9701CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2013 series

9702 PHYSICS

9702/43 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 October/November 2013 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

Section A

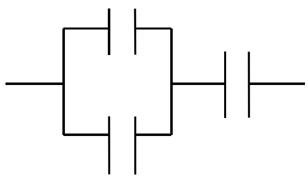
1	**(a)**	force proportional to product of the two masses and inversely proportional to the square of their separation		M1	
		either reference to point masses *or* separation >> 'size' of masses		A1	[2]
	(b)	gravitational force provides the centripetal force		B1	
		$GMm/R^2 = mR\omega^2$		M1	
		where *m is* the mass of the planet		A1	
		$GM = R^3\omega^2$		A0	[3]
	(c)	$\omega = 2\pi / T$		C1	
		either $M_{star} / M_{Sun} = (R_{star} / R_{Sun})^3 \times (T_{Sun} / T_{star})^2$			
		$M_{star} = 4^3 \times (½)^2 \times 2.0 \times 10^{30}$		C1	
		$= 3.2 \times 10^{31}$ kg		A1	[3]
		or $M_{star} = (2\pi)^2 R_{star}{}^3 / GT^2$		(C1)	
		$= \{(2\pi)^2 \times (6.0 \times 10^{11})^3\} / \{6.67 \times 10^{-11} \times (2 \times 365 \times 24 \times 3600)^2\}$		(C1)	
		$= 3.2 \times 10^{31}$ kg		(A1)	
2	**(a)**	**(i)**	sum of kinetic and potential energies of the molecules	M1	
			reference to random distribution	A1	[2]
		(ii)	for ideal gas, no intermolecular forces	M1	
			so no potential energy (only kinetic)	A1	[2]
	(b)	**(i)**	*either* change in kinetic energy $= 3/2 \times 1.38 \times 10^{-23} \times 1.0 \times 6.02 \times 10^{23} \times 180$	C1	
			$= 2240$ J	A1	[2]
			or $R = kN_A$		
			energy $= 3/2 \times 1.0 \times 8.31 \times 180$	(C1)	
			$= 2240$ J	(A1)	
		(ii)	increase in internal energy = heat supplied + work done on system	B1	
			2240 = energy supplied – 1500	C1	
			energy supplied = 3740 J	A1	[3]
3	**(a)**		work done bringing unit positive charge	M1	
			from infinity (to the point)	A1	[2]
	(b)	**(i)**	*either* both potentials are positive / same sign	M1	
			so same sign	A1	[2]
			or gradients are positive & negative (so fields in opposite directions)	(M1)	
			so same sign	(A1)	
		(ii)	the individual potentials are summed	B1	[1]
		(iii)	allow value of *x* between 10 nm and 13 nm	A1	[1]
		(iv)	$V = 0.43$ V (*allow* 0.42 V $\rightarrow$ 0.44 V)	M1	
			energy $= 2 \times 1.6 \times 10^{-19} \times 0.43$	A1	
			$= 1.4 \times 10^{-19}$ J	A1	[3]

4 **(a)** e.g. store energy (do not allow ‘store charge’)
in smoothing circuits
blocking d.c.
in oscillators
any sensible suggestions, one each, max. 2 B2 [2]

(b) **(i)** potential across each capacitor is the same <u>and</u> $Q = CV$ B1 [1]

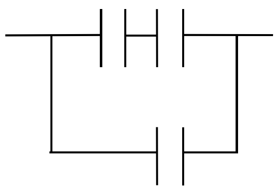
(ii) total charge $Q = Q_1 + Q_2 + Q_3$ M1
$CV = C_1V + C_2V + C_3V$ M1
(*allow* $Q = CV$ *here* or in **(i)**)
so $C = C_1 + C_2 + C_3$ A0 [2]

(c) **(i)**



A1 [1]

(ii)



A1 [1]

5 **(a)** **(i)** region (of space)
either where a moving charge (may) experience a force
or around a magnet where another magnet experiences a force B1 [1]

(ii) ($\Phi =$) $BA \sin\theta$ A1 [1]

(b) **(i)** plane of frame is always parallel to B_V / flux linkage always zero B1 [1]

(ii) $\Delta\Phi = 1.8 \times 10^{-5} \times 52 \times 10^{-2} \times 95 \times 10^{-2}$ C1
$= 8.9 \times 10^{-6}$ Wb A1 [2]

(c) **(i)** (induced) e.m.f. proportional to rate of M1
change of (magnetic) flux (linkage) A1 [2]
(*allow rate of cutting of flux*)

(ii) e.m.f. $= (8.9 \times 10^{-6}) / 0.30$
$= 3.0 \times 10^{-5}$ V A1 [1]

