**ABHINAV ACADEMY**

**UDUPI**

# CET25P13 NUCLEI

## Class 12 - Physics

**Time Allowed: 1 hour and 30 minutes** **Maximum Marks: 75**

1. $M_p$ denotes the mass of a proton and $M_n$ that of a neutron. A given nucleus, of binding energy B, contains Z protons and N neutrons. The mass M(N, Z) of the nucleus is given by (where c is the velocity of light) **[1]**

   a) $M(N, Z) = NM_n + ZM_p - Bc^2$

   b) $M(N, Z) = NM_n + ZM_p - \frac{B}{c^2}$

   c) $M(N, Z) = NM_n + ZM_p + Bc^2$

   d) $M(N, Z) = ZM_n + ZM_p + \frac{B}{c^2}$

2. The radius of a nucleus of a mass number A is directly proportional to: **[1]**

   a) $A^3$

   b) $A^{\frac{2}{3}}$

   c) A

   d) $A^{\frac{1}{3}}$

3. When an electron is emitted from a nucleus; then effect of its neutron-proton ratio will **[1]**

   a) either remain same or increase

   b) remain same

   c) decrease

   d) increase

4. An atom of mass number 15 and atomic number 7 captures an $\alpha$-particle and then emits a proton. The mass number and atomic number of the resulting atom will be respectively. **[1]**

   a) 18 and 8

   b) 16 and 4

   c) 14 and 2

   d) 15 and 3

5. What percent of original radioactive substance is left after 5 half life times? **[1]**

   a) 20%

   b) 3%

   c) 5%

   d) 10%

6. Nuclear fission is best explained by **[1]**

   a) independent particle model of the nucleus

   b) proton-proton cycle

   c) liquid droplet theory

   d) Yukawa $\pi$-meson theory

7. Charge on nucleus is: **[1]**

   a) neutral

   b) negative

   c) zero

   d) Positive

8. Two nuclei have their mass numbers in the ratio of 1 : 27. What is the ratio of their nuclear densities? **[1]**

   a) 1 : 3

   b) 1 : 1

   c) 1 : 27

   d) 1 : 9

9. Which one is not possible? **[1]**

a) ${}_1H^2 + {}_1H^2 \rightarrow 2He^4$

b) ${}_8O^{16} + {}_0n^1 \rightarrow {}_7N^{14} + 3\ {}_1H^1 + 2\ {}_{-1}\beta^0$

This reaction is not balanced properly.

c) ${}_{16}S^{32} + {}_1H^1 \rightarrow {}_{17}Cl^{35} + {}_2He^4$

d) ${}_7N^{14} + {}_0n^1 \rightarrow {}_7N^{16} + {}_1H^1$

10. Which of the following is the best nuclear fuel? **[1]**

a) Uranium - 236

b) Plutonium - 239

c) Thorium - 236

d) Neptunium - 239

11. A proton moving with **u** m/s strikes a stationary nucleus of mass A. The ratio of final to initial kinetic energy of proton is **[1]**

a) $\frac{(1-A)^2}{(1+A)^2}\frac{(1-u^2)}{(1+u)}$

b) $\frac{A^2}{(A+1)^2}\frac{(1+u^2)}{(1-u^2)}$

c) $\frac{A^2}{(A-1)^2}$

d) $\frac{(1-A)^2}{(1+A)^2}$

12. In the nucleus of ${}_{11}Na^{23}$, the number of protons, neutrons and electrons are **[1]**

a) 12, 11, 0

b) 11, 12, 0

c) 23,12,11

d) 23, 11, 12

13. X amount of energy is required to remove an electron from its orbit and Y amount of energy is required to remove a nucleon from the nucleus. **[1]**

a) X = Y

b) $X \geq Y$

c) Y > X

d) X > Y

14. The size of nucleus of an atom of mass number A is proportional to **[1]**

a) $A^{5/3}$

b) $A^{1/3}$

c) $A^{2/3}$

d) $A^{3/4}$

15. The density of nuclear matter is of the order of: **[1]**

a) $10^{27}$ kg/m$^3$

b) $10^{17}$ kg/m$^3$

c) $10^{12}$ kg/m$^3$

d) $10^3$ kg/m$^3$

16. Which of the following statements is **not** true for nuclear forces? **[1]**

a) They saturate as the separation between two nucleons increases.

b) They have about the same magnitude for different pairs of nucleons.

c) They are stronger than Coulomb forces.

d) They are always attractive.

