DSE-II

NUCLEAR & PARTICLE PHYSICS

1 MARK QUESTIONS:

1. An unknown chemical element is presented by the following formula: $^{A}_{Z}X$. What is the name of index Z?
   A. Atomic mass number B. Atomic number C. Principle quantum number
   D. Orbital quantum number E. Magnetic quantum number

2. An unknown chemical element is presented by the following formula: $^{A}_{Z}X$. What is the name of index A?
   A. Atomic mass number B. Atomic number C. Principle quantum number
   D. Orbital quantum number E. Magnetic quantum number

3. The atomic number is equivalent to which of the following?
   A. The number of neutrons in the atom. B. The number of protons in the atom.
   C. The number of nucleons in the atom. D. The number of α–particles in the atom.
   E. None of the above

4. The atomic mass number is equivalent to which of the following?
   A. The number of neutrons in the atom. B. The number of protons in the atom.
   C. The number of nucleons in the atom D. The number of α–particles in the atom.
   E. None of the above

5. Which of the following particles has the smallest mass?
   A. Proton B. Electron C. Neutron D. Nucleus E. Nucleon

6. Which of the following statements about the mass of an atom is true?
   A. It is evenly divided between the protons and the orbiting electrons.
   B. It is evenly divided between the nucleons and the orbiting electrons.
   C. It is concentrated in the electron cloud.
   D. It is concentrated in the nucleus.
   E. It is evenly divided between protons, neutrons and orbiting electrons.

7. Which of the following is correct for the number of neutrons in the nucleus?
   A. N = A –Z B. N = Z – A C. N = Z +A D. N = Z E. N = A

8. How many electrons are in the $^{12}_{6}C$ atom?
   A. 12 B. 6 C. 18 D. 3 E. 9

9. How many nucleons are in the $^{20}_{10}Ne$ atom?
   A. 12 B. 30 C. 18 D. 10 E. 20

10. How many neutrons are in the $^{23}_{11}Na$ atom?
    A. 12 B. 11 C. 18 D. 24 E. 9

11. How many protons are in the $^{14}_{7}N$ atom?

A. 14 B. 6 C. 7 D. 10 E. 9

12. What law did Ernest Rutherford use to estimate the size of the nucleus?
    A. Conservation of nucleon number
    B. Conservation of angular momentum
    C. Conservation of linear momentum
    D. Conservation of energy
    E. Conservation of charge

13. Why are nuclear energy levels more complex than electron energy levels?
    A. Nuclear energy levels depend only on attractive forces.
    B. Nuclear energy levels depend on attractive and repulsive forces.
    C. Nuclear energy levels are an order of one hundred times as great as electron energy levels.
    D. Electron energy levels depend on the interaction between neutrons and electrons.
    E. Electron energy levels have greater energy than the nuclear energy levels.

14. Which of the following about the nuclear force is true?
    A. It is an attractive force between electrons and protons in an atom.
    B. It is an attractive force between electrons and neutrons in an atom.
    C. It is much weaker than the electromagnetic force.
    D. It is much weaker than the gravitational force.
    E. It is a strong, short-range, attractive force between the nucleons.

15. What force is responsible for the radioactive decay of the nucleus?
    A. Gravitational force
    B. Weak Nuclear force
    C. Strong Nuclear force
    D. Electromagnetic force

16. Isotopes of an element:
    A. have the same number of protons and electrons, but a different number of neutrons.
    B. have the same number of protons and neutrons, but a different number of electrons.
    C. have different number of protons.
    D. have different number of electrons.
    E. have the same number of neutrons and protons.

17. Binding energy is:
    A. the amount of energy required to break a nucleus apart into protons and neutrons.
    B. the amount of energy required to break a nucleus apart into protons and electrons.
    C. the amount of energy required to break a nucleus apart into electrons and neutrons.
    D. the amount of energy released when neutrons change energy levels.
    E. the amount of energy released when protons change energy levels.

18. If m_H is the atomic mass of Hydrogen, m_n is the mass of a neutron, and M is the atomic mass of the atom, which of the following is the mass defect formula?

A. $\Delta m = Z \cdot m_H + N \cdot m_n - M$ B. $\Delta m = Z \cdot m_H + N \cdot m_n + M$ C. $\Delta m = Z \cdot m_H - N \cdot m_n - M$

