Unit 21: Nuclear Physics

107 MCQs. Correct option in bold. 1 mark each.

1. The atomic nucleus is composed of protons and neutrons known as
A. quarks only B. electrons
C. photons **D. nucleons**

2. Thomson's plum pudding model was disproved in 1911 by
A. Rutherford's alpha particle scattering experiment
B. Faraday's experiment
C. Becquerel's experiment
D. Millikan's oil drop experiment

3. About 1 in every _____ alpha particles was deflected by more than 90°.
A. 200 B. 2 **C. 20,000** D. 2,000,000

4. The fact that a few alpha particles bounced back showed that the atom has a
A. uniformly distributed charge **B. small, dense, positive nucleus**
C. no mass at its centre D. negative nucleus

5. The fact that most alpha particles passed through undeflected showed that the atom is
A. mostly empty space B. all positive
C. all negative D. solid throughout

6. Rutherford's model is known as the
A. quantum model **B. nuclear model of the atom**
C. liquid drop model D. plum pudding model

7. The number of protons in a nucleus is called the
A. isotope number B. neutron number
C. mass number **D. atomic number**

8. The atomic number is denoted by
A. N B. A **C. Z** D. P

9. The total number of nucleons in a nucleus is called the
A. mass number B. atomic number
C. neutron number D. charge number

10. The mass number is denoted by
A. M **B. A** C. Z D. N

11. The number of neutrons in a nucleus is
A. A × Z B. Z − A **C. A − Z** D. A + Z

12. A nuclide is a kind of atom with specific values of
A. mass and volume B. charge and volume
C. density only **D. mass number and atomic number**

13. Uranium (Z = 92) has an isotope with mass number 239. The number of neutrons is
A. 239 **B. 147** C. 92 D. 331

14. Polonium-209 (Z = 84) has _____ neutrons.
A. 209 B. 84 C. 293 **D. 125**

15. Isotopes of an element have a different number of
A. neutrons B. electrons
C. atomic number D. protons

16. The three isotopes of hydrogen are protium, deuterium and
A. lithium B. neon **C. tritium** D. helium

17. Deuterium has
A. one proton and one neutron B. two protons and one neutron
C. one proton and no neutron D. one proton and two neutrons

18. Tritium has
A. two protons and one neutron **B. one proton and two neutrons**
C. one proton only D. one proton and one neutron

19. Unstable isotopes that emit radiation to attain stability are called
A. isobars B. stable isotopes
C. isotones **D. radioisotopes**

20. Chlorine-37 and potassium-39 are
A. isobars B. isomers **C. isotones** D. isotopes

21. Radioactivity was accidentally discovered in 1896 by
A. Einstein **B. Henri Becquerel**
C. Marie Curie D. Rutherford

22. Marie Curie and Pierre Curie discovered the elements
A. polonium and radium B. radon and helium
C. uranium and thorium D. cobalt and iodine

23. The natural emission of radiation from unstable nuclei is called
A. fusion B. fission
C. radioactivity D. ionisation

24. The three types of nuclear radiation are
A. alpha, beta and X-rays B. beta, gamma and neutron only
C. X, Y and Z **D. alpha, beta and gamma**

25. An alpha particle is equivalent to a
A. electron **B. helium nucleus**
C. hydrogen nucleus D. photon

26. An alpha particle consists of
A. two protons and two neutrons B. one proton and one neutron
C. two protons and one neutron D. four protons

27. The charge of an alpha particle is _____ times the charge of a proton.
A. one B. four C. three **D. two**

28. A beta particle is a fast moving
A. helium nucleus B. proton
C. electron D. neutron

29. In beta emission, a neutron in the nucleus transforms into a proton and an
A. electron B. alpha particle
C. photon D. neutron

30. In an electric field, beta particles are attracted towards the
A. negative plate B. both plates
C. neither plate **D. positive plate**

31. Gamma rays in an electric or magnetic field are
A. deflected towards the positive plate B. deflected towards the negative plate
C. not deflected D. deflected in circles

32. Beta particles deflect more than alpha particles because they are
A. much heavier **B. much lighter**
C. neutral D. more charged

33. The radiation with the highest ionizing ability is
A. beta B. gamma C. all equal **D. alpha**

34. The radiation with the greatest penetrating power is
A. gamma B. alpha C. all equal D. beta

35. Alpha particles are stopped by
A. thick lead **B. a sheet of paper**
C. thin aluminium D. thick concrete only

36. Beta particles are stopped by
A. a sheet of paper B. air
C. a few millimetres of aluminium D. nothing

37. Gamma rays require _____ to shield them effectively.
A. thick lead or concrete B. air
C. thin aluminium D. paper

38. The law of conservation of nucleons states that the total mass number
A. increases during decay B. becomes zero
C. remains constant during decay D. decreases by 4 in every decay

