Particle Physics Mark Scheme 2

Level	International A Level
Subject	Physics
Exam Board	CIE
Торіс	Particle & Nuclear Physics
Sub Topic	Particle Physics
Paper Type	Theory
Booklet	Mark Scheme 2

Time Allowed:	78 minutes
Score:	/65
Percentage:	/100

CHEMISTRY ONLINE

A*	A	В	С	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1	(a	(i)	2	protons and 2 neutrons	В	1	[1]
		(ii)	e. ma co ab (<i>n</i> <u>hic</u> de (<i>C</i>	g. positively charged 2e ass 4u nstant energy sorbed by thin paper or few cm of air $(3 \text{ cm} \rightarrow 8 \text{ cm})$ of low penetration) ahly ionizing flected in electric/magnetic fields one mark for each property, max 2)	В	2	[2]
	(b)	<u>ma</u> diff en ph	a <u>ss-e</u> ferei ergy oton	energy is conserved nce in mass 'changed' into a form of energy r in the form of kinetic energy of the products / γ-radiation is / e.m. radiation	B B B	1 1 1	[3]
2	(a)	thi ac ot	in pa Iditic her i	aper reduces count rate hence α on of 1 cm of aluminium causes little more count rate reduction hence radiation is γ	e only	B1 B1	[2]
	(b)) m: loc ch	agne ok fo iarge	etic field perpendicular to direction of radiation or a count rate in expected direction / area if there were negatively ed radiation present. If no count rate recorded then β not present.		B1 B1	[2]
3		(a)	nuc and	lei with the same number of protons a different number of neutrons	B1 B1	[2]	
		(b)	(i)	(mass + energy) (taken together) is conserved momentum is conserved one point required max. 1	(B1) (B1) B1	[1]	
			(ii)	a = 1 and b = 0 x = 56 y = 92	B1 B1 B1	[3]	
		(c)	pro nuc	ton number = 90 leon number = 235	B1 B1	[2]	

(a (i) the half life / count rate / rate of decay / activity is the same no matter what external factors / environmental factors or two named factors such as temperature and pressure changes are applied

(ii) the observations of the count rate / count rate / rate of decay / activity / radioactivity during decay shows variations / fluctuations
B1

(b) property α -particle β-particle γ -radiation 0 (+)2e charge -е 9.11×10^{-31} kg 0 mass и 0.01 to 0.1 c up to 0.99 c speed С one mark for each correct line **B**3 [3] (c) collision with molecules B1 causes ionisation (of the molecule) / electron is removed **B1** [2] (a (i) most α -particles were deviated through small angles B2 [2] 5 (allow 1 mark for 'straight through' / undeviated) (ii) small fraction of α -particles deviated through large angles M1 greater than 90° (allow rebound back) A1 [2] (b) e.g. β -particles have a range of energies β-particles deviated by (orbital) electrons β-particle has (very) small mass (any two sensible suggestions, 1 each, max 2) B2 [2]

Do not allow β -particles have negative charge or β -particles have high speed

4

B1

[1]

[1]

6	(a)	nuc nuc	lei/atoms with same proton number/atomic number	B1 B1	[2]
	(b)	(i)	92	A1	[1]
		(ii)	146	A1	[1]
	(c)	(i)	mass = $238 \times 1.66 \times 10^{-27}$ = 3.95×10^{-25} kg	C1 A1	[2]
		(ii)	volume = $\frac{4}{3}\pi \times (8.9 \times 10^{-15})^3$ (= 2.95 × 10 ⁻⁴²)	C1	
			density = $(3.95 \times 10^{-25})/(2.95 \times 10^{-42})$ = 1.3×10^{17} kg m ⁻³	A1	[2]
	(d)	nuc	leus contains <u>most of mass of atom</u>	B1	
		eith or	<i>er</i> nuclear diameter/volume <u>very much</u> less than that of atom atom is mostly (empty) space	B1	[2]
7	(a	(i)	either helium <u>nucleus</u>		[4]
			or contains 2 protons and 2 neutrons B1		[1]
		(ii)	e.g. range is a few cm in air/sheet of <u>thin</u> paper speed up to 0.1 <i>c</i> causes dense ionisation in air positively charged or deflected in magnetic or electric fields (<i>any two, 1 each to max 2</i>)		[2]
	(b)	(i)	⁴ α		
	()	(-)	$either {}^{1}_{1}p \text{ or } {}^{1}_{1}HB1$		[2]
		(ii)	initially, α -particle must have some kinetic energy B1		[1]
		(ii)	2 $1.1 \text{ MeV} = 1.1 \times 1.6 \times 10^{-13} = 1.76 \times 10^{-13} \text{ J}$ C1 $E_{\text{K}} = \frac{1}{2}mv^2$ C1 $1.76 \times {}^{-13} = \frac{1}{2}$ ${}^{-27} \times v^2$ C1 $v = 7.3 \times 10^6 \text{ m s}^{-1}$ A1		[4]
			$v = 7.3 \times 10^{6} \text{ m s}^{-1}$ use of 1.67 × 10 ⁻²⁷ kg for mass is a maximum of 3/4	A1	A1

8	(a	(i)	<i>either</i> helium nucleus <i>or</i> particle containing two protons and two neutrons	B1	[1]
		(ii)	allow any value between 1 cm and 10 cm		[1]
	(b)	(i)	energy = (8.5 × 10 ⁻¹³)/(1.6 × 10 ⁻¹³) = 5.3 MeV	Μ	[1]
		(ii)	number = $(5.3 \times 10^6)/31$ = 1.7 × 10 ⁵ (allow 2 s.f. only)	A	[2]
		(iii)	number per unit length = (1.7 × 10 ⁵) / (a)(ii) correct numerical value correct unit	A1 B1	[2]
9	(a)	dev	iation shown correctly	B1	[1]
	(b)	sma acce	aller deviation (not zero deviation) eptable path wrt position of N	M1 A1	[2]
	(c)	the in co (spe	nucleus is (very) small omparison to the atom ecial <i>case: 'atom is mostly empty space' scores 1 mark</i>)	M1 A1	[2]
	(d)	dev sarr	iation depends on charge on the nucleus / N / electrostatic repulsion ne charge so no change in deviation	B1 B1	[2]
				[Total	: 7]