## **CAMBRIDGE INTERNATIONAL EXAMINATIONS**

GCE Advanced Subsidiary Level and GCE Advanced Level

## MARK SCHEME for the May/June 2014 series

## 9702 PHYSICS

9702/41

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.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2014 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.



Page 2	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2014	9702	41

## **Section A**

1 M1 (a) work done bringing unit mass from infinity (to the point) Α1 [2] **(b)**  $E_{\rm P} = -m\phi$ B1 [1] C<sub>1</sub> (c)  $\phi \propto 1/x$  $(= 1.05 \times 10^7 \text{ J kg}^{-1})$ either at 6R from centre, potential is  $(6.3 \times 10^{7})/6$ and at 5R from centre, potential is  $(6.3 \times 10^7)/5$  (=  $1.26 \times 10^7$  J kg<sup>-1</sup>) C1 change in energy =  $(1.26 - 1.05) \times 10^7 \times 1.3$ C1  $= 2.7 \times 10^6 \text{ J}$ **A1** or change in potential =  $(1/5 - 1/6) \times (6.3 \times 10')$ (C1) change in energy =  $(1/5 - 1/6) \times (6.3 \times 10^7) \times 1.3$ (C1)  $= 2.7 \times 10^6 \text{ J}$ (A1) [4] 2 (a) the number of atoms M1 in 12 g of carbon-12 Α1 [2] **(b) (i)** amount = 3.2/40= 0.080 molΑ1 [1] (ii) pV = nRT $p \times 210 \times 10^{-6} = 0.080 \times 8.31 \times 310$ C1  $p = 9.8 \times 10^5 \, \text{Pa}$ Α1 [2] (do not credit if T in °C not K) (iii) either pV =  $1/3 \times Nm < c^2 >$  $N = 0.080 \times 6.02 \times 10^{23} \ (= 4.82 \times 10^{22})$ and  $m = 40 \times 1.66 \times 10^{-27}$  (= 6.64 × 10<sup>-26</sup>) C1  $9.8 \times 10^{5} \times 210 \times 10^{-6} = 1/3 \times 4.82 \times 10^{22} \times 6.64 \times 10^{-26} \times < c^{2} > 0.8 \times 10^{-2} \times < c^{2} \times 10^{-2} \times 10^{-2} \times < c^{2} \times 10^{-2$ C1  $\langle c^2 \rangle = 1.93 \times 10^5$  $c_{\rm RMS} = 440 \; {\rm m \; s^{-1}}$ Α1 [3]  $Nm = 3.2 \times 10^{-3}$ or (C1)  $9.8 \times 10^{5} \times 210 \times 10^{-6} = 1/3 \times 3.2 \times 10^{-3} \times < c^{2} >$ (C1) $\langle c^2 \rangle = 1.93 \times 10^5$  $c_{\rm RMS} = 440 \text{ m s}^{-1}$ (A1)  $1/2 m < c^2 > = 3/2 kT$ (C1) or  $1/2 \times 40 \times 1.66 \times 10^{-27} < c^2 > = 3/2 \times 1.38 \times 10^{-23} \times 310$ (C1)  $\langle c^2 \rangle = 1.93 \times 10^5$  $c_{\rm RMS} = 440 \; {\rm m \; s^{-1}}$ (A1)

(if T in °C not K award max 1/3, unless already penalised in (b)(ii))

