1. Define the half life period of a radioactive substance. Establish its relationship with decay constant.
2. Explain how Rutherford’s experiment on scattering of alpha – particle led to estimation of size of nucleus.
3. Draw a diagram to show the variation of binding energy per nucleon with mass no. of different nuclei. State the reason why nuclei undergo nuclear fission.
4. You are given two nucleoids
   \[ \begin{array}{c} 7 \\ X \\ 3 \\ \end{array} \quad \begin{array}{c} 4 \\ Y \\ 3 \end{array} \]
   (i) Are they the isotopes of same element? Why?
   (ii) Which one of the two is likely to be more stable? Give reason.
5. Why is neutron so efficient as a bombardment particle?
6. How is moderator able to slow down fast moving neutrons in a nuclear reactor?
7. Explain the phenomena of fission. Give one representative equation.
8. Show that the nuclear density is same for all the nuclei.
9. Explain alpha decay giving an example.
10. Differentiate between artificial and induced radioactivity.
11. Briefly discuss the uses of a nuclear reactor.
12. A radioactive isotope has a half-life of T years. After how much time is its activity reduced to 6.25% of its original activity? (Ans : Binding energy = 104.72 MeV)
13. Obtain the binding energy of a nitrogen nucleus from the following data.
   \[ M_H = 1.00783 \text{ u; } M_N = 1.00867 \text{ u} \]
   \[ M_n = 1.00867 \text{ u} \]
   Give your answer in MeV . (Ans: Binding energy = 104.72 MeV)
14. Define mass no. (A) of an atomic nucleus. Assuming the nucleus to be spherical, give the relation b\w mass no. (A) and radius (R) of the nucleus.

Calculate the density of nuclear matter.
Radius of nucleus of H = 1.1 x 10^{-15} A
What is the ratio of the order of magnitude of density of nuclear matter and density of ordinary matter?

15. The half life of a radioactive sample is 30 s. Calculate (1) the decay constant (2) time taken for sample to become \( \frac{1}{4} \) of initial value. [Ans. (i) 0.02315^{-1} (ii) t = 60 Seconds]
16. What is the power output of U reactor if it takes 30 days to use 2 Kg fuel, and if each fission gives 185 MeV of usable energy?
17. Calculate binding energy per nucleon of \( _{83}^{209}\text{Bi} \). Given
   \[ m (_{83}^{209}\text{Bi}) = 208.980388 \text{ a.m.u} \]
   \[ m (\text{neutron}) = 1.008665 \text{ a.m.u} \]
   \[ m (\text{Proton}) = 1.007825 \text{ a.m.u} \]
   [Ans B.E / Nucleon = 8.84 MeV]
18. A radioactive nuclear ‘A’ undergoes a series of decay according to following scheme :

\[ A \xrightarrow{\alpha} A_1 \xrightarrow{\beta} A_2 \xrightarrow{\alpha} A_3 \xrightarrow{\gamma} A_4 \]

The mass number and atomic number of \( A_4 \) are 172 & 69 respectively. What are these numbers for \( A \)?
19. Two nuclei have mass numbers in the ratio 1 : 3 what is the ratio of their nuclear densities.

20. The energy levels of an atom are as shown below. Which of them will result in transition of a photon of wavelength 275 nm?

Which transition corresponds to emission of radiation of maximum wavelength?