# Nuclei

## Case Study Based Questions

**Directions: In the following questions, a statement of Assertion (A) is followed by a statement of Reason (R). Mark the correct choice as:**

a. Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

b. Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

c. Assertion (A) is true but Reason (R) is false.

d. Both Assertion (A) and Reason (R) are false.

**Q1.**

**Assertion(A): The nucleus ${}^{7}_{3}X$ is more stable than the nucleus ${}^{4}_{3}Y$.**

**Reason (R): ${}^{7}_{3}X$ contains more number of protons.**

*(CBSE 2023)*

**Answer :**

(c) In nucleus ${}^{7}_{3}X$;

Number of protons $(p) = 3$
Number of neutrons $(n) = 7 - 3 = 4$
In nucleus ${}^{4}_{3}Y$;

Number of protons $(p) = 3$
Number of neutrons $(n) = 4 - 3 = 1$
Thus, for the same charge number $Z$, the nucleus with more neutrons is more stable. Therefore, ${}^{7}_{3}X$; is more stable.

**Q2. Assertion (A):** The whole mass of the atom is concentrated in the nucleus.

**Reason (R):** The mass of nucleus can be either less than or more than the sum of the masses of nucleons present in it.

**Answer :** (c) The mass of a nucleus is always less than the sum of the masses of the nucleons present in it. When nucleons combine to form a nucleus, some energy is liberated, and this is the binding energy of the nucleus. The mass of the nucleus cannot be more than the total mass of the nucleons because then stable nucleus cannot be formed.

**Q3. Assertion (A): Forces acting between proton-proton ($f_{pp}$), proton-neutron ($f_{pn}$) and neutron-neutron ($f_{nn}$) are such that $f_{pp} < f_{pn} = f_{nn}$.**

**Reason (R): Electrostatic force of repulsion between two protons reduces net nuclear forces between them.**

**Answer :** (d) The electrostatic force of repulsion between proton-proton decreases the nuclear force between them.

**Q4. Assertion (A):** Nuclear force between neutron-neutron, proton-neutron and proton-proton is approximately the same.

**Reason (R):** The nuclear force does not depend on the electric charge.

**Answer :** (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

**Q5. Assertion (A):** Neutrons penetrate matter more readily as compared to protons.

**Reason (R):** Neutrons are slightly more massive than protons.

**Answer :** (b) Neutron is about 0.1 more massive than protons. But the unique thing about the neutron is that while it is heavy, it has no charge (it is neutral). This lack of charge gives it the ability to penetrate matter without interacting as quickly as the beta particles or alpha particles.

**Q6. Assertion (A):** Fusion of hydrogen nuclei into helium nuclei is the source of energy of all stars.

**Reason (R):** In fusion, heavier nuclei split to form lighter nuclei.

**Answer :** (c) In fusion, lighter nuclei combine to form a heavier nucleus. Fusion of hydrogen nuclei into helium nuclei is the source of energy of all stars including our Sun.

**Q7. Assertion (A):** There occurs a chain reaction when uranium is bombarded with slow neutrons.

**Reason (R):** When uranium is bombarded with slow neutrons, more neutrons are produced.

**Answer :** (a) When uranium is bombarded by slow neutrons, the reaction is represented as

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{144}_{56}Ba + ^{89}_{36}Kr + 3^{1}_{0}n + \text{Energy}$$

As more neutrons are produced, there are additional neutrons strike on other uranium nuclei to produce even more neutrons. Thus, a chain reaction is established.

**Q8. Assertion (A):** Thermonuclear fusion reactions may become the source of unlimited power for the mankind.

**Reason (R):** A single fusion event involving isotopes of hydrogen produces more energy than energy from nuclear fission of a single uranium.

**Answer :** (c) When fusion is achieved by raising the temperature of the system so that particles have enough kinetic energy to overcome the coulomb repulsive behaviour, it is called thermonuclear fusion. It is clean source of energy but energy released in one fusion is much less than a single uranium fission.