17. The binding energy of deuteron is 2.2 MeV and that of ${}^4_2He$ is 28 MeV. If two deuterons are fused to form one ${}^4_2He$, then the energy released is **[1]**

a) 23.6 MeV

b) 19.2 MeV

c) 30.2 MeV

d) 5.8 MeV

18. The ratio of the nuclear densities of two nuclei having mass numbers 64 and 125 is **[1]**

a) 1

b) $\frac{64}{125}$

c) $\frac{5}{4}$

d) $\frac{4}{5}$

19. In an atomic bomb, the energy is released due to **[1]**

a) chain reaction of neutrons and $_{92}U^{236}$

b) chain reaction of neutrons and $_{92}U^{240}$

c) chain reaction of neutrons and $_{92}U^{238}$

d) chain reaction of neutrons and $_{92}U^{235}$

20. What is the rest mass energy of an electron? **[1]**

a) 0.51 MeV

b) 1 eV

c) 931 MeV

d) 831 MeV

21. The mass equivalent to $10 \times 10^5$ kWh energy will **[1]**

a) $4 \times 10^{-5}$ kg

b) $8 \times 10^{-5}$ kg

c) $5 \times 10^{-5}$ kg

d) $3 \times 10^{-5}$ kg

22. The mass of a neutron is the same as that of: **[1]**

a) an electron

b) a meson

c) a proton

d) a positron

23. The mass of neutron and proton are 1.0087 u and 1.0073 u respectively. If the neutrons and protons combine to form a helium nucleus of mass 4.0015 u, the binding energy of the helium nucleus will be: **[1]**

a) 27.3 MeV

b) 20.8 MeV

c) 14.2 MeV

d) 28.4 MeV

24. One milligram of matter converted into energy, will give **[1]**

a) $9 \times 10^3$ joule

b) 9 joule

c) $9 \times 10^5$ joule

d) $9 \times 10^{10}$ joule

25. Which of the following particles can be added to the nucleus of an atom without changing its chemical properties? **[1]**

a) Alpha Particles

b) Electrons

c) Neutrons

d) Protons

26. A nucleus represented by the symbol $_ZX^A$ has: **[1]**

a) Z protons and A neutrons

b) Z neutrons and A - Z protons

c) A protons and Z - A neutrons

d) Z protons and A - Z neutrons

27. If $M_o$ is the mass of an oxygen isotope $_8O^{17}$, $M_p$ and $M_n$ are the masses of a proton and neutron respectively, the nuclear binding energy of the isotope is: **[1]**

a) $(8\ M_p + 9\ M_n - M_o)\ c^2$

b) $(M_o - 8\ M_p)\ c^2$

c) $(M_o - 17\ M_n)\ c^2$

d) $(M_o - 8\ M_p - 9\ M_n)\ c^2$

28. Nucleus of an atom of mass no. 24 and charge no. 11 consists of **[1]**

a) 11 protons and 13 neutrons

b) 11 electrons, 11 protons and 13 neutrons

c) 11 protons and 13 electrons

d) 11 electrons, 11 protons and 11 neutrons

29. The radioactive decay of uranium into thorium is represented by the equation $^{238}_{92}U \rightarrow ^{234}_{90}Th + x$. What is x? **[1]**

a) an alpha particle
b) an electron
c) a neutron
d) proton

30. $M_n$ and $M_p$ represent the mass of neutron and proton respectively. An element having mass M has N neutrons and Z protons, then the correct relation will be **[1]**

a) M ~ N[$M_n$ + $M_p$]
b) M > [N$M_n$ + Z - $M_p$]
c) M = [N - $M_n$ + Z -$M_p$]
d) M < [N - $M_n$ + Z - $M_p$]

31. $r_1$ and $r_2$ are the radii of atomic nuclei of mass numbers 64 and 27 respectively. The ratio $\frac{r_1}{r_2}$ is **[1]**

a) $\frac{27}{64}$
b) $\frac{3}{4}$
c) $\frac{4}{3}$
d) $\frac{64}{27}$

32. The mass of a nucleus in its ground state is **[1]**

a) greater than the total mass of neutrons and protons.
b) less than the total mass of neutrons and protons.
c) equal to the total mass of neutron, protons and electrons.
d) equal to the total mass of neutrons and protons.

