Atomic Structure
Chapter 1

1. The force of attraction between the nucleus and an orbital electron is called the electron
   A. Valence C. Binding energy
   B. Transition number D. Valence number

2. The schematic display most often employed to represent the structure of the atom was developed by:
   A. Charles Dalton C. Michael Crookes
   B. Neils Bohr D. Charles Darwin

3. The chemical properties of an atom are primarily controlled by its
   A. Number of protons C. Atomic weight
   B. Number of neutrons D. Valence number

4. The orderly arrangement of the elements by their atomic number and chemical properties is found in an:
   A. Emission spectrum C. Auger table
   B. Table of contents D. Periodic table

5. The principal unit of energy measurement on the atomic scale is the-
   A. Electron volt C. Coulomb
   B. Neutron D. Farad

6. The atomic number of the atom is determined by those particles which have an atomic mass unit of 1 and a single positive charge called-
   A. Electrons C. Protons
   B. Positrons D. Neutrons

7. The majority of the mass of the nucleus’s is derived from
   A. Protons and electrons C. Protons, neutrons and electrons
   B. Protons and neutrons D. Alpha, beta, gamma

8. An atom that loses an orbital electron from the electrical influence of the nucleus has undergone:
   A. Radioactive decay C. Ionization
   B. Subluxation D. Covalent bonding

9. The number of outer shell electrons is known as the
   A. Electron quota C. Valence
   B. Orbital energy D. Quantum mottle
10. In the symbol $^{60}$Co$_{27}$, the number in the lower right-hand corner indicates the:
   A. Mass number  
   B. Atomic number  
   C. Isotope number  
   D. Ionization level

11. In the previous question, the number in the upper left-hand corner indicates the
   A. Mass number  
   B. Atomic number  
   C. Isotope number  
   D. Ionization level

12. A neutral atom that loses an electron by ionization is termed a
   A. Negative atom  
   B. Positive atom  
   C. Negative ion  
   D. Positive ion

13. The smallest division of a substance possessing the same chemical and physical properties of the substance as a whole is called a/an-
   A. Atom  
   B. Element  
   C. Molecule  
   D. Isotope

14. The tiny particles possessing a negative charge of $1.6 \times 10^{-9}$ Coulombs that orbit the nucleus of an atom are termed:
   A. Electrons  
   B. Protons  
   C. Neutrons  
   D. Photons

15. The centralized portion of an atom, the nucleus, is primarily composed of particles called the
   1. Electrons  
   2. Neutrons  
   3. Protons
   A. 1 & 2 only  
   B. 1 & 3 only  
   C. 2 & 3 only  
   D. 1, 2, & 3

16. The photons produced during the orbital transitions of electrons from a higher to lower energy are termed:
   A. Characteristic radiations  
   B. Corpuscular radiations  
   C. Vacancy radiations  
   D. Field radiations

17. The formula $2n^2$ is used to calculate:
   A. Minimum number of electrons in an orbital shell  
   B. Maximum number of electrons in an orbital shell  
   C. Total number of electrons in the atom  
   D. Number of outer shell electrons in an atom
18. The atomic mass of an atom can be estimated by adding the atomic masses of the


A. 1 & 2 only  C. 2 & 3 only
B. 1 & 3 only  D. 1, 2, & 3

19. The highest electron binding energy of an atom is found in the electron's level.
A. First energy orbital  C. Third energy orbital
B. Second energy orbital  D. All are the same

20. A given atom has the following binding energies: K shell - 1000 eV, L shell - 70 eV, M shell - 10 eV. During a M-L transition, the photon energy emitted will be
A. 910 eV  C. 60 eV
B. 80 eV  D. Unable to determine

21. The chemical bond formed when two or more atoms share electrons is termed
A. Ionic bonding  C. Covalent bonding
B. Polar bonding  D. Valence bonding

22. The interconvertibility of mass and energy first proposed by Einstein is expressed by the equation-
A. $E = \frac{1}{2}mv^2$  C. $E = mc^2$
B. $E = hv$  D. $E = \frac{2v^2}{\lambda}$

