DPP – 1

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Q 1. A α particle after passing through a potential difference of V volt collides with a nucleus. If the atomic number of the nucleus is Z then the distance of closest approach of α-particle to the nucleus will be-

(a) $14.4\frac{Z}{V}$ Å (b) $14.4\frac{Z}{V}$ m

(c) $14.4\frac{Z}{V}$ cm (d) All of the above

Q 2. An α-particle of energy 5 MeV is scattered through 180° by a stationary uranium nucleus. The distance of closest approach is of the order of -

(a) 1Å (b) 10^{-10} cm

(c) 10^{-12} cm (d) 10^{-15} cm

Q 3. Two protons are kept at a separation of 50Å. Fn is the nuclear force and Fe is the electrostatic force between them, then -

(a) Fn >> Fe (b) Fn = Fe (c) Fn << Fe (d) Fn » Fe

Q 4. As the mass number A increases, which of the following quantities related to a nucleus do not change -

(a) mass (b) volume

(c) density (d) binding energy

Q 5. Particles which can be added to the nucleus of an atom without changing its chemical properties are called –

(a) Neutrons (b) electrons

(c) Protons (d) Alpha-particles

Q 6. Which of the following is not isotone with others ?

(a) ${}^{40}_{18}Ar$ (b) ${}^{42}_{20}Ca$

(c) ${}^{43}_{21}Sc$ (d) ${}^{41}_{21}Sc$

Q 7. The radius of the nucleus with nucleon number 2 is 1.5×10^{-15}m, then the radius of nucleus with nucleon number 54 will be -

(a) 3×10^{-15} m (b) 4.5×10^{-15} m

(c) 6×10^{-15} m (d) 9.5×10^{-15} m

Q 8. If there are N nucleons in a nucleus of radius R, then the number of nucleons in a nucleus of radius 2R will be -

(a) N (b) 2N (c) 8N (d) $2^{1/3}$N

Q 9. Attractive nuclear forces exist between -
(a) neutron - neutron
(b) proton - proton
(c) neutron - proton
(d) all of the above

Q 10. Binding energies of nuclei ${}_1^2H$, ${}_2^4He$, ${}_{25}^{56}Fe$ and ${}_{92}^{235}U$ are 2.22, 28.3, 492 and 1786 respectively. Most stable nucleus is -
(a) ${}_{25}^{56}Fe$
(b) ${}_1^2H$
(c) ${}_{92}^{235}U$
(d) ${}_2^4He$

Q 11. The binding energy of a deuterium nucleus is about 1.115 MeV per nucleon. Then the mass defect of the nucleus is about –
(a) 2.23 u
(b) 0.0024 u
(c) 2077 u
(d) None of the above

Q 12. In nuclear reactions –
(a) mass and momentum both are conserved
(b) energy and momentum both are conserved
(c) charge and momentum both are conserved
(d) energy and charge both are conserved

Q 13. If the mass of proton = 1.008 a.m.u. and mass of neutron = 1.009 a.m.u., then binding energy per nucleon for ${}_4^9Be$ (mass = 9.012 amu) would be –
(a) 0.065 MeV
(b) 60.44 MeV
(c) 67.2 MeV
(d) 6.72 MeV

Q 14. If the binding energy per nucleon in Li^7 and He^4 nuclei are 5.60 MeV and 7.06 MeV, then energy of the reaction $Li^7 + H^1$ ¾ → 2 ${}_2^4He$ is –
(a) 19.6 MeV
(b) 2.4 MeV
(c) 8.4 MeV
(d) 17.3 MeV

Q 15. If the rest mass of electron or positron is 0.51 MeV, then the kinetic energy of each particle in the electron-positron pair production by a γ-photon of 2.42 MeV will be –
(a) 0.3 MeV
(b) 1.9 MeV
(c) 0.7 MeV
(d) 1.5 MeV

Q 16. An electron and a positron may annihilate one another producing two γ-ray photons of equal energy. The minimum energy of each of these photons is –
(a) 8.2×10^{-14} MeV
(b) 8.2×10^{-14} J
(c) 16.4×10^{-14} MeV
(d) 16.4×10^{-14} J

