

**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**

**GCE Advanced Subsidiary Level and GCE Advanced Level**

## **MARK SCHEME for the October/November 2007 question paper**

### **9702 PHYSICS**

**9702/04**

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

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### Section A

- 1 (a) (i) angle subtended at centre of circle ..... B1  
arc equal in length to the radius ..... B1 [2]
- (ii) arc =  $r\theta$  and for one revolution, arc =  $2\pi r$  ..... M1  
so,  $\theta = 2\pi r/r = 2\pi$  ..... A0 [1]
- (b) (i) *either* weight provides/equals the centripetal force ..... B1  
*or* acceleration of free fall is centripetal acceleration ..... B1  
 $9.8 = 0.13 \times \omega^2$  ..... M1  
 $\omega = 8.7 \text{ rad s}^{-1}$  ..... A0 [2]
- (ii) force in cord = weight + centripetal force (*can be an equation*) ..... C1  
force in cord =  $(L - 13) \times 5/1.8$  *or* force constant =  $5.0/1.8$  ..... C1  
 $(L - 13) \times 5/1.8 = 5.0 + 5/9.8 \times L \times 10^{-2} \times 8.7^2$  ..... C1  
 $L = 17.2 \text{ cm}$  ..... A1 [4]  
(*constant centripetal force of 5.0 N gives L = 16.6 cm allow 2/4*)
- 2 (a) (i)  $pV = nRT$  ..... C1  
 $V = (8.31 \times 300)/(1.02 \times 10^5)$  ..... C1  
=  $0.0244 \text{ m}^3$  (if uses Celsius, then 0/2) ..... A1 [2]
- (ii) volume occupied by one atom =  $0.0244 / (6.02 \times 10^{23}) = 4.06 \times 10^{-26} \text{ m}^3$  ..... M1  
separation  $\approx \sqrt[3]{(4.06 \times 10^{-26})}$  ..... A1  
=  $3.44 \times 10^{-9} \text{ m}$  ..... A0 [2]
- (b) (i)  $F = GMm / r^2$  ..... C1  
=  $(6.67 \times 10^{-11} \times \{4 \times 1.66 \times 10^{-27}\}^2) / (3.44 \times 10^{-9})^2$  ..... C1  
=  $2.49 \times 10^{-46} \text{ N}$  ..... A1 [3]
- (ii) ratio =  $(4 \times 1.66 \times 10^{-27} \times 9.8) / 2.49 \times 10^{-46}$  ..... C1  
=  $2.6 \times 10^{20}$  ..... A1 [2]
- (c) assumption that forces between atoms are negligible ..... B1  
comment e.g. ratio shows gravitational force to be very small  
e.g. force is very much less than weight  
e.g. if there are forces, they are not gravitational ..... B1 [2]

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- 3 (a) (i) 0.8 cm ..... B1 [1]
- (ii) (max.) kinetic energy = 2.56 mJ ..... C1  
 $v_{(MAX)} = \omega a$  ..... C1  
(max.) kinetic energy =  $\frac{1}{2}m\omega^2 a^2$  or  $\frac{1}{2}m\omega^2 (a^2 - x^2)$  ..... C1  
 $2.56 \times 10^{-3} = \frac{1}{2} \times 0.130 \times \omega^2 \times (0.8 \times 10^{-2})^2$  ..... M1  
 $\omega = 24.8 \text{ rad s}^{-1}$  ..... C1  
 $f = \omega/2\pi$  ..... M1  
= 4.0 Hz (3.95 Hz) ..... A0 [6]
- (b) (i) line parallel to x-axis at 2.56 mJ ..... B1 [1]
- (ii) 1 4.0 Hz ..... B1  
2 0.50 cm (allow  $\pm 0.03 \text{ cm}$ ) ..... B1 [2]
- 4 (a) (i) *either* lines directed away from sphere  
or lines go from positive to negative  
or line shows direction of force on positive charge ..... M1  
so positively charged ..... A1 [2]
- (ii) *either* all lines (appear to) radiate from centre  
or all lines are normal to surface of sphere ..... B1 [1]
- (b) tangent to curve ..... B1  
in correct position and direction ..... B1 [2]
- (c) (i)  $V = (0.76 \times 10^{-9}) / (4\pi \times 8.85 \times 10^{-12} \times 0.024)$  ..... C1  
= 285 V ..... A1 [2]
- (ii) negative charge is induced on (inside of) box ..... M1  
formula applies to isolated (point) charge  
OR less work done moving test charge from infinity ..... A1  
so potential is lower ..... A1 [3]
- (d) *either* gravitational field is always attractive  
or field lines must be directed towards both box and sphere ..... B1 [1]

