New

SURE SHOT QUESTIONS 2026

Chapter – 13 (Questions)

Nuclei

➢ Questions

1. A heavy nucleus X of mass number 240 and binding energy per nucleon 7.6 MeV is split into two fragments Y and Z of mass numbers 110 and 130. The binding energy Q released per fission in MeV.

2. Calculate the energy in fusion reaction :
$\frac{1}{2}H + {}^{2}_{1}H \rightarrow {}^{3}_{2}He + n$, where BE of ${}^{2}_{1}H = 2.23\ MeV$ and of ${}^{3}_{2}He = 7.73\ MeV$.

3. (i) Explain the processes of nuclear fission and nuclear fusion by using the plot of binding energy per nucleon (BE/A) versus the mass number A.
(ii) A radioactive isotope has a half-life of 10 years. How long will it take for the activity to reduce to 3.125%?

4. Distinguish between nuclear fission and nuclear fusion. Show how in both these processes energy is released.
Calculate the energy released in MeV in the deuterium-tritium fusion reaction

$$ {}^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + n $$

Using the data :

$m\,({}^{2}_{1}H) = 2.014102\ \mu$
$m\,({}^{3}_{1}H) = 3.016049\ \mu$
$m\,({}^{4}_{2}He) = 4.002603\ \mu$
$m_n = 1.008665\ \mu$
1 amu = 931.5 MeV/c^2

5. The radius of a spherical nucleus as measured by electron scattering is 3.6 fm. What is the likely mass number of the nucleus?

6. If both the number of protons and the number of neutrons are conserved in a nuclear reaction like
${}^{12}_{6}C + {}^{12}_{6}C \rightarrow {}^{20}_{10}Ne + {}^{4}_{2}He$
In what way is mass converted into energy? Explain.

7. Draw a graph showing the variation of potential energy between a pair of nucleons as a function of their separation. Indicate the regions in which the nuclear force is (i) attractive, (ii) repulsive.

8. A heavy nucleus X of mass number 240 and binding energy per nucleon 7.6 MeV is split into two fragments Y and Z of mass numbers 110 and 130. The binding energy of two nucleons is 8.5. Calculate the energy Q released per fission in MeV.

9. (a) Draw the plot of binding energy per nucleon (B.E./A) as a function of mass number A. Write two important conclusions that can be drawn regarding the nature of nuclear force.
(b) Use this graph to explain the release of energy in both the processes of nuclear fusion and fission.

10. When four hydrogen nuclei combine to form a helium nucleus estimate the amount of energy in MeV released in this process of fusion (Neglect the masses of electrons and neutrons). Given:
(i) Mass of ${}^{1}_{1}H = 1.007825\ u$
(ii) Mass of Helium Nucleus $= 4.002603\ u,\ 1u = 931\ MeV/c^2$

11. The carbon isotope ${}^{12}_{6}C$ has a nuclear mass of 12.00000 u. Calculate the binding energy of its nuclues. Given m_p = 1.007825 u ; m_n = 1.008665 u.

12. Calculate the energy released/absorbed (in MeV) in the nuclear reaction
${}^{1}_{1}H + {}^{3}_{1}H \rightarrow {}^{2}_{1}H + {}^{2}_{1}H$
$given : m({}^{1}_{1}H) = 1.007825\ u$
$m({}^{2}_{1}H) = 2.014102\ u$
$m({}^{3}_{1}H) = 3.016049\ u$

13. If both the number of protons and neutrons in a nuclear reaction is conserved, in what way is mass converted into energy (or vice versa)? Explain giving one example.

14. (a) Differentiate between nuclear fission and nuclear fusion.
(b) Deuterium undergoes fusion as per the reaction.

$${}_{1}^{2}H + {}_{1}^{2}H \rightarrow {}_{2}^{3}He + {}_{0}^{1}n + 3.27\,MeV$$

Find the duration for which an electric bulb of 500 W can be kept glowing by the fusion of 100 g of deuterium.

15. Calculate for how many years will the fusion of 2.0 kg deuterium keep 800 W electric lamp glowing. Take the fusion reaction as

$${}_{1}^{2}H + {}_{1}^{2}H \rightarrow {}_{2}^{3}He + {}_{0}^{1}n + 3.27\,MeV$$

16. Show that density of nucleus is independent of its mass number A.

17. In the study of Geiger – Marsden experiment on scattering of α -particles by a thin foil of gold, draw the trajectory of α -particles in the coulomb field of target nucleus. Explain briefly how one gets the information on the size of the nucleus from this study.

