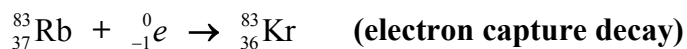
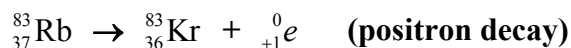


- Write two possible mechanisms for the radioactive decay of  $^{83}\text{Rb}$  to  $^{83}\text{Kr}$ .

**Marks**  
**5**



The half-life of  $^{83}\text{Rb}$  is 86.2 days. Calculate the activity (in Bq) of an isotopically pure 1.000 g sample of  $^{83}\text{Rb}$ . (The molar mass of  $^{83}\text{Rb}$  is  $82.915110 \text{ g mol}^{-1}$ .)

As 1 mol of  $^{83}\text{Rb}$  has a mass of 82.915110 g, the number of nuclei,  $N$ , in 1.000 g is:

number of nuclei = number of moles  $\times$  Avogadro's constant

$$N = \left( \frac{1.000}{82.915110} \text{ mol} \right) \times (6.022 \times 10^{23} \text{ nuclei mol}^{-1}) = 7.263 \times 10^{21} \text{ nuclei}$$

The activity ( $A$ ) is related to  $N$  by  $A = \lambda N$  where  $\lambda$  is the decay constant. The half life,  $t_{1/2}$ , is related to the decay constant,  $\lambda$ , by  $t_{1/2} = \ln 2 / \lambda$ . Hence,

$$\lambda = \ln 2 / (86.2 \times 24 \times 60 \times 60 \text{ s}) = 9.31 \times 10^{-8} \text{ s}^{-1}$$

The activity is thus,

$$\begin{aligned} A &= \lambda N = (9.31 \times 10^{-8} \text{ s}^{-1}) \times (7.263 \times 10^{21} \text{ nuclei}) \\ &= 6.76 \times 10^{14} \text{ nuclei s}^{-1} = 6.76 \times 10^{14} \text{ Bq} \end{aligned}$$

Answer:  $6.76 \times 10^{14} \text{ Bq}$

How many days will it take for this sample to diminish to 1 % of its initial activity?

The number of radioactive nuclei decays with time according to  $\ln(N_0/N_t) = \lambda t$ . As the activity is proportional to the number of nuclei ( $A = \lambda N$ ), this can be rewritten as:

$$\ln(A_0/A_t) = \lambda t$$

If the activity drops to 1% of its initial value,  $A_0/A_t = (100/1) = 100$ .

As  $\lambda = 9.31 \times 10^{-8} \text{ s}^{-1}$ :

$$\ln(100) = (9.31 \times 10^{-8} \text{ s}^{-1})t$$

$$t = 49000000 \text{ s} = 600 \text{ days}$$

Answer: 600 days