

**CAMBRIDGE INTERNATIONAL EXAMINATIONS**

Cambridge International Advanced Subsidiary and Advanced Level

## **MARK SCHEME for the May/June 2015 series**

### **9702 PHYSICS**

**9702/42**

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

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- 1 (a) (i) 1.  $F = Gm_1m_2/x^2$   
 $= (6.67 \times 10^{-11} \times 2.50 \times 5.98 \times 10^{24}) / (6.37 \times 10^6)^2$   
 $= 24.6 \text{ N (accept 2 s.f. or more)}$  M1  
A1 [2]
2.  $F = mx\omega^2$  or  $F = mv^2/x$  and  $v = \omega x$  (accept  $x$  or  $r$  for distance)  
 $= 2.50 \times 6.37 \times 10^6 \times (2\pi/24 \times 3600)^2$   
 $= 0.0842 \text{ N (accept 2 s.f. or more)}$  C1  
A1 [2]
- (ii) reading =  $24.575 - 0.0842$   
 $= 24.5 \text{ N (accept only 3 s.f.)}$  B1  
A1 [2]
- (b) gravitational force provides the centripetal force M1  
gravitational force is 'equal' to the centripetal force  
(accept  $Gm_1m_2/x^2 = mx\omega^2$  or  $F_C = F_G$ ) M1  
'weight'/sensation of weight/contact force/reaction force is difference between  $F_G$   
and  $F_C$  which is zero A1 [3]
- 2 (a) mean speed =  $1.44 \times 10^3 \text{ m s}^{-1}$  A1 [1]
- (b) evidence of summing of individual squared speeds C1  
mean square speed =  $2.09 \times 10^6 \text{ m}^2 \text{ s}^{-2}$  A1 [2]
- (c) root-mean-square speed =  $1.45 \times 10^3 \text{ m s}^{-1}$  A1 [1]  
(allow ECF from (b) but only if arithmetic error)
- 3 (a) (numerically equal to) quantity of heat/(thermal) energy to change state/phase of  
unit mass M1  
at constant temperature A1 [2]  
(allow 1/2 for definition restricted to fusion or vaporisation)
- (b) (i) constant gradient/straight line (allow linear/constant slope) B1 [1]
- (ii)  $Pt = mL$  or power = gradient  $\times L$  C1  
use of gradient of graph  
(or two points separated by at least 3.5 minutes) M1  
 $110 \times 60 = L \times (372 - 325) \times 10^{-3} / 7.0$   
 $L = 9.80 \times 10^5 \text{ J kg}^{-1}$  (accept 2 s.f.) (allow 9.8 to 9.9 rounded to 2 s.f.) A1 [3]
- (iii) some energy/heat is lost to the surroundings or vapour condenses on sides M1  
so value is an overestimate A1 [2]
- 4 (a) displacement (directly) proportional to acceleration/force M1  
either displacement and acceleration in opposite directions  
or acceleration (always) towards a (fixed) point A1 [2]

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- (b) (i)  $\frac{1}{3}\pi$  rad or 1.05 rad (*allow 60° if unit clear*) A1 [1]
- (ii)  $a_0 = -\omega^2 x_0$   
 $= (-) (2\pi/1.2)^2 \times 0.030$   
 $= (-) 0.82 \text{ m s}^{-2}$   
*(special case: using oscillator P gives  $x_0 = 1.7 \text{ cm}$  and  $a_0 = 0.47 \text{ m s}^{-1}$  for 1/2)* C1  
A1 [2]
- (iii) max. energy  $\propto x_0^2$   
ratio =  $3.0^2/1.7^2$   
 $= 3.1$  (*at least 2 s.f.*) C1  
A1 [2]  
*(if has inverse ratio but has stated max. energy  $\propto x_0^2$  then allow 1/2)*
- (c) graph: straight line through (0,0) with negative gradient M1  
correct end-points (-3.0, +0.82) and (+3.0, -0.82) A1 [2]
- 5 (a) work done bringing/moving per unit positive charge M1  
from infinity (to the point) A1 [2]
- (b) (i) slope/gradient (of the line/graph/tangent) B1 [1]  
*(allow  $dV/dx$ , but **not**  $\Delta V/\Delta x$  or  $V/x$ )*  
*(allow potential gradient)*  
*(negative sign not required)*
- (ii) maximum at surface of sphere A or at  $x = 0$  (cm) B1  
zero at  $x = 6$  (cm) B1  
then increases but in opposite direction B1 [3]  
*(any mention of attraction max. 2/3)*
- (c) (i) M shown between  $x = 5.5 \text{ cm}$  and  $x = 6.5 \text{ cm}$  B1 [1]
- (ii) 1.  $\Delta V = (570 - 230) = 340 \text{ V}$  (*allow 330 V to 340 V*) A1 [1]
2.  $q(\Delta)V = \frac{1}{2}mv^2$  **or** change/loss in PE = change/gain in KE **or**  $\Delta E_K = \Delta E_P$  B1
- $4.8 \times 10^7 \times 340 = \frac{1}{2}v^2$  C1  
 $v^2 = 3.26 \times 10^{10}$   
 $v = 1.8 \times 10^5 \text{ m s}^{-1}$  (*not 1 s.f.*) A1 [3]
- 6 (a) packet/quantum/discrete amount of energy M1  
of electromagnetic energy/radiation/waves A1 [2]
- (b) (i) arrow below axis and pointing to right B1 [1]

