
PHYSICS

Paper 4 A Level Structured Questions

SPECIMEN MARK SCHEME

9702/04

For Examination from 2016

2 hours

MAXIMUM MARK: 100

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

1	(a) (i) $F_G = GMm / R^2$ $= (6.67 \times 10^{-11} \times 5.98 \times 10^{24}) / (6380 \times 10^3)^2$ $= 9.80 \text{ N}$	C1 A1	[2]
	(ii) $F_C = mR\omega^2$ $\omega = 2\pi / T$ $F_C = (4\pi^2 \times 6380 \times 10^3) / (8.62 \times 10^4)^2$ $= 0.0339 \text{ N}$	C1 C1 A1	[3]
	(iii) $F_G - F_C = 9.77 \text{ N}$	A1	[1]
	(b) 9.77 ms^{-2} because acceleration is resultant force per unit mass	B1	[1]
			[Total: 7]
2	(a) $pV / T = \text{constant}$ $T = (6.5 \times 10^6 \times 30 \times 300) / (1.1 \times 10^5 \times 540)$ $= 985 \text{ K}$	C1 A1	[2]
	(b) (i) $\Delta U = q + w$ symbols explained ($q = \text{heating}$, $w = \text{work}$) consistent set of directions of energy change	M1 A1	[2]
	(ii) q is zero $\Delta U = w$ and so U increases U increases so E_K of atoms increases and T increases	B1 B1 A1	[3]
			[Total: 7]
3	(a) (i) $\omega = 2\pi f$	B1	[1]
	(ii) <i>either</i> (-)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 $k(e - x)$ resultant $= k(e + x) - k(e - x)$ $= 2kx$	C1 M1 A0	[2]
	(ii) $F = ma$ $a = -2kx / m$ (-) sign explained	B1 A0 B1	[2]
	(iii) $\omega^2 = 2k / m$ $(2\pi f)^2 = (2 \times 120) / 0.90$ $f = 2.6 \text{ Hz}$	C1 C1 A1	[3]
			[Total: 9]

- 4 (a) amplitude of carrier wave varies in synchrony with displacement of information signal M1 A1 [2]
- (b) graph: three vertical lines symmetrical with smaller sidebands at frequencies 70, 75 and 80 kHz M1 A1 A1 [3]
- (c) bandwidth = 10 kHz B1 [1]
- [Total: 6]**
- 5 (a) unwanted energy / power that is random B1 [1]
- (b) number of dB = $10 \lg(P_{\text{OUT}} / P_{\text{IN}})$
 $63 = 10 \lg(P_{\text{OUT}} / (2.5 \times 10^{-6}))$
 $P_{\text{OUT}} = 5.0 \text{ W}$ C1 C1 A1 [3]
- (c) attenuation = $10 \lg(5.0 / (3.5 \times 10^{-8})) = 81.5 \text{ dB}$
length = $81.5 / 12 = 6.8 \text{ km}$ C1 A1 [2]
- [Total: 6]**
- 6 (a) field strength equals the potential gradient field strength and potential gradient are in opposite directions M1 A1 [2]
- (b) at $x = 10 \text{ cm}$, force is maximum because the gradient is largest repulsion / force to right because sphere and proton have like charges as x increases, force decreases becomes zero at $x = 35 \text{ cm}$ as x increases from $x = 35 \text{ cm}$ to $x = 41 \text{ cm}$, force increases in opposite direction M1 A1 B1 B1 B1 B1 [6]
- [Total: 8]**
- 7 (a) + – B1 [1]
- (b) (i) 1. 4.5V A1
2. use of potential divider formula $(9 \times 800) / (800 + 2200)$ C1
2.4V A1
3. – 9.0V B1 [4]
- (ii) LED G (allow e.c.f. from (i)) B1 [1]
- (c) as temperature rises, potential at B increases at 60°C , green goes out and red comes on (allow ecf from (b)(ii)) M1 A1 [2]

[Total: 8]**[Turn over]**

8	(a) (i)	50 mT (<i>allow 50 ± 1 mT for full credit</i>)	A1	[1]
	(ii)	flux linkage = BAN $= 50 \times 10^{-3} \times 0.4 \times 10^{-4} \times 150$ $= 3.0 \times 10^{-4} \text{ Wb}$	C1 M1 A0	[2]
	(b)	e.m.f. (induced) is proportional to the rate of change of (magnetic) flux (linkage) (<i>allow 'rate of cutting'</i>)	M1 A1	[2]
	(c) (i)	new flux linkage = $8.0 \times 10^{-3} \times 0.4 \times 10^{-4} \times 150$ $= 4.8 \times 10^{-4} \text{ Wb}$ change = $2.52 \times 10^{-4} \text{ Wb}$	C1 A1	[2]
	(ii)	e.m.f. = $(2.52 \times 10^{-4}) / 0.30$ $= 8.4 \times 10^{-4} \text{ V}$	C1 A1	[2]
	(d)	flux linkage decreases as distance increases so speed must increase to keep rate constant	B1 B1	[2]
				[Total: 11]
9	(a)	into the plane of the paper / downwards	B1	[1]
	(b) (i)	centripetal force = mv^2/r $mv^2/r = Bqv$ hence $q/m = v/rB$ (<i>some algebra essential</i>)	B1 B1	[2]
	(ii)	$q/m = (8.2 \times 10^6) / (23 \times 10^{-2} \times 0.74)$ $= 4.82 \times 10^7 \text{ C kg}^{-1}$	C1 A1	[2]
				[Total: 5]
10	(a)	single diode <i>either in series with R or in series with a.c. supply</i>	M1 A1	[2]
	(b) (i)	1. 5.4 V (<i>allow ±0.1 V</i>) 2. $V = IR$ $I = 5.4 / (1.5 \times 10^3)$ $= 3.6 \times 10^{-3} \text{ A}$ 3. time = 0.027 s	A1 A1 A1	[1] [1] [1]
	(ii)	1. $Q = It$ $= 3.6 \times 10^{-3} \times 0.027$ $= 9.72 \times 10^{-5} \text{ C}$ 2. $C = \Delta Q / \Delta V$ (<i>allow Q/V</i>) $= (9.72 \times 10^{-5}) / 1.2$ $= 8.1 \times 10^{-5} \text{ F}$	C1 A1 C1 A1	[2] [2] [2]

(c) line: reasonable shape with less ripple	B1	[1]
		[Total: 10]
11 at 0K, 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) per unit time	M1	
	A1	[2]
(ii) greater energy of α -particle (parent) nucleus less stable nucleus more likely to decay hence radium-224	M0	
	A1	
	A1	
	A1	[3]
(b) (i) $\lambda = \ln 2 / 3.6$		
$= 0.193$	A1	
unit: day^{-1}	A1	[2]
(allow full credit for $2.23 \times 10^{-6} \text{ s}^{-1}$)		
(ii) $N = \{(2.24 \times 10^{-3}) / 224\} \times 6.02 \times 10^{23}$	C1	
$= 6.02 \times 10^{18}$	C1	
activity = λN		
$= 2.23 \times 10^{-6} \times 6.02 \times 10^{18}$	C1	
$= 1.3 \times 10^{13} \text{ Bq}$	A1	[4]
		[Total: 11]

Categorisation of marks

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

B marks: These are awarded as independent 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 method 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 compensatory 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 answer 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.