PHYSICS

BOOKS - NN GHOSH PHYSICS (HINGLISH)

NUCLEAR FISSION AND FUSION

Example

1. Calculate the binding energy of helium nucleus $\left(._2^4He\right)$ and express the quantity in MeV and J

$$\begin{array}{lcll} \text{Mass of helium nucleus} & = & 4.0028 & amu \\ \text{Mass of proton} & = & 1.00758 & amu \\ \text{Mass of neutron} & = & 1.00897 & amu \end{array}$$

Watch Video Solution

2. Complete the nuclear reaction and calculate the energy released.

$.^{7}_{3}Li + \mid H(\text{proton}) \rightarrow .^{4}_{2}He + ? + Q$

$$\begin{array}{lcll} \text{Given that mass of lithium atom} & = & 7.01822 & amu \\ \text{Mass of proton} & = & 1.00812 & amu \\ \text{Mass of } \alpha - \text{particle} & = & 4.00390 & amu \end{array}$$

Watch Video Solution

3. Calculate how much coal is equivalent to 1kg of $.^{235}U$. Given that 200 MeV is released per fission process and 8000 kcal is released as heat of combustion of 1 kg of coal. Avogadro constant $= 6.1 \times 10^{26} Kgmol^{-1}$

Watch Video Solution

4. find the disintegration energy Q liberated in β^{-} and β^{+} decays if the masses of the parent atom M_p the daughter atom M_d and an electron m are known.

Watch Video Solution

5. Making use of the table of atomic masses given above find:

(a) the mean binding energy per nucleon in $._7^{14}N$

(b) the binding energy of an alpha-particle in $._8^{16}O$.

Watch Video Solution

6. Making use of the table of atomic masses given above find the energy required for the separation of an $._8^{16}O$ nucleus into 4 identical particle

Watch Video Solution

7. Find the binding energy of a nucleus consisting of an equal number of protons and neutrons and with a radius one-and a -half times smaller that that of the $.^{27}Al$ nucleus. Consult the atomic tables for required masses.

Watch Video Solution

8. Find the difference in binding energies of a neutron and a proton in a B^{11} nucleus.Explain why there is the difference.

Watch Video Solution

9. A particle of mass m strikes a stationary nucleus of mass M and activated an endoergic reaction. Show that the threshold kinetic energy required to initiate this reaction is $T_{th} = \frac{m+M}{M}|Q|$. Where Q is the energy of the reaction.

Watch Video Solution

Exercises

1. Calculate the binding energy of the lithium atom $\left(._3^7 Li\right)$ from the following data:

$$\begin{aligned} \text{mass of proton} &= 1.00759 \quad amu \\ \text{mass of neutron} &= 1.00898 \quad amu \\ \text{mass of electron} &= 0.00055 \quad amu \\ \text{mass of lithium atom} &= 7.01818 \quad amu \end{aligned}$$

Watch Video Solution

2. Find the minimum energy that a γ-ray must have to give rise to an electron -positron pair.

$$\begin{aligned} \text{Mass of electron} &= 0.00055 amu \\ \text{Mass of positron} &= 0.00055 amu \end{aligned}$$

Watch Video Solution

3. Calculate the energy released by fission of 1 g of $._{92}^{235}U$, assuming that an energy of 200 MeV is released by fission of each atom of $.^{235}U$. (Avogardo constant is $= 6.023 \times 10^{26} kgmol^{-1}$)

Watch Video Solution

4. A reaction develop nuclear energy at the rate of $3 \times 10^4 kW$. How many atoms of $.^{215}U$ undergo fission per second? How much $.^{235}U$ is burnt in 1000 hours of operation ? (Assume that 200 Mev is released per fission and Avogadro constant is 6.023×10^{26} per kg mole)

Watch Video Solution

5. Calculate the amount of energy set free by the annigilation of an electron and a positron. Given that mass of electron $= 0.00055$ amu and positron = 0.00055 amu.