23. The octet rule states that the most chemically stable atoms have an outer shell configuration with:
A. Two electrons  C. Seven electrons
B. Four electrons  D. Eight electrons

24. The natural state of matter with the highest energy due to the movement of atoms is the
A. Gaseous state
B. Liquid state
C. Plastic state
D. Solid state

25. About 99% of the atom's mass is located within the
A. Orbital shell
B. Valence shell
C. Nucleus
D. Alpha particle
26. Ionization of an atom may occur from exposing the atom to
   A. 1 only  
   B. 2 only  
   C. 3 only  
   D. 1, 2, & 3

27. The electron binding energy is dependent upon the
   A. 1 & 2 only  
   B. 1 & 3 only  
   C. 2 & 3 only  
   D. 1, 2, & 3

28. Which of the following atoms would possess the highest energy for its K shell electron?
   A. $^{16}_8O$  
   B. $^{23}_{11}Na$  
   C. $^{53}_{29}Cu$  
   D. $^{126}_{53}I$

29. An atom that has seven orbital electrons belongs to a group of elements known as
   A. Inert gasses  
   B. Noble gasses  
   C. Halogens  
   D. Rare earth elements

30. Two or more chemicals with the same chemical formula, but having different chemical
    properties, are termed:
    A. Isomers  
    B. Isotopes  
    C. Isobars  
    D. Isotones

31. The formation of molecules can be accomplished through the interaction of valence
    electrons by a process termed
    A. Ionic bonding  
    B. Covalent bonding  
    C. Both of the above  
    D. Neither of the above

32. The mass of an orbital electron is about _________ the mass of a proton.
    A. $1/000$  
    B. $1/10$  
    C. $20$ times  
    D. $2000$ times

33. Which of the following is true concerning the K shell electrons of two different atoms?
    A. The electron binding energy is the same for both atoms  
    B. The electron binding energy is characteristic of each atom  
    C. The heavier element will have more K shell electrons  
    D. All of the above
34. In a neutral atom the electrical neutrality is achieved by maintaining a balance between the
   A. Protons and electrons  C. Electrons and positrons
   B. Neutrons and positrons  D. Protons and neutrons

35. The atomic particle which has a weight of 1 amu and carries no charge is called a/an
   A. Proton  C. Neutron
   B. Electron  D. Negatron

36. Nuclides having the same atomic number but different atomic masses are termed
   A. Isotopes  C. Isobars
   B. Isotones  D. Neutrinos

37. The physical state of matter is related to the degree of molecular attraction. Which state
   corresponds to the highest degree of molecular attraction
   A. Solid  C. Plastic
   B. Liquid  D. Gas

38. A neutral atom that gains an electron will have a:
   A. Neutral charge  C. Positive charge
   B. Negative charge

39. The chemical bonding of two atoms by the transfer of an electron is a form of
   ___________ bonding.
   A. Ionic  C. Mutual
   B. Covalent  D. Polar

40. Characteristic radiation emission occurs when:
   A. Electrons move from lower to higher orbital shells
   B. Electrons move from higher to lower orbital shells
   C. The atom has an unstable nucleus
   D. The atom undergoes nuclear fission

41. The mass energy equivalent value for an electron is:
   A. 0.60 MeV  C. 0.391 MeV
   B. 0.147 MeV  D. 0.511 MeV

42. An electron with a lowest binding energy is most likely located in the:
   A. K shell  C. M shell
   B. L shell  D. It is the same for all electrons

43. Which of the three fundamental particles has the lowest atomic mass?
   A. Electron  C. Proton
   B. Photon  D. Neutron
44. The most chemically stable elements having a filled outer shell configuration are termed
   A. Alkali metals
   B. Alkaline metals
   C. Nobel gases
   D. Halogens

45. The physical characteristics of the atom are controlled by the atom's
   A. Atomic number
   B. Atomic mass
   C. Valence number
   D. Electron binding energy

