OCR
RECOGNISING ACHIEVEMENT

GCE

Physics B (Advancing Physics)

Advanced GCE

Unit **G495:** Field and Particle Pictures

Mark Scheme for January 2011

Oxford Cambridge and RSA Examinations

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Question			Expected Answer	Mark	Rationale/Additional Guidance
1	a		N_s = (3800x15)/230 (1) = 250 turns (1)	2	Only one mark for 247.8 or 247; 248 ok.
	b		Magnetic flux linkage (1)	1	
2	a		Equipotential line curved, crossing field lines at right angles (1)	1	Mark in area of field shown.
	b		Separation of field lines changes (1)	1	Accept equipotential lines are curved; accept field lines are curved/not parallel
3			mass defect = 1.0×10^{-29} (1) $E = 1.0 \times 10^{-29} \times 9 \times 10^{16} = 9 \times 10^{-13}$ J (1)	2	
4			Potential difference (1) between x_1 and x_2 (1)	2	Second mark is dependent on first. Accept work done (energy) in moving unit charge between x_1 and x_2; accept voltage for p.d.
5	a		3.0×10^{-10} m	1	
	b		two loops	1	Must be drawn at n = 2
6	a		photon		
	b		positron		
	c		neutron	3	
7	a		proton	1	
	b		Energy is transferred to create new particles (1) possessing k.e. (1)	1 1	Energy transfer to new particles worth 1 mark
8	a		Correct line (1)	1	Continuous loop within iron linking through stator coil
	b		S pole at the top of the rotor , N pole at lower end (1)	1	
9			top line, B, (1) bottom line C (1)	2	
			Total Section A	**[21]**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
10	a	i	Greater proportion deflected (1) a greater chance of close approach to a nucleus (1)	2	Accept more particles bounce back Accept more layers but not just more nuclei
		ii	Smaller proportion deflected (1) as less time spent near nuclei (1) AW	2	Accept less particles bounce back Accept increased velocity/momentum arguments but not just KE
	b	i	5 MeV(1)	1	Not -5 MeV
		ii	$5 \times 10^{6} \times 1.6 \times 10^{-19} = 8 \times 10^{-13}$ (1) J	1	Allow ecf including - value
		iii	$r = \frac{2 \times 79 \times (1.6 \times 10^{-19})^2}{8 \times 10^{-13}} \times 9 \times 10^{9}$ (1) $= 4.55 \times 10^{-14}$ m (1)	2	Allow ecf Accept 4.5, 4.6 or 5×10^{-14} m
	c		Ratio of volumes = $(6 \times 10^{-5})^3$ (1) = 2.16×10^{-13} Density = $1.9 \times 10^{4} / 2.16 \times 10^{-3} = 9 \times 10^{16}$ kg m^{-3} (1) Assumption: e.g. all mass in nucleus or no volume between gold atoms (1) AW	1 1 1	 Allow electrons have no mass
			Total	**[11]**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
11	a	i	$^{131}_{54}Xe$ (1)	1	
		ii	anti-lepton (1)	1	
	b	i	initial activity = $(4 \times 10^{-11}/131) \times 6.02 \times 10^{23} \times 1.0 \times 10^{-6}$ (1) $= 1.8(4) \times 10^{5}$ Bq (1)	2	
		ii	$A/A_0 = e^{-\lambda t} = e^{-1 \times 10\text{^}-6 \times 50 \times 24 \times 60 \times 60}$ (1) $= e^{-4.32} = 0.013$ (1) = 1%	2	Or working from $A/A_0 = 0.01$ ln 0.01 = $-\lambda$ t $-4.6 = -1 \times 10^{-6}$ t (1) t = 4600000 = 53.2 days (1) Or 6.64 half lives from 1% activity (1) leading to 53 days (1) Or 6.25 half lives so $2^{6.25}$ (1)leading to 1.3% activity (1) Working showing between 6 and 7 half lives worth 1 mark
		iii	Energy = $(4 \times 10^{-11}/131) \times 6.02 \times 10^{23} \times 1 \times 10^{-13}$ = 0.0184 J (1) dose =(0.0184)/0.05 =0.37 Gy (1)	2	May see 1.84×10^{11} decays from bi
		iv	Assumes all energy transferred in gland (1) All iodine decayed (in gland) (1)	2	Accept all beta particles absorbed in gland Do not accept iodine may have decayed before entering gland
			Total	**[10]**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
12	a	i	B (1)	1	
		ii	$70 \times 10^3/0.2 = 3.5 \times 10^5$ V m^{-1} (1)	1	
	b		$E = 9.1 \times 10^{-31} \times 9 \times 10^{16}$ (1) $= 8.2 \times 10^{-14}$	1	Accept clear working or own answer. Do not penalise rounding error to 8.1...
	c	i	$\gamma = (8.2 \times 10^{-14} + 1.1 \times 10^{-14})/ 8.2 \times 10^{-14} = 1.1$ (1)	1	Do not allow ecf from "show that"
		ii	B	1	
	d		γ factor is about 1.1 (1) Comparison with γ factor = 1 (1) Consistent conclusion (1)	 3	New calculation or statement that γ factor is similar to previous value. Can be argued either way; dependent on 2nd mark
			Total	**[8]**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
13	a	i	f = 1/0.04= 25 Hz(1)	1	
	b		Clear use of $\varepsilon = Nd\varphi/dt$ (1) Max emf = 2.5 V(1) $d\Phi/dt = 2.5/700 = 0.00357$ (1) Wb s^{-1}	3	 Need own answer
	c		max flux = $0.0036/(2 \times \pi \times 25) = 2.27 \times 10^{-5}$ Wb (1) max flux density $=2.27 \times 10^{-5}/ 0.000625$ (1) = 0.036 T (1)	3	$\cos 2\pi ft = 1$ can be implicit; or can substitute t = 0, 20ms or 40ms. independent method mark for dividing by area = 0.000625 or 0.037 with intermediate rounding. Don't allow 1SF answer. Dependent on both previous marks unless POT error.