Q 17. A nuclear fission is represented by the following reaction :

$$U^{236} = X^{111} + Y^{122} + 3n$$

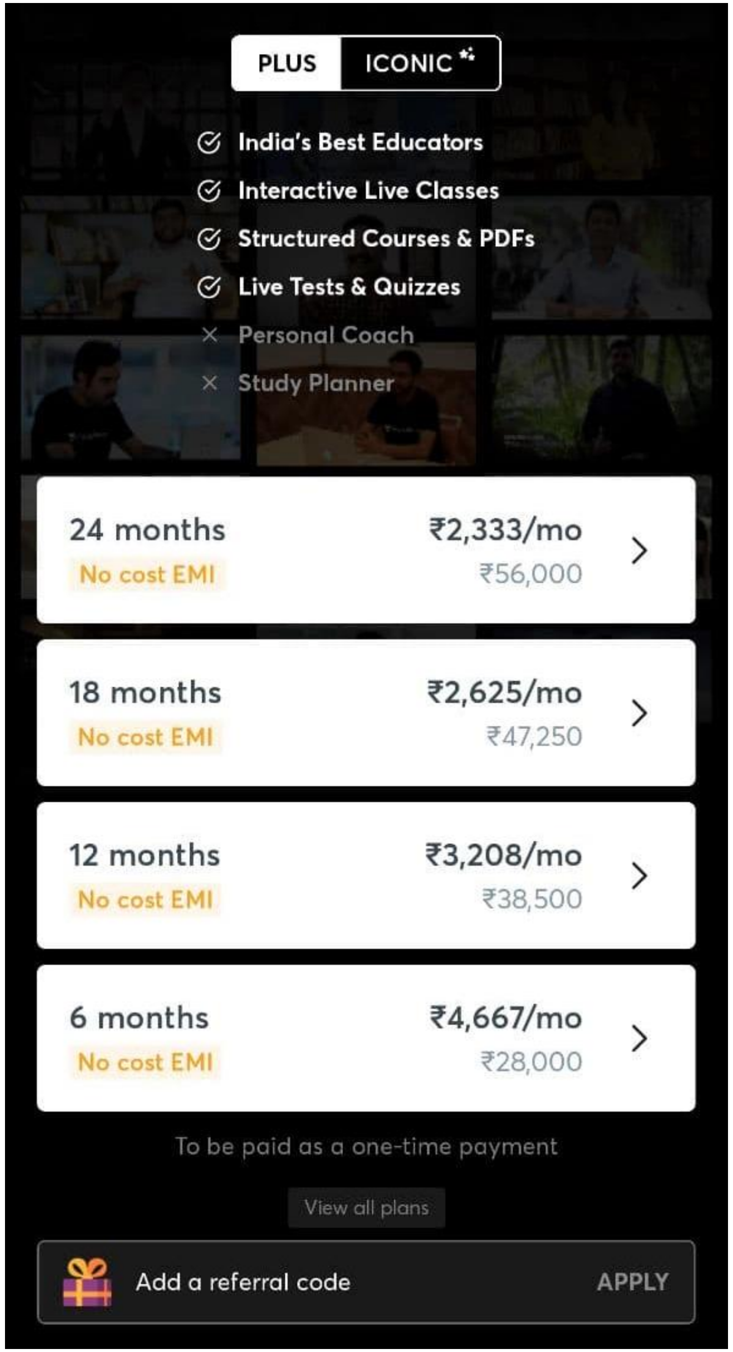
If the binding energies per nucleon of X^{111}, Y^{122} and U^{236} are 8.6MeV, 8.5 MeV and 7.6 MeV respectively, then the energy released in the reaction will be –
(a) 200 MeV
(b) 202 MeV
(c) 195 MeV
(d) 198 MeV

Q 18. Calculate the mass defect for helium-4 nucleus, given M(He) = 4.0015084, M(p) = 1.007276 u, M(n) = 1.008665u –

(a) 0.03074 (b) 0.030384
(c) 0.030374 (d) 0.30374

Answer Key

Q.1 a	**Q.2 c**	**Q.3 c**	**Q.4 c**	**Q.5 a**
Q.6 d	**Q.7 b**	**Q.8 c**	**Q.9 d**	**Q.10 a**
Q.11 b	**Q.12 c**	**Q.13 d**	**Q.14 d**	**Q.15 c**
Q.16 b	**Q.17 d**	**Q.18 c**		