D. $\Delta m = Z \cdot m_H - N \cdot m_n + M$ E. $\Delta m = M - Z \cdot m_H - N \cdot m_n$

19. When nucleons form a stable nucleus, binding energy is:

A. created from nothing. B. destroyed into nothing.

C. transformed into visible light. D. absorbed as high energy photons or particles.

E. released as high energy photons or particles.

20. When a nucleus is divided into its constituents, energy is:

A. created from nothing. B. destroyed into nothing.

C. transformed into visible light. D. absorbed by the nucleus which then breaks it apart.

E. released by the nucleus as it breaks apart.

21. An isotope with a high Binding Energy per nucleon:

A. will decay in a short period of time. B. is very unstable.

C. is very stable . D. has very few electrons.

E. has more protons than neutrons.

22. Why do heavier nuclei have a greater ratio of neutrons to protons than lighter nuclei?

A. to add more nucleons so that the binding energy is greater.

B. to provide a greater weak nuclear force.

C. to provide more attractive electromagnetic force.

D. to provide more attractive strong nuclear force to balance the repulsive electromagnetic force.

E. to provide more repulsive strong nuclear force to balance the attractive electromagnetic force.

23. Which of the following is the alpha particle?

A. ${}^{0}_{+1}e$ B. ${}^{0}_{-1}e$ C. ${}^{1}_{0}n$ D. ${}^{1}_{1}H$ E. ${}^{4}_{2}He$

24. Which of the following is the β^- particle?

A. ${}^{0}_{+1}e$ B. ${}^{0}_{-1}e$ C. ${}^{1}_{0}n$ D. ${}^{1}_{1}H$ E. ${}^{4}_{2}He$

25. Which of the following is the β^+ particle?

A. ${}^{0}_{+1}e$ B. ${}^{0}_{-1}e$ C. ${}^{1}_{0}n$ D. ${}^{1}_{1}H$ E. ${}^{4}_{2}He$

26. Which of the following about the gamma ray is true?

A. It carries a positive charge. B. It carries a negative charge.

C. It can be deflected by a magnetic field. D. It can be deflected by an electric field.

E. It has zero rest mass and a neutral charge.

27. Which type of radiation is stopped by a sheet of paper?

A. alpha particle B. beta particle C. Gamma ray

D. X-ray E. Ultraviolet radiation

28. What is the missing element from the following equation $^{226}_{88}Ra \rightarrow ? + ^{4}_{2}He$?

A. $^{230}_{86}Rn$ B. $^{220}_{86}Rn$ C. $^{228}_{86}Rn$ D. $^{222}_{86}Rn$ E. $^{224}_{86}Rn$

29. What is the missing element from the following equation $^{14}_{6}C \rightarrow ? + ^{0}_{-1}e$?

A. $^{13}_{7}N$ B. $^{12}_{6}C$ C. $^{17}_{8}O$ D. $^{16}_{8}O$ E. $^{14}_{7}N$

30. A 100 g sample of a radioactive element has a half-life of 5 days. How many grams of radioactive material will remain after 15 days?

A. 100 g B. 50 g C. 25 g D. 12.5 g E. 0 g

31. A reaction that releases more energy than is put into it is called:

A. endothermic B. exothermic C. nuclear
D. chemical E. radioactivity

32. The following reaction: $^{1}_{0}n + ^{235}_{92}U \rightarrow ^{141}_{56}Ba + ^{92}_{36}Kr + 3^{1}_{0}n$ is called:

A. Fusion B. Fission C. alpha decay D. beta decay E. gamma decay

33. The following reaction: $^{2}_{1}H + ^{3}_{1}H \rightarrow ^{4}_{2}He + ^{1}_{0}n$ is called:

A. Fusion B. Fission C. alpha decay D. beta decay E. gamma decay

1.5 MARK QUESTIONS:

1. What is the relation between mass no. and nuclear radius?
2. What is atomic mass unit?
3. Define binding energy.
4. Define packing fraction.
5. What are magic numbers?
6. What is semi-empirical mass formula?
7. Define half-life period.
8. Define radioactivity.
9. What is nuclear stability?
10. Define parity.
11. What is the Q-value of nuclear reaction?
12. Which quantities are conserved in nuclear reactions?
13. What is dead time of G-M counter?
14. What is recovery time of G-M counter?
15. What do you understand by the energy resolution of a detector?
16. What is a Van de Graaff generator?
17. Describe the principle of a linear accelerator.
18. Quarks come in how many flavours?
19. Write the name of hadron family.
20. What are bosons?
21. What are fermions?
22. What are gauge bosons?
23. What is strangeness?
24. What is isospin?
25. What is glue ball?

2.5 MARK QUESTIONS:

1. Distinguish between Fermions & Bosons?
2. Why are kaons and hyperons strange particles?
3. What is the difference between particle and its antiparticle?
4. $p + p = p + n + \pi^+$ Is the reaction possible?
5. $e^+ + e^- = \mu^- + \sum^+$ Is the reaction possible?
6. What is charge conjugation?
7. How is a neutrino different from an antineutrino?
8. Write the properties of nuclear force?
9. Prove that nuclear density is independent of mass no.?
10. Explain binding energy curve?
11. Give reasons for the non-existence of electrons in the nucleus.
12. Explain nuclear magnetic moment.
13. What are the success of nuclear shell model?
14. What is the use of semi-empirical mass formula?
15. What are the draw backs of liquid drop model?

16. Distinguish between nuclear fission and nuclear fusion.
17. Why are particle accelerators required?
18. What are the disadvantages of a linear accelerator?
19. How does Cyclotron accelerator operate?
20. State the law of radioactivity.

5 MARK QUESTIONS:

1. Explain the postulates of liquid drop model. Give a simple derivation of semi empirical mass formula.
2. Explain fermi gas model of nucleus.
3. Give salient features of nuclear shell model and point out its success and failures.
4. What is radioactivity? State the law of radioactivity. Show that radioactivity decay is exponential in nature.
5. What is β decay? Discuss briefly the selection rules for β decay.
6. What is a nuclear reaction? Discuss conservation laws for nuclear reactions.
7. Explain the working, principle and construction of the G-M counter.
8. Explain the difference between ionization chamber, proportional counter and G-M counter. How is quenching achieved in G-M counter?
9. Explain the principle and working of a scintillation counter.
10. Explain the principle, construction and working of the cyclotron.
11. What are elementary particles? Classify them on the basis of their spin.
12. What are quarks? Give qualitative description of quark model.