	d		Any two from: stronger magnet (1) larger number of turns on coil (1) reduced air gap (1) core of larger c.s. area AW (1) laminated core (1) core of higher permeability AW (1)	2	 Allow "more coils"
			Total	**[9]**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
14			d = v x t = (70 x 1.6) x 1 = 112 km (1)	1	
			Total	**[1]**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
15	a		10^6 / (60 x 60) = 277.7W (1)	1	Accept clear working or own answer. Do not penalise rounding error to 277
	b		No energy absorbed from sun (1) so suit needs to radiate less energy (1) So pumping rate of LCVG will need to decrease (1)	3	Allow: ambient temperature is lower in dark area(1) So rate of heat loss from suit is higher (1) Dependent on scoring at least one of the first two marks. QWC: complete and clear argument required for 3 marks.
	c	i	mass = density x volume = 1.4 x 0.058 = 81 g (1)	1	Accept clear working or own answer.
		ii	Heating provided = 280 W x 5 s = 1400 J (1) ⇨ temp rise = 1400 / (0.081 x 900) = 19.2 ^oC (1) final temp = 18 + 19.2 = 37.2 ^0C (1)	3	 0.080 kg gives 19.4 ^0C Independent mark for adding calculated temperature rise to 18
		iii	Use $p_1V_1 / T_1 = p_2V_2 / T_2$ (1) ⇨ $p_2 / p_1 = (273 + 37.2) / (273 + 18) = 1.065$ (1)	2	Or use of $P \propto T$ (1) 2.07 from use of Celsius temperatures will score 1 Allow ecf from cii
			Total	**[10]**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
16	a		Idea of constant ratio property or of rate of change of parameter being proportional to the value of the parameter itself (1) Selection of three appropriate data pairs from graph (1) One calculation performed (1) Second calculation performed (1) Conclusion relating data to exponential nature of relationship (1)	5	To award 5/5 technical terms must be correctly spelled e.g. exponential, proportional, gradient, ratio
	b		In suit, pressure is smaller => less gas particles per unit volume. (1) Fraction of these which are oxygen molecules is larger. (1)	2	Accept less mass of gas, fewer moles of gas, but not less volume or "less gas" Allow reverse argument May see factor of 3 in number of particles m^{-3} & factor of 5 in proportion of O_2
			Total	**[7]**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
17			A material made of two different substances (1) which combines the favourable properties of the individual substances (1) Example, quoting component substances (1) Beneficial properties of component parts (1)	4	Allow more/several PTFE-coated silica fibre or aluminium coated polymer. If synthetic rubber, must identify two materials used Two correct identified properties.
			Total	**[4]**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
18	a		KE = ½ m v^2 = ½ 1.0 x 10^{-6} x (50 x 10^3)^2(1) = 1250 J (1)	2	Need own answer for second mark
	b	i	Energy available for vaporisation = 0.9 x 1.25 kJ = 1125 J (1) mass vaporised = 1125 / 10.5 x 10^6 = 1.1 x10^{-4} kg (1)	2	 Accept calculations based on 1kJ leading to 8.6 x 10^{-5}kg. Accept reverse argument.
		ii	Volume = mass / density (1) ⇨ 1/2 x 4/3 π r^3 = 1.1 x10^{-4} / 2400 (1) ⇨ r = 2.8 x 10^{-3} m(1)	3	Allow ecf Missing ½ gives answer 2.2 x 10^{-3}m worth 1 mark overall
			Total	**[7]**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
19	a	i	no. of protons = 10^9 / 1.7 x 10^{-27} (1) = 5.9 x 10^{35} (1)	2	Need own value for second mark. Allow reverse arguments leading to 1.0(2) x 10^9kg or 1.67 x 10^{-27}kg
		ii	Flux = 6 x 10^{35} / (4 π x (1.5 x 10^{11})^2) (1) = 2.1 x 10^{12} m^{-2} s^{-1} (1)	2	Need own value for 2nd mark. For information $4\pi r^2$ = 2.8 x 10^{23}
	b	i	(1.6 x 10^{-16}) x 2.1 x 10^{12} x 1.5 = 0.0005(04) J (1)	1	Allow 0.00048J
		ii	Any three valid points from: Calculation of dose = energy kg^{-1} (1) Calculation of effective dose = 20 x dose (1) (Effective) dose reduced by suit (1) 3% to 5% cancer risk per Sv (1) Consistent risk conclusion (1)	3	ecf from bi. Accept astronaut masses 40 – 125kg Must be some element of comparison
			Total	**[8]**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
20	a	i	Momentum = mass x velocity = 5 x 225 = 1125 (1)	1	Need clear working or own value.
		ii	F = ma = 225 x 4/20 = 45 N (1) Then, F = $\Delta p/\Delta t = v\Delta m/\Delta t$ (1) ⇨ $\Delta m/\Delta t$ = F/v = 45/600 = 0.075 kg/s (1)	3	Or correct use of conservation of momentum (1), find mass of gas = 1.5kg (1) and divide by 20 s. (1)
			Total	**[4]**	

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