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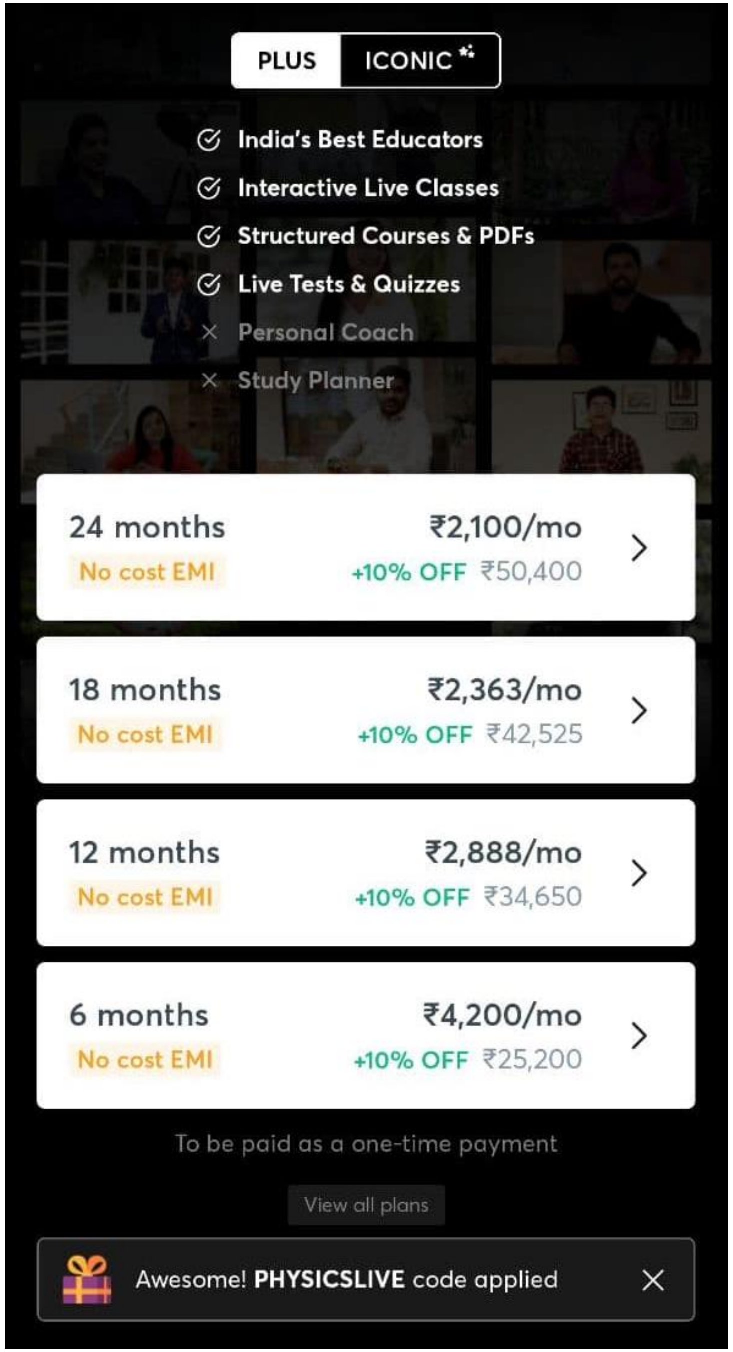

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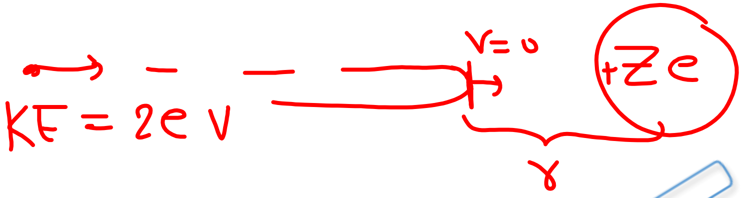
Written Solution