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- (ii) 1.  $E = hc/\lambda$   
 $= (6.63 \times 10^{-34} \times 3.0 \times 10^8)/(6.80 \times 10^{-12})$   
 $= 2.93 \times 10^{-14} \text{ J (accept 2 s.f.)}$  C1  
A1 [2]
2. energy of electron  $= (3.06 - 2.93) \times 10^{-14}$   
 $= 1.3 \times 10^{-15} \text{ J}$  C1  
speed  $= \sqrt{(2E/m)}$  C1  
 $= 5.4 \times 10^7 \text{ ms}^{-1}$  A1 [3]
- (c) momentum is a vector quantity B1  
*either* must consider momentum in two directions  
*or* direction changes so cannot just consider magnitude B1 [2]
- 7 (a) moving magnet gives rise to/causes/induces e.m.f./current in solenoid/coil B1  
(induced current) creates field/flux in solenoid that opposes (motion of) magnet B1  
work is done/energy is needed to move magnet (into solenoid) B1  
(induced) current gives heating effect (in resistor) which comes from the work done B1 [4]
- (b) current in primary coil give rise to (magnetic) flux/field B1  
(magnetic) flux/field (in core) is in phase with current (in primary coil) B1  
(magnetic) flux threads/links/cuts secondary coil inducing e.m.f. in secondary coil B1  
(*there must be a mention of secondary coil*)  
e.m.f. induced proportional to rate of change/cutting of flux/field so not in phase B1 [4]
- 8 (a) (i) energy  $= 5.75 \times 1.6 \times 10^{-13}$   
 $= 9.2 \times 10^{-13} \text{ J}$  A1 [1]
- (ii) number  $= 1900/(9.2 \times 10^{-13} \times 0.24)$   
 $= 8.6 \times 10^{15} \text{ s}^{-1}$  C1  
A1 [2]
- (b) (i) decay constant  $= 0.693/(2.8 \times 365 \times 24 \times 3600)$   
 $= 7.85 \times 10^{-9} \text{ s}^{-1}$  (*allow 7.8 or 7.9 to 2 s.f.*) C1  
A1 [2]
- (ii)  $A = \lambda N$   
 $8.6 \times 10^{15} = 7.85 \times 10^{-9} \times N$  C1  
 $N = 1.096 \times 10^{24}$  C1
- mass  $= (1.096 \times 10^{24} \times 236)/(6.02 \times 10^{23})$   
 $= 430 \text{ g}$  M1  
A1 [4]
- (c)  $0.84 = 1.9 \exp(-7.85 \times 10^{-9} t)$  C1  
 $t = 1.04 \times 10^8 \text{ s}$   
 $= 3.3 \text{ years}$  A1 [2]

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### Section B

- 9 (a)  $V_B = 1000 \text{ mV}$  C1  
 when strained,  $V_A = 2000 \times 121.5 / (121.5 + 120.0)$   
 $= 1006.2 \text{ mV}$  M1  
 change =  $6.2 \text{ mV}$  (*allow 6 mV*) A1 [3]
- (b) (i) 1. resistor between  $V_{IN}$  and  $V^-$  and  $V^+$  connected to earth B1  
 resistor between  $V^-$  and  $V_{OUT}$  B1 [2]
2. P/+ sign shown on earth side of voltmeter B1 [1]
- (ii) ratio of  $R_F / R_{IN} = 40$  M1  
 $R_{IN}$  between  $100 \Omega$  and  $10 \text{ k}\Omega$  A1 [2]  
 (*any values must link to the correct resistors on the diagram*)
- 10 (a) product of density (of medium) and speed (of ultrasound) M1  
 in the medium A1 [2]
- (b) (i)  $7.0 \times 10^6 = 1.7 \times 10^3 \times \text{speed}$  C1  
 $\text{speed} = 4.12 \times 10^3 \text{ m s}^{-1}$   
 $\text{wavelength} = (4.12 \times 10^3) / (9.0 \times 10^5) \text{ m}$  C1  
 $= 4.6 \text{ mm}$  (*2 s.f. minimum*) A1 [3]
- (ii) for air/tissue boundary,  $I_R / I \approx 1$  M1  
 for air/tissue boundary, (almost) complete reflection/no transmission A1  
 for gel/tissue boundary,  $I_R / I = 0.1^2 / 3.1^2$   
 $= 1.04 \times 10^{-3}$  (*accept 1 s.f.*) M1  
 gel enables (almost) complete transmission (into the tissue) A1 [4]
- 11 (a) (i) metal (*allow specific example of a metal*) B1 [1]
- (ii) e.g. provides 'return' for the signal  
 shields inner core from interference/reduces cross-talk/reduces noise  
 increased security  
 (*any two sensible suggestions, 1 each*) B2 [2]
- (b) (i) (gradual) loss of power/intensity/amplitude B1 [1]
- (ii) dB is a log scale B1  
*either* large (range of) numbers are easier to handle (on a log scale)  
*or* compounding attenuations/amplifications is easier B1 [2]
- (c) attenuation =  $190 \times 11 \times 10^{-3} = 2.09 \text{ dB}$  C1  
 $-2.09 = 10 \lg(P_{OUT} / P_{IN})$  C1  
 ratio = 0.62 A1 [3]

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- 12 handset transmits (identification) signal to number of base stations B1  
base stations transfers (signal) to cellular exchange B1  
*(idea of stations needed at least once in first two marking points)*
- computer at cellular exchange selects base station with strongest signal B1  
computer at cellular exchange selects a carrier frequency for mobile phone B1 [4]  
*(idea of computer needed at least once in these two marking points)*