

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

### **9702 PHYSICS**

**9702/42**

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

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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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*) C1 A1 [2]  
(*allow  $1.0 \times 10^8 \text{ J}$  if evidence that  $E_K$  evaluated separately for each  $r$* )
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*) C1 A1 [2]  
(*allow  $1.8$  or  $1.9 \times 10^8 \text{ J}$* )
- (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 B1  
no potential energy B1  
internal energy is kinetic energy (of random motion) of molecules B1 [3]  
(*reference to random motion here then allow back credit to (i) if M1 scored*)
- (b) kinetic energy  $\propto$  thermodynamic temperature B1  
*either temperature in Celsius, not kelvin so incorrect*  
*or temperature in kelvin is not doubled* B1 [2]
- 3 (a) temperature of the spheres is the same B1  
no (net) transfer of energy between the spheres B1 [2]
- (b) (i) power =  $m \times c \times \Delta\theta$  where  $m$  is mass per second C1  
 $3800 = m \times 4.2 \times (42 - 18)$  C1  
 $m = 38 \text{ g s}^{-1}$  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 M1  
shows acceleration proportional to displacement A1  
negative gradient M1  
shows acceleration and displacement in opposite directions A1 [4]

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