

**CAMBRIDGE INTERNATIONAL EXAMINATIONS**  
GCE Advanced Subsidiary Level and GCE Advanced Level

## **MARK SCHEME for the October/November 2012 series**

### **9702 PHYSICS**

**9702/42**

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

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### Section A

- 1 (a) force is proportional to the product of the masses and inversely proportional to the square of the separation  
*either* point masses *or* separation  $\gg$  size of masses
- M1  
A1 [2]
- (b) (i) gravitational force provides the centripetal force  
 $mv^2/r = GMm/r^2$  and  $E_K = \frac{1}{2}mv^2$   
hence  $E_K = GMm/2r$
- B1  
M1  
A0 [2]
- (ii) 1.  $\Delta E_K = \frac{1}{2} \times 4.00 \times 10^{14} \times 620 \times (\{7.30 \times 10^6\}^{-1} - \{7.34 \times 10^6\}^{-1})$   
 $= 9.26 \times 10^7 \text{ J}$  (*ignore any sign in answer*)  
(*allow*  $1.0 \times 10^8 \text{ J}$  *if evidence that*  $E_K$  *evaluated separately for each*  $r$ )
- C1  
A1 [2]
2.  $\Delta E_P = 4.00 \times 10^{14} \times 620 \times (\{7.30 \times 10^6\}^{-1} - \{7.34 \times 10^6\}^{-1})$   
 $= 1.85 \times 10^8 \text{ J}$  (*ignore any sign in answer*)  
(*allow*  $1.8$  *or*  $1.9 \times 10^8 \text{ J}$ )
- C1  
A1 [2]
- (iii) *either*  $(7.30 \times 10^6)^{-1} - (7.34 \times 10^6)^{-1}$  *or*  $\Delta E_K$  *is positive* /  $E_K$  *increased*  
speed has increased
- M1  
A1 [2]
- 2 (a) (i) sum of potential energy and kinetic energy of atoms / molecules / particles  
reference to random
- M1  
A1 [2]
- (ii) no intermolecular forces  
no potential energy  
internal energy is kinetic energy (of random motion) of molecules  
(*reference to random motion here then allow back credit to (i) if M1 scored*)
- B1  
B1  
B1 [3]
- (b) kinetic energy  $\propto$  thermodynamic temperature  
*either* temperature in Celsius, not kelvin so incorrect  
*or* temperature in kelvin is not doubled
- B1  
B1 [2]
- 3 (a) temperature of the spheres is the same  
no (net) transfer of energy between the spheres
- B1  
B1 [2]
- (b) (i) power =  $m \times c \times \Delta\theta$  where  $m$  is mass per second  
 $3800 = m \times 4.2 \times (42 - 18)$   
 $m = 38 \text{ g s}^{-1}$
- C1  
C1  
A1 [3]
- (ii) some thermal energy is lost to the surroundings  
so rate is an overestimate
- M1  
A1 [2]
- 4 (a) straight line through origin  
shows acceleration proportional to displacement  
negative gradient  
shows acceleration and displacement in opposite directions
- M1  
A1  
M1  
A1 [4]

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- (b) (i) 2.8 cm A1 [1]
- (ii) *either* gradient =  $\omega^2$  and  $\omega = 2\pi f$  or  $a = -\omega^2 x$  and  $\omega = 2\pi f$  C1  
 gradient =  $13.5 / (2.8 \times 10^{-2}) = 482$   
 $\omega = 22 \text{ rad s}^{-1}$  C1  
 frequency =  $(22/2\pi) = 3.5 \text{ Hz}$  A1 [3]
- (c) e.g. lower spring may not be extended  
 e.g. upper spring may exceed limit of proportionality / elastic limit  
 (any sensible suggestion) B1 [1]
- 5 (a) (i) ratio of charge and potential (difference)/ voltage  
 (ratio must be clear) B1 [1]
- (ii) capacitor has equal magnitudes of (+)ve and (-)ve charge B1  
total charge on capacitor is zero (so does not store charge) B1  
 (+)ve and (-)ve charges to be separated M1  
 work done to achieve this so stores energy A1 [4]
- (b) (i) capacitance of Y and Z together is  $24 \mu\text{F}$  C1  
 $1/C = 1/24 + 1/12$   
 $C = 8.0 \mu\text{F}$  (allow 1 s.f.) A1 [2]
- (ii) some discussion as to why all charge of one sign on one plate of X B1  
 $Q = (CV) = 8.0 \times 10^{-6} \times 9.0$  M1  
 $= 72 \mu\text{C}$  A0 [2]
- (iii) 1.  $V = (72 \times 10^{-6}) / (12 \times 10^{-6})$  A1 [1]  
 $= 6.0 \text{ V}$  (allow 1 s.f.) (allow 72/12)
2. *either*  $Q = 12 \times 10^{-6} \times 3.0$  or charge is shared between Y and Z C1  
 charge =  $36 \mu\text{C}$  A1 [2]  
 Must have correct voltage in (iii)1 if just quote of  $36 \mu\text{C}$  in (iii)2.
- 6 (a) (i) particle must be moving M1  
 with component of velocity normal to magnetic field A1 [2]
- (ii)  $F = Bqv \sin \theta$  M1  
 $q$ ,  $v$  and  $\theta$  explained A1 [2]
- (b) (i) face BCGF shaded A1 [1]
- (ii) between face BCGF and face ADHE A1 [1]
- (c) potential difference gives rise to an electric field M1  
*either*  $F_E = qE$  (no need to explain symbols)  
 or electric field gives rise to force (on an electron) A1 [2]

