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

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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 → 0.44 V*) M1
energy $= 2 \times 1.6 \times 10^{-19} \times 0.43$ A1
$= 1.4 \times 10^{-19}$ J A1 [3]

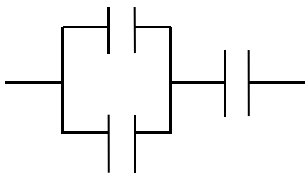
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4 **(a)** e.g. store energy (do not allow 'store charge')
in smoothing circuits
blocking d.c.
in oscillators
any sensible suggestions, one each, max. 2 B2 [2]

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

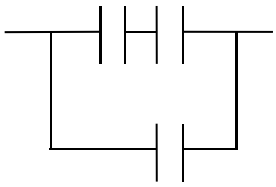
(ii) total charge $Q = Q_1 + Q_2 + Q_3$ M1
$CV = C_1V + C_2V + C_3V$ M1
(*allow* $Q = CV$ *here* or in **(i)**)
so $C = C_1 + C_2 + C_3$ A0 [2]

(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) (Φ =) $BA \sin\theta$ 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]

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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]

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(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]

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(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({3.1×10^3}/P) C1
$P = 9.8 \times 10^{-16}$ W A1 [3]

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