From the relation R = $R_0 A^{1/3}$, where R_0 is constant and A is the mass number of the nucleus, show that nuclear matter density is independent of A.

18. Draw a graph showing the variation of binding energy per nucleon with mass number of different nuclei. Write any two salient features of the curve. How does this curve explain the release of energy both in the processes of nuclear fission and fusion?

OR

Explain the processes of nuclear fission and nuclear fusion by using the plot of binding energy per nucleon (BE/A) versus the mass number A.

OR

Draw a plot of B.E./A versus mass number A for 2 < A < 170. Use this graph to explain the release of energy in the process of nuclear fusion of two light nuclei.

19. (a) Explain the processes of nuclear fission and nuclear fusion by using the plot of binding energy per nucleon (BE/A) versus the mass number A.

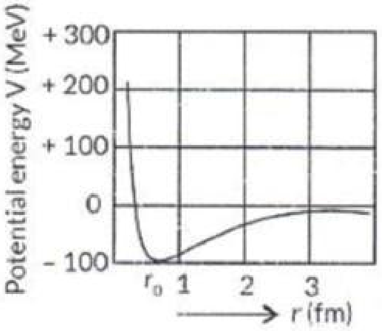
(b) A radioactive isotope has a half-life of 10 years. How long will it take for the activity to reduce to 3.125%?

20. Calculate binding energy per nucleon of ${}_{85}Bi^{209}$ Given m $({}_{85}Bi^{209}) = 208.980388\ amu$. Mass of neutron = 1.008665 amu and mass of proton = 1.007825 amu.

21. The potential energy (V) of a pair of nucleons varies with the separation (r) between them, in the manner shown. Use this graph to explain why the force between the nucleons must be regarded as

(i) strongly repulsive for separation values less than r_0

(ii) attractive nuclear force $(r > r_0)$



22. The fission properties of ${}_{94}^{239}Pu$ are very similar to those of ${}_{92}^{235}U$. The average energy released per fission is 180 MeV. How much energy, in MeV, is released if all the atoms in 1 kg of pure ${}_{94}^{239}Pu$ undergo fission?

23. A star converts all its hydrogen into helium achieving 100% helium composition. It then converts helium to carbon via the reaction. ${}_{2}^{4}He + {}_{2}^{4}He + {}_{2}^{4}He \rightarrow {}_{6}^{12}C + 7.27\ MeV$ The mass of the star is $5.0 \times 10^{32}\ kg$ and it generates energy at the rate of 5×10^{30} watt. How long will it take to convert all the helium to carbon at this rate?

24. Obtain the binding energy of the nuclei ${}_{26}^{56}Fe$ and ${}_{83}^{209}Bi$ in units of MeV from the following data: m$({}_{26}^{56}Fe)$ = 55.934939 u m$({}_{83}^{209}Bi)$ = 208.980388 u

25. Calculate and compare the energy released by (a) fusion of 1.0 kg of hydrogen deep within the Sun and (b) the fission of $1.0\ kg$ of $235U$ in a fission reactor.

Chapter – 13 (Solutions)

Nuclei

➢ Solutions

1. Soln. We have ${}^{240}X = {}^{110}Y + {}^{130}Z$

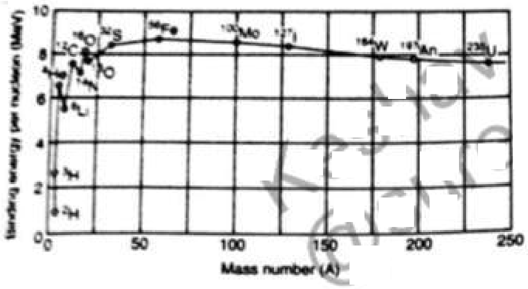
Binding energy for X = 7.6 MeV
Binding energy of two fragments Y and Z = 8.5 MeV.
Energy released, Q = 240 (8.5 – 7.6) MeV = 216 MeV

2. Soln. Total Binding energy of Initial System

i.e., ${}^{1}_{2}H + {}^{1}_{2}H = (2.23 + 2.23)\text{ MeV}$
$= 4.46\ MeV$

Binding energy of final system i.e., ${}^{2}_{3}He$
= 7.73 MeV
Hence energy released = 7.73 MeV – 4.46 MeV
= 3.27 MeV

3. (Soln. (i)



From the above graph, it's clear that binding energy per nucleon is low for very light and for very heavy nuclei. If a nucleus of lower binding energy is converted into higher binding energy then energy is released. There are two methods of converting lower binding energy into higher binding energy.

