

Revision Sheet

A-Level Physics · Unit 23 Nuclear physics

7 vocabulary items · 38 marks of exam questions (4 questions)

Part 1 · Vocabulary review answer key. Section A wants the exact English spelling.

Question	Answer	Marks
1	spontaneous	1
2	random	1
3	half-life	1
4	binding energy	1
5	binding energy per nucleon	1
6	activity	1
7	decay constant	1

8(a)	probability of decay (of a nucleus)
	per unit time
8(b)	$A = \lambda N$
	$N = \text{mass} / (\text{nucleon number} \times u)$
	$2.92 \times 10^9 = (\lambda \times 5.87 \times 10^{-10}) / (131 \times 1.66 \times 10^{-27})$
	$\lambda = 1.08 \times 10^{-6} \text{ s}^{-1}$
8(c)	<ul style="list-style-type: none"> sample emits radiation in all directions some radiation is absorbed by air/detector window self-absorption within the source dead time/inefficiency of detector <i>Any two points, 1 mark each</i>

9(a)	(two small) nuclei join together
	to form one larger nucleus
9(b)	line with a peak at $A \approx 56$
	line with steep initial positive gradient on the left of peak and shallower negative gradient at all points to the right of peak and line does not return to 0 binding energy
9(c)(i)	X shown at value of A to the right of the peak
9(c)(ii)	Y shown at value of A close to 1
9(d)	energy from 1 nucleus = $(1.77 \times 10^{13}) / (6.02 \times 10^{23})$ (= $2.94 \times 10^{-11} \text{ J}$)
	binding energy of Z = $[(1.25 + 1.81) \times 10^{-10}] - 2.94 \times 10^{-11}$ (= $2.77 \times 10^{-10} \text{ J}$)
	nucleon number of Z = $93 + 139 + 2 - 1$ (= 233)
	binding energy per nucleon = $(2.77 \times 10^{-10}) / (233 \times 1.60 \times 10^{-13})$ = 7.43 MeV

10(a)(i)	cannot predict when a (particular) nucleus will decay or cannot predict which nucleus will decay next
10(a)(ii)	not affected by external / environmental factors
10(b)(i)	line fluctuates or trend is a straight line
10(b)(ii)	straight line of best fit drawn on Fig. 10.1
10(b)(iii)	$M = M_0 \exp(-\lambda t)$ so $\ln M = \ln M_0 - \lambda t$ so gradient = $-\lambda$ (and magnitude of gradient = λ)
10(b)(iv)	gradient = $(-)(8.0 - 4.8) / (11.6 - 0)$ (allow any correct pair of values from Fig. 10.1)
	$\lambda = 0.28 \text{ s}^{-1}$
10(b)(v)	half-life = $0.693 / \lambda$
	= $0.693 / 0.28$
	= 2.5 s
10(c)	(for reaction to occur,) energy is released
	energy release comes from fall in mass so total mass of products must be less (than mass of carbon-15)

11(a)	spontaneous emission of (ionising) radiation
	emission from unstable nucleus
11(b)(i)	curve with decreasing negative gradient passing through $(0, N_0)$
	curve passing through $(T, 0.5N_0)$
	curve passing through $(2T, 0.25N_0)$ and $(3T, 0.125N_0)$
11(b)(ii)	line through origin with positive gradient
	straight line passing through (N_0, A_0)
11(c)(i)	activity
11(c)(ii)	decay constant
11(d)	$N = N_0 \exp(-\ln 2 \times 1.70T / T)$
	$N / N_0 = 0.31$