1. An electron can be represented by _____.
   A) $^{-1}_{0}e$
   B) $^{0}_{-1}e$
   C) $^{0}_{0}e$
   D) $^{-1}_{-1}e$

2. In the equation
   $^{26}_{12}Mg + {}^{1}_{1}p \longrightarrow {}^{4}_{2}\alpha + X$,
   'X' is the element _____.
   A) Be
   B) Ne
   C) Na
   D) K

3. 'X' in the equation $^{59}_{27}Co + {}^{2}_{1}H \longrightarrow {}^{60}_{27}Co + X$ is _____.
   A) $^{4}_{2}\alpha$
   B) $^{1}_{1}p$
   C) $^{0}_{-1}\beta$
   D) $^{0}_{1}\beta$

4. Species 'X' in the equation $^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{94}_{36}Kr + {}^{139}_{56}Ba + 3X$ is a(an) _____.
   A) proton
   B) positron
   C) neutron
   D) electron

5. Chromium-53 on bombardment with α-particles yields _____ and a neutron.
   A) $^{56}_{26}Fe$
   B) $^{57}_{27}Co$
   C) $^{56}_{28}Ni$
   D) $^{56}_{27}Co$

6. $^{20}_{8}\mathrm{O}$ disintegrates into $^{20}_{9}\mathrm{F}$ and _____.
   A) $^{0}_{-1}\beta$
   B) $^{1}_{1}\mathrm{H}$
   C) $^{0}_{1}\beta$
   D) $^{1}_{0}\mathrm{n}$

7. $^{135}_{53}\mathrm{I}$ disintegrates into _____ and a β-particle.
   A) Xe
   B) At
   C) Rn
   D) Cs

8. $^{40}_{19}\mathrm{K}$ emits a β-particle and yields _____.
   A) Mg
   B) Ar
   C) Ca
   D) Ba

9. When a cobalt-59 nucleus is bombarded with a neutron, the products are manganese-56 and a(an) _____.
   A) α-particle
   B) β-particle
   C) positron
   D) proton

10. On bombardment with a neutron, uranium-235 yields ^{99}Sr, ^{135}Te and _____.
   A) $^{1}_{1}\mathrm{H}$
   B) $2^{1}_{0}\mathrm{n}$
   C) $^{2}_{1}\mathrm{H}$
   D) $^{4}_{2}\mathrm{He}$

11. Identify the nuclear magic number: _____
   A) 10
   B) 20
   C) 40
   D) 54

12. _____ is not a nuclear magic number.
    A) 2
    B) 50
    C) 82
    D) 36

13. Nuclear belt stability is based on the _____ ratio.
    A) $\frac{e}{n}$
    B) $\frac{e}{p}$
    C) $\frac{e}{m}$
    D) $\frac{n}{p}$

14. The _____ nucleus does not exist.
    A) $^{24}_{11}Na$
    B) $^{3}_{2}He$
    C) $^{37}_{17}Cl$
    D) $^{2}_{2}He$

15. The equation used to calculate nuclear binding energy is _____.
    A) $E = h\nu$
    B) $E = mc^2$
    C) $\lambda = \frac{h}{mv}$
    D) $E = mvr$

16. The density of an atomic nucleus is on the order of _____ g/cm^3.
    A) 10^2
    B) 10^{27}
    C) 10^{14}
    D) 10^5

17. The radius of an atomic nucleus is approximately ____ pm.
    A) 10^{-9}
    B) 10^{-12}
    C) 10^{-3}
    D) 10^{-8}

18. The most stable nucleus shown below is _____.
    A) $^{48}_{20}\mathrm{Ca}$
    B) $^{48}_{21}\mathrm{Sc}$
    C) $^{9}_{3}\mathrm{Li}$
    D) $^{23}_{11}\mathrm{Na}$

19. Of the following nuclei, only _____ is radioactive.
    A) $^{60}_{27}\mathrm{Co}$
    B) $^{40}_{20}\mathrm{Ca}$
    C) $^{20}_{10}\mathrm{Ne}$
    D) $^{23}_{11}\mathrm{Na}$

20. The binding energy per nucleon of fluorine-19 (18.9984 amu) is _____.
    A) 1.25×10^{-12} J
    B) 1.25×10^{-6} J
    C) 3.02×10^{5} J
    D) 6.023×10^{8} J

21. The binding energy per nucleon of ^{127}I (126.9004 amu) is _____.
    A) 1.36×10^{12} J
    B) 4.32×10^{-6} J
    C) 1.36×10^{-12} J
    D) 4.32×10^{6} J

