Tutorial Answers Nuclear Physics

Question 1

a.) **1.0076 u** b.) **1.67×10^{-27} kg**

Question 2

a.) **9.10×10^{-31} kg** b.) **5.48×10^{-4} u**

Question 3

$A = \lambda N =$ **1.5×10^{5} s^{-1}**

Question 4

$A = \lambda N = 200\ s^{-1} =$ **200 Bq**

After 1s, we might expect 800 nuclei to remain undecayed. The activity would then be

$A = 0.2 \times 800 =$ **160 Bq**

Question 5

Half life approximately 2.5 years.

Decay constant, $\lambda = 0.693 / 2.5 =$ **0.277 $year^{-1}$**

Question 6

a.) $\lambda = 0.693 / (8 \times 24 \times 60 \times 60) =$ **1.0026×10^{-6} s^{-1}**

b.) $A = \lambda N =$ **1.0026×10^{12} s^{-1}**

c.) $N = 1 \times 10^{18} \exp -(1.0026 \times 10^{-6} \times 24 \times 24 \times 3600)$

$N =$ **1.27×10^{17}**

d.) $A = 1.0026 \times 10^{12} \exp -(1.0026 \times 10^{-6} \times 3 \times 24 \times 3600)$

$A =$ **7.73×10^{11} s^{-1}**

Question 7

a.) $\frac{1}{2} mv^2 = eV$

$\frac{1}{2} (6.8 \times 10^{-27}) v^2 = 6.3 \times 10^{6} \times 1.6 \times 10^{-19}$

$v =$ **1.72×10^{6} ms^{-1}**

b.) $I = Q/t = 1.0 \times 10^{-9}$ A or 1.0×10^{-9} Cs^{-1}

Each electron is 1.6×10^{-19} C

No electrons flowing per second = no of ion-pairs produced per second

$= 1.0 \times 10^{-9} / 1.6 \times 10^{-19}$ C = **6.25×10^{9} s^{-1}**

c.) No of ion-pairs produced by each alpha particle = 6.3 M / 30 = **2.1×10^{5}**

No of alpha particle emitted per second = $6.25 \times 10^{9}\ s^{-1} / 2.1 \times 10^{5}$ **= 2.98×10^{-4} s^{-1}**

d.) $A = \lambda N$

$2.98 \times 10^{4} = (0.693 / 55)(N)$

$N =$ **2.37×10^{6} atoms**

Question 8

a.) i.) **2** $\mathbf{{}_{0}^{1}n}$ ii.) **Fission reaction**

b.) i.) Binding energy of uranium-235 = 235 x 7.5 M = 1763 MeV
Binding energy of products = 234 x 8.5 M = 1989 MeV
Energy change = **225 MeV**

ii.) **Kinetic energy of neutrons / photons (gamma ray)**

Question 9

a.) **2 protons and 2 neutrons**

b.) 13.9993 + 4.0015 = 18.0008
16.9947 + 1.0073 = 18.0020
Change in mass = **0.0012 u** = **1.99×10^{-30} kg**

c.) $E = mc^2$ = **1.79×10^{-13} J**

d.) $(4 \times 3 \times 10^7) = 17v + (1 \times 6 \times 10^7)$
v = **3.5×10^6 ms^{-1}**