Fission: A heavy nucleus (low BEN) is broken into two lower nucleus (higher BEN) and energy is released. This process is known as Fission.

Fusion: Two light nucleus (low BEN) are joined and form one nucleus of higher BEN, energy is released. This process is known as Fusion.

(ii) $$\frac{N}{N_0} = \frac{3.125}{100}$$
$$= (1/2)^5$$

Comparing this with the following standard equation

We may write $\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$ where, $n = \frac{t}{T_{\frac{1}{2}}}$

$$\left(\frac{1}{2}\right)^5 = \left(\frac{1}{2}\right)^n \text{; hence n = 5}$$

Half life of the radioisotope is given 10 years,

Putting the value of n and $T_{1/2}$ in $\left[n = \frac{t}{T_{1/2}}\right]$

$$5 = \frac{t}{10}$$
$$t = 50\,years$$

4. Soln. Nuclear Fission is the breaking down of heavier nucleus into smaller fragments while nuclear fusion is combining of lighter nuclei to form heavier nucleus. We see that bonding energy per nucleon of daughter nuclei in both fission and fusion processes is more than that of parent nuclei. Further, the difference in binding energy is released in form of energy while in both the process certain masses gets converted into energy.

In both processes, some mass gets converted into energy.

Energy Released

$$Q = \left[m\left({}^{2}_{1}H\right) + m\left({}^{3}_{1}H\right) - m\left({}^{4}_{2}He\right) - m(\text{n})\right]$$
$$\times 931.5\,MeV = [2.014102 + 3.016049 - 4.002603 - 1.008665] \times 931.5\,MeV$$
$$= 0.018883 \times 931.5\,MeV$$
$$= 17.59\ MeV$$

5. Soln. (a) Nuclear radius $R = R_0(\text{A})^{1/3}$

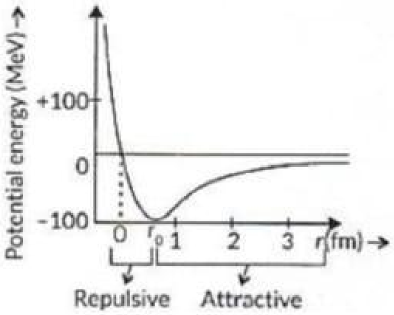
Where A is the mass number of a nucleus.
Given: R = 3.6 fm

$$\therefore\ 3.6\ fm = (1.2\,\text{fm})(\text{A}^{1/3}) \qquad [\because \text{R}_0 = 1.2\ \text{fm}]$$

Or $A = (3)^3 = 27$

6. Soln. If fact the number of protons and number of neutrons are same before and after a nuclear reaction but the binding energies of nuclei present before and after nuclear reaction are different. This difference is called the mass defect. This mass defect appears as energy of reaction. In this sense a nuclear reaction is an example of mass-energy interconversion.

7. Soln. Plot of potential energy of a pair of nucleons as a function of their separation is given in the figure.



Conclusions: (i) The nuclear force is much stronger than the coulomb force acting between charges or the gravitational forces between masses.

(ii) The nuclear force between two nucleons falls rapidly to zero as their distance is more than a few fermies.

(iii) For a separation greater than r_0, the force is attractive and for separation less than r_0, the force is strongly repulsive.

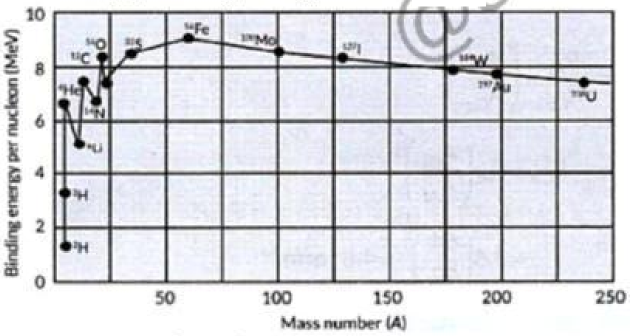
8. Soln. We have $^{240}X = {}^{110}Y + {}^{130}Z$

Binding energy for X = 7.6 MeV

Binding energy of two fragments Y and Z = 8.5 MeV

Energy released, Q = 240 (8.5 – 7.6) MeV = 216 MeV

9. Soln. (a) Binding energy curve:



Two salient features of the curve

(i) The binding energy per nucleon, E_{bn}, is practically constant, i.e., practically independent of the atomic number for nuclei of middle mass number (30 < A < 170).
The curve has a maximum value of about 8.75 MeV for A = 56 and has a value of 7.6 MeV for A = 238.