22. The binding energy of an atom per nucleon is on the order of _____.
    A) 10^{-6} J
    B) 10^{-8} J
    C) 10^{-12} J
    D) 10^{-10}

23. ^{232}Th decays to ^{228}Th. The numbers of α and β-particles produced are _____.
    A) 1α, 2β
    B) 2α, 1β
    C) 2α, 2β
    D) 1α, 1β

24. Radioactive decay follows _____ order kinetics.
    A) zero
    B) second
    C) first
    D) third

25. The half-life of Tl-206 decay to Pb-206 is 4.20 minutes. Starting with 5.00×10^{22} atoms of Tl-206, the number of Tl atoms left after 42.0 minutes is _____.
    A) 4.89×10^{19}
    B) 2.12×10^{21}
    C) 9.72×10^{17}
    D) 7.50×10^{15}

26. The rate law for radioactive decay is _____.
    A) Rate = k
    B) Rate = λN^2
    C) Rate = λN
    D) Rate = λ / N

27. $^{232}_{90}$Th loses six α and four β particles. The final isotope produced is _____.
    A) Pb-208
    B) Bi-208
    C) Pb-206
    D) Po-208

28. The half-life of strontium-90 is 28.1 yr. A 1.00 g of ^{90}Sr will be reduced to 0.200 g by decay in the time _____.
    A) 56.2 yrs
    B) 65.2 yrs
    C) 75.3 yrs
    D) 52.4 yrs

29. Consider the decay series A→B→C→D where A, B and C are radioactive isotopes with half-lives of 4.50 s, 15.0 days, and 1.00 s, respectively. Starting with 1.00 mol of A, the number of moles of A left after 30 days is _____.
    A) 0.001
    B) 0.01
    C) 0.1
    D) zero

30. One element can be converted into another by nuclear _____.
    A) reduction
    B) oxidation
    C) transmutation
    D) deceleration

31. In the reaction $X(p,\alpha)\,{}^{12}_{6}C$, X is _____.
    A) ${}^{14}_{7}N$
    B) ${}^{15}_{7}N$
    C) ${}^{16}_{8}O$
    D) ${}^{16}_{7}N$

32. X in the reaction ${}^{27}_{13}Al(d,\alpha)X$ is _____.
    A) ${}^{27}_{11}Na$
    B) ${}^{20}_{18}Ar$
    C) ${}^{25}_{12}Mg$
    D) ${}^{23}_{18}Ar$

33. The isotope produced in the reaction ${}^{55}_{25}Mn(n,\gamma)X$ is _____.
    A) Mn-56
    B) Fe-56
    C) Co-56
    D) Ni-57

34. The projectile used to convert $^{80}_{34}\mathrm{Se}$ into $^{81}_{34}\mathrm{Se}$ and $^{1}_{1}\mathrm{H}$ is _____.
A) $^{1}_{0}\mathrm{n}$
B) $^{4}_{2}\mathrm{He}$
C) $^{2}_{1}\mathrm{H}$
D) $2^{1}_{0}\mathrm{n}$

35. The target nuclei, X in the reaction $\mathrm{X(d,2p)^{9}_{3}Li}$ is _____.
A) $^{9}_{5}\mathrm{B}$
B) $^{9}_{4}\mathrm{Be}$
C) $^{9}_{3}\mathrm{Li}$
D) $^{14}_{7}\mathrm{N}$

36. The species X in the reaction $^{10}_{5}\mathrm{B(n,\alpha)X}$ is _____.
A) $^{7}_{3}\mathrm{Li}$
B) $^{8}_{3}\mathrm{Li}$
C) $^{9}_{3}\mathrm{Li}$
D) $^{7}_{4}\mathrm{Be}$

37. Heavier nuclei are broken down into smaller nuclei by nuclear _____.
A) fusion
B) transmutation
C) fission
D) oxidation

38. A self-sustained nuclear fission reaction is called a _____.
A) chain reaction
B) reversible reaction
C) fusion
D) fragmentation

39. The moderator in a nuclear reactor _____.
A) reduces the energy of neutrons
B) increases the energy of neutrons
C) increases the number of neutrons
D) reduces the number of neutrons

40. The material in a nuclear reactor that reduces the number of neutrons is called a _____.
    A) reducer
    B) moderator
    C) control rod
    D) reflector

