Unit: 8. Nuclear Physics (25 marks)	
1 mark → 4 Questions	5 mark → 1 Question 60
3 mark → 2 Questions 44,45	10 mark → 1 Question 68,

UNIT – 8. Nuclear Physics – 1 mark Questions

1. Isotope have ---- [O-10]
a) same mass number but different atomic numbers
b) same proton number and neutron number
c) same proton and different neutron numbers
d) same neutron number and different proton numbers

2. Which of the following are isotones? ----- [M-11]
a) $_{92}U^{235}$ and $_{92}U^{138}$ b) $_{8}O^{16}$ and $_{7}N^{14}$
c) $_{6}C^{14}$ and $_{7}N^{14}$ ***d) $_{7}N^{14}$ and $_{6}C^{13}$***

3. When mass number increases, nuclear density ----- [J-11]
a) increases b) decreases
c) remains constant d) may increase (or) decrease

4. Positive rays of the same element produces two different traces in Bainbridge spectrometer. The positive ions have ---
a) same mass with different velocities
b) same mass with same velocity
c) different masses with same velocity
d) different masses with different velocities [M-12]

5. Based on quark model a neutron is represented as --
a) uud ***b) udd*** c) udd' d) u'du [J,O-06] – omitted

6. The nuclear fission can be explained by -----
a) shell model ***b) liquid drop model***
c) quark model d) Bohr atom model [J-11,13]

7. The ionization power is maximum for ----- [DPM,M-12,O-10]
a) neutrons ***b) alpha particle***
c) gamma rays d) beta partiles

8. The penetrating power is maximum for ----- [O-06]
a) α- particle b) β- particles
c) γ rays d) protons

9. Arrange the α,β and γrays in the increasing order of their ionizing power: ----- [M-11]
a) α β γ b) β α γ ***c) γ β α*** d) γ α β

10. In a β decay, ---- [M-09, S-09]
a) atomic number decreases by one b) mass number decreases by one
c) proton number remains the same
d) neutron number decreases by one

11. The nucleons in a nucleus is attracted by --- [J-12]
a) gravitational force b) electrostatic force
c) nuclear force d) magnetic force

12. The nuclear force between a proton and another proton inside the nucleus is -----
a) zero ***b) short range***
c) repulsive d) long range [O-11]

13. Nuclear force is due to the continuous exchange of particles called ---- [M-06, M-09, S-09]
a) leptons ***b) mesons*** c) hyperons d) photons

14. The particles which exchange between the nucleons and responsible for the origin of the nuclear force are ---- [J-07]
a) photons b) leptons ***c) mesons*** d) baryons

15. The energy released per fission is [J-13]
a) 200 eV ***b) 200 MeV*** c) 200meV d) 200GeV

16. The radioisotopes used in agriculture is ----
a) $_{15}P^{32}$ b) $_{11}Na^{23}$
c) $_{15}P^{31}$ d) $_{11}Na^{24}$ [J-06, J-08,S-08S-09,M-11,S-12]

17. Anemia can be diagnosed by ---
a) $_{15}P^{31}$ b) $_{15}P^{32}$
c) $_{26}Fe^{59}$ d) $_{11}Na^{24}$ [M-07,J-07,J-09,M-10,J-11]

18. The radio-isotope used in the treatment of skin disease is : [J-13]
a) Na^{21} b) I^{131}
c) Fe^{59} ***d) P^{32}***

19. Which of the following is used to detect the presence of blocks in blood vessels? ---
a) $_{15}P^{31}$ b) $_{15}P^{32}$
c) $_{26}Fe^{59}$ ***d) $_{11}Na^{24}$*** [M-08]

20. The moderator used in nuclear reactor is ---- [M-07]
a) Cadmium b) Boron carbide
c) Heavy water d) Uranium ($_{92}U^{235}$)

