Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS	**9702/04**
Paper 4 A Level Structured Questions	**For Examination from 2016**
SPECIMEN MARK SCHEME	
	2 hours

MAXIMUM MARK: 100

This document consists of **6** printed pages.

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1 (a) (i) $F_G = GMm / R^2$ — C1

$= (6.67 \times 10^{-11} \times 5.98 \times 10^{24}) / (6380 \times 10^3)^2$

$= 9.80\,\text{N}$ — A1 [2]

(ii) $F_C = mR\omega^2$ — C1

$\omega = 2\pi / T$ — C1

$F_C = (4\pi^2 \times 6380 \times 10^3) / (8.62 \times 10^4)^2$

$= 0.0339\,\text{N}$ — A1 [3]

(iii) $F_G - F_C = 9.77\,\text{N}$ — A1 [1]

(b) $9.77\,\text{m s}^{-2}$ because acceleration is resultant force per unit mass — B1 [1]

[Total: 7]

2 (a) $pV / T = \text{constant}$

$T = (6.5 \times 10^6 \times 30 \times 300) / (1.1 \times 10^5 \times 540)$ — C1

$= 985\,\text{K}$ — A1 [2]

(b) (i) $\Delta U = q + w$

symbols explained ($q = $ heating, $w = $ work) — M1

consistent set of directions of energy change — A1 [2]

(ii) q is zero — B1

$\Delta U = w$ and so U increases — B1

U increases so E_K of atoms increases and T increases — A1 [3]

[Total: 7]

3 (a) (i) $\omega = 2\pi f$ — B1 [1]

(ii) *either* $(-)$ve because a and x are in opposite directions

or a is always directed towards mean position — B1 [1]

(b) (i) forces in springs are $k(e + x)$ and $k(e - x)$ — C1

resultant $= k(e + x) - k(e - x)$ — M1

$= 2kx$ — A0 [2]

(ii) $F = ma$ — B1

$a = -2kx / m$ — A0

$(-)$ sign explained — B1 [2]

(iii) $\omega^2 = 2k / m$ — C1

$(2\pi f)^2 = (2 \times 120) / 0.90$ — C1

$f = 2.6\,\text{Hz}$ — A1 [3]

[Total: 9]

4 (a) amplitude of carrier wave varies   M1
     in synchrony with displacement of information signal   A1   [2]

    (b) graph: three vertical lines   M1
     symmetrical with smaller sidebands   A1
     at frequencies 70, 75 and 80 kHz   A1   [3]

    (c) bandwidth = 10 kHz   B1   [1]

                                                       [Total: 6]

5 (a) unwanted energy / power that is random   B1   [1]

    (b) number of dB = $10 \lg(P_{OUT} / P_{IN})$ C1
     $63 = 10 \lg(P_{OUT} / (2.5 \times 10^{-6}))$ C1
     $P_{OUT} = 5.0\,W$ A1   [3]

    (c) attenuation = $10 \lg(5.0 / (3.5 \times 10^{-8})) = 81.5$ dB   C1
     length = 81.5 / 12 = 6.8 km   A1   [2]

                                                       [Total: 6]

6 (a) field strength equals the potential gradient   M1
     field strength and potential gradient are in opposite directions   A1   [2]

    (b) at $x = 10$ cm, force is maximum   M1
     because the gradient is largest   A1
     repulsion / force to right because sphere and proton have like charges   B1
     as x increases, force decreases   B1
     becomes zero at $x = 35$ cm   B1
     as x increases from $x = 35$ cm to $x = 41$ cm, force increases in opposite direction   B1   [6]

                                                       [Total: 8]

7 (a) + −   B1   [1]

    (b) (i) **1.** 4.5 V   A1
         2. use of potential divider formula (9 × 800) / (800 + 2200)   C1
           2.4 V   A1
         3. − 9.0 V   B1   [4]

         (ii) LED G   (allow e.c.f. from **(i)**)   B1   [1]

    (c) as temperature rises, potential at B increases   M1
     at 60 °C, green goes out and red comes on (allow ecf from **(b)(ii)**)   A1   [2]

                                                       [Total: 8]

8	**(a)**	**(i)**	50 mT (*allow 50 ± 1 mT for full credit*)	A1	[1]

(ii) flux linkage = *BAN* C1
$$= 50 \times 10^{-3} \times 0.4 \times 10^{-4} \times 150$$ M1
$$= 3.0 \times 10^{-4} \text{ Wb}$$ A0 [2]

(b) e.m.f. (induced) is proportional to the rate M1
of change of (magnetic) flux (linkage) A1 [2]
(*allow 'rate of cutting'*)