(iii) This question part was removed from the assessment. All candidates were awarded 1 mark. B1 [1]

6	**(a)**	*either* constant speed parallel to plate *or* accelerated motion / force normal to plate / in direction field	B1	
		so not circular	A0	[1]
	(b) (i)	direction of force due to magnetic field opposite to that due to electric field	B1	
		magnetic field into plane of page	B1	[2]
	(ii)	force due to magnetic field = force due to electric field	B1	
		$Bqv = qE$		
		$B = E / v$	C1	
		$= (2.8 \times 10^4) / (4.7 \times 10^5)$		
		$= 6.0 \times 10^{-2}$ T	A1	[3]
	(c) (i)	no change / not deviated	B1	[1]
	(ii)	deviated upwards	B1	[1]
	(iii)	no change / not deviated	B1	[1]
7	**(a) (i)**	minimum photon energy	B1	
		minimum energy to remove an electron (from the surface)	B1	[2]
	(ii)	*either* maximum KE is photon energy – work function energy *or* max KE when electron ejected from the surface	B1	
		energies lower than max because energy required to bring electron to the surface	B1	[2]
	(b) (i)	threshold frequency = 1.0×10^{15} Hz (*allow* $\pm 0.05 \times 10^{15}$)	C1	
		work function energy $= hf_0$	C1	
		$= 6.63 \times 10^{-34} \times 1.0 \times 10^{15}$		
		$= 6.63 \times 10^{-19}$ J	A1	[3]
		(*allow alternative approaches based on use of co-ordinates of points on the line*)		
	(ii)	sketch: straight line with same gradient	M1	
		displaced to right	A1	[2]
	(iii)	intensity determines number of photons arriving per unit time	B1	
		intensity determines number of electrons per unit time (not energy)	B1	[2]
8	**(a)**	probability of decay (of a nucleus) / fraction of number of nuclei in sample that decay	M1	
		per unit time	A1	[2]
		(*allow* $\lambda = (dN / dt) / N$ *with symbols explained – (M1), (A1)*)		
	(b) (i)	number $= (1.2 \times 6.02 \times 10^{23}) / 235$	C1	
		$= 3.1 \times 10^{21}$	A1	[2]

		(ii)	$N = N_0 e^{-\lambda t}$		
			negligible activity from the krypton	B1	
			for barium, $N = (3.1 \times 10^{21}) \exp(-6.4 \times 10^{-4} \times 3600)$		
			$= 3.1 \times 10^{20}$	C1	
			activity $= \lambda N$		
			$= 6.4 \times 10^{-4} \times 3.1 \times 10^{20}$	C1	
			$= 2.0 \times 10^{17}$ Bq	A1	[4]

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)**	gain $= 1 + (10.8 / 1.2)$	C1	
			$= 10$	A1	[2]
		(ii)	graph: straight line from (0,0) towards V_{IN} = 1.0 V, V_{OUT} = 10 V	B1	
			horizontal line at V_{OUT} = 9.0 V to V_{IN} = 2.0 V	B1	
			correct +9.0 V → –9.0 V (and correct shape to V_{IN} = 0)	B1	[3]
10	**(a)**		nuclei spin / precess	B1	
			spin / precess about direction of magnetic field	B1	
			either frequency of precession depends on magnetic field strength *or* large field means frequency in radio frequency range	B1	[3]
	(b)		non-uniform field means frequency of precession different in different regions of subject	B1	
			enables location of precessing nuclei to be determined	B1	
			enables thickness of slice to be varied / location of slice to be changed	B1	[3]
11	**(a)**	**(i)**	*either* series of 'highs' and 'lows' *or* two discrete values	M1	
			with no intermediate values	A1	[2]
		(ii)	e.g. noise can be eliminated (NOT 'no noise') signal can be regenerated addition of extra data to check for errors larger data carrying capacity cheaper circuits more reliable circuits (*any three, 1 each*)	B3	[3]

(b) (i) 1. amplifier		B1	[1]
2. digital-to-analogue converter (*allow DAC*)		B1	[1]
(ii) output of ADC is number of digits all at one time		B1	
parallel-to-serial sends digits one after another		B1	[2]
12 (a) e.g. no / little ionospheric reflection			
large information carrying capacity			
(*any two sensible suggestions, 1 each*)		B2	[2]
(b) prevents (very) low power signal received at satellite		M1	
being swamped by high-power transmitted signal		A1	[2]
(c) attenuation / dB $= 10\ \lg(P_2/P_1)$		C1	
$185 = 10\ \lg(\{3.1 \times 10^3\}/P)$		C1	
$P = 9.8 \times 10^{-16}$ W		A1	[3]