

How to use this worksheet. Twenty-eight questions, about 32 minutes, with the answer key at the end. Count **half-lives** rather than dividing times. Read whether the question asks for the fraction **remaining** or the fraction **decayed**.

Formula sheet

$R = R_0 A^{1/3}$, $R_0 \approx 1.2 \text{ fm}$ | nuclear density is the same for every nucleus

Mass defect $\Delta m = (Zm_p + Nm_n) - M$ | Binding energy = $\Delta m \times 931.5 \text{ MeV per u}$

$N = N_0 e^{-\lambda t}$ | $T = 0.693/\lambda$ | after n half-lives a fraction $(1/2)^n$ remains

Alpha: $A - 4$, $Z - 2$ | Beta-minus: A same, $Z + 1$ | Gamma: both unchanged

Section A · Level 1 — Nuclear structure, mass defect and decay laws

Ten questions. None should take more than twenty seconds.

1. The nucleus of an atom contains:

(1) Protons and electrons (2) Protons and neutrons (3) Neutrons and electrons (4) Electrons only

2. Nuclides having the same atomic number but different mass numbers are called:

(1) Isobars (2) Isotopes (3) Isotones (4) Isomers

3. Nuclides having the same mass number but different atomic numbers are called:

(1) Isotopes (2) Isobars (3) Isotones (4) Isomers

4. The radius of a nucleus of mass number A is proportional to:

(1) A (2) A^2 (3) $A^{1/3}$ (4) $A^{1/2}$

5. The density of nuclear matter is:

(1) Proportional to A (2) Inversely proportional to A (3) Nearly the same for all nuclei (4) Zero

6. The difference between the sum of the masses of the free nucleons and the actual nuclear mass is called the:

(1) Binding energy (2) Mass defect (3) Packing fraction (4) Q value

7. One atomic mass unit is equivalent to:

(1) 931.5 MeV (2) 1.6 MeV (3) 8.8 MeV (4) 200 MeV

8. In alpha decay, the mass number of the nucleus:

(1) Increases by 4 (2) Decreases by 4 (3) Stays the same (4) Decreases by 2

9. In beta-minus decay, the atomic number:

(1) Decreases by 1 (2) Increases by 1 (3) Stays the same (4) Decreases by 2

10. In gamma emission, the mass number and atomic number:

(1) Both decrease (2) Both increase (3) Both stay the same (4) Only A changes

Working space — Questions 1 to 10

Write the formula before you substitute.

Section B · Level 2 — Binding energy, half-life and nuclear radius

Ten questions. Count half-lives rather than dividing the times.

11. A nucleus has a mass defect of 0.02 u. Its binding energy is closest to:

(1) 9.3 MeV (2) 18.6 MeV (3) 37.3 MeV (4) 93 MeV

12. After three half-lives, the fraction of a radioactive sample remaining is:

(1) $1/2$ (2) $1/4$ (3) $1/8$ (4) $1/16$

13. A sample has a half-life of 30 minutes. After 90 minutes the fraction remaining is:

- (1) $1/2$ (2) $1/3$ (3) $1/8$ (4) $1/9$

14. The relation between half-life T and decay constant λ is:

- (1) $T = \lambda$ (2) $T = 0.693\lambda$ (3) $T = 0.693 / \lambda$ (4) $T = \lambda / 0.693$

15. Two nuclei have mass numbers 1 and 27. The ratio of their radii is:

- (1) 1 : 27 (2) 1 : 9 (3) 1 : 3 (4) 1 : $3\sqrt{3}$

16. Two nuclei have mass numbers 8 and 64. The ratio of their radii is:

- (1) 1 : 8 (2) 1 : 4 (3) 1 : 2 (4) 1 : 64

17. The binding energy per nucleon is greatest for nuclei with mass number near:

- (1) 4 (2) 56 (3) 138 (4) 238

18. The energy released in the fission of one uranium-235 nucleus is about:

- (1) 2 MeV (2) 20 MeV (3) 200 MeV (4) 2000 MeV

19. After two half-lives, the fraction of a sample that has decayed is:

- (1) $1/4$ (2) $1/2$ (3) $3/4$ (4) $7/8$

20. The activity of a radioactive sample is measured in:

- (1) Joule (2) Becquerel (3) Tesla (4) Coulomb

Working space — Questions 11 to 20 Write the formula before you substitute.

Section C • Level 3 — Nuclear forces, fission, fusion and reactors

Eight questions. Think in terms of the binding energy per nucleon curve.

21. Energy is released in nuclear fission because the binding energy per nucleon of the products is:

- (1) Lower than that of the parent (2) Higher than that of the parent (3) Equal to that of the parent (4) Zero

22. Energy is released in nuclear fusion because light nuclei combine to form a nucleus with:

- (1) Lower binding energy per nucleon (2) Higher binding energy per nucleon (3) The same binding energy per nucleon (4) No binding energy

23. Nuclear forces are:

- (1) Long range and weak (2) Short range and much stronger than the electrostatic force (3) Weaker than gravity (4) Effective only between protons

24. Nuclear forces are said to be charge independent because they act:

- (1) Only between protons (2) Only between neutrons (3) Equally between all pairs of nucleons (4) Only between electrons

25. The half-life of a radioactive substance does not depend on:

- (1) The substance itself (2) The temperature and pressure (3) The decay constant (4) The nuclear structure

26. A radioactive nucleus emits an alpha particle followed by two beta-minus particles. Compared with the original, the final nucleus is:

- (1) A different element (2) An isotope of the original element (3) An isobar of the original (4) Identical in every way

27. Why is a chain reaction possible in uranium fission?

- (1) Each fission releases energy (2) Each fission releases more neutrons than it consumes (3) The products are stable (4) The neutrons are charged

28. In a nuclear reactor, the moderator is used to:

- (1) Absorb all the neutrons (2) Slow the neutrons down (3) Speed the neutrons up (4) Cool the reactor core

Working space — Questions 21 to 28*Write the formula before you substitute.***Answer key**

Check only after you have attempted every question. Full worked solutions for each one are on the worksheet page at aviatelearnings.com.

1. (2)	7. (1)	13. (3)	19. (3)	25. (2)
2. (2)	8. (2)	14. (3)	20. (2)	26. (2)
3. (2)	9. (2)	15. (3)	21. (2)	27. (2)
4. (3)	10. (3)	16. (3)	22. (2)	28. (2)
5. (3)	11. (2)	17. (2)	23. (2)	
6. (2)	12. (3)	18. (3)	24. (3)	

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