(ii) E_{bn} is lower for both light nuclei (A < 30) and heavy nuclei (A < 30) and heavy nuclei (A > 170).
(b) The binding energy curve can be used to explain the phenomena of nuclear fission and nuclear fusion.

Nuclear fission: Binding energy per nucleon is smaller for heavier nuclei than the middle ones, i.e., heavier nuclei are less stable. When a heavier nucleus splits into the lighter nuclei, the B.E./nucleon changes from about 7.6 MeV to 8.4 MeV. Greater binding energy of the product nuclei results in the liberation of energy. This is what happens in nuclear fission which is the basis of the atom bomb.

Nuclear fusion: The binding energy per nucleon is small for light nuclei, i.e., they are less stable. So when two light nuclei combine to form a heavier nucleus, the higher binding energy per nucleon of the latter results in the release of energy. This is what happens in a nuclear fusion which is the basis of the hydrogen bomb.

10. Soln. Energy released = $\Delta m \times 931$ MeV

$$\Delta m = 4m({}^1_1\text{H}) - \text{m}({}^4_2\text{He})$$

Energy released

$$Q = [4m({}^1_1\text{H}) - \text{m}({}^4_2\text{He})] \times 931\text{MeV}$$
$$= [4 \times 1.007825 - 4.002603] \times 931 MeV = 26.72 MeV$$

11. Ans. Carbon isotope $^{12}_{6}C$ has a nuclear $mass = 12.000000\ u$

mass of proton, m_p = 1.007825 u
mass of neutron, m_n = 1.008665 u
Binding energy, $\Delta B = ((6m_p + 6m_n) - 12.000000)\,c^2$
$= (6 \times (1.007825 + 1.008665) - 12.000000)\,c^2$
$= (0.09894)\ \text{amu}\ c^2 \times 931.5\ \dfrac{\text{MeV}}{c^2} = 92.16\ \text{MeV}$

12. Ans.

$${}^1_1\text{H} + {}^3_1\text{H} \rightarrow {}^2_1\text{H} + {}^2_1\text{H}$$

Given that, $m({}^1_1\text{H})$ = 1.007825 u, $m({}^2_1\text{H})$ = 2.014102 u,
$m({}^3_1\text{H})$ = 3.016049 u
Q = (initial mass) – (final mass)
Q = (1.007825 u + 3.016049 u) – (2 × 2.014102 u)
Q = 4.023874 u) – 4.028204 u
Q = – 0.00433 u

As, some mass is converted into energy, hence the Q value is negative and thus energy is absorbed during the reaction.

13. Ans. A certain number of neutrons and protons are brought together to form a nucleus of a certain charge and mass, and energy ΔE_b will be released in this process. The energy ΔE_b is called the binding energy of the nucleus.

If we separate a nucleus into its nucleons we would have to transfer a total energy equal to ΔE_b, to the nucleons.

Example: ${}_{92}U^{235} + {}_0n^1 \rightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3{}^1_0n + Q$

The energy (Q) released was estimated to be 200 MeV per fission (or about 0.9 MeV per nucleon) and its equivalent to the difference in masses of the nuclei before and after the fission.

14. Ans. (a)

	Nuclear Fission		Nuclear Fusion
1.	The process of splitting of a heavy nucleus into two nuclei of nearly comparable masses with liberation of energy is called nuclear fission. Example: ${}^{235}_{92}U + {}^1_0n \rightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3{}^1_0n + Q$	1.	When two or more than two light nuclei fuse together to form heavy nucleus with the liberation of energy, the process is called nuclear fusion. Example: ${}^2_1H + {}^2_1H \rightarrow {}^3_2He + {}^1_0n + 3.2MeV$
2.	A suitable bullet or projectile like neutron is needed to initiate nuclear fission	2.	The lighter nuclei have to be brought very close to each other against electrostatic repulsion
3.	Fission of single nucleus of U^{235}_{92} produces approx. 200 MeV energy.	3.	Four protons combine to form helium nucleus which produces approx. 24 MeV energy.