39. In alpha decay, the daughter nuclide has a nucleon number reduced by
A. zero B. two C. one **D. four**

40. In alpha decay, the daughter nuclide has a proton number reduced by
A. one **B. two** C. four D. zero

41. When uranium-238 (Z = 92) emits an alpha particle, it becomes
A. thorium-234 (Z = 90) B. thorium-238 (Z = 90)
C. protactinium-234 (Z = 91) D. plutonium-242 (Z = 94)

42. Radon-222 (Z = 86) after alpha decay becomes
A. lead-214 (Z = 82) B. bismuth-218 (Z = 83)
C. polonium-218 (Z = 84) D. polonium-222 (Z = 84)

43. In beta decay, the proton number
A. decreases by one **B. increases by one**
C. decreases by two D. stays the same

44. During beta decay, the nucleon number
A. decreases by 4 B. increases by 1
C. decreases by 1 **D. does not change**

45. Cobalt-60 (Z = 27) after beta decay becomes
A. cobalt-59 (Z = 27) **B. nickel-60 (Z = 28)**
C. nickel-59 (Z = 28) D. iron-60 (Z = 26)

46. In gamma decay, the atomic number
A. decreases by 2 B. decreases by 1
C. does not change D. increases by 1

47. Gamma decay is due to a transition between states of
A. the same nucleus B. two electrons
C. two atoms D. different elements

48. A beta-plus (positron) emission changes a proton into a
A. photon B. electron
C. alpha particle **D. neutron**

49. Fluorine-18 is used in
A. carbon dating B. smoke detectors
C. PET scans D. thickness gauges

50. The process of changing one element into another by radioactive decay is called
A. nuclear transmutation B. nuclear fusion
C. ionisation D. doping

51. Nuclear decay is a
A. process controlled by temperature B. predictable process for one nucleus
C. process caused by pressure **D. spontaneous and random process**

52. The half-life is the time in which half of the original radioactive nuclei
A. remain stable **B. decay**
C. double D. are created

53. The half-life of a radioactive isotope depends on
A. temperature B. pressure
C. humidity **D. the nature of the nucleus only**

54. A radioactive element has a half-life of two years. After six years, the sample remaining is
A. 50 % **B. 12.5 %** C. 25 % D. 75 %

55. The half-life of a stable isotope is theoretically
A. one day B. one year **C. infinite** D. zero

56. A 50 mg sample of lead-212 (half-life 10.6 h) is left for 53 h. The amount left is
A. 1.56 mg B. 25 mg C. 0.5 mg D. 5 mg

57. A radioactive substance has a half-life of 16 months. One-eighth of it is left after
A. 16 months B. 128 months
C. 32 months **D. 48 months**

58. In 420 days one-eighth of polonium remains undecayed. Its half-life is
A. 140 days B. 420 days C. 52.5 days D. 210 days

59. The half-life of radium is 1600 years. Starting with 1 kg, 250 g remains after
A. 4800 years **B. 3200 years**
C. 1600 years D. 800 years

60. Three-fourth of a radioactive isotope decays in one hour. Its half-life is
A. 15 minutes B. 45 minutes
C. 30 minutes D. 60 minutes

61. The half-life of an isotope is 5 days. Starting with 64,000 nuclei, the number left after 30 days is
A. 1,000 B. 500 C. 10,000 D. 2,000

62. The half-life of carbon-14 is
A. 57.3 years B. 5730 days
C. 573 years **D. 5730 years**

63. The half-life of uranium-238 is about
A. 8 days B. 30 years
C. 4.5 billion years D. 704 million years

64. The SI unit of activity is the
A. sievert **B. becquerel** C. curie D. gray

65. The curie is equal to
A. 10^{10} decays per hour B. 1 decay per second
C. 3.7×10^{10} decays per second D. 3.7×10^{6} decays per second

66. Carbon-14 is formed in the atmosphere when neutrons from cosmic rays collide with
A. hydrogen atoms **B. nitrogen atoms**
C. oxygen atoms D. carbon-12 atoms

67. After an organism dies, the proportion of carbon-14 in it
A. gradually decreases B. remains constant
C. doubles D. increases

68. Carbon-14 dating is effective for tissues up to about
A. 500 years old B. 5 million years old
C. 5 billion years old **D. 50 to 60 thousand years old**

69. A fossil has one-eighth of the carbon-14 ratio of a living animal. Its age is (half-life 5730 y)
A. 5,730 years **B. 17,190 years**
C. 45,840 years D. 11,460 years

70. A skull has 25 % of its initial carbon-14. Its age is
A. 11,460 years B. 17,190 years
C. 5,730 years D. 22,920 years

71. A piece of wood has three tenths of the C-14 of living trees. Its age is about
A. 3,000 years B. 11,460 years
C. 9,953 years D. 5,730 years