	Page 3		ye 3 Mark Scheme GCE AS/A LEVEL – May/June 2014		Syllabus 9702	Paper 41		
				G	CE AS/A LEVEL – May/June 2014	9702	41	
3	(a)	or	lic	quid volum	plume = $(1.69 - 1.00 \times 10^{-3})$ e << volume of vapour $10^5 \times 1.69 = 1.71 \times 10^5$ (J)		M1 A1	[2]
	(b)	(i)	<b>1.</b> he	eating of sy	stem/thermal energy supplied to the system	า	B1	[1]
			<b>2.</b> wo	ork done o	n the system		B1	[1]
		(ii)			$10^6$ ) – $(1.71 \times 10^5)$ $10^6$ J (3 s.f. needed)		C1 A1	[2]
4	(a)	kine	etic (e	nergy)/KE	/E <sub>K</sub>		B1	[1]
	(b)	<i>or</i> new	<u>m</u> / amp	<u>iax</u> E propolitude is 1.	nergy = 0.60 mJ ortional to (amplitude)²/equivalent numerical 3 cm e = 0.2 cm	working	B1 B1 B1	[3]
5	(a)	grap	Cl	urve with d	at constant potential = $V_0$ from $x = 0$ to $x = r$ ecreasing gradient ough $(2r, 0.50V_0)$ and $(4r, 0.25V_0)$		B1 M1 A1	[3]
	(b)	grap	CI pa	urve with dassing thro	at $E=0$ from $x=0$ to $x=r$ lecreasing gradient from $(r, E_0)$ ough $(2r, \frac{1}{4}E_0)$ k line must be drawn to $x=4r$ and must not	touch x-axis)	B1 M1 A1	[3]
6	(a)	(i)	ener	gy = <i>EQ</i> = 9.0 : = 0.20	× 22 × 10 <sup>-3</sup> ) J		C1 A1	[2]
		(ii)		f = Q/V = $(22 \times 1)$ = 4.7 V	$0^{-3}$ )/(4700 × $10^{-6}$ )		C1 A1	[2]
			2.	either	$E = \frac{1}{2}CV^{2}$ = $\frac{1}{2} \times 4700 \times 10^{-6} \times 4.7^{2}$ = $5.1 \times 10^{-2} \text{ J}$		C1	[0]
				or	$= 3.1 \times 10^{-3}$ $E = \frac{1}{2}QV$		A1 (C1)	[2]
				OI.	$= \frac{1}{2} \times 22 \times 10^{-3} \times 4.7$ = 5.1 \times 10^{-2} J		(A1)	
				or	$= 3.1 \times 10^{-3}$ $E = \frac{1}{2}Q^{2}/C$		(C1)	
				<i>3</i> ,	$= \frac{1}{2} \times (22 \times 10^{-3})^{2} / 4700 \times 10^{-6}$ $= 5.1 \times 10^{-2} \text{ J}$		(A1)	

	Page 4		Mark Scheme	Syllabus	Paper	•
			GCE AS/A LEVEL – May/June 2014	9702	41	
	(b)	energy lost (as thermal energy) in resistance/wires/battery/resistor (award only if answer in (a)(i) > answer in (a)(ii)2)				[1]
7	(a)	,	$V_{\rm H}$ increases from zero when current switched on $V_{\rm H}$ then non-zero constant $V_{\rm H}$ returns to zero when current switched off		B1 B1 B1	[3]
	(b)		duced) e.m.f. proportional to rate change of (magnetic) flux (linkage)		M1 A1	[2]
		zer	se as current is being switched on o e.m.f. when current in coil se in opposite direction when switching off		B1 B1 B1	[3]
8	(a)	allow: d	e and equal amounts (of charge) liscrete amounts of 1.6 $\times$ 10 <sup>-19</sup> C/elementary charge/e ntegral multiples of 1.6 $\times$ 10 <sup>-19</sup> C/elementary charge/e		В1	[1]
	(b)		= $qV/d$ $D^{-14} = (q \times 680)/(7.0 \times 10^{-3})$ $\times 10^{-19}$ C		C1 A1	[2]
	(c)		tary charge = $1.6 \times 10^{-19}$ C (allow $1.6 \times 10^{-19}$ C to $1.7 \times 10^{-19}$ C to $1.$	× 10 <sup>-19</sup> C )	MO	
			it is a common factor highest common factor		C1 A1	[2]
9	(a)	max max rate	time delay between illumination and emission x. (kinetic) energy of electron dependent on frequency x. (kinetic) energy of electron independent of intensity e of emission of electrons dependent on/proportional to	intensity	D2	[O]
	(b)	` •	ree separate statements, one mark each, maximum 3) oton) interaction with electron may be below surface		B3 B1	[3]
	` /		ergy required to bring electron to surface		B1	[2]

