Specimen Paper

GCE A LEVEL

MARK SCHEME

MAXIMUM MARK: 100

SYLLABUS/COMPONENT: 9702/04

PHYSICS
Paper 4

Section A

1	**(a)**	**(i)**	radial lines	B1	
			pointing inwards	B1	
		(ii)	no difference *OR* lines closer near surface of smaller sphere	B1	[3]
	(b)	**(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	
		(ii)	$F_C = mR\omega^2$	C1	
			$\omega = 2\pi / T$	C1	
			$F_C = (4\pi^2 \times 6380 \times 10^3) / (8.64 \times 10^4)^2$		
			$= 0.0337$ N	A1	
		(iii)	$F_G. - F_C = 9.77$ N	A1	[6]
	(c)		because acceleration (of free fall) is (resultant) force per unit mass	B1	
			acceleration = 9.77 m s^{-2}	B1	[2]
2	**(a)**	**(i)**	$\omega = 2\pi f$	B1	
		(ii)	(-)ve because *a* and *x* in opposite directions		
			OR *a* directed towards mean position / centre	B1	[2]
	(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	
			(-)ve 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]

3	**(a)** single diode		M1	
	in series with R *OR* in series with a.c. supply		A1	[2]
	(b) (i) 1	5.4 V (allow ±0.1 V)	A1	
	(i) 2	$V = iR$		
		$I = 5.4 / 1.5 \times 10^{3}$	C1	
		$= 3.6 \times 10^{-3}$ A	A1	
	(i) 3	time = 0.027 s	A1	[4]
	(ii) 1	$Q = it$		
		$= 3.6 \times 10^{-3} \times 0.027$	C1	
		$= 9.72 \times 10^{-5}$ C	A1	
	(ii) 2	$C = \Delta Q / \Delta V$ (allow $C = Q/V$ for this mark)	C1	
		$= (9.72 \times 10^{-5}) / 1.2$		
		$= 8.1 \times 10^{-5}$ F	A1	[4]
	(c) line:	reasonable shape with less ripple	B1	[1]
4	**(a) (i)**	50 mT	A1	
	(ii)	flux linkage $= BAN$	C1	
		$= 50 \times 10^{-3} \times 0.4 \times 10^{-4} \times 150 = 3.0 \times 10^{-4}$ Wb	A1	[3]
		(*allow 49 mT* $\rightarrow 2.94 \times 10^{-4}$ *Wb or 51 mT* $\rightarrow 3.06 \times 10^{-4}$ *Wb*)		
	(b)	e.m.f. / induced voltage (*do not allow current*)		
		proportional/equal to	B1	
		rate of change/cutting of flux (linkage)	B1	[2]
	(c) (i)	new flux linkage $= 8.0 \times 10^{-3} \times 0.4 \times 10^{-4} \times 150$		
		$= 4.8 \times 10^{-5}$ 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) *either*	flux linkage decreases as distance increases	B1	
		so speed must increase to keep rate of change constant	B1	[2]
	or	at constant speed, e.m.f. / flux linkage decreases as x increases	(B1)	
		so increase speed to keep rate constant	(B1)	

5	**(a)** into (plane of) paper / downwards	B1	[1]
	(b) (i) the <u>centripetal force</u> = mv^2 / r	B1	
	$mv^2/r = Bqv$ <u>hence</u> $q/m = v/rB$ (*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]
	(c) (i) mass $= (1.6 \times 10^{-19}) / (4.82 \times 10^7 \times 1.66 \times 10^{-27})$	C1	
	$= 2u$		[2]
	(ii) proton + neutron	B1	[1]
6	**(a)** pV / T = constant	C1	
	$T = (6.5 \times 10^6 \times 30 \times 300) / (1.1 \times 10^5 \times 540)$	C1	
	= 985 K	A1	[3]
	(*if uses °C, allow 1/3 marks for clear formula)*		
	(b) (i) $\Delta U = q + w$		
	symbols identified correctly	M1	
	directions correct	A1	[2]
	(ii) q is zero	B1	
	is positive *OR* $\Delta U = w$ and U increases	B1	
	ΔU is rise in kinetic energy of <u>atoms</u>	M1	
	and mean kinetic energy $\propto T$	A1	[4]
	(*allow 1 of the last two marks if states 'U increases so T rises'*)		
7	**(a) (i)** *either* probability of decay per unit time *or* dN/dt = (-)λN OR A = (-)λN with symbols explained	M1	
		A1	[2]
	(ii) greater energy of α-particle means	M0	
	(parent) nucleus less stable	A1	
	nucleus more likely to decay	A1	
	hence Radium-224	A1	[3]
	(b) (i) *either* λ = ln2 / 3.6 *or* λ = ln2 / 3.6 × 24 × 3600		
	= 0.193 = 2.23×10^{-6}	A1	
	unit day^{-1} s^{-1}	A1	[2]
	(*one sig.fig., -1, allow λ in hr^{-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]

Section B

8	**(a)** + –	B1	[1]
	(b) (i) 1. 4.5 V	B1	
	2. Use of potential divider formula $9 \times 800 / (800 + 2200)$	C1	
	2.4 V	A1	
	3. – 9.0 V	B1	[4]
	(ii) green (*e.c.f. from (a) and (i)3*)	B1	[1]
	(c) as temperature rises, potential/voltage at B increases	M1	
	at 60 °C, green goes out, red comes on	A1	[2]
9	**(a) (i)** clear distinction of boundaries between regions	B1	
	(ii) significant difference in blackening of different regions	B1	[2]
	(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]
10	**(a)** amplitude of carrier wave varies	M1	
	in synchrony with (displacement of information) signal	A1	[2]
	(b) three vertical lines	B1	
	symmetrical with smaller sidebands	B1	
	at frequencies 70, 75 and 80 kHz	B1	[3]
	(c) bandwidth = 10 kHz	B1	[1]
11	**(a)** unwanted energy / power that is random or that covers whole spectrum	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 = $10\lg(5 / 3.5 \times 10^{-8}) = 81.5$ dB	C1	
	length = 81.5 / 12 = 6.8 km	A1	[2]
12	e.g. permits entry to PSTN		
	selects base station for any handset		
	allocates a carrier frequency/channel		
	monitors handset signal to re-allocate base station		
	allocates time slot for multiplexing etc		
	(*any four sensible suggestions, 1 each to max 4)*	B4	[4]