(c) **(i)** new flux linkage $= 8.0 \times 10^{-3} \times 0.4 \times 10^{-4} \times 150$
$$= 4.8 \times 10^{-4} \text{ Wb}$$ C1
change $= 2.52 \times 10^{-4}$ Wb A1 [2]

(ii) e.m.f. $= (2.52 \times 10^{-4}) / 0.30$ C1
$$= 8.4 \times 10^{-4} \text{ V}$$ A1 [2]

(d) flux linkage decreases as distance increases B1
so speed must increase to keep rate constant B1 [2]

[Total: 11]

9 **(a)** into the plane of the paper / downwards B1 [1]

(b) **(i)** centripetal force $= mv^2 / r$ B1
$mv^2 / r = Bqv$ hence $q / m = v / rB$ (*some algebra essential*) B1 [2]

(ii) $q / m = (8.2 \times 10^6) / (23 \times 10^{-2} \times 0.74)$ C1
$$= 4.82 \times 10^7 \text{ C kg}^{-1}$$ A1 [2]

[Total: 5]

10 **(a)** single diode M1
either in series with R *or* in series with a.c. supply A1 [2]

(b) **(i)** **1.** 5.4 V (*allow ±0.1 V*) A1 [1]
2. $V = IR$
$I = 5.4 / (1.5 \times 10^3)$
$$= 3.6 \times 10^{-3} \text{ A}$$ A1 [1]
3. time = 0.027 s A1 [1]

(ii) **1.** $Q = It$
$$= 3.6 \times 10^{-3} \times 0.027$$ C1
$$= 9.72 \times 10^{-5} \text{ C}$$ A1 [2]
2. $C = \Delta Q / \Delta V$ (*allow Q/V*) C1
$$= (9.72 \times 10^{-5}) / 1.2$$
$$= 8.1 \times 10^{-5} \text{ F}$$ A1 [2]

5

(c) line: reasonable shape with less ripple   B1   [1]

[Total: 10]

11 at 0 K, VB is filled, CB is empty   B1
as temperature rises, electrons gain energy to enter CB   M1
positive holes are formed in VB   A1
lattice vibrations increase   B1
effect due to increase in charge carriers outweighs effect due to increase in
lattice vibrations   M1
so current larger and resistance smaller   A1   [6]

[Total: 6]

12 (a) (i) clear distinction of boundaries between regions   B1   [1]

(ii) significant difference in degree of blackening between regions   B1   [1]

(b) (i) $\frac{1}{2} = e^{-\mu}$ C1
$\mu = 0.693\,\text{mm}^{-1}$ A1   [2]

(ii) X-ray photons are more penetrating   M1
μ is smaller   A1   [2]

[Total: 6]

13 (a) (i) probability of decay (of a nucleus)   M1
per unit time   A1   [2]

(ii) greater energy of α-particle   M0
(parent) nucleus less stable   A1
nucleus more likely to decay   A1
hence radium−224   A1   [3]

(b) (i) $\lambda = \ln 2 / 3.6$
$= 0.193$ A1
unit: day^{-1} A1   [2]
(*allow full credit for 2.23 × 10^{-6} s^{-1}*)

(ii) $N = \{(2.24 \times 10^{-3}) / 224\} \times 6.02 \times 10^{23}$ C1
$= 6.02 \times 10^{18}$ C1
activity $= \lambda N$
$= 2.23 \times 10^{-6} \times 6.02 \times 10^{18}$ C1
$= 1.3 \times 10^{13}$ Bq   A1   [4]

[Total: 11]

Categorisation of marks

The marking scheme categorises marks on the *MACB* scheme.

B marks: These are awarded as <u>independent</u> marks, which do not depend on other marks. For a B-mark to be scored, the point to which it refers must be seen specifically in the candidate's answer.

M marks: These are <u>method</u> marks upon which A-marks (accuracy marks) later depend. For an M-mark to be scored, the point to which it refers must be seen in the candidate's answer. If a candidate fails to score a particular M-mark, then none of the dependent A-marks can be scored.

C marks: These are <u>compensatory</u> method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a C-mark and the candidate does not write down the actual equation but does correct working which shows he/she knew the equation, then the C-mark is awarded.

A marks: These are accuracy or <u>answer</u> marks which either depend on an M-mark, or allow a C-mark to be scored.

Conventions within the marking scheme

BRACKETS
Where brackets are shown in the marking scheme, the candidate is not required to give the bracketed information in order to earn the available marks.

UNDERLINING
In the marking scheme, underlining indicates information that is essential for marks to be awarded.