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- 7 (a) induced e.m.f./current produces effects / acts in such a direction / tends to oppose the change causing it M1  
A1 [2]
- (b) (i) 1. to reduce flux losses/increase flux linkage/easily magnetised and demagnetised B1 [1]
2. to reduce energy / heat losses (*do not allow 'to prevent energy losses'*) caused by eddy currents M1  
A1 [2]  
(*allow 1 mark for 'reduce eddy currents'*)
- (ii) alternating current / voltage B1  
gives rise to (changing) flux in core B1  
flux links the secondary coil M1  
(by Faraday's law) changing flux induces e.m.f. (in secondary coil) A1 [4]
- 8 (a) discrete quantity / packet / quantum of energy of electromagnetic radiation B1  
energy of photon = Planck constant  $\times$  frequency B1 [2]
- (b) threshold frequency (1)  
rate of emission is proportional to intensity (1)  
max. kinetic energy of electron dependent on frequency (1)  
max. kinetic energy independent of intensity (1)  
(*any three, 1 each, max 3*) B3 [3]
- (c) *either*  $E = hc/\lambda$  *or*  $hc/\lambda = eV$  C1  
 $\lambda = 450 \text{ nm}$  to give work function of  $3.5 \text{ eV}$   
energy =  $4.4 \times 10^{-19}$  or  $2.8 \text{ eV}$  to give  $\lambda = 355 \text{ nm}$  M1  
 $2.8 \text{ eV} < 3.5 \text{ eV}$  so no emission  $355 \text{ nm} < 450 \text{ nm}$  so no A1 [3]
- or* work function =  $3.5 \text{ eV}$   
threshold frequency =  $8.45 \times 10^{14} \text{ Hz}$  C1  
 $450 \text{ nm} = 6.67 \times 10^{14} \text{ Hz}$  M1  
 $6.67 \times 10^{14} \text{ Hz} < 8.45 \times 10^{14} \text{ Hz}$  A1

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### Section B

- 9 (a) e.g. zero output impedance/resistance  
infinite input impedance/resistance  
infinite (open loop) gain  
infinite bandwidth  
infinite slew rate  
*1 each, max. 3* B3 [3]
- (b) (i) graph: square wave M1  
correct cross-over points where  $V_2 = V_1$  A1  
amplitude 5V A1  
correct polarity (*positive at  $t = 0$* ) A1 [4]
- (ii) correct symbol for LED M1  
diodes connected correctly between  $V_{OUT}$  and earth A1  
correct polarity consistent with graph in (i) A1 [3]  
(*R points 'down' if (i) correct*)
- 10 X-ray images taken from different angles / X-rays directed from different angles B1  
of one section / slice (1)  
all images in the same plane (1)  
images combined to give image of section / slice B1  
images of successive sections / slices combined B1  
image formed using a computer B1  
image formed is 3D image (1)  
that can be rotated / viewed from different angles (1)  
(*four B-marks plus any two additional marks*) B2 [6]
- 11 (a) e.g. noise can be eliminated / filtered / signal can be regenerated  
extra bits can be added to check for errors  
multiplexing possible  
digital circuits are more reliable / cheaper  
data can be encrypted for security  
*any sensible advantages, 1 each, max. 3* B3 [3]
- (b) (i) 1. higher frequencies can be reproduced B1 [1]  
2. smaller changes in loudness / amplitude can be detected B1 [1]
- (ii) bit rate =  $44.1 \times 10^3 \times 16$  C1  
=  $7.06 \times 10^5 \text{ s}^{-1}$   
number =  $7.06 \times 10^6 \times 340$   
=  $2.4 \times 10^8$  A1 [2]
- 12 (a) (i) signal in one wire (pair) is picked up by a neighbouring wire (pair) B1 [1]
- (ii) outer of coaxial cable is earthed B1  
outer shields the core from noise / external signals B1 [2]

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- (b) attenuation per unit length =  $1/L \times 10 \lg(P_2/P_1)$  C1
- signal power at receiver =  $10^{2.5} \times 3.8 \times 10^{-8}$
- =  $1.2 \times 10^{-5} \text{ W}$  C1
- attenuation in wire pair =  $10 \lg(\{3.0 \times 10^{-3}\}/\{1.2 \times 10^{-5}\})$
- = 24 dB C1
- attenuation per unit length =  $24/1.4$
- =  $17 \text{ dB km}^{-1}$  A1 [4]
- (other correct methods of calculation are possible)*