21. Which of the following is not moderator ------- [J-07]
a) Liquid sodium b) Ordinary water
c) Graphite d) Heavy water

22. The coolant used in fast breeder reactor is -----
a) ordinary water b) heavy water
c) liquid sodium d) boron carbide [O-10]

23. In a nuclear reactor, cadmium rods are used to -------
a) speed up neutrons b) slow down neutrons
c) absorb neutrons d) remove heat

24. The fuel used in Kamini (Kalpakkam mini reactor) is ---- [S-09]
a) mixture of carbides of uranium and plutonium
b) mixture of oxides of uranium and plutonium
c) $_{92}U^{233}$ d) $_{92}U^{235}$

25. The fuel used in Kamini reactor is ---
a) $_{92}U^{238}$ ***b) $_{92}U^{233}$***
c) $_{92}U^{239}$ d) low enriched uranium [S-07]

26. The explosion of atom bomb is based on -- [J-09,M-10,J-10,M-11]
a) Uncontrolled fission reaction b) controlled fission reaction
c) fusion reaction d) thermonuclear reaction

27. Hydrogen bomb is based on the principle of ----
a) nuclear fission ***b) nuclear fusion***
c) nuclear force d) carbon nitrogen cycle [O-11,M-12]

28. Slow neutrons are neutrons having energies between ---
a) 1000 eV to 2000 eV b) 2000 eV to 0.5 eV
c) 0 to 1000 eV d) 0.5 MeV to 10 MeV

29. 1 Curie is : [M-13]
a) activity of I gram of uranium b) 1 disintegration/second
c) 3 x 10^{10} becquerrel d) 1.6 x 10^{12} isintegration/second

30. The unit of disintegration constant is ------
a) no unit b) second
c) second $^{-1}$ d) curie [M-12]

31. In proton-proton cycle four protons fuse together to give ---- [S-12]
a) an α particle, two electrons, two neutrinos and energy of 26.7 MeV
b) an α particle, two positrons,two neutrinos and energy of 26.7 MeV
c) a helium atom, two positrons, two neutrinos and energy of 26.7 MeV
d) an α particle,two positrons, two anti-neutrinos and energy of 26.7 MeV

32. The cosmic ray intensity is maximum at a latitude of ----
a) 0^0 b) 45^0 ***c) 90^0*** d) 60^0 [O-11]

33. Particle that has no charge and no mass but travels with velocity of light is ------
a) baryon b) meson
c) lepton ***d) photon*** [S-08]

34. Which of the following is massless and chargeless but carrier of energy and spin? ---- [J-12]
a) neutrino b)muon
c) pion d) kaon

35. Photon has
a) energy but zero mass b) mass but zero energy
c) zero mass & zero energy d) infinite mass & energy

36. Which of the following belongs to Baryon group ? ---
a) photon b) electron
c) pion ***d) proton*** [M-10]

37. Which of the following is lepton --------
a) electron b) proton
c) neutron d) π- meson [M-06]

UNIT – 8. Nuclear Physics – 1 mark Problems

1. The mass defect of certain nucleus is 0.03 amu. Then its binding energy is ----
a) 27.93 eV b) 27.93 keV
c) 27.93 GeV ***d) 27.93 MeV*** [J-12]

2. 1 amu is equal to ------- [O-06,S-08,J-08]
a) 931 eV b) mass of carbon atom
c) mass of one proton ***d) 1.66 x 10^{-27} kg***

3. The energy equivalent of 1 amu is ----- [J-09]
a) 931 MeV b) 931 meV c) 931 eV d) 913 MeV

4. The binding energy of $_{26}Fe^{56}$ nucleus is --- [S-07,J-10,J-11]
a) 8.8 MeV b) 88 MeV ***c) 493 MeV*** d) 41.3 MeV

5. The nuclei $_{13}Al^{27}$ and $_{14}Si^{28}$ are examples of ----
a) isotopes b) isobars
c) isotones d) isomers [S-07,M-08]