(b) Given: m = 100 g, P = 500 W

Here two deuterium nuclei produce 3.27 MeV energy $= 5.232 \times 10^{-13}$ J

$$\therefore \text{ Energy per nuclei} = \frac{5.232\times10^{-13}}{2}$$

$$= 2.616\times10^{-13} J$$

No, of deuterium atoms in 100 g

$$= \frac{6.023\times10^{23}\times100}{2} = 3.011\times10^{25} \; atoms$$

$\therefore$ Total energy $= 3.011 \times 10^{25} \times 2.616 \times 10^{-13}$

$= 7.88 \times 10^{12}$ J

$$Power = \frac{Energy}{Time} \Rightarrow t = \frac{7.88\times10^{12}}{500} = 1.58\times10^{10} s$$

$$= \frac{1.58\times10^{10}}{365\times24\times60\times60} = 500 \; years$$

15. Ans. Given m = 2 kg, P = 800 W.

Here, two deuterium nuclei produce 3.27 MeV energy $= 5.232 \times 10^{-13}$ J

$$\therefore \text{ Energy per nuclei} = \frac{5.232\times10^{-13}}{2} = 2.616\times10^{-13} J$$

Number of deuterium atom in 2 kg

$$= \frac{6.023\times10^{23}\times2000}{2} = 6.023\times10^{26}$$

atom

$$\therefore \text{ Total energy} = 6.023\times10^{26}\times2.616\times10^{-13}$$

$$= 15.75\times10^{13} J$$

$$Power = \frac{Energy}{Time} \Rightarrow t = \frac{15.75\times10^{13}}{800} = 1.96\times10^{11} s$$

$$= \frac{1.96\times10^{11}}{365\times24\times60\times60} = 6.2\times10^{3} \; years$$

16. Ans. Nucleus was first discovered in 1911 by Lord Rutherford and his associates by experiments of scattering of α-particle by atoms. He found that the scattering result could be explained.

Atoms consists of a small, central, massive and positive core surrounded by orbiting electron. The experiment results indicated that the size of the nucleus is of the order of 10^{-14} metres and it thus 10,000 times smaller than the size of atom.

Relation between the radius and mass number of the nucleus $R = R_0 A^{1/3}$

If m is the average mass of a nucleon and R is the nuclear radius, then mas of nucleus = mA, where A is the mass number of the element.

Volume of the nucleus, $V = \frac{4}{3}\pi R^3$

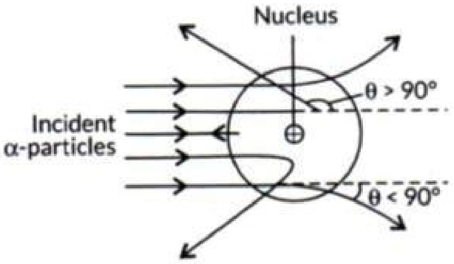
$$\therefore \quad V = \frac{4}{3}\pi\left(R_0A^{1/3}\right)^3 \Rightarrow V = \frac{4}{3}\pi R_0^3 A$$

Density of nuclear matter, $\rho = \frac{mA}{V}$

$$\Rightarrow \rho = \frac{mA}{\frac{4}{3}\pi R_0^3 A} \Rightarrow \rho = \frac{3m}{4\pi R_0^3}$$

This shows that the nuclear density is independent of A.

17. Ans. Trajectory of α -particles in coulomb field of target nucleus shows that only a small fraction of the number of incident α -particles (1 in 8000) rebound back.



