

## **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.

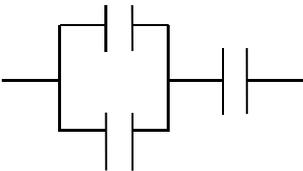
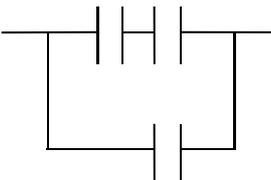
Cambridge is publishing the mark schemes for the October/November 2013 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

Page 2	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – October/November 2013	9702	43

### Section A

- 1 (a) force proportional to product of the two masses and inversely proportional to the square of their separation  
*either* reference to point masses *or* separation  $\gg$  'size' of masses M1  
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*  $M_{\text{star}} / M_{\text{Sun}} = (R_{\text{star}} / R_{\text{Sun}})^3 \times (T_{\text{Sun}} / T_{\text{star}})^2$   
 $M_{\text{star}} = 4^3 \times (1/2)^2 \times 2.0 \times 10^{30}$  C1  
 $= 3.2 \times 10^{31} \text{ kg}$  A1 [3]  
*or*  $M_{\text{star}} = (2\pi)^2 R_{\text{star}}^3 / GT^2$  (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)  
 $= 3.2 \times 10^{31} \text{ kg}$  (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  
 $= 2240 \text{ J}$  A1 [2]  
*or*  $R = kN_A$   
energy  $= 3/2 \times 1.0 \times 8.31 \times 180$  (C1)  
 $= 2240 \text{ J}$  (A1)
- (ii) increase in internal energy = heat supplied + work done on system B1  
 $2240 = \text{energy supplied} - 1500$  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)  $V = 0.43 \text{ V}$  (allow  $0.42 \text{ V} \rightarrow 0.44 \text{ V}$ ) M1  
energy  $= 2 \times 1.6 \times 10^{-19} \times 0.43$  A1  
 $= 1.4 \times 10^{-19} \text{ J}$  A1 [3]

Page 3	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – October/November 2013	9702	43

- 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 and  $Q = CV$  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  
 $= 8.9 \times 10^{-6} \text{ Wb}$  A1 [2]
- (c) (i) (induced) e.m.f. proportional to rate of  
change of (magnetic) flux (linkage) M1  
*(allow rate of cutting of flux)* A1 [2]
- (ii) e.m.f.  $= (8.9 \times 10^{-6}) / 0.30$   
 $= 3.0 \times 10^{-5} \text{ V}$  A1 [1]
- (iii) This question part was removed from the assessment. All candidates were  
awarded 1 mark. B1 [1]

Page 4	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – October/November 2013	9702	43

- 6 (a) *either* constant speed parallel to plate  
or accelerated motion/force normal to plate/in direction field  
so not circular B1  
A0 [1]
- (b) (i) direction of force due to magnetic field opposite to that due to electric field  
magnetic field into plane of page B1  
B1 [2]
- (ii) force due to magnetic field = force due to electric field B1  
 $Bqv = qE$   
 $B = E / v$  C1  
 $= (2.8 \times 10^4) / (4.7 \times 10^5)$   
 $= 6.0 \times 10^{-2} \text{ T}$  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 B1  
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 =  $1.0 \times 10^{15} \text{ Hz}$  (allow  $\pm 0.05 \times 10^{15}$ ) C1  
work function energy =  $hf_0$  C1  
 $= 6.63 \times 10^{-34} \times 1.0 \times 10^{15}$   
 $= 6.63 \times 10^{-19} \text{ J}$  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]

Page 5	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – October/November 2013	9702	43

- (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  $= 1 + (10.8 / 1.2)$   
 $= 10$  C1  
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  $\rightarrow$   $-9.0$  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  
with no intermediate values M1  
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]

Page 6	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – October/November 2013	9702	43

- (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  
being swamped by high-power transmitted signal M1  
A1 [2]
- (c) attenuation/dB =  $10 \lg(P_2/P_1)$  C1  
 $185 = 10 \lg(\{3.1 \times 10^3\}/P)$  C1  
 $P = 9.8 \times 10^{-16} \text{ W}$  A1 [3]