DPP- 1 Nuclear Physics: Nucleus, Binding Energy, Q Value

By Physicsaholics Team

Q1) A α particle after passing through a potential difference of V volt collides with a nucleus. If the atomic number of the nucleus is Z then the distance of closest approach of α-particle to the nucleus will be-



$2eV = \frac{9\times10^9 \times 2e\, Ze}{r}$

$r = \frac{9\times10^9 \times 1.6\times10^{-19} \times Z}{V}$

$= (14.4\times10^{-10})\frac{Z}{V}$

$= \left[14.4\frac{Z}{V}\right]$ Å

(a) $14.4\frac{Z}{V}$ Å

(b) $14.4\frac{Z}{V}$ m

(c) $14.4\frac{Z}{V}$ cm

(d) All of the above

Q2) An α-particle of energy 5 MeV is scattered through 180° by a stationary uranium nucleus. The distance of closest approach is of the order of -

Initial KE = final P.E

$5\times10^6 e = \frac{9\times10^9 \times (2e)(92e)}{r}$

$_{92}U^{235}$

$r = \frac{9\times10^9}{5\times10^6} \times 184 \times 1.6\times10^{-19}$

$= \frac{9\times294.4}{5} \times 10^{-16}$

(a) 1Å

(b) 10^{-10} cm

(c) 10^{-12} cm

(d) 10^{-15} cm

$= \frac{2649.6}{5} \times 10^{-16}$

$= 529.9 \times 10^{-16}$ m

$= 5.299\times10^{-14}$ m $= 5.299\times10^{-12}$ cm

Q3) Two protons are kept at a separation of 50Å. Fn is the nuclear force and Fe is the electrostatic force between them, then -

Nuclear forces are only effective for short range ($\sim 10^{-15}$ m) inside nucleus. So, at 50 Å separation nuclear forces will be negligible.

(a) $F_n >> F_e$ (b) $F_n = F_e$ (c) $F_n << F_e$ (d) $F_n \approx F_e$

Q4) As the mass number A increases, which of the following quantities related to a nucleus do not change -

$R = R_0 A^{1/3}$

$\rho = \frac{A \text{ amu}}{\frac{4}{3}\pi R_0^3 A}$

(a) mass

(b) volume

(c) density

(d) binding energy

Q5) Particles which can be added to the nucleus of an atom without changing its chemical properties are called -

Adding neutron does not changes atomic number (Z) of an atom, so it will not change chemical properties of atom.

(a) Neutrons ✓

(b) electrons

(c) Protons

(d) Alpha-particles

Q6) Which of the following is not isotone with others ?

(a) ${}^{40}_{18}Ar$ → n = 22

(b) ${}^{42}_{20}Ca$ → n = 22

(c) ${}^{43}_{21}Sc$ → n = 22

(d) ${}^{41}_{21}Sc$ → n = 20

Q7) The radius of the nucleus with nucleon number 2 is 1.5×10^{-15}m, then the radius of nucleus with nucleon number 54 will be -

$R = R_o A^{1/3}$

$R \propto A^{1/3}$

A increases to 27 times ⇒ R increases to 3 times

(a) 3×10^{-15} m
(b) 4.5×10^{-15} m
(c) 6×10^{-15} m
(d) 9.5×10^{-15} m

Q8) If there are N nucleons in a nucleus of radius R, then the number of nucleons in a nucleus of radius 2R will be -

(a) N (b) 2N (c) 8N (d) $2^{1/3}$N

Volume V

Volume 8V

Nuclear density = Constant

No of nucleons $\propto$ volume.

Q9) Attractive nuclear forces exist between -

Nuclear forces exists between nucleons.

And Neutron & Protons both are nucleons.

