Previous Years Examination Questions

1 Mark Question

1. How is the radius of a nucleus related to its mass number? **All India 2011C**

2 Marks Questions

2. (i) Distinguish between isotopes and isobars.

(ii) Two nuclei have different mass numbers A_1 and A_2 . Are these nuclei necessarily the isotopes of the same element ? Explain. **CBSE 2022 (Term-II)**

3. How the size of a nucleus is experimentally determined? Write the relation between the radius and mass number of the nucleus. Show that the density of nucleus is independent of its mass number. **Delhi 2012, 2011C**

Previous Years

Examination Questions

1 Mark Questions

1. Four nuclei of an element undergo fusion to form a heavier nucleus, with release of energy. Which of the two—the parent or the daughter nucleus—would have higher binding energy per nucleon? **2018**

2. Calculate the energy in fusion reaction $_1^2H + _1^2H \longrightarrow _2^3He + n$, where BE of $_1^2H$ = 2.23 MeV and of $_2^3He$ = 7.73 MeV. **Delhi 2016**

3. A nucleus with mass number $A = 240$ and BE / A = 7.6 MeV breaks into two fragments each of $A = 120$ with BE/A = 8.5 MeV. Calculate the released energy. **Delhi 2015**

4. Draw a graph showing the variation of potential energy between a pair of nucleons as a function of their separation. Indicate the function in which the nuclear force is (i) attractive, (ii) repulsive. **All India 2012**

5. Write any two characteristic properties of nuclear force. **All India 2011**

6. 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). **Foreign 2011**
Given :
Mass of $_1^1H$ = 1.007825 u
Mass of helium nucleus = 4.002603 u,
1 u = 931 MeV/c^2

7. A heavy nucleus X of mass number 240 and binding energy per nucleon 7.6 MeV is splitted into two fragments Y and Z of mass numbers 110 and 130. The binding energy of nucleons in Y and Z is 8.5 MeV per nucleon. Calculate the energy released per fission in MeV. **Delhi 2010**

8. If both the numbers of protons and neutrons are conserved in a nuclear reaction like
$$_6C^{12} + _6C^{12} \longrightarrow _{10}Ne^{20} + _2He^4$$
In what way, is the mass converted into the energy? Explain. **Delhi 2010**

9. Draw a plot of the binding energy per nucleon as a function of mass number for a large number of nuclei $20 < A < 240$. How do you explain the constancy of binding energy per nucleon in the range of $30 < A < 170$ using the property that nuclear force is short-ranged? **All India 2010**

2 Marks Question

10. Calculate for how many years will the fusion of 2.0 kg deuterium keep 800 W electric lamp glowing. Take the fusion reaction as **Delhi 2020**
$$_1^2H + _1^2H \longrightarrow _2^3He + _0^1n + 3.27\ MeV$$

3 Marks Questions

11. (i) Depict the variation of the potential energy of a pair of nucleons with the separation between them.
(ii) Imagine the fission of a $_{26}^{56}Fe$ into two equal fragments of $_{13}^{28}Al$ nucleus. Is the fission energetically possible. Justify your by working out Q-value of the process. **CBSE 2022 (Term-II)**
Given, $m\,(_{26}^{56}Fe)$ = 55.93494u,
$m\,(_{13}^{28}Al)$ = 27.981914 u.

12. (i) State two distinguishing features of nuclear force.

(ii) Draw a plot showing the variation of potential energy of a pair of nucleons as a function of their separation. Mark the regions on the graph where the force is (a) attractive and (b) repulsive. **All India 2019**

13. (i) Draw a plot showing the variation of potential energy of a pair of nucleons as a function of their separation. Mark the regions, where the nuclear force is (a) attractive and (b) repulsive.

(ii) In the nuclear reaction,

$n + {}^{235}_{92}\mathrm{U} \longrightarrow {}^{a}_{54}\mathrm{Xe} + {}^{94}_{b}\mathrm{Sr} + 2n$

Determine the value of a and b. **2018C**

14. (i) Write three characteristic properties of nuclear force.