33. A nucleus represented by the symbol $^{A}_{z}X$ has **[1]**

a) Z protons and A neutrons
b) A protons and Z - A neutrons.
c) Z protons and A -Z neutrons
d) Z neutrons and A -Z protons

34. What amount of energy is released by deuterium and tritium fusion? **[1]**

a) 12.6 eV
b) 60.6 eV
c) 17.6 eV
d) 28.3 eV

35. In nuclear reaction: **[1]**

$_2\text{He}^4 + {}_zX^A \longrightarrow {}_{Z+2}Y^{A+3} + {}_z \cdot M^A$

where M denotes

a) neutron
b) positron
c) electron
d) proton

36. A radioactive element X has atomic number Z and atomic mass number A. It decays by the emission of an alpha particle and a gamma ray. The new element is **[1]**

a) $^{A-4}_{Z-2}Y$
b) $^{A-2}_{Z-2}Y$
c) $^{A+4}_{Z+2}Y$
d) $^{A+1}_{Z}Y$

37. A nuclear reaction is given below. The masses in amu of reactant and product nuclei are given in brackets: **[1]**

$\underset{(1.002)}{\text{A}} + \underset{(1.004)}{\text{B}} \longrightarrow \underset{(1.001)}{\text{C}} + \underset{(1.003)}{\text{D}} + \mathbf{QMev}$

The value of energy Q is

a) 0.465 MeV
b) 1.862 MeV
c) 1.234 MeV
d) 0.91 MeV

38. What is missing in the following nuclear reaction? **[1]**

$_1H^2 + _1H^2 \longrightarrow _2He^3 + ?$

a) meson

b) electron

c) neutron

d) positron

39. A freshly prepared radioactive source of half-life 2h emits radiation of intensity which is 64 times the permissible safe level. Calculate, the minimum time after which it would be possible to work safely with this source. **[1]**

a) 12 h

b) 6 h

c) 24 h

d) 130 h

40. In the reaction $_1^2H + _1^3H \rightarrow _2^4He + _0^1n$, if the binding energies of $_1^2H$, $_1^3H$ and $_2^4H$ are respectively a, b and c (in MeV), then the energy (in MeV) released in this reaction is **[1]**

a) c - a - b

b) c + a - b

c) a + b - c

d) a + b + c

41. When a hydrogen bomb explodes, which of the following is used? **[1]**

a) Nuclear Fusion

b) Nuclear Fission

c) Both nuclear fusion and nuclear fission

d) Neither nuclear fission nor nuclear fusion

42. The radius of $_{13}^{27}X$ nucleus is R. The radius of $_{53}^{125}Y$ nucleus will be **[1]**

a) $\frac{5}{3}R$

b) $\left(\frac{13}{53}R\right)^{1/3}$

c) $\left(\frac{5}{3}R\right)^{1/3}$

d) $\left(\frac{13}{53}\right)^{1/3}R$

43. _____ has the mass closest to the mass of positron. **[1]**

a) Neutron

b) Neutrino

c) Electron

d) Proton

44. A neutron can cause fission in **[1]**

a) uranium-238

b) thorium

c) hydrogen

d) uranium-235

45. In any nuclear reaction the reactants and the resultants must always be in conformity with the law of conservation of **[1]**

a) mass number alone

b) energy alone

c) charge number alone

d) both charge and mass number

46. The energy released when 1 a.m.u. of mass is completely converted into energy is **[1]**

a) 391 MeV

b) 931 MeV

c) 1 MeV

d) 797 MeV

47. The gravitational force between an H-atom and another particle of mass m will be given by Newton's law: **[1]**

F = $G\frac{M.m}{r^2}$, where r is in km and

a) M is not related to the mass of the hydrogen

b) M = $M_{proton}$ + $M_{electron}$ - $\frac{BE}{c^2}$(BE = 13.6

atom

eV)

c) $M = m_{proton} + m_{electron}$

d) $M = m_{proton} + m_{electron} - \frac{|V|}{c^2}$ (|V| = magnitude of the potential energy of electron in the H-atom)

