10^{-11} \times 6.42 \times 10^{23})/(6.79 \times 10^6/2)$  (C1)  
 $v = 5.02 \times 10^3 \text{ m s}^{-1}$  (A1) [3]
- (c) (i)  $1/2 \times 2 \times 1.66 \times 10^{-27} \times (5.03 \times 10^3)^2 = \frac{3}{2} \times 1.38 \times 10^{-23} \times T$  C1  
 $T = 2030 \text{ K}$  A1 [2]
- (ii) either because there is a range of speeds M1  
some molecules have a higher speed A1  
or some escape from point above planet surface (M1)  
so initial potential energy is higher (A1) [2]
- 2 (a) temperature scale calibrated assuming linear change of property with temperature B1  
neither property varies linearly with temperature B1 [2]
- (b) (i) does not depend on the property of a substance B1 [1]  
(ii) temperature at which atoms have minimum/zero energy B1 [1]
- (c) (i) 323.15 K A1 [1]  
(ii) 30.00 K A1 [1]

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- 3 (a) acceleration proportional to displacement/distance from fixed point and in opposite directions/directed towards fixed point M1 A1 [2]
- (b) energy =  $\frac{1}{2}m\omega^2x_0^2$  and  $\omega = 2\pi f$   
=  $\frac{1}{2} \times 5.8 \times 10^{-3} \times (2\pi \times 4.5)^2 \times (3.0 \times 10^{-3})^2$   
=  $2.1 \times 10^{-5} \text{ J}$  C1 C1 A1 [3]
- (c) (i) at maximum displacement above rest position M1 A1 [2]
- (ii) acceleration =  $(-)\omega^2x_0$  and acceleration = 9.81 or  $g$   
 $9.81 = (2\pi \times 4.5)^2 \times x_0$   
 $x_0 = 1.2 \times 10^{-2} \text{ m}$  C1 A1 [2]
- 4 (a) e.g. storing energy  
separating charge  
blocking d.c.  
producing electrical oscillations  
tuning circuits  
smoothing  
preventing sparks  
timing circuits  
*(any two sensible suggestions, 1 each, max 2)* B2 [2]
- (b) (i)  $-Q$  (induced) on opposite plate of  $C_1$   
by charge conservation, charges are  $-Q, +Q, -Q, +Q, -Q$  B1 B1 [2]
- (ii) total p.d.  $V = V_1 + V_2 + V_3$   
 $Q/C = Q/C_1 + Q/C_2 + Q/C_3$   
 $1/C = 1/C_1 + 1/C_2 + 1/C_3$  B1 B1 A0 [2]
- (c) (i) energy =  $\frac{1}{2}CV^2$  or energy =  $\frac{1}{2}QV$  and  $C = Q/V$   
=  $\frac{1}{2} \times 12 \times 10^{-6} \times 9.0^2$   
=  $4.9 \times 10^{-4} \text{ J}$  C1 A1 [2]
- (ii) energy dissipated in (resistance of) wire/as a spark B1 [1]

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- 5 (a) supply connected correctly (to left & right) B1  
load connected correctly (to top & bottom) B1 [2]
- (b) e.g. power supplied on every half-cycle  
greater average/mean power  
*(any sensible suggestion, 1 mark)* B1 [1]
- (c) (i) reduction in the variation of the output voltage/current B1 [1]
- (ii) larger capacitance produces more smoothing M1  
*either* product  $RC$  larger  
*or* for the same load A1 [2]
- 6 (a) unit of magnetic flux density B1  
field normal to (straight) conductor carrying current of 1 A M1  
force per unit length is  $1 \text{ N m}^{-1}$  A1 [3]
- (b) (i) force on particle always normal to direction of motion M1  
(and speed of particle is constant)  
magnetic force provides the centripetal force A1 [2]
- (ii)  $mv^2/r = Bqv$  M1  
 $r = mv/Bq$  A0 [1]
- (c) (i) the momentum/speed is becoming less M1  
so the radius is becoming smaller A1 [2]
- (ii) 1. spirals are in opposite directions M1  
so oppositely charged A1 [2]
2. equal initial radii M1  
so equal (initial) speeds A1 [2]