(ii) Draw a plot of potential energy of a pair of nucleons as a function of their separation. Write two important conclusions that can be drawn from the graph. **Delhi 2015**

15. Distinguish between nuclear fission and fusion. Show how in both these processes energy is released.

Calculate the energy release in MeV in the deuterium-tritium fusion reaction.

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

Using the data

$$m({}^{2}_{1}\mathrm{H}) = 2.014102\ \mathrm{u},$$
$$m({}^{3}_{1}\mathrm{H}) = 3.016049\ \mathrm{u},$$
$$m({}^{4}_{2}\mathrm{He}) = 4.002603\ \mathrm{u},$$
$$m_n = 1.008665\ \mathrm{u}$$
$$1\ \mathrm{u} = 931.5\ \frac{\mathrm{MeV}}{c^2}$$ **All India 2015**

16. (i) Write the relation for binding energy (BE) (in MeV) of a nucleus of mass ${}^{A}_{Z}M$, atomic number (Z) and mass number (A) in terms of the masses of its constituents namely neutrons and protons.

(ii) Draw a plot of BE/A *versus* mass number A for $2 \leq A \leq 170$. Use this graph to explain the release of energy in the process of nuclear fusion of two light nuclei. **Delhi 2014**

17. In a typical nuclear reaction e.g.,

${}^{2}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} \rightarrow + {}^{3}_{2}\mathrm{He} + {}^{1}_{0}n + 3.27\ \mathrm{MeV}$, although number of nucleons is conserved, yet energy is released. How? Explain. **All India 2013**

18. Draw a plot of potential energy between a pair of nucleons as a function of their separation. Mark the regions where potential energy is

(i) positive and

(ii) negative. **Delhi 2013**

19. Answer the following.

(i) Why is the binding energy per nucleon found to be constant for nuclei in the range of mass number (A) lying between 30 and 170?

(ii) When a heavy nucleus with mass number $A = 240$ breaks into two nuclei, $A = 120$, energy is released in the process. **Foreign 2012**

20. (i) In a typical nuclear reaction, e.g.

${}^{2}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} \longrightarrow {}^{3}_{2}\mathrm{He} + n + 3.27$

although number of nucleons is conserved yet energy is released. How? Explain.

(ii) Show that nuclear density in a given nucleus is independent of mass number A. **Delhi 2012**

21. (i) What characteristic property of nuclear force explains the constancy of binding energy per nucleon (BE/A) in the range of mass number A lying $30 < A < 170$?

(ii) Show that the density of nucleus over a wide range of nuclei is constant and independent of mass number A. **Delhi 2012**

22. Draw a plot of potential energy of a pair of nucleons as a function of their separations. Mark the regions where the nuclear force is (i) attractive and (ii) repulsive. Write any two characteristic features of nuclear forces. **All India 2012**

23. Using the curve for the binding energy per nucleon as a function of mass number A, state clearly how the release in energy in the processes of nuclear fission and nuclear fusion can be explained. **All India 2011**

24. Explain giving necessary reactions, how energy is released during

(i) fission? (ii) fusion? **All India 2011C**

5 Marks Questions

25. (i) Draw the plot of binding energy per nucleon (BE/A) as a function of mass number A. Write two important conclusions that can be drawn regarding the nature of nuclear force.

(ii) Use this graph to explain the release of energy in both the processes of nuclear fusion and fission.

(iii) Write the basic nuclear process of neutron undergoing β-decay. Why is the detection of neutrinos found very difficult? **All India 2013**

26. Define the Q-value of a nuclear process. When can a nuclear process not proceed spontaneously? If both the number of protons and the number of neutrons are conserved in a nuclear reaction in what way is mass converted into energy (or *vice-versa*) in the nuclear reaction? **All India 2010C**