**Q9. Assertion (A):** Cadmium rods used in a nuclear reactor, control the rate of fission.

**Reason (R):** Cadmium rod speed up the slow neutrons.

**Answer :** (c) Cadmium rods are used in a nuclear reactor to control the rate of fission. The cadmium rods do not slow down or speed up the neutrons produced in a fission reaction of $^{235}U$. Instead, they absorb the neutrons thereby regulating the power level of the reactor.

**Q10. Assertion:** Density of all the nuclei is same.

**Reason:** Radius of nucleus is directly proportional to the cube root of mass number.

**Q11. Assertion:** Neutrons penetrate matter more readily as compared to protons.

**Reason:** Neutrons are slightly more massive than protons.

**Q12. Assertion:** The mass number of a nucleus is always less than its atomic number.

**Reason:** Mass number of a nucleus may be equal to its atomic number.

**Q13. Assertion:** The binding energy per nucleon, for nuclei with atomic mass number A > 100, decrease with A.

**Reason:** The forces are weak for heavier nuclei.

**Q14. Assertion:** Radioactivity of 108 undecayed radioactive nuclei of half life of 50 days is equal to that of 1.2 × 108 number of undecayed nuclei of some other material with half life of 60 days.

**Reason:** Radioactivity is proportional to half-life.

**Q15. Assertion:** The ionising power of β-particle is less compared to β-particles but their penetrating power is more.

**Reason:** The mass of β-particle is less than the mass of α- particle.

**Q16. Assertion:** Radioactive nuclei emit $\beta^{-1}$ particles.

**Reason:** Electrons exist inside the nucleus.

**Q17. Assertion:** ${}_{Z}X^{A}$ undergoes 2α, 2β- particles and 2γ-rays, the daughter product is ${}_{Z-2}Y^{A-8}$.

**Reason:** In α- decay the mass number decreases by 4 and atomic number decreases by 2. In β-decay the mass number remains unchanged, but atomic number increases by 1.

**Q18. Assertion:** The heavier nuclei tend to have larger N/Z ratio because neutron does not exert electric force.

**Reason:** Coulomb forces have longer range compared to the nuclear force.

**Q19. Assertion:** A free neutron decays to a proton but a free proton does not decay to a neutron. This is because neutron is an uncharged particle and proton is a charged particle.

**Reason:** Neutron has larger rest mass than the proton.

**Q20. Assertion:** Cobalt-60 is useful in cancer therapy.
**Reason:** Cobalt -60 is source of γ- radiations capable of killing cancerous cells.

**Q21. Assertion:** It is not possible to use $^{35}Cl$ as the fuel for fusion energy.
**Reason:** The binding energy of $^{35}Cl$ is to small.

**Q22. Assertion:** Energy is released when heavy nuclei undergo fission or light nuclei undergo fusion.

**Reason:** For heavy nuclei, binding energy per nucleon increases with increasing Z while for light nuclei it decreases with increasing Z.

# ANSWER KEY 10 to 22

**Q10 :** (a)

**Q11 :** (b) Both statements are separately correct.

**Q12 :** (d) In case of hydrogen atom mass number and atomic number are equal.

**Q13 :** (c) Nuclear force is nearly same for all nucleus.

**Q14 :** (c)

**Q15 :** (b) β-particles, being emitted with very high speed compared to α-particles, pass for very little time near the atoms of the medium. So the probability of the atoms being ionised is comparatively less. But due to this reason, their loss of energy is very slow and they can penetrate the medium through a sufficient depth.

**Q16 :** (c) Electrons are not inside nucleus.

**Q17 :** (a) **Q18 :** (a) **Q19 :** (d) **Q20 :** (d)

**Q21 :** (c)

**Q22 :** (d) We know that energy is released when heavy nuclei undergo fission or light nuclei undergo fusion. Therefore statement (1) is correct.
The second statement is false because for heavy nuclei the binding energy per nucleon decreases with increasing Z and for light nuclei, B.E/nucleon increases with increasing Z.