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- 5 (a) e.g. separate charges, store energy, smoothing circuit. etc. .... B1 [1]  
*(allow 'stores charge')*
- (b) (i) charge = current  $\times$  time ..... B1 [1]
- (ii) area is  $21.2 \text{ cm}^2$  (*allow  $\pm 0.5 \text{ cm}^2$* ) ..... C2  
*(allow 1 mark if outside  $\pm 0.5 \text{ cm}^2$  but within  $\pm 1.0 \text{ cm}^2$ )*  
 $1.0 \text{ cm}^2$  represents  $(0.125 \times 10^{-3} \times 1.25 =)$   $156 \mu\text{C}$  ..... C1  
charge =  $3300 \mu\text{C}$  ..... A1 [4]
- (iii) capacitance =  $Q/V$  ..... C1  
=  $(3300 \times 10^{-6}) / 15$   
=  $220 \mu\text{F}$  ..... A1 [2]
- (c) *either* energy =  $\frac{1}{2}CV^2$  or energy =  $\frac{1}{2}QV$  and  $C = Q/V$  ..... C1  
 $\frac{1}{2} \times C \times 15^2 = 2 \times \frac{1}{2} \times C \times V^2$  ..... C1  
 $V = 10.6 \text{ V}$  ..... A1 [3]
- 6 (a) (i)  $BI \sin \theta$  ..... B1 [1]
- (ii) (downwards) into (the plane of) the paper ..... B1 [1]
- (b) (i) magnetic field (due to current) in one loop OR each loop acts as a coil ..... B1  
cuts/is normal to current in second loop OR produces magnetic field ..... B1  
causing force on second loop OR fields in same direction ..... M1  
*either* Newton's 3rd discussed  
or vice versa clear gives rise to attraction OR so attracts ..... A1 [4]
- (ii)  $B = 2 \times 10^{-7} I / 0.75 \times 10^{-2} (= 2.67 \times 10^{-5} \text{ T})$  ..... C1  
force =  $0.26 \times 10^{-3} \times 9.81 (= 2.55 \times 10^{-3} \text{ N})$  ..... C1  
 $F = BIL$   
 $2.55 \times 10^{-3} = 2.67 \times 10^{-5} \times I^2 \times 2\pi \times 4.7 \times 10^{-2}$  ..... C1  
 $I = 18 \text{ A}$  ..... A1 [4]

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- 7 (a) energy required to (completely) separate the nucleons (in a nucleus) ..... B1 [1]
- (b) (i) U labelled near right-hand end of line ..... B1  
Ba and Kr in approximately correct positions ..... B1 [2]
- (ii) binding energy is  $A \times E_B$  ..... B1  
*either* binding energy of U < binding energy of (Ba + Kr)  
*or*  $E_B$  of U <  $E_B$  of (Ba + Kr) ..... B1 [2]
- (c) Krypton-92 reduced to 1/8 in 9 s ..... M1  
in 9 s, very little decay of Barium-141 ..... M1  
so, approximately 9 s ..... A1 [3]
- OR
- $\lambda_{Kr} = 0.231$  or  $\lambda_{Ba} = 6.42 \times 10^{-4}$  (M1)  
 $8 = e^{-\lambda_B \times t} / e^{-\lambda_K \times t}$  (C1)  
 $t = 9.0$  s (A1)

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### Section B

- 8 (a) (i) - 9 V
- (ii) + 9 V (both (i) and (ii) correct for the mark) ..... B1 [1]
- (b) × × ..... B1  
 ✓ × ..... B1  
 ✓ ✓ ..... B1 [3]  
 (no e.c.f. from (a))
- (c) (i) cct: thermistor and resistor in series ..... M1  
 output connections across thermistor ..... A1 [2]
- (ii) as temperature decreases, thermistor resistance increases ..... B1  
 p.d. across thermistor =  $R_T / (R + R_T) \times V$  ..... M1  
 as  $R_T$  increases, output increases ..... A1 [3]
- 9 (a) product of density (of medium) and speed of sound (in medium) ..... B1 [1]
- (b) difference in acoustic impedance ..... M1  
 determines fraction of incident intensity  
 that is reflected/amount of reflection ..... A1 [2]
- (c) pulse of ultrasound (directed into body) ..... B1  
 reflected at boundary (between tissues) ..... B1  
 (reflected pulse is) detected and processed ..... B1  
 time for return of echo gives (information on) depth ..... B1  
 amount of reflection gives information on tissue structures ..... B1 [5]
- 10 (a) (i) amplitude (modulated) (allow 'AM') ..... B1 [1]
- (ii) carrier (frequency / wave) ..... B1 [1]
- (iii) sideband (frequency) ..... B1 [1]
- (b) 10 kHz ..... B1 [1]
- (c) sketch: general shape i.e. any wave that is amplitude modulated ..... M1  
 correct period for modulating waveform (200  $\mu$ s) ..... A1  
 correct period for carrier waveform (20  $\mu$ s) ..... A1 [3]

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- 11 (a) carrier frequencies can be re-used (simultaneously without interference) ..... B1  
so that number of handsets possible is increased ..... B1  
OR anything sensible e.g. UHF used (B1)  
so 'line of sight' (B1) [2]
- (b) handset sends out an (identifying) signal ..... M1  
communicated by base stations to (computer at) exchange ..... A1  
computer selects base station with strongest signal ..... B1  
and allocates a (carrier) frequency ..... B1 [4]