#### **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

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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Page 2	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – October/November 2012	9702	42

## Section A

1	inv	force is proportional to the product of the masses and inversely proportional to the square of the separation either point masses or separation >> size of masses		[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 × 10 <sup>7</sup> J (ignore any sign in answer) (allow 1.0 × 10 <sup>8</sup> 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 × 10 <sup>8</sup> J (ignore any sign in answer) (allow 1.8 or 1.9 × 10 <sup>8</sup> J)	C1 A1	[2]
	(iii)	either $(7.30 \times 10^6)^{-1}$ – $(7.34 \times 10^6)^{-1}$ or $\Delta E_{\rm K}$ is positive/E <sub>K</sub> 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]
	` '	etic energy ∞ thermodynamic temperature  her temperature in Celsius, not kelvin so incorrect	B1	
	or	temperature in kelvin is not doubled	B1	[2]
3		nperature of the spheres is the same (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 $3800 = m \times 4.2 \times (42 - 18)$ $m = 38 \mathrm{g  s^{-1}}$	C1 C1 A1	[3]
	(ii)	some thermal energy is lost to the surroundings so rate is an overestimate	M1 A1	[2]
4	sh ne	aight line through origin ows acceleration proportional to displacement gative gradient ows acceleration and displacement in opposite directions	M1 A1 M1 A1	[4]

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		GCE AS/A LEVEL – October/November 201	2 9702	42	
	(b) (i)	2.8 cm		A1	[1]
	(ii)	gradient = $13.5/(2.8 \times 10^{-2}) = 482$	$\pi f$	C1	
		$\omega = 22 \mathrm{rad} \mathrm{s}^{-1}$		C1	
		frequency = $(22/2\pi =) 3.5 Hz$		A1	[3]
	e.g	<ul> <li>lower spring may not be extended</li> <li>upper spring may exceed limit of proportionality/elasting sensible suggestion)</li> </ul>	c limit	B1	[1]
5	(a) (i)	ratio of charge and potential (difference)/voltage (ratio must be clear)		B1	[1]
		(ratio must be clear)		Β,	ניו
	(ii)	capacitor has equal magnitudes of (+)ve and (-)ve cha		B1	
		total charge on capacitor is zero (so does not store charges to be separated	arge)	B1 M1	
		work done to achieve this so stores energy		A1	[4]
		<b>3</b> 7			
	(b) (i)	canacitance of V and 7 together is 24 uF		C1	
	(b) (i)	capacitance of Y and Z together is 24 $\mu$ F 1/C = 1/24 + 1/12		Ci	
		$C = 8.0 \ \mu F \ (allow \ 1 \ s.f.)$		A1	[2]
	(ii)	some discussion as to why all charge of one sign on o	ne plate of Y	B1	
	(11)	$Q = (CV = ) 8.0 \times 10^{-6} \times 9.0$	ne plate of X	M1	
		= 72 μC		A0	[2]
	(iii)	1. $V = (72 \times 10^{-6})/(12 \times 10^{-6})$			
	(111)	= 6.0  V  (allow 1  s.f.)  (allow 72/12)		A1	[1]
		, , , , ,	V 17	0.4	
		2. either Q = $12 \times 10^{-6} \times 3.0$ or charge is shared between charge = $36 \mu\text{C}$	veen Y and ∠	C1 A1	[2]
		Must have correct voltage in (iii)1 if just quote of 3	6μC in <b>(iii)</b> 2.	711	[-]
_					
6	(a) (i)	particle must be moving with component of velocity normal to magnetic field		M1 A1	[2]
		with component of velocity normal to magnetic field		Aı	[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) pot	ential difference gives rise to an <u>electric</u> field		M1	
	eitl	ner $F_E = qE$ (no need to explain symbols)		• •	
	or	electric field gives rise to force (on an electron)		A1	[2]