(a) neutron - neutron

(b) proton - proton

(c) neutron - proton

(d) all of the above ✓

Q10) Binding energies of nuclei ${}_{1}^{2}H$, ${}_{2}^{4}He$, ${}_{25}^{56}Fe$ and ${}_{92}^{235}U$ are 2.22, 28.3, 492 and 1786 respectively. Most stable nucleus is -

2 4 56 235

biggest

→ most stable

(a) ${}_{25}^{56}Fe$ (b) ${}_{1}^{2}H$ (c) ${}_{92}^{235}U$ (d) ${}_{2}^{4}He$

Q11) The binding energy of a deuterium nucleus is about 1.115 MeV per nucleon. Then the mass defect of the nucleus is about -

$B.E. = 1.115 \times 2$
$= 2.230\ MeV = \Delta m c^2$

$1\ amu \equiv 931\ MeV$
$\Delta m = \frac{2.230}{931}\ u$

(a) 2.23 u

(b) 0.0024 u

(c) 2077 u

(d) None of the above

Q12) In nuclear reactions -

(a) mass and momentum both are conserved

(b) energy and momentum both are conserved

(c) charge and momentum both are conserved

(d) energy and charge both are conserved

Q13) If the mass of proton = 1.008 a.m.u. and mass of neutron = 1.009 a.m.u., then binding energy per nucleon for ${}^{9}_{4}Be$ (mass = 9.012 amu) would be -

$\Delta m = (4 \times 1.008 + 5 \times 1.009) - 9.012$

$= 4.032 + 5.045 - 9.012$

$= 9.077 - 9.012$

$= .065\ u$

$\frac{BE}{A} = \frac{60.515}{9}$

$= 6.72\ MeV$

(a) 0.065 MeV

(b) 60.44 MeV

(c) 67.2 MeV

(d) 6.72 MeV

$BE = 931 \times .065$

4655

55860

60.515 MeV

Q14) If the binding energy per nucleon in Li^7 and He^4 nuclei are 5.60 MeV and 7.06 MeV, then energy of the reaction $Li^7 + H^1 \longrightarrow 2\,{}_2^4He$ is -

$\Delta E = (4 \times 7.06 \times 2) - (7 \times 5.6)$

$= 56.48 - 39.2$

$= 17.28$

(a) 19.6 MeV

(b) 2.4 MeV

(c) 8.4 MeV

(d) 17.3 MeV ✓

Q15) If the rest mass of electron or positron is 0.51 MeV, then the kinetic energy of each particle in the electron-positron pair production by a γ-photon of 2.42 MeV will be -

$\gamma \longrightarrow e^- + e^+$

2.42 MeV → .51 MeV + K, .51 MeV + K

(a) 0.3 MeV

(b) 1.9 MeV

(c) 0.7 MeV

(d) 1.5 MeV

$2K + 1.02\ \text{MeV} = 2.42\ \text{MeV}$

$2K = 1.4\ \text{MeV}$

$K = .7\ \text{MeV}$

Q16) An electron and a positron may annihilate one another producing two γ-ray photons of equal energy. The minimum energy of each of these photon is -

$e^- + e^+ \longrightarrow \gamma + \gamma$

$P = 0$ $\quad$ $P = 0$

(a) 8.2×10^{-14} MeV

(b) 8.2×10^{-14} J

(c) 16.4×10^{-14} MeV

(d) 16.4×10^{-14} J

mass of electron

$E_\gamma = m_0 c^2$

$= 9.1 \times 10^{-31} \times 9 \times 10^{16}$

$= 81.9 \times 10^{-15} = 8.19 \times 10^{-14}$ J

Q17) A nuclear fission is represented by the following reaction :

$$U^{236} = X^{111} + Y^{122} + 3n$$

If the binding energies per nucleon of X^{111}, Y^{122} and U^{236} are 8.6MeV, 8.5 MeV and 7.6 MeV respectively, then the energy released in the reaction will be -

$\Delta E = (111 \times 8.6 + 122 \times 8.5) - (236 \times 7.6)$

$= 954.6 + 1037.0 - 1793.6$

$= 1991.6 - 1793.6 = 198.0$

(a) 200 MeV

(b) 202 MeV

(c) 195 MeV

(d) 198 MeV ✓

Q18) Calculate the mass defect for helium-4 nucleus, given M(He) = 4.0015084, M(p) = 1.007276 u, M(n) = 1.008665u -

$$\Delta m = (2 \times 1.007276 + 2 \times 1.008665) - 4.0015084$$

$$= 2.014552 + 2.017330 - 4.0015084$$

$$= 4.031882 - 4.001508$$

$$= 0.030374$$

(a) 0.03074

(b) 0.030384

(c) 0.030374 ✓

(d) 0.30374

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