Cambridge International AS & A Level

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

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1	**(a) (i)**	$F_G = GMm / R^2$	C1	
		$= (6.67 \times 10^{-11} \times 5.98 \times 10^{24}) / (6380 \times 10^3)^2$		
		$= 9.80\,N$	A1	[2]
	(ii)	$F_C = mR\omega^2$	C1	
		$\omega = 2\pi / T$	C1	
		$F_C = (4\pi^2 \times 6380 \times 10^3) / (8.62 \times 10^4)^2$		
		$= 0.0339\,N$	A1	[3]
	(iii)	$F_G - F_C = 9.77\,N$	A1	[1]
	(b)	$9.77\,m\,s^{-2}$ because acceleration is resultant force per unit mass	B1	[1]
				[Total: 7]
2	**(a)**	$pV / T =$ constant		
		$T = (6.5 \times 10^6 \times 30 \times 300) / (1.1 \times 10^5 \times 540)$	C1	
		$= 985\,K$	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	
		$f = 2.6\,Hz$	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 × 10^{-6}))	C1	
		P_{OUT} = 5.0 W	A1	[3]
	(c)	attenuation = 10 lg(5.0 / (3.5 × 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	
		$= 3.0 \times 10^{-4}$ 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 $= 8.0 \times 10^{-3} \times 0.4 \times 10^{-4} \times 150$		
		$= 4.8 \times 10^{-4}$ Wb	C1	
		change $= 2.52 \times 10^{-4}$ Wb	A1	[2]
		(ii) e.m.f. $= (2.52 \times 10^{-4}) / 0.30$	C1	
		$= 8.4 \times 10^{-4}$ 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	
		$= 4.82 \times 10^7$ 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. $V = IR$		
		$I = 5.4 / (1.5 \times 10^3)$		
		$= 3.6 \times 10^{-3}$ A	A1	[1]
		3. time = 0.027 s	A1	[1]
		(ii) **1.** $Q = It$		
		$= 3.6 \times 10^{-3} \times 0.027$	C1	
		$= 9.72 \times 10^{-5}$ C	A1	[2]
		2. $C = \Delta Q / \Delta V$ (*allow Q/V*)	C1	
		$= (9.72 \times 10^{-5}) / 1.2$		
		$= 8.1 \times 10^{-5}$ F	A1	[2]

	(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* $2.23 \times 10^{-6}\ s^{-1}$)		
		(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]

<u>Categorisation of marks</u>

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.

<u>Conventions within the marking scheme</u>

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.