	Page 5				Syllabus	Paper	
				GCE AS/A LEVEL – May/June 2014	9702	41	
		(ii) 1. threshold frequency = $5.8 \times 10^{14}$ Hz					[1]
		$2. \ \Phi = \ hf_0$					
				= $6.63 \times 10^{-34} \times 5.8 \times 10^{14}$ = $3.84 \times 10^{-19}$ (J)		C1	
				$= (3.84 \times 10^{-19})/(1.6 \times 10^{-19})$		O1	
				= 2.4 eV		A1	[3]
			0	r			
				$f = \Phi + E_{\text{MAX}}$	l h into	(C1)	
				hooses point on line and substitutes values $E_{MAX}$ , $f$ and quation with the units of the $hf$ term converted from J to		(C1)	
			Φ	p = 2.4 eV		(A1)	
10	(a)			equired to separate the nucleons (in a nucleus)		M1	
			nfinity ow re	verse statement)		A1	[2]
		(		,			
	(b)	(i)		= (2 × 1.00867) + 1.00728 – 3.01551		C1	
				= $9.11 \times 10^{-3}$ u ing energy = $9.11 \times 10^{-3} \times 930$		C1	
			biriu	= 8.47 MeV		A1	[3]
				w 930 to 934 MeV so answer could be in range 8.47 to w 2 s.f.)	9 8.51 MeV)		
		(ii)		= 211.70394 - 209.93722			
				= 1.76672 u ing energy per nucleon = (1.76672 × 930)/210		C1 C1	
				= 7.82 MeV		A1	[3]
			•	w 930 to 934 MeV so answer could be in range 7.82 to w 2 s.f.)	o 7.86 MeV)		
	(c)			ling energy of barium and krypton		M1	
		ıs g	reate	r than binding energy of uranium		A1	[2]
Section B							
11	(a)	(i)	inve	rting amplifier		B1	[1]
		(ii)	gain	is very large/infinite		B1	
		- ,	$V^{\dagger}$ is	s earthed/zero		B1	[0]
			ior a	implifier not to saturate, P must be (almost) earth/zero		B1	[3]
	(b)	(i)	R <sub>A</sub> =	: 100 kΩ		A1	
			_	: 10 kΩ = 1000 mV		A1 A1	[3]
							[3]
		(ii)	varia	able range meter		B1	[1]

Page 6	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2014	9702	41

12	(a)	series of X-ray images (for one section/slice) taken from different angles to give image of the section/slice repeated for many slices to build up three-dimensional image (of whole object)	M1 M1 A1 M1 A1	[5]
	(b)	deduction of background from readings division by three	C1 C1	
		P=5 Q=9 R=7 S=13		
		(four correct 2/2, three correct 1/2)	A2	[4]
13	(a)	e.g. noise can be eliminated/waveform can be regenerated extra bits of data can be added to check for errors cheaper/more reliable		
		greater <u>rate</u> of transfer of data (1 each, max 2)	B2	[2]
	(b)	receives bits all at one time transmits the bits one after another	B1 B1	[2]
	(c)	sampling frequency must be higher than/(at least) twice frequency to be sampled either higher (range of) frequencies reproduced on the disc	M1	
		or lower (range of) frequencies on phone	A1	
		either higher quality (of sound) on disc or high quality (of sound) not required for phone	B1	[3]
14	(a)	reduction in power (allow intensity/amplitude)	B1	[1]
	(b)			
		= 72 dB	A1	[1]
		(ii) gain/attenuation/dB = 10 $\lg(P_2/P_1)$ 72 = 10 $\lg(P_{IN}/P_{OUT})$ or -72 = 10 $\lg(P_{OUT}/P_{IN})$ ratio = 1.6 × 10 <sup>7</sup>	C1 C1 A1	[3]
	(c)	e.g. enables smaller/more manageable numbers to be used		
	(-)	e.g. gains in dB for series amplifiers are added, not multiplied	B1	[1]