This shows that the number of α -particles undergoing head – on collision is small. This implies that the entire positive charge of the atom is concentrated in a small volume. So, this experiment is an important way to determine an upper limit on the size of nucleus.

$$\text{Density of nucleus} = \frac{Mass\ of\ nucleus}{Volume}$$

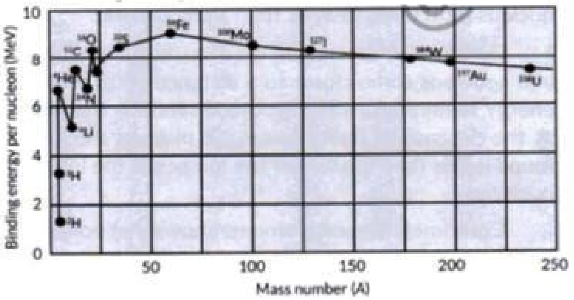
$$\rho = \frac{A\times m}{\frac{4}{3}\pi R^2};\ where\ R = R_0 A^{1/3}$$

$$Density\ \rho = \frac{A\times m}{\frac{4}{3}\pi R_0^3 A} = \frac{m}{\frac{4}{3}\pi R_0^3}; \rho = \frac{3m}{4\pi R_0^3}$$

$$\rho = 2.97\times 10^{17}\ kg\,m^{-3}$$

So, nuclear density is constant irrespective of mass number of size.

18. Ans. Binding energy curve.



Two salient features of the curve

(i) The binding energy per nucleon, E_{bn}, is practically constant i.e., practically independent of the atomic number for nuclei of middle mass number (30 < A < 170).

The curve has a maximum value of about 8.75 MeV for A = 56 and has a value of 7.6 MeV for A = 238.

(ii) E_{bn} is lower for both light nuclei (A < 30) and heavy nuclei (A > 170).

Nuclear fission: Binding energy per nucleon is smaller for heavier nuclei than the middle ones, i.e., heavier nuclei are less stable. When a heavier nucleus splits into the lighter nuclei, the B.E./nucleon changes from about 7.6 MeV to 8.4 MeV. Greater binding energy of the product nuclei results in the liberation of energy. This is what happens in nuclear fission which is the basis of the atom bomb.

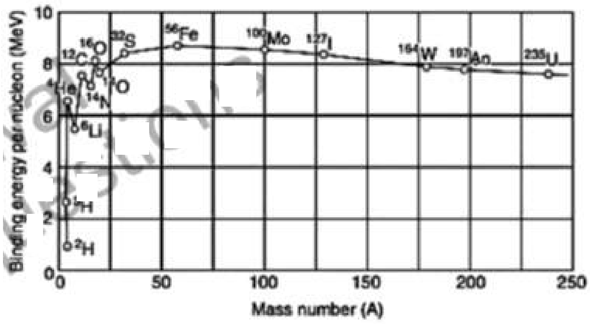
Nuclear fusion: The binding energy per nucleon is small for light nuclei, i.e., they are less stable. So when two light nuclei combine to form a heavier nucleus, the higher binding energy per nucleon of the latter results in the release of energy. This is what happens in a nuclear fusion which is the basis of the hydrogen bomb.

19. Soln. (a) Drawing the plot

Explaining the process of Nuclear fission and Nuclear fussion

(b) Finding the required time

(a) The plot of (B.E./nucleon) verses mass number is as shown.



[Note: Also accept the diagram that just shows the general shape of the graph].

From the plot we note that

(i) During nuclear fission

A heavy nucleus in the larger mass region (A > 200) breaks into two middle level nuclei, resulting in an increase in B.E./nucleon. This results in a release of energy.

(ii) During nuclear fusion

Light nuclei in the lower mass region (A < 20) fuse to form a nucleus having higher B.E./nucleon. Hence energy gets released.

[Alternatively: As per the plot: During nuclear fission as well as nuclear fusion, the final value of B.E./nucleon is more than its initial value. Hence energy gets released in both these processes.]

(b) We have

$$3.125\% = \frac{3.125}{100} = \frac{1}{32} = \frac{1}{2^5}$$

Half life = 10 years

$\therefore$ Required time = 5×10 years = 50 Years

20. Soln. $\Delta m = Zm_p + (A - Z)m_n - m_N$

$= 85\times1.007825+124\times1.008665-208.980388$

$= 1.75924$

B.E. per nucleon =

$$\frac{B.E.}{A}=\frac{\Delta m\times931.5}{209}MeV=7.84MeV$$

21. Soln. The potential energy is minimum at a distance r_0 of about 0.8 fm.

(i) For values less than r_0, potential energy V becomes positive, so the force between the nucleons becomes repulsive.

(ii) For values more than r_0, potential energy V becomes negative, so the force between the nucleons becomes attractive.