72. Ionizing radiation is radiation with energy greater than
A. 1 eV B. 1000 eV C. 0.1 eV **D. 13.6 eV**

73. Ionizing radiation mainly damages the cells' molecule called
A. DNA B. water only
C. fat D. sugar only

74. The most harmful effect of radiation is believed to be the
A. weight loss **B. DNA double-strand break**
C. loss of colour D. heating of skin

75. The safety mantra when working around ionizing radiation is
A. speed, mass and charge B. heat, light and sound
C. time, distance and shielding D. push, pull and turn

76. The unit of absorbed radiation dose is the
A. becquerel B. curie C. hertz **D. gray**

77. The unit of equivalent dose is the
A. becquerel **B. sievert** C. gray D. curie

78. The annual dose limit for the general public is
A. 20 mSv per year B. 100 mSv per year
C. 1 mSv per year D. 50 mSv per year

79. The annual dose limit for radiation workers is
A. 100 mSv per year B. 50 mSv per year
C. 1 mSv per year **D. 20 mSv per year**

80. The radioactive material in smoke detectors is typically
A. americium-241 B. iodine-131
C. cobalt-60 D. uranium-238

81. A smoke alarm uses a source emitting
A. X-rays B. gamma rays
C. beta particles **D. alpha particles**

82. Food irradiation uses
A. gamma rays B. alpha particles
C. radio waves D. infrared

83. The ideal isotope for food irradiation is
A. Strontium-90 **B. Cobalt-60**
C. Iodine-131 D. Plutonium-239

84. Beta emitters are used to control the thickness of
A. thick materials B. liquids only
C. thin materials D. gases

85. Gamma emitters are used to control the thickness of
A. gases B. air
C. thin materials like paper **D. thick materials**

86. The most commonly used radioisotope in medical diagnosis is
A. americium-241 **B. technetium-99m**
C. cobalt-60 D. uranium-235

87. Technetium-99m has a half-life of about
A. six minutes B. six years
C. six hours D. six days

88. For medical diagnosis, a radioisotope should emit gamma rays and have a
A. short half-life B. very long half-life
C. very high energy only D. alpha emission

89. Iodine-131 is used to treat cancer of the
A. brain **B. thyroid gland**
C. liver D. lungs

90. The largest contributor to natural background radiation for most people is
A. nuclear fallout B. food
C. cosmic rays **D. radon gas**

91. Nuclear fission was discovered in 1938 by
A. Otto Hahn and Fritz Strassmann B. Einstein and Bohr
C. Curie and Becquerel D. Rutherford and Geiger

92. Nuclear fission is the splitting of a heavy nucleus by absorbing a
A. electron B. alpha particle
C. neutron D. proton

93. On the average, about _____ neutrons are released per fission.
A. 1 B. 10 C. 20 **D. 2.5**

94. The energy released in a single fission event is about
A. 2 MeV **B. 200 MeV** C. 2 keV D. 20 eV

95. 1 kg of uranium delivers as much energy as about
A. 3 tons of coal B. 30 kg of coal
C. 3000 tons of coal D. 30 tons of coal

96. The energy released in nuclear reactions arises from the
A. mass defect B. chemical bonds
C. friction D. heat of the Sun

97. Einstein's mass-energy relation is
A. $E = m^2c$ **B. $E = mc^2$** C. $E = mc$ D. $E = m/c^2$

98. A mass of 2 μg converted completely into energy releases
A. 180 MJ B. 1.8 MJ C. 1800 MJ D. 18 MJ

99. If every neutron emitted in fission causes another fission, the process is called a
A. fusion cycle B. decay series
C. chain reaction D. radiation cycle

100. An uncontrolled fission chain reaction is the principle of the
A. X-ray tube B. nuclear reactor
C. smoke alarm **D. atomic bomb**

101. Nuclear fusion is the process of
A. emission of alpha particles
B. splitting a heavy nucleus
C. combining two light nuclei into a heavier nucleus
D. emission of beta particles

102. The energy of the Sun is released due to
A. nuclear fission **B. nuclear fusion**
C. reduction D. oxidation

103. In the Sun, fusion converts
A. hydrogen into helium B. helium into hydrogen
C. carbon into oxygen D. uranium into lead

104. Dark matter makes up about _____ of the universe.
A. 90 % B. 68 % C. 5 % **D. 27 %**

105. Dark matter interacts through
A. gravity but not electromagnetic forces B. no forces
C. strong forces only D. electromagnetic forces

106. A theory is scientific only if it makes assertions that can be
A. never changed B. proved forever
C. tested and potentially disproven D. accepted without testing

107. The idea that a scientific theory must be disprovable is called
A. uncertainty **B. falsifiability**
C. superposition D. relativity