



A Level Physics A

H556/02 Exploring physics

Question Set 21

- 1 An isotope of polonium-213 ($^{213}_{84}\text{Po}$) first decays into an isotope of lead-209 ($^{209}_{82}\text{Pb}$) and this lead isotope then decays into the stable isotope of bismuth (Bi).

Fig. 24 shows two arrows on a neutron number N against proton number Z chart to illustrate these two decays.

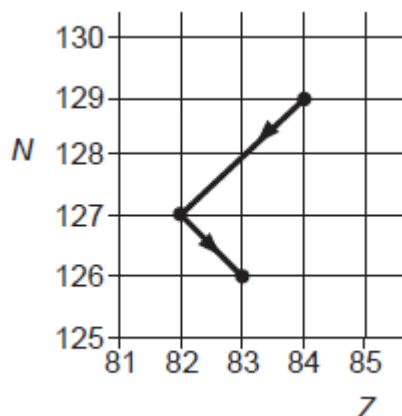
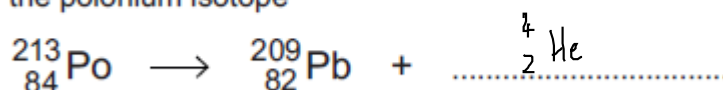


Fig. 24

- (a) Complete the nuclear decay equations for

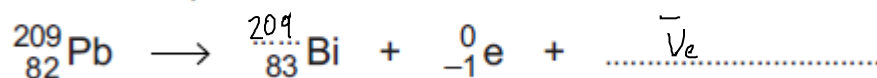
- (i) the polonium isotope



[1]

- (ii)

the lead isotope.



[2]

- (b) A pure sample of polonium-213 is being produced in a research laboratory.

The half-life of $^{213}_{84}\text{Po}$ is very small compared with the half-life of $^{209}_{82}\text{Pb}$.

After a very short time, the ionising radiation detected from the sample is mainly from the beta-minus decay of the lead-209 nuclei.

- (i) Briefly describe and explain an experiment that can be carried out to confirm the beta-minus radiation emitted from the lead nuclei.

— Place aluminium sheet between source and detector to show that count rate decreases.

[2]

(ii) The activity of the sample of $^{209}_{82}\text{Pb}$ after 7.0 hours is 12 kBq.

The half-life of $^{209}_{82}\text{Pb}$ is 3.3 hours.

Calculate the initial number of lead-209 nuclei in this sample.

$$\lambda = \frac{\ln(2)}{t_{1/2}} = \frac{\ln(2)}{3.3} = 0.21 \text{ hr}^{-1}$$

$$A = A_0 e^{-\lambda t}$$

$$\text{Sub in } t = 7 \quad A = 12 \times 10^3$$

$$12 \times 10^3 = A_0 e^{-0.21 \times 7} \Rightarrow A_0 = 5.22 \times 10^4 \text{ Bq}$$

$$A = \lambda N \quad \text{so} \quad A_0 = \lambda N_0 \quad \text{but first need } \lambda \text{ in } \text{second}^{-1}$$

$$0.21 \text{ hr}^{-1} = \frac{0.21}{3600} \text{ s}^{-1} = 5.84 \times 10^{-5} \text{ s}^{-1}$$

$$N_0 = \frac{A_0}{\lambda} = \frac{5.22 \times 10^4}{5.84 \times 10^{-5}} = 8.9 \times 10^8$$

number of nuclei = 8.9×10^8 [4]

Total Marks for Question Set 21: 9

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