6. The nuclear radius of $_4Be^8$ nucleus is : [M-13]
a) 1.3 x 10^{-15} m ***b) 2.6 x 10^{-15} m***
c) 1.3 x 10^{-13} m d) 2.6 x 10^{-13} m

7. If the nuclear radius is 2.6 x 10^{-15} m, the mass number will be -
a) 2 b) 4 ***c) 8*** d) 16 [S-12]

8. The radius of nucleus is 5.2 F. The number of nucleons in the nucleus is ---- [J-08]
a) 2 b) 104 ***c) 64*** d) 128

9. The mean life of (τ) and half-life ($T_{1/2}$) of a radioactive element are related as ---
a) $\tau = 2T_{1/2}$ ***b) $\tau = T_{1/2}/0.6931$***
c) $\tau = 0.6931T_{1/2}$ d) $T_{1/2}/2$ [M-08]

10. The half-life of certain radioactive element disintegration consatant 0.06931 per day is ----- [S-07,08,09, J-12]
a) 10 days b) 14 days c) 1 day d) 100 days

11. The half-life of radioactive element is 300 days. The disintegration constant of radioactive element is ----
a) 0.00231 day ***b) 0.00231 / day***
c) 0.0231 / day d) 0.0231 day [M-09]

12. The mean life of radon is 5.5 days. Its half-life is -----
a) 8 days b) 2.8 days
c) 0.38 days ***d) 3.8 days*** [J-09]

13. The half-life period of N^{13} is 10.1 minute. Its life time is ------
a) 5.05 minute b) 20.2 minute
c) 10.1/0.6931 ***d) ifinity*** [O-10,M-13]

14. According to the law of disintegration $N = N_0e^{-\lambda t}$, the number of radioactive atoms that have been decayed during a time t is -----
a) N_0 b) N ***c) $N_0 - N$*** d) $N_0/2$ [O-10]

15. When $_5B^{10}$ is bombarded with neutron an α particle is emitted, the residual nucleus is [DPM]
a) $_3Li^7$ b) $_1H^2$ c) $_1H^3$ d) $_2He^4$

16. In the nuclear reaction, $_{80}Hg^{198} + X \rightarrow {}_{79}Au^{198} + {}_1H^1$, X stands for --- [J-08, M-09]
a) Proton b) electron ***c) neutron*** d) deuteron

17. In the nuclear reaction, $_4Be^9 + X \rightarrow {}_{12}C^{12} + {}_1n^0$, X stands for ---
a) Proton ***b) alpha particle***
c) electron d) deuteron [M-10]

18. In the following nuclear reaction, $_7N^{14} + {}_0n^1 \rightarrow X\ {}_1H^1$ the element X is
a) $_6N^{14}$ ***b) $_6C^{14}$***
c) $_6O^{14}$ d) $_7C^{13}$ [M-06]

19. $_{13}Al^{27} + {}_2He^4 \rightarrow X + {}_0n^1$ the element X is ------
a) $_{15}Si^{30}$ ***b) $_{15}P^{30}$*** c) $_{15}S^{30}$ d) $_{15}Si^{29}$ [O-06]

20. If 1 kg of substance is fully converted into energy, the energy produced is ----
a) 9 x 10^{16} J b) 9 x 10^{24} J
c) 1 J d) 3 x 10^{18}J [O-10]

21. In a β - decay (M,O-09)
a) atomic number decreases by one
b) mass number decreases by one
c) number of proton remains the same
d) nutron number decreases by one

22. An element zX^A successively undergoes three α decays and four β decays and gets converted to an element Y. The mass number and atomic number of the element Y are respectively
a) A – 12, Z- 2 b) A- 12, Z+ 2
c) A-12, Z+2 d) A – 8, Z +2 [J-07]

23. A radioactive elemnt $_zX^A$ after emitting three α- particles and four β- particles is converted into an element Y represented as [M-08]
a) $_{Z-6}Y^{A-12}$ b) $_{Z+2}Y^{A-12}$ c) ***$_{Z-2}Y^{A-12}$*** d) $_{Z-10}Y^{A-12}$