41. _____ can be used as a moderator in nuclear reactors.
    A) D_2O
    B) Na
    C) O_2
    D) H_2

42. The control rods used in a nuclear reactor are _____.
    A) Ca
    B) Cu
    C) Cd
    D) Cs

43. In a nuclear reactor, boron is used as _____.
    A) control rods
    B) a coolant
    C) a monitor
    D) a moderator

44. The percentage of ^{235}U in naturally occurring uranium is _____.
    A) 7%
    B) 70%
    C) 0.7%
    D) 0.07%

45. Nuclear fuel consists of uranium in the form of _____.
    A) U_3O_8
    B) U_2SO_4
    C) UO_2
    D) U_3SiO_3

46. A breeder reactor produces _____.
    A) more fissionable materials than it uses
    B) less fissionable materials than it uses
    C) stable nuclei only
    D) light nuclei only

47. The union of smaller nuclei into larger nuclei is nuclear _____.
    A) fusion
    B) fission
    C) fragmentation
    D) transmutation

48. Thermonuclear reactions are often called _____ reactions.
    A) fission
    B) fertile
    C) fusion
    D) thermodynamic

49. A plasma is a _____.
    A) gas consisting of positive ions
    B) gaseous mixture of positive ions and electrons
    C) liquid mixture of positive ions and electrons
    D) solid mixture of positive and negative ions

50. The correct statement is: _____
    A) Lighter elements undergo nuclear fission
    B) Heavier elements undergo nuclear fission
    C) Heavier elements undergo nuclear fusion
    D) Lighter elements undergo nuclear fusion and fission

51. A hydrogen bomb works under the principle of _____.
    A) nuclear fission
    B) moderation
    C) nuclear fusion
    D) nuclear oxidation

52. The mechanism of the following reaction (I* = ^{128}I) shows that _____:

$$^{*}IO_4^-(aq) + 2I^-(aq) + H_2O(l) \longrightarrow {}^{*}I_2(s) + IO_3^-(aq) + OH^-(aq)$$

A) I^- is oxidized to IO_3^-
B) IO_4^- is reduced to IO_3^-
C) I_2 is formed from I^-
D) I_2 is formed from I^- and IO_4^-

53. _____ cannot be used as a radioactive tracer.
A) ^{24}Na
B) ^{128}I
C) ^{59}Fe
D) ^{35}Cl

54. The most stable nuclei will have the number of neutrons and protons as _____.
A) odd-odd
B) even-even
C) odd-even
D) even-odd

55. The species X in the equation $^{3}_{1}H \longrightarrow {}^{3}_{2}He + X$ is _____.
A) $^{0}_{+1}e$
B) $^{1}_{1}H$
C) $^{0}_{-1}e$
D) $^{2}_{1}H$

56. The ratio of $^{1}_{1}H$ to $^{3}_{1}H$ in ordinary water is 1.0×10^{17} to 1. _____ disintegrations per minute will be observed from 1.000 kg water. (The half-life of $^{3}_{1}H$ is 12.5 yrs)
A) 70.
B) 16.
C) 40.
D) 96.

57. A unit of radioactivity is _____.
A) the joule
B) the curie
C) the röngten
D) the becquerel

58. One curie corresponds to _____ disintegration/s.
A) 3.00×10^{7}
B) 1.00×10^{10}
C) 3.70×10^{10}
D) 2.00×10^{8}

59. The activity of 0.500 g of $^{237}_{93}\mathrm{Np}$ ($t_{1/2} = 2.20 \times 10^{6}$ yrs) is _____ millicuries.
A) 3.43
B) 34.3
C) 8.72
D) 0.343

60. $^{237}_{93}\mathrm{Np}$ emits an α-particle to yield _____.
A) Pa
B) Pu
C) Th
D) U

61. Uranium-235 on fission by slow neutrons yields barium, 3 neutrons and _____.
A) krypton
B) xenon
C) radon
D) cesium

62. When $^{235}_{92}\mathrm{U}$ undergoes fission by neutrons it yields cesium, 2 neutrons and _____.
A) barium
B) calcium
C) rubidium
D) francium

63. On bombardment with a neutron, U-235 yields bromine, 3 neutrons and _____.
A) iodine
B) lanthanum
C) cesium
D) sodium

64. $^{235}_{92}U$ undergoes fission with a neutron to yield Sm, 4 neutrons and _____.
A) Sn
B) Zr
C) Ti
D) Zn