22. Soln. Number of atoms present in 1 mole i.;e.,

239 g of $^{239}_{94}Pu$ = 6.023×10^{23}

$\therefore$ Number of atoms present in 1000 g of $^{239}_{94}Pu$

$$=\frac{6.023\times10^{23}\times1000}{239}=2.52\times10^{24}$$

Energy released per fission = 180 MeV

Total energy released = $2.52\times1024\times180MeV$

$= 4.54\times1026\ MeV$.

23. Soln. As $4\times10^{-3}\,kg$ of He consists of 6.023×10^{23} He atoms,

So $5\times10^{32}\,kg$ of He consists of

$$\frac{6.023\times10^{23}\times5\times10^{32}}{4\times10^{-3}}=7.52875\times10^{58}\,atoms$$

Now, 3 atoms of He produce energy

$= 7.27\times10^{6}\times1.6\times10^{-19}\,J$.

So, all He atoms in star produce

$$\text{Total energy} = \frac{7.27\times1.6\times10^{-13}}{3}\times7.52875\times10^{58}\,J$$

$= 29.2\times10^{45}\,J$

As power generated is $P=5\times10^{30}W$

$\therefore$ Time taken to convert all the atoms into carbon

$$=\frac{29.2\times10^{45}}{5\times10^{30}}=5.84\times10^{15}\,seconds$$

$$=\frac{5.84\times10^{15}}{365\times24\times60\times60}=1.85\times10^{8}\,years$$

24. Soln. Let us first find the binding energy of

No. of protons in Fe = Z = 26

Mass of protons = 26 x 1.007825 u = 26.203450 u

No. of neutrons in Fe n = A – Z = 56 – 26 = 30

Mass of neutrons = 30 x 1.008665 u = 30.259950 u

Total theoretical mass of nucleus

= 26.206450 u + 30.259950 u = 56.463400 u

Actual mass of Fe nucleus = 55.934939 u

Mass defect Δm= Total mass – Actual mass = 0.528461 u

B.E. of $^{56}_{26}Fe$. Nucleus

$$E=\Delta mc^2=0.528461(931.5)\,\text{MeV}$$
$$=492.26MeV$$

$$\frac{B.E.}{nucleon}\,of\,^{56}_{26}Fe=\frac{492.26}{56}MeV=8.79MeV$$

(b) Now binding energy of $^{56}_{26}Fe$

No. of protons in Bi = Z = 83

No. of neutrons in $Bi\Rightarrow n=A-Z=209-83=126$

Mass of protons = $83\times1.007825u=83.649475u$

Mass of neutrons = $126\times1.008665u=127.091790u$

Total theoretical mass of nucleus = $210.741265u$

Actual mass of Bi nucleus = 208.980388 u

Mass defect $\Delta m=1.760877u$

B.E. of $^{209}_{83}Bi$ nucleus =

$$\Delta mc^2=1.760877\times931.5MeV$$
$$=1640.3MeV$$

$$\frac{B.E.}{nucleon}\,of\,^{209}_{83}Bi=\frac{1640.3}{209}MeV=7.85MeV$$

So, $^{56}_{26}Fe$ is much more stable than $^{209}_{83}Bi$ due to more binding energy per nucleon.

25. Soln.

(a) Fusion reactions taking place within core of sun, 4 hydrogen nuclei combine to form a helium nucleus with the release of 26 MeV of energy.

$$4\,^1_1H\longrightarrow\,^4_2He+2e^{+}+26MeV$$

Number of atoms in 1 kg of ^1_1H

$$n=\frac{1000g\times6\times10^{23}}{Atomic\,mass}=\frac{1000\,g}{1\,g}\times6\times10^{23}$$

$$n=6\times10^{26}\,atoms$$

Energy released in the fusion of 1 kg of ^1_1H

$$E=\frac{6\times10^{26}\times26}{4}MeV$$

$$E=39\times10^{26}\,MeV.$$

(b) Energy released per fission of U-235 is 200 MeV.

Number of atoms in 1 kg U – 235

$$n=\frac{1000g\times6\times10^{23}}{235\,g}=25.53\times10^{23}$$

Total energy released for fission of 1 kg of uranium

$$E = 25.53 \times 1023 \times 200\,MeV$$
$$= 5.1 \times 1026\,MeV$$

So the energy released in fusion of 1 kg of Hydrogen is nearly 8 times the energy released in fission of 1 kg of uranium – 235