24. The numbers of α and β particles emitted when an isotope $_{92}U^{238}$ undergoes α and β decays to form $_{82}Pb^{206}$ are respectively ------
a) 6 , 8 b) 4 ,3
c) 8, 6 d) 3 ,4 [M-07]

25. The time taken by the radioactive element to reduce 1/e time is ----
a) half life ***b) mean life***
c) half life /2 d) twice the mean life [DPM,M-12,J-13]

26. The time taken by the radioactive element to reduce $e^{-1/2}$ times its original amount is its ------ [J-06]
a) half life period b) half life period/2
c) mean half-life period ***d) mean life period/2***

UNIT – 8. Nuclear Physics – 3 mark Questions

1. What is mass defect? [O-10]
2. What is α decay? Give example. [DPM,J-06,M-13]
3. Write any three properties of neutron. [J-06,M-08,O-11]
4. What is binding energy of a nucleus? [S-09]
5. Write any 3 conclusions from binding energy curve [O-06M-08]
6. Write any three properties of nuclear forces. [J-08,M-09,J-11]
7. What do you mean by artificial radioactivity [J-12,S-12]
8. Define curie. [DPM, O-06,10,M-08,10,J-13]

9. Define Roentgen. [J-07,S-08]
10. Write proton-proton cycle that takes place in sun and stars. [M-11]
11. Define critical and critical mass. [S-08]
12. What are the uses of nuclear reactors? [J-11,M-13]
13. What is the use of control rod in the reactor? Mention any two control rods. [S-07]
14. What is meant by breeder reactor? [M-09]
15. Write a note on leptons. [J-07,M-12]
16. What are cosmic rays? [J-08,10]
17. How do you classify the neutrons in terms of its kinetic energy [J-09]
18. What is pair production and annihilation of matter?[M-06,J-06,M-07]

UNIT – 8. Nuclear Physics – 3 mark Problems

1. Select the pairs of isotopes, isobars and isotones from the following nuclei: $_{11}Na^{22}$, $_{12}Mg^{24}$, $_{11}Na^{24}$, $_{10}Ne^{23}$. [M-12]
2. The half- life of radon is 3.8 days. Calculate its mean life. [M-07,S-09,J-10]
3. The half-life of $_{84}Po^{218}$ is 3 minutes. What percentage of the sample has decayed in 15 minutes? [S-07,J-13]
4. The radioactive isotope $_{84}Po^{214}$ undergoes a successive disintegration of two α decays and two β decays. Find the atomic number and mass number of the resulting isotope. [J-09]
5. Tritium has a half-life of 12.5 years. What fraction of the sample will be left over 25 years? [M-10]
6. Tritium has a half-life of 12.5 years. What fraction of the sample will be left over 50years? [J-12,S-12]
7. What percentage of given radioactive substance will be left afte 5 half-life periods? [M-11]
8. Calculate the number of atoms in one gram of $_3Li^6$. (Avagadro number = 6.023×10^{23}) [O-11]

UNIT – 8. Nuclear Physics – 5 mark Questions

1. Explain Soddy-Fajan's radioactive displacement laws [M-11]
2. Explain the properties of neutrons [J-13]
3. Write notes on biological hazards of radiations. [S-08]
4. Explain how cosmic ray shower is formed. [M-07,J-12]
5. Explain the latitude effect of cosmic rays. [J-09]
6. Write the properties of α - rays. [S-10,O-10]