Watch Video Solution

6. Complete the following nuclear reactions:

(i) $._7\hat{}(14)N + ._2^4He \to ._8O + ._1^1H$

(ii) $.^{24}Mg + ._2^4He \to ._{13}^{27}Al +$

(iii) $._3Li + .^3n \to .^4He + ._1^3H$

Watch Video Solution

Watch Video Solution

7. Calculate the energy released in kilowatt-hours when 100g of $._3^7 Li$ are converted into $._2^4 He$ by proton bombardment. Mass of $._3^7 Li = 7.0183 amu$, mass of proton = 1.0081 amu. Write down the nuclear reaction.

Watch Video Solution

8. calculate the energy released in the nuclear fusion of isotopes of hydrogen

(i) $._1^2 H + ._1^2 H \rightarrow ._2^3 He + ._0^1 n$

(ii) $._1^2 H + ._1^3 H \rightarrow ._2^4 He + ._0^1 n$

Given that mass of neutron = 1.00867 amu

$$\text{mass of} \quad ._1^2 H = 2.01410 \quad amu$$
$$\text{mas of} \quad ._1^3 H = 3.01603 \quad amu$$
$$\text{mass of} \quad ._2^3 H = 3.0160 \quad amu$$
$$\text{mass of} \quad ._2^4 He = 4.00260 \quad amu$$

Watch Video Solution

9. Using conservation laws show that an electron cannot absorb a photon completely.

[Hint : $hv = mc^2 - m_0c^2$ and $\frac{hv}{c} = mv$]

Watch Video Solution

10. Making use of the tables of atomic masses, determine the energies of the following reaction:

(a) $Li^7(p, n)Be^7$,

(b)$Be^9(n, \gamma)Be^{10}$,

(c)$Li^7(\alpha, n)B^{10}$,

(d) $O^{16}(d, \alpha)N^{14}$.

Watch Video Solution

11. Taking the values of atomic masses from the tables, find the maximum kinetic energy of beta-particles emitted by Be^{10} nuclei formed directly in the ground state.

Watch Video Solution

Watch Video Solution

12. A stationary $._{82}^{200}Pb$ nucleus emits an α-particle with kinetic energy $T_{\alpha} = 5.77MeV$. Find the recoil velocity of a daughter nucleus. What fraction of the total energy liberated in this decay is accounted for by the recoil energy of daughter nucleus ?

Watch Video Solution

13. Making use of the tables of atomic masses, find:

(a) the mean binding energy per one nucleon in O^{16} nucleus

(b) The binding energy of neutron and an alpha-particle in a B^{11} nuclues.

Watch Video Solution

14. A nucleus X, initially at rest , undergoes alpha dacay according to the equation ,

$$_(92)^{A}X \rightarrow_{Z}^{228} Y+\alpha$$

(a) Find the value of A and Z in the above process.

(b) The alpha particle produced in the above process is found to move in a circular track of radius $0.11m$ in a uniform magnetic field of 3 Tesla find the energy (in MeV) released during the process and the binding energy of the parent nucleus X

Given that

$: m(Y) = 228.03u, m\left(_ (0)^1 n\right) = 1.0029u.$

$m\left(_ (2)^4 He\right) = 4.003u, m\left(_ (1)^1 H\right) = 1.008u$

Watch Video Solution

15. A uranium nucleus $.^{235} U$ liberates 200 MeV per fission 1.5 kg of uranium reacts during explosion of a uranium bomb. What is the mass of an equivalent TNT bomb if the heating capacity of TNT is $4.1 \times 10^6 J/kg$?

Watch Video Solution

16. Can a silicon nucleus $\left(._{14}^{31}Si\right)$ transfrom into a phosphorus nucleus $\left(._{15}^{31}P\right)$? What particle would be emitted in the process ? What is their total energy?

$m_{Si} = 30.97535amu, m_p = 30.97376amu$

Watch Video Solution

17. Stationery nucleus $.^{238}U$ decays by a emission generaring a total kinetic energy T:

$._{92}^{238} \rightarrow ._{90}^{234}Th + ._{2}^{4}\alpha$

What is the kinetic energy of the α-particle?

Watch Video Solution

18. Find the maximum energy that a beta particle can have in the following decay

$\hat{\ } 176Lu \rightarrow^{176} Hf + e + \overrightarrow{v}.$

Alomic mass of $\hat{\ } 176Lu$ is $175.942694u$ and that of $\hat{\ } 176Hf$ is $175.941420u$.

Watch Video Solution