

Nuclei — CBSE Pattern Test 2

Class 12 Physics · 90 minutes · 40 marks · Sections A–D with answer key · Narayan Gurukul Academy

Test 2 — CBSE Pattern (90 minutes, 40 marks)

Class 12 Physics · Nuclei · Narayan Gurukul Academy (ClassApna)

General Instructions: (1) This paper has four sections — Section A (1×10), Section B (2×4), Section C (3×4) and Section D (5×2) — total 40 marks. Time allowed: 90 minutes.
(2) All questions are compulsory. No overall choice is given; internal choice, where allowed, is clearly marked.
(3) For MCQ questions choose the single correct option; for VSA answers write a single line.
(4) Take $g = 10 \text{ m/s}^2$. All symbols carry their usual meaning. Use of a calculator is not permitted.

Section A — MCQ & VSA ($10 \times 1 = 10$ marks)

- The density of nuclear matter is
 - independent of mass number
 - proportional to A
 - inversely proportional to A
 - proportional to A^2
- The binding energy per nucleon is maximum for
 - iron ($A \approx 56$)
 - hydrogen
 - uranium
 - helium
- Gamma emission involves the emission of
 - a high-energy photon
 - an electron
 - a helium nucleus
 - a positron
- After two half-lives, the fraction of nuclei remaining is
 - $1/4$
 - $1/2$
 - $1/8$
 - $3/4$
- In a nuclear reactor, the function of the moderator is to
 - slow down neutrons
 - absorb neutrons
 - reflect neutrons
 - speed up neutrons
- The energy released in a fission reaction comes from the
 - mass defect
 - electron emission
 - gamma absorption
 - kinetic energy of atoms
- The activity of a radioactive sample is measured in
 - becquerel

- (B) joule
(C) volt
(D) ampere per metre
8. The atomic mass unit 1 u is equal to
(A) 931.5 MeV
(B) 1.66×10^{-27} kg
(C) 1 eV
(D) 13.6 eV
9. What is nuclear fusion?
10. What fraction of a radioactive sample remains after three half-lives?

Section B — Short Answer I ($4 \times 2 = 8$ marks)

11. The radius of a nucleus with mass number 27 is 3.6 fm. Find the radius of a nucleus with mass number 64.
12. The half-life of a radioactive sample is 5 years. Find the fraction remaining after 20 years.
13. The decay constant of a radioactive substance is 0.0693 per day. Find its mean life.
14. Give one difference between nuclear fission and nuclear fusion.

Section C — Short Answer II ($4 \times 3 = 12$ marks)

15. Define mass defect and binding energy. Derive the relation between them and explain the binding energy per nucleon curve.
16. Define half-life and derive the relation between half-life and decay constant. A radioactive substance has a half-life of 10 days; find the time in which $3/4$ of the sample decays.
17. Explain nuclear fusion and the conditions required for it, and state why it is a source of energy in the Sun.
18. Describe the composition of a nucleus and the nature of the nuclear force.

Section D — Long Answers ($2 \times 5 = 10$ marks)

19. Explain nuclear fission and nuclear fusion. With the help of the binding energy per nucleon curve, explain why energy is released in both processes. Describe the role of a moderator and control rods in a nuclear reactor.
20. Define mass defect and binding energy. Derive the expression for the binding energy of a nucleus, calculate it for a mass defect of 0.2 u, and explain the significance of the binding energy per nucleon curve.

Answer Key (Marking Scheme)

- Q1 — (A) independent of mass number. Q2 — (A) iron ($A \approx 56$). Q3 — (A) a high-energy photon. Q4 — (A) $1/4$.
Q5 — (A) slow down neutrons. Q6 — (A) mass defect. Q7 — (A) becquerel. Q8 — (A) 931.5 MeV.
Q9 — The combining of lighter nuclei to form a heavier nucleus with the release of energy.
Q10 — $1/8$.
Q11 — $r = 3.6 \times (64/27)^{1/3} = 3.6 \times 4/3 = 4.8$ fm.
Q12 — 4 half-lives, so $1/16$ remains.
Q13 — $\tau = 1/\lambda = 1/0.0693 \approx 14.4$ days.
Q14 — Fission splits a heavy nucleus; fusion combines light nuclei.
Q15 — $\Delta m = \text{mass of nucleons} - \text{mass of nucleus}$; B.E. = $\Delta m c^2$; the curve peaks near $A = 56$.

Q16 — $T_{1/2} = 0.693/\lambda$; $3/4$ decayed after 2 half-lives = 20 days.

Q17 — Fusion requires very high temperature and pressure; in the Sun hydrogen nuclei fuse into helium.

Q18 — Protons and neutrons held by the short-range strong nuclear force.

Q19 — Both move towards higher binding energy per nucleon; moderator slows neutrons, control rods absorb them.

Q20 — B.E. = $0.2 \times 931.5 = 186.3$ MeV; curve explains stability and energy release.