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- 7 (a) (i) packet/quantum of energy of electromagnetic radiation M1 A1 [2]
- (ii) minimum energy to cause emission of an electron (from surface) B1 [1]
- (b) (i)  $hc/\lambda = \Phi + E_{\max}$   
 $c$  and  $h$  explained M1 A1 [2]
- (ii) 1. *either* when  $1/\lambda = 0$ ,  $\Phi = -E_{\max}$   
or evidence of use of x-axis intercept from graph  
or chooses point close to the line and substitutes values of  $1/\lambda$  and  $E_{\max}$  into  $hc/\lambda = \Phi + E_{\max}$   
 $\Phi = 4.0 \times 10^{-19}$  J (allow  $\pm 0.2 \times 10^{-19}$  J) C1 A1 [2]
2. *either* gradient of graph is  $1/hc$   
gradient =  $4.80 \times 10^{24} \rightarrow 5.06 \times 10^{24}$  C1 M1  
 $h = 1/(\text{gradient} \times 3.0 \times 10^8)$   
=  $6.6 \times 10^{-34}$  Js  $\rightarrow 6.9 \times 10^{-34}$  Js A1  
or chooses point close to the line and substitutes values of  $1/\lambda$  and  $E_{\max}$  into  $hc/\lambda = \Phi + E_{\max}$  (C1)  
values of  $1/\lambda$  and  $E_{\max}$  are correct within half a square (M1)  
 $h = 6.6 \times 10^{-34}$  Js  $\rightarrow 6.9 \times 10^{-34}$  Js (A1) [3]
- (Allow full credit for the correct use of any appropriate method)  
(Do not allow 'circular' calculations in **part 2** that lead to the same value of Planck constant that was substituted in **part 1**)
- 8 (a) (i) probability of decay (of a nucleus) M1  
per unit time A1 [2]
- (ii)  $\lambda t_{1/2} = \ln 2$   
 $\lambda = \ln 2 / (3.82 \times 24 \times 3600)$  M1  
=  $2.1 \times 10^{-6} \text{ s}^{-1}$  A0 [1]
- (b)  $A = \lambda N$  C1  
 $200 = 2.1 \times 10^{-6} \times N$  C1  
 $N = 9.5 \times 10^7$   
ratio =  $(2.5 \times 10^{25}) / (9.5 \times 10^7)$   
=  $2.6 \times 10^{17}$  A1 [3]

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### Section B

- 9 (a) any value greater than, or equal to, 5 k $\Omega$  B1 [1]
- (b) (i) 'positive' shown in correct position B1 [1]
- (ii)  $V^+ = (500/2200) \times 4.5$   
 $\approx 1\text{ V}$  B1  
 $V^- > V^+$  so output is negative M1  
green LED on, (red LED off) A1 [3]  
*(allow full ecf of incorrect value of  $V^+$ )*
- (iii) *either  $V^+$  increases or  $V^+ > V^-$*  M1  
green LED off, red LED on A1 [2]
- 10 quartz/piezo-electric crystal B1  
p.d. across crystal causes *either* centres of (+) and (-) charge to move B1  
*or* crystal to change shape B1  
alternating p.d. (in ultrasound frequency range) causes crystal to vibrate B1  
crystal cut to produce resonance B1  
when crystal made to vibrate by ultrasound wave M1  
alternating p.d. produced across the crystal A1 [6]
- 11 (a) sharpness: ease with which edges of structures can be seen B1  
contrast: difference in degree of blackening between structures B1 [2]
- (b) (i)  $I = I_0 e^{-\mu x}$  C1  
 $I/I_0 = \exp(-0.20 \times 8)$   
 $= 0.20$  A1 [2]
- (ii)  $I/I_0 = \exp(-\mu_1 \times x_1) \times \exp(-\mu_2 \times x_2)$  (could be three terms) C1  
 $I/I_0 = \exp(-0.20 \times 4) \times \exp(-12 \times 4)$  C1  
 $I/I_0 = 6.4 \times 10^{-22}$  or  $I/I_0 \approx 0$  A1 [3]
- (c) (i) sharpness unknown/no B1 [1]
- (ii) contrast good/yes (ecf from (b)) B1 [1]

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- 12 (a) e.g. carrier frequencies can be re-used (without interference) (M1)  
so increased number of handsets can be used (A1)  
e.g. lower power transmitters (M1)  
so less interference (A1)  
e.g. UHF used (M1)  
so must be line-of-sight/short handset aerial (A1)  
*(any two sensible suggestions with explanation, max 4)* B4 [4]
- (b) computer at cellular exchange B1  
monitors the signal power B1  
relayed from several base stations B1  
switches call to base station with strongest signal B1 [4]