48. Only proton contributes positive charge for the nucleus as: **[1]**

a) charge on neutrons balanced with charge on electrons

b) positive charge on neutrons discharges

c) neutrons are not present inside the nucleus

d) neutrons are electrically neutral entities

49. When a nucleus emits a photon, what happens to its atomic number and its actual mass? **[1]**

a) Its atomic number and its actual mass both increase

b) Its atomic number remains the same but its actual mass decreases

c) Its atomic number and its actual mass both decrease

d) Its atomic number and its actual mass remain unchanged

50. A nucleus of uranium decays at rest into nuclei of thorium and helium. Then **[1]**

a) The helium nucleus has more momentum than the thorium nucleus.

b) The helium nucleus has less momentum than the thorium nucleus.

c) The helium nucleus has more kinetic energy than the thorium nucleus.

d) The helium nucleus has less kinetic energy than the thorium nucleus.

51. The mass number of a nucleus is **[1]**

A. always less than its atomic number

B. always more than its atomic number

C. sometimes equal to its atomic number

D. sometimes less than and sometimes more than its atomic number.

a) (C)

b) (B)

c) (D)

d) (A)

52. The binding energy per nucleon is maximum in case of **[1]**

a) $^{235}_{92}\mathrm{U}$

b) $^{4}_{2}\mathrm{He}$

c) $^{141}_{56}\mathrm{Ba}$

d) $^{56}_{26}\mathrm{Fe}$

53. The volume of the nucleus is: **[1]**

a) directly proportional to the number of neutrons

b) directly proportional to the number of mesons

c) directly proportional to the atomic number

d) directly proportional to the mass number

54. Two spherical nuclei have mass numbers 216 and 64 with their radii $R_1$ and $R_2$ respectively. The ratio, $\frac{R_1}{R_2}$ is equal to **[1]**

a) 1 : 3

b) 3 : 2

c) 1 : 2

d) 2 : 3

55. $X(n,\alpha)^{7}_{3}\mathrm{Li}$, then X will be **[1]**

a) $^{9}_{5}$ B

b) $^{11}_{4}$ Be

c) $^{10}_{5}$ B

d) $^{4}_{2}$He

56. Which of the following has the highest neutron ratio? **[1]**

A. $_{8}O^{16}$

B. $_{2}He^{4}$

C. $_{26}Fe^{56}$

D. $_{92}U^{235}$

a) (C)

b) (B)

c) (D)

d) (A)

57. In a nuclear reaction which of the following is conserved? **[1]**

a) Charge

b) Sum of mass and energy

c) Momentum

d) All of these

58. In a fission reaction **[1]**

$^{236}_{92}\text{U} \rightarrow {}^{117}X + {}^{117}Y + n + n$

the binding energy per nucleon of X and Y is 8.5 MeV whereas that of $^{236}$U is 7.6 MeV. The total energy liberated will be about

a) 2000 MeV

b) 200 keV

c) 2 MeV

d) 200 MeV

59. Calculate power output of $^{235}_{92}U$ reactor, if it takes 30 days to use up 2 kg of fuel, and if each fission gives 185 MeV of useable energy. Avogadros number = $6 \times 10^{23}$ mol$^{-1}$. **[1]**

a) 54.3 MW

b) 58.3 MW

c) 56.3 MW

d) 60.3 MW

60. The binding energies per nucleon for deuteron and an $\alpha$-particle are $x_1$ and $x_2$ respectively. The energy Q released in the reaction **[1]**

$^{2}\text{H}_1 + {}^{2}\text{H}_1 \rightarrow {}^{4}\text{He}_2 + Q$ is

a) $2(x_2 - x_1)$

b) $2(x_1 + x_2)$

c) $4(x_1 + x_2)$

d) $4(x_2 - x_1)$

61. What is the main source of energy of the sun? **[1]**

a) Gravitational energy liberated during the slow contraction of the sun.

b) Nuclear fission of heavier unstable elements in the sun.

c) Combustion of pure carbon present in the sun.

d) Nuclear fusion of lighter elements in the sun.

