

Nuclei — Assignment 1

Class 12 Physics · Topic-wise question bank covering every concept of the chapter · Narayan Gurukul Academy

Instructions: (1) Attempt all questions. This worksheet walks through every concept of the chapter, topic by topic.
(2) The interactive MCQ version of these questions (with instant answer reveal) is available on the notes page.
(3) Universal values: $g = 10 \text{ m/s}^2$ unless stated. Give answers with correct SI units.

Nuclear Composition and Size

MCQ Questions (choose the correct option)

- The radius of a nucleus is proportional to
 - $A^{1/3}$
 - A
 - A^2
 - $A^{1/2}$
- The density of nuclear matter is
 - independent of mass number
 - proportional to A
 - inversely proportional to A
 - proportional to A^2
- The atomic mass unit 1 u is equal to
 - 931.5 MeV
 - $1.66 \times 10^{-27} \text{ kg}$
 - 1 eV
 - 13.6 eV
- Nucleons are held together in the nucleus by
 - the strong nuclear force
 - the gravitational force
 - the electromagnetic force
 - the weak force alone

1 Mark Questions

- Write the relation between the radius of a nucleus and its mass number.
- What is the charge and mass of a neutron?
- What is meant by nuclear density?

2 Mark Questions

- Define mass number and atomic number. How many protons and neutrons are in an atom of ^{235}U ? (Ans: 92 protons, 143 neutrons)
- Show that the nuclear density is independent of the mass number.

3 Mark Questions

- Derive the relation between the radius of a nucleus and its mass number and show that nuclear density is nearly constant for all nuclei.
- Describe the composition of a nucleus and the nature of the nuclear force.

Mass Defect and Binding Energy

MCQ Questions (choose the correct option)

1. The mass defect of a nucleus is the difference between the
 - (A) mass of nucleons and the mass of the nucleus
 - (B) mass of protons and neutrons
 - (C) mass of electrons and protons
 - (D) binding energy and mass
2. 1 u of mass corresponds to an energy of
 - (A) 931.5 MeV
 - (B) 1 MeV
 - (C) 13.6 eV
 - (D) 1.6×10^{-13} J
3. The binding energy per nucleon is maximum for
 - (A) iron ($A \approx 56$)
 - (B) hydrogen
 - (C) uranium
 - (D) helium
4. The binding energy of a nucleus is the energy
 - (A) required to separate its nucleons completely
 - (B) released when electrons combine
 - (C) of the photons emitted
 - (D) of the ground state

1 Mark Questions

1. Define mass defect.
2. Define the binding energy of a nucleus.
3. What is the energy equivalent of 1 u of mass?

2 Mark Questions

1. Define mass defect and binding energy and write the relation between them.
2. The mass defect of a nucleus is 0.2 u. Find its binding energy. (Ans: 186.3 MeV)

3 Mark Questions

1. Derive the expression for the binding energy of a nucleus and explain the binding energy per nucleon curve.
2. Explain the significance of the binding energy per nucleon curve with respect to nuclear stability, fission and fusion.

Radioactivity and Decay Laws

MCQ Questions (choose the correct option)

1. In alpha decay, the atomic number of the nucleus
 - (A) decreases by 2
 - (B) increases by 2
 - (C) decreases by 4
 - (D) is unchanged

2. In beta-minus decay, the atomic number
 - (A) increases by 1
 - (B) decreases by 1
 - (C) decreases by 2
 - (D) is unchanged
3. The radioactive decay law states that the rate of decay is proportional to
 - (A) the number of undecayed nuclei
 - (B) the square of the number of nuclei
 - (C) the mass
 - (D) $1/N$
4. Gamma emission involves the emission of
 - (A) a high-energy photon
 - (B) an electron
 - (C) a helium nucleus
 - (D) a positron

1 Mark Questions

1. State the radioactive decay law.
2. What is emitted in alpha decay?
3. What is the change in atomic number in beta-minus decay?

2 Mark Questions

1. State the laws of radioactive decay and write the decay equation $N = N_0 e^{(-\lambda t)}$.
2. A radioactive sample has 10^6 nuclei. If its decay constant is 0.693 per day, find the number remaining after 2 days.
(Ans: 2.5×10^5)

3 Mark Questions

1. State the laws of radioactive disintegration and derive the relation $N = N_0 e^{(-\lambda t)}$.
2. Describe the different types of radioactive decay and illustrate the changes in the parent nucleus in each case.

Half-Life and Mean Life

MCQ Questions (choose the correct option)

1. The half-life of a radioactive substance is related to the decay constant by
 - (A) $T_{1/2} = 0.693/\lambda$
 - (B) $T_{1/2} = \lambda/0.693$
 - (C) $T_{1/2} = 0.693\lambda$
 - (D) $T_{1/2} = 1/\lambda$
2. The mean life of a radioactive substance is
 - (A) $1/\lambda$
 - (B) $0.693/\lambda$
 - (C) λ
 - (D) 0.693λ
3. After two half-lives, the fraction of nuclei remaining is
 - (A) $1/4$

- (B) $\frac{1}{2}$
 - (C) $\frac{1}{8}$
 - (D) $\frac{3}{4}$
4. The activity of a radioactive sample is measured in
- (A) becquerel
 - (B) joule
 - (C) volt
 - (D) ampere per metre

1 Mark Questions

1. Write the relation between half-life and decay constant.
2. Write the relation between mean life and decay constant.
3. What fraction of a radioactive sample remains after three half-lives?

2 Mark Questions

1. Define half-life of a radioactive substance and derive the relation between half-life and decay constant.
2. The half-life of a radioactive sample is 5 years. Find the fraction remaining after 20 years. (Ans: $\frac{1}{16}$)

3 Mark Questions

1. Define half-life and mean life and derive the relation between them.
2. The half-life of a radioactive substance is 10 days. Find the time in which $\frac{3}{4}$ of the sample decays and its mean life.

Nuclear Fission and Fusion

MCQ Questions (choose the correct option)

1. Nuclear fission involves the
 - (A) splitting of a heavy nucleus
 - (B) combining of light nuclei
 - (C) emission of an electron
 - (D) absorption of a photon
2. In a nuclear reactor, the function of the moderator is to
 - (A) slow down neutrons
 - (B) absorb neutrons
 - (C) reflect neutrons
 - (D) speed up neutrons
3. Nuclear fusion is the source of energy in
 - (A) the Sun and stars
 - (B) a nuclear reactor
 - (C) a betatron
 - (D) a cyclotron
4. The energy released in a fission reaction comes from the
 - (A) mass defect
 - (B) electron emission
 - (C) gamma absorption
 - (D) kinetic energy of atoms

1 Mark Questions

1. What is nuclear fission?
2. What is nuclear fusion?
3. Name one source of energy in which nuclear fusion takes place.

2 Mark Questions

1. Differentiate between nuclear fission and nuclear fusion.
2. Explain the role of the moderator and control rods in a nuclear reactor.

3 Mark Questions

1. Explain nuclear fission and describe how a chain reaction is maintained in a nuclear reactor.
2. Explain nuclear fusion and the conditions required for it, and state why it is a source of energy in the Sun.