UNIT – 8. Nuclear Physics – 5 mark Problems

1. Calculate the binding energy and binding energy per nucleon of $_{20}Ca^{40}$ nucleus. Given: mass of 1 proton = 1.007825 amu; mass of 1 neutron = 1.008665 amu; mass of $_{20}Ca^{40}$ = 39.96259 amu. or
2. Calculate the energy released when two $_1H^2$ nuclei fuse together to form a single $_2He^4$ nucleus. Given the binding energies per nucleon of $_1H^2$ and $_2He^4$ are 1.1 MeV and 7.0 MeV respectively. [S-12] Or
3. Calculate the energy released in the following equation: $_{13}Al^{27} + {}_1H^2 \rightarrow {}_{12}Mg^{25} + {}_2He^4$. Given the mass of $_{13}Al^{27}$ nucleus = 26.981535 amu. Mass of $_1H^2$ = 2.014102 amu. Mass of $_{12}Mg^{25}$ = 24.98584 amu. Mass of $_2He^4$ nucleus = 4.002604 amu. [S-12]
4. The binding energy per nucleon for $_6C^{12}$ nucleus is 7.68 MeV $_6C^{13}$ is 7.47 MeV. Calculate th neutron from energy required to remove a $_6C^{13}$ nucleus. [M-09]
5. If the mass defect of the nucleus $_6C^{12}$ is 0.098 amu,then calculate the binding energy per nucleon. [J-07]
6. Calculate the energy released in the following equation: $_3Li^6 + {}_0n^1 \rightarrow {}_2He^4 + {}_1H^3$. Given the mass of $_3Li^6$ nucleus = 6.015126 amu. Mass of $_0n^1$ = 1.008665 amu. Mass of $_2He^4$ = 4.002604 amu. Mass of $_1He^3$ nucleus = 3.016049 amu. [O-11]
7. The disintegration constant λ of a radioactive element is 0.00231 per day. Calculate its half-life and mean life. [M-10]
8. Calculate the time required for 60% of a sample of radon to undergo decay. Given $T_{1/2}$ of radon = 3.8 days. (M-08,13)
9. A piece of bone from an archeological site is found to give a count rate of 15 counts per minute. A similar sample of fresh bone gives a rate of 19 counts per minute. Calculate the age of the specimen. (Given $T_{1/2}$ = 5570 years) or [O-11]
10. A reactor is developing energy at the rate of 32 MW. Calculate the required number of fission of fissions per second of $_{92}U^{235}$. Assume the energy per fission is 200 MeV. [J-06,J-08,S-09,J-11]
11. Show that the mass of radium ($_{88}Ra^{226}$) with an activity of 1 curie is almost a gram.(Given $T_{1/2}$ = 1600 years, 1curie = 3.7×10^{10} disintegrations per second) [O-06,M-08,12]
12. Calculate the energy released when 1 kg of $_{92}U^{235}$ undergoes nuclear fission. Assume, energy per fission is 200 MeV Calculate the mass of coal required to produce the same energy as that produced by the fission of 1 kg of U^{235}. Given: heat of combustion of coal = 33.6×10^6J/kg, 1 ton = 1000 kg. Energy per fission of U^{235} = 200 MeV. 1eV = 1.6×10^{-19}J. Avogadro number = 6.023×10^{23}. Express your answer in kilowatt hour also. [dpm M-06,J-08]

UNIT – 8. Nuclear Physics – 10 mark Questions

1. Describe Bainbridge mass spectrometer to determine the isotopic masses of nuclei. [DPM,J-06,J-07, O-07,08,M-09,J-10,O-10,J-11,S-12]
2. Explain the construction and working of GM counter. [M-07,S-07,J-09,M-11,M-13]
3. Obtain an expression for the amount of radioactive substance present at any moment. Obtain the relation between half life and decay constant. [S-08,09,M-12]
4. What are cosmic rays? Explain the latitude effect of cosmic rays? [M-08,10, J-13]
5. State the law of radioactive disintegration. Obtain the relation $N = N_0 e^{-\lambda t}$. Derive the relation between half-life period and decay constant. [O-11,J-12]
6. What is a nuclear reactor? Explain the functions of i) moderator ii) control rods and iii) neutron reflector. Mention the uses of nuclear reactor. (Diagram not necessary) [M-06]

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