65. The nuclear binding energy of ^{10}B (10.0129 amu) is _____ J/nucleon.
A) 1.040×10^{-12}
B) 1.199×10^{-12}
C) 1.690×10^{-12}
D) 1.010×10^{-12}

66. The binding energy of ^{14}N(14.00307 amu) is _____ J/nucleon.
A) 1.000×10^{-12}
B) 2.010×10^{-12}
C) 1.199×10^{-12}
D) 3.120×10^{-12}

67. Of the following, _____ has the greatest binding energy per nucleon.
A) ^{10}B (10.0129 amu)
B) ^{11}B (11.00931 amu)
C) ^{14}N (14.00307 amu)
D) ^{56}Fe (55.9349 amu)

68. An example of a nonradioactive isotope is _____.
A) ^{14}C
B) $^{3}_{1}H$
C) ^{131}I
D) $^{14}_{7}N$

69. Pu-242 undergoes α-particle emission and yields ____.
A) ^{238}U
B) ^{235}U
C) ^{238}Np
D) ^{238}Cm

70. $^{251}_{98}Cf$ transforms into $^{247}_{96}Cm$ by emitting _____.
A) $^{1}_{1}H$
B) $^{0}_{-1}e$
C) $^{4}_{2}He$
D) $^{1}_{0}n$

71. Iodine-131 undergoes β-decay to yield _____.
A) Radon
B) Xenon
C) Argon
D) Astatine

72. $^{18}_{7}N$ will emit _____ to obtain a stable nucleus.
A) $^{0}_{-1}e$
B) $^{1}_{1}H$
C) $^{1}_{0}n$
D) $^{4}_{2}He$

73. Calcium in bones can be replaced by _____.
A) Sc
B) Sr
C) Zn
D) Cs

74. Astatine can be prepared by bombarding _____ with α-particles.
A) Br-209
B) Po-209
C) Bi-209
D) Rn-209

75. $\frac{n}{p}$

The $\frac{n}{p}$ ratio equals 2 for the nucleus_____.

A) $^{3}_{1}H$

B) $^{14}_{7}N$

C) $^{12}_{6}C$

D) $^{2}_{1}H$

76. $\frac{n}{p}$

A nucleus not having a $\frac{n}{p}$ ratio equal to one is _____.

A) $^{2}_{1}H$

B) $^{16}_{8}O$

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

D) $^{14}_{6}C$

77. The age of wood can be determined by using _____ decay.

A) ^{14}N

B) ^{14}C

C) ^{18}O

D) ^{12}C

78. ^{40}K decays into ^{40}Ar ($t_{1/2} = 1.2 \times 10^{9}$ yr) by yielding a(an)_____.

A) electron

B) positron

C) neutron

D) proton

79. A sample of moon rock contains 18% ^{40}K and 82% ^{40}Ar by mass. ^{40}K decays to ^{40}Ar with a half-life of 1.2×10^{9} yr. The age of the rock is _____.

A) 2×10^{7} yr

B) 4×10^{8} yr

C) 3×10^{9} yr

D) 7×10^{10} yr

80. β-decay of ^{90}Sr yields _____.
    A) Y
    B) Rb
    C) Sc
    D) Zr

81. ^{90}Zr can be obtained from the β-decay of _____.
    A) N
    B) Hf
    C) Ti
    D) Y

82. The intensity of radiation depends on _____.
    A) the isotope half-life
    B) the isotope decay rate constant
    C) amount of the isotope
    D) all of the above

83. Thyroid gland activity is studied by using _____.
    A) ^{127}I
    B) ^{131}I
    C) ^{24}Na
    D) ^{14}C

84. One millicurie is _____ disintegrations/s.
    A) 3.7×10^{10}
    B) 3.7×10^{13}
    C) 3.7×10^{7}
    D) 1000

85. The element $^{270}_{110}X$ must be a/an _____.
    A) halogen
    B) rare gas
    C) transition metal
    D) alkali metal

86. The element $^{274}_{112}Z$ will resemble _____.
A) Zn
B) Co
C) As
D) Ni

87. The element $^{285}_{114}X$ will belong to the _____ family.
A) halogen
B) nitrogen
C) carbon
D) oxygen

88. The energy released when one U-238 atom decays to Th-234 is _____ J. The atomic masses are: U-238, 238.0508; Th-234, 234.0436 amu; He-4, 4.0026 amu.
A) 4.12×10^{-11}
B) 6.87×10^{-13}
C) 3.12×10^{-9}
D) 7.12×10^{-15}