Mark Scheme

Syllabus

Paper

Page 3

	Page 4				Mark So		Syllabus	Paper	
				GCE AS/A L	EVEL – Oc	tober/November 2012	9702	42	
7	(a)	induced e.m.f./current produces effects/acts in such a direction/tends to oppose the change causing it			/tends	M1 A1	[2]		
	(b)	(i)		o reduce flux lagnetised	losses/incre	ease flux linkage/easily	magnetised <u>ar</u>	nd B1	[1]
			caus	reduce energy/l sed by eddy curre w 1 mark for 'red	ents	(do not allow 'to prevent e urrents')	nergy losses')	M1 A1	[2]
		(ii)	give flux	rnating current/vos rise to (changin links the <u>seconda</u> Faraday's law) ch	g) flux in co ary coil	re induces e.m.f. (in seconda	ary coil)	B1 B1 M1 A1	[4]
8	(a)			quantity/packet/ f photon = Planc		energy of electromagnetic frequency	radiation	B1 B1	[2]
	(b)	rate max max	e of e x. kin x. kin	d frequency mission is propor etic energy of ele etic energy indep ee, 1 each, max 3	ctron deper endent of in	ndent on frequency	(1) (1) (1) (1)	В3	[3]
	(c)			= <i>hc/λ</i> nm to give		or $hc/\lambda = eV$ work function of 3.5 eV		C1	
		ene	rgy =	4.4 × 10 <sup>-19</sup> or 2.3 3.5 eV so no emi		to give $\lambda = 355 \text{nm}$ 355 nm < 450 nm so no		M1 A1	[3]
		thre	sholo nm =	function = 3.5 eV d frequency = 8.4 = 6.67×10 <sup>14</sup> Hz 0 <sup>14</sup> Hz < 8.45 × 10				C1 M1 A1	

Page 5	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – October/November 2012	9702	42

## **Section B**

9	(a)	infir infir infir infir	zero output impedance/resistance nite input impedance/resistance nite (open loop) gain nite bandwidth nite slew rate ach, max. 3	В3	[3]
		(i) (ii)	graph: square wave correct cross-over points where $V_2 = V_1$ amplitude 5 V correct polarity (positive at $t = 0$ ) correct symbol for LED diodes connected correctly between $V_{OUT}$ and earth correct polarity consistent with graph in (i) ( $R$ points 'down' if (i) correct)	M1 A1 A1 A1 M1 A1	[4] [3]
10	of o all ir imag imag imag that	ne s mag ges ges ge fo ge fo	nages taken from different angles / X-rays directed from different angles section/slice (1) es in the same plane (1) combined to give image of section/slice of successive sections/slices combined ormed using a computer ormed is 3D image (1) a be rotated/viewed from different angles (1) marks plus any two additional marks)	B1 B1 B1 B1	[6]
11		extr mul digi data any	noise can be eliminated/filtered/signal can be regenerated ra bits can be added to check for errors ltiplexing possible tal circuits are more reliable/cheaper a can be encrypted for security sensible advantages, 1 each, max. 3	В3	[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 = $44.1 \times 10^3 \times 16$ = $7.06 \times 10^5 \text{ s}^{-1}$	C1	
			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 outer shields the core from noise/external signals	B1 B1	[2]

	GCE AS/A LEVEL – October/November 2012	9702	42	
(b)	attenuation per unit length = $1/L \times 10 \lg(P_2/P_1)$ signal power at receiver = $10^{2.5} \times 3.8 \times 10^{-8}$		C1	
	$= 1.2 \times 10^{-5} \text{W}$		C1	
	attenuation in wire pair = $10 \log((3.0 \times 10^{-3})/(1.2 \times 10^{-5}))$		•	
	= 24 dB attenuation per unit length = 24 / 1.4		C1	
	$= 17 \text{ dB km}^{-1}$		A1	[4]

**Syllabus** 

**Paper** 

Mark Scheme

Page 6