46. The Stability of a nucleus is highly dependent upon the of the nucleus
   A. N-Z ratio
   B. e- - e+ ratio
   C. A-N ratio
   D. All of the above

47. The nuclear particle possessing a single positive charge with a mass of $1.67 \times 10^{-24}$ gm is termed the:
   A. Neutron
   B. Positron
   C. Proton
   D. Electron

48. The term applied to the raising of an electron to a higher energy orbit within a given atom is called:
   A. Excitation
   B. Ionization
   C. Stabilization
   D. Neutralization

49. The maximum number of inner or K shell electrons in any atom is:
   A. 1
   B. 2
   C. 4
   D. 8

50. The smallest part of an element that retains all the characteristic properties of that element in bulk is called a/an:
   A. Molecule
   B. Atom
   C. Coulomb
   D. Nuclide

51. The following atoms are: $^{13}C, ^{14}N, ^{16}O$
   A. Isotopes
   B. Isobars
   C. Isotones
   D. Isomers

52. The principal force involved with nuclear binding is the
   A. Electromagnetic force
   B. Weak force
   C. Gravitational force
   D. Strong force
53. The average nuclear binding energy that must be exceeded to remove nucleons from the nucleus is in the range of:
   A. 5-8 eV   C. 5-8 MeV
   B. 5-8 keV   D. 5-8 GeV

54. Atoms with different types of nuclear configurations are termed
   A. Elements  C. Molecules
   B. Nuclides  D. Mixtures

55. The term used to describe the process in which light nuclei combine to form a heavier nucleus is:
   A. Fusion     C. Nuclear capture
   B. Fission    D. De-excitation

56. The difference between the true mass of an atom and the sum of the free masses of its constituents is termed the:
   A. Transition mass   C. Relative mass
   B. Mass deficit      D. Atomic mass

57. Which of the following elements does not exhibit a high capture cross section (or slow neutrons?)
   A. Boron
   B. Cadmium
   C. Lead
   D. Lithium

58. Which of the following neutrons is not normally associated with the ejection of nucleons from the target atom
   A. Relativistic neutrons   C. Thermal neutrons
   B. Intermediate neutrons  D. Fast neutrons

59. The vast majority of spontaneous radioactive decay and fission processes are
   A. Endogeric   C. Endothermic
   B. Exogeric    D. None of the above

60. The end result of a radioactive decay series is a/an
   A. Unstable nuclide   C. Fusionable nuclide
   B. Fissionable nuclide D. Stable nuclide

61. The principal emission particle associated with the transformation of a proton into a neutron is:
   A. Beta-       C. Alpha-
   B. Beta+      D. Alpha+
62. An alpha particle is most similar to the nucleus of a atom.
   A. Hydrogen  
   B. Deuterium  
   C. Helium  
   D. Lithium

63. If the activity of a radioactive source is 400 mR/hr. and has a half-life of 6 hours, what will the activity of this source be in one day?
   A. 133 mR/hr.  
   B. 25 mR/hr.  
   C. 12.5 mR/hr.  
   D. 6.25 mR/hr.

64. The specific term used to designate a nuclear excited state is
   A. Isotope  
   B. Isomer  
   C. Isotone  
   D. Isobar

65. After an alpha decay, the daughter nuclide will have an atomic mass number _____ amu lower than the parent.
   A. One  
   B. Two  
   C. Four  
   D. Six

Pertaining to the diagram of the decay scheme below, answer questions 66-69.