62. The origin of nuclear force is ascribed to the exchange of the following particle between a pair of nucleons **[1]**

a) photon

b) mu-meson

c) electron

d) $\pi$-meson

63. A nucleus ${}_{n}X^{m}$ emits one alpha and two beta particles. The resulting nucleus is: **[1]**

a) ${}_{n-2}X^{m-4}$ b) ${}_{n-4}X^{m-4}$

c) ${}_{n}X^{m-4}$ d) ${}_{n}X^{m-5}$

64. When a nucleus in an atom undergoes radioactive decay, the electronic energy levels of the atom **[1]**

a) do not change for any type of radioactivity b) change for $\beta$-radioactivity but not for others

c) change for $\alpha$-radioactivity but not for others d) change for $\alpha$ and $\beta$ radioactivity but not for $\gamma$-radioactivity

65. The binding energies per nucleon of deuteron ${}_{1}H^{2}$ and helium (${}_{2}He^{4}$) nuclei are 1.1 MeV and 7 MeV respectively. If two deuterons fuse together to form a helium nucleus, then energy produced is: **[1]**

a) 5.9 MeV b) 23.6 MeV

c) 26.9 MeV d) 32.4 MeV

66. The ratio of the radii of the nuclei ${}_{14}A^{27}$ and ${}_{52}Te^{125}$ Te is approximately **[1]**

a) 40 : 17 b) 6 : 10

c) 13 : 52 d) 14 : 73

67. A nuclear reactor delivers a power of 10 W. Find fuel consumed by the reactor per hour, if its efficiency is 20% (Given, c = $3 \times 10^{8}$ m/s) **[1]**

a) $8 \times 10^{-9}$ g/hr b) $2 \times 10^{-9}$ g/hr

c) $9 \times 10^{-12}$ g/hr d) $2 \times 10^{-6}$ g/hr

68. If radius of the ${}^{27}_{13}Al$ nucleus is taken to be $R_{Al}$, then the radius of ${}^{125}_{53}Te$ nucleus is nearly **[1]**

a) $\frac{3}{5}R_{Al}$ b) $\frac{5}{3}R_{Al}$

c) $\left(\frac{13}{53}\right)^{1/3}R_{Al}$ d) $\left(\frac{53}{13}\right)^{1/3}R_{Al}$

69. Atomic weight of Boron is 10.81 and it has two isotopes ${}_{5}B^{10}$ and ${}_{5}B^{11}$. Then the ratio of ${}_{5}B^{10}$ : ${}_{5}B^{11}$ in nature would be **[1]**

a) 10 : 11 b) 15 : 16

c) 19 : 81 d) 81 : 19

70. Nuclear binding energy is equivalent to: **[1]**

a) Mass of proton b) Mass of neutron

c) Mass of nucleus d) Mass defect of the nucleus

71. The radius of nucleus is: **[1]**

a) not related to its mass number b) inversely proportional to its mass number

c) proportional to its mass number d) proportional to the cube root of its mass number

72. The mass density of a nucleus varies with mass number A as **[1]**

a) $A^2$

b) constant

c) A

d) $\frac{1}{A}$

73. The reaction responsible for the production of light energy from the sun is **[1]**

a) fission

b) nuclear

c) scission

d) fusion

74. Number of neutrons emitted per fission is 1.6 when the energy released per fission is 200 MeV. the number of neutrons emitted per second when 20 MW power is generated will be **[1]**

a) $3.9 \times 10^{19}$

b) $10^{18}$

c) $10^{19}$

d) $3.9 \times 10^{20}$

75. The constituents of atomic nuclei are believed to be **[1]**

a) protons only

b) neutrons and protons

c) electrons, protons and neutrons

d) electrons and protons