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 = 2.52×10^{-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 ℃, 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 = λN		
	$= 2.23 \times 10^{-6} \times 6.02 \times 10^{18}$	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 × 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) ½ = $e^{-\mu}$	C1	
	μ = 0.693 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 × 10^{-6})	C1	
	P_{OUT} = 5.0 W	A1	[3]
	(c) attenuation = 10 lg(5 / 3.5 × 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]