66. This is an example of a ____________ particle decay scheme.
   A. Positive  
   B. Negative  
   C. Both of the above  
   D. Neither of the above
67. The principal daughter nuclide for this decay scheme is:
   A. $^{226}_{89}\text{Ac}$ C. $^{222}_{88}\text{Rn}$
   B. $^{226}_{86}\text{Ra}$ D. $^{226}_{86}\text{Rn}$

68. The average energy of the particle emission is:
   A. 4.8 MeV C. 413 keV
   B. 600 keV D. 190 keV

69. In order to achieve a grounded state, the majority of the alpha emissions are associated with a:
   A. 0.60 MeV gamma emission C. 0.19 MeV positron emission
   B. 0.45 MeV beta emission D. No secondary emission

70. The most likely radionuclides undergoing spontaneous beta decay will possess an unfavorably high N-Z ratio or have an excess of:
   A. Neutrons
   B. Protons
   C. Positrons
   D. Electrons

71. Nuclides with relatively long periods or lifetimes in an excited state are referred to as being
   A. Grounded
   B. Mass bound
   C. Modulated
   D. Metastable

72. The radioactive decay of $^{12}$C into $^{12}$N is an example of
   A. Isobaric decay
   B. Isotonic decay
   C. Isotropic decay
   D. Isomeric decay

73. The rate of radioactive decay is greatly influenced by:
   A. Chemical bonding
   B. Temperature changes
   C. Pressure changes
   D. None of the above

74. The fusion process occurs only in nuclides possessing a:
   A. Low atomic number
   B. High atomic number
   C. Both of the above
   D. Neither of the above

75. The production of nuclides possessing the same atomic mass and different atomic numbers (isobars) will result from:
   A. 1 only C. 3 only
   B. 2 only D. 1, 2, & 3
76. After beta decay, the daughter nuclide will have an atomic mass that is ________ the parent nuclide.
   A. Higher than  C. The same as
   B. Lower than

77. The instability of most lighter nuclides normally results from an
   A. Excess of neutrons  C. Excess of neutrinos
   B. Excess of protons  D. Excess of mesons

78. The emission of a beta particle is associated with the transformation of a ________ into a/an
   A. Neutron/proton  C. Proton/neutron
   B. Photon/proton  D. Neutron/electron

79. Which of the following are examples of heavy charged particles
   1. Alpha  2. Tritons  3. Deuterons
   A. 1 & 2 only
   B. 1 & 3 only
   C. 2 & 3 only
   D. 1, 2, & 3

80. A radioactive source has a half-life of eight hours. How long would it take to reduce a 200 millicurie/hr. source to a level of 12.5 millicurie/hr.?
   A. 8 hours  C. 24 hours
   B. 16 hours  D. 32 hours

81. Which of the following radionuclides is most likely to decay by alpha decay?
   A. C-14  C. Sn-113
   B. Mo-99  D. Po-218

82. The average energy it takes to remove an electron from an orbital shell in a gas is about
   A. 34 eV  C. 4.2 keV
   B. 69 eV  D. 6.7 keV

83. Which of the following elements does not exhibit a high capture cross section for slow neutrons?
   A. Boron
   B. Cadmium
   C. Lead
   D. Lithium
Pertaining to the diagram of the decay scheme below, answer questions 84 - 87.

60 Co

84. This is an example of a _______ particle decay scheme.
   A. Positive    C. Both of the above
   B. Negative    D. Neither of the above

85. The principal daughter nuclide for this decay scheme is:
   A. $^{60}\text{Co}$    C. $^{60}\text{Fe}$
   B. $^{60}\text{Ni}$    D. $^{56}\text{Mn}$

86. The major particulate emissions will possess an energy of about
   A. 0.31 MeV    C. 1.3 MeV
   B. 1.2 MeV     D. 1.5 MeV

87. In order to achieve a grounded state, the energy of the gamma emission following the major particle emission is:
   A. 1.5 MeV    C. 1.2 MeV
   B. 1.3 MeV    D. .31 MeV

88. After alpha decay, the atomic number of the parent nuclide is:
   A. Increased by 2    C. Decreased by 1
   B. Increased by 4    D. Decreased by 2

89. Which of the following neutrons is not normally associated with the ejection of nucleons from the target atom?
   A. Relativistic neutrons    C. Thermal neutrons
   B. Intermediate neutrons    D. Fast neutrons
90. The bluish light seen around the core of swimming pool reactors due to electron velocities greater than the speed of light in the medium is called:

A. Rutherford radiation  C. Bragg radiation
B. Cerenkov radiation  D. Barn radiation