Chapter 1. ATOMIC STRUCTURE

1.1. Choose the **correct** statement(s):

1) The atoms which have the same atomic number and different mass numbers are called isotopes.

2) The atomic nuclei of isotopes of the same element have different numbers of neutrons.

3) The atomic weight of an element in the periodic table is the average of atomic weights of the isotopes in ratios that exist in nature.

4) Except for the most abundant isotope of an element, all other isotopes are radioactive.

a) 1 b) 1, 2 c) 1, 4 d) 1, 2, 3

1.2. The atomic weight of the ${}_{1}^{2}H$ isotope is determined by:

a) The weights of one proton and one neutron.

b) The weights of one electron and one neutron.

c) The weight of one electron.

d) The weight of one proton.

1.3. Choose the **correct** statement about the properties of isotopes of an element:

a) Isotopes of the same element have the same chemical and physical properties.

b) Atoms with the same nuclear charge and the same mass number are called isotopes.

c) Isotopes of the same element have the same number of neutrons and the same number of protons.

d) Isotopes of the same element occupy the same cell in the periodic table of elements.

1.4. Which of the following statements regarding atomic particles is **incorrect**?

a) Protons are found in the nucleus and are positively charged particles.

b) Electrons move around the nucleus and contribute little to the mass of the atom

c) The numbers of neutrons, protons and electrons are always equal in a neutral atom

d) Neutrons are found in the nucleus and they have no charge

1.5. Choose the **correct** statement:

a) Atoms with the same nuclear charge and the same mass number are called isotopes.

b) For each element, the number of protons in the nucleus of an atom is fixed, but the number of neutrons can vary, which is an isotopic phenomenon.

c) Atoms that have the same mass number but a different number of protons in the nucleus are known as isotopes.

d) Isotopes of the same element have the same physical and chemical properties.

1.6. Choose **all the correct** statement(s):

1) Isotopes are the atoms with the same atomic number but difference mass numbers.

2) The atomic weight of an element is the average of the atomic weights of the isotopes according to the ratio of these isotopes in nature.

3) The only difference in structure between the isotopes is the different number of neutrons.

4) Except for the most abundant isotope of an element, all other isotopes are radioactive.

a) 1 b) 1 and 2 c) 1 and 4 d) 1, 2 and 3

1.7. Choose the **incorrect** statement about the Bohr model of an atom that is applied to hydrogen atom or hydrogen-like ions (i.e., ion with only 1 electron).

a) When moving in the Bohr orbit, the energy of an electron does not change.

b) An electron of mass m, which is moving with speed v in a Bohr orbit of radius r, has a magnitude of the angular momentum is given by: $mvr = nh/2\pi$.

c) Electron only absorbs or emits the radiation when moving from one orbit to another.

d) The emitted radiation has a wavelength λ is equal to: $\lambda = |E_{initial} - E_{final}|/h$.

1.8. The wavelength of the radiation emitted by the hydrogen atom follows the formula: $1/\lambda = R_H (1/n_1^2 - 1/n_2^2)$. If $n_1 = 1$ and $n_2 = 4$, the radiation corresponds to the transition of an electron:

a) From orbit 4 to orbit 1, the radiation belongs to the Lyman series.

b) From orbit 1 to orbit 4, the radiation belongs to the Lyman series.

c) From orbit 1 to orbit 4, the radiation belongs to the Balmer series.

d) From orbit 4 to orbit 1, the radiation belongs to the Balmer series.

1.9. Radiation with the minimum wavelength of a hydrogen atom is emitted when an electron:

a) Falls from infinity to orbit 1. b) Jumps from orbit 1 to orbit 2.

c) Jumps from orbit 1 to infinity. d) Falls from orbit 2 to orbit 1.

1.10. The uncertainty principle states that _____.

a) matter and energy are really the same thing.

b) it is impossible to know anything with certainty.

c) it is impossible to know the exact position and momentum of an electron.

d) there can only be one uncertain digit in a reported number.

1.11. Choose the **incorrect** statement(s):

1) The energy of AOs in the *n* shell always greater than that in the (*n*-1) shell.

2) Angular momentum quantum number *l* determines the shape and name of the atomic orbital.

3) Magnetic quantum number m_l has values from *n* to –*n*.

4) Angular momentum quantum number has values from 0 to *n*-1.

a) 1 and 2. b) 1 and 3. c) 1, 2 and 3. d) 1, 3 and 4.

1.12. Choose the **incorrect** statement:

a) Principal quantum number *n* has a positive integer value and the maximum value is 7.

b) Angular momentum quantum number *l* (i.e., corresponding to a value of the principal quantum number *n*) is always less than *n*.

c) The energy of electron and the average distance between nucleus and electron increase with increasing *n*.

d) The formula $2n^2$ indicates the maximum number of electrons that can be in the n^{th} shell of an atom.

1.13. The principal quantum number *n* and angular momentum quantum number *l* respectively determine, respectively:

a) The orientation and shape of the atomic orbital.

b) The shape and orientation of the atomic orbital.

c) The energy of electrons and the orientation of the atomic orbital.

d) The energy of electrons and the shape of the atomic orbital.

1.14. The magnetic quantum number m_l determines:

a) The shape of the atomic orbital. b) The size of the atomic orbital.

c) The orientation of the atomic orbital. d) The energy of electrons.

1.15. Choose the **incorrect** statement. The magnetic quantum number m_l:

a) Determines the orientation of the atomic orbital in space.

b) Determines the number of atomic orbitals in a subshell.

c) Has values from l to - l.

d) Determines the energy of a subshell.

1.16. Choose the **incorrect** statement:

a) The principal quantum number n has positive integer values (e.g., 1, 2, 3, ...) that determine the energy of electrons and the size of the atomic orbital. The greater n is, the higher energy of the electron and the larger size of the atomic orbital are. In multielectron atoms, electrons with the same n value form an electron shell and they have the same energy.

b) The angular momentum quantum number l has values from 0 to n-1. It describes the shape of electron cloud and the energy of atomic electron. Electrons which have the same values of n and l form an electron subshell and they have the same energy.

c) The magnetic quantum number m_l may have values from -l to +l. It defines the orientation of atomic orbitals in a magnetic field.

d) The spin quantum number m_s defines the characteristic of an electron and has only two values $-{}^1/_2$ and $+{}^1/_2$.

1.17. Choose the **correct** statement(s). An atomic orbital is:

1) The region in which there is maximum probability of finding an electron.

2) The surface with equal electron density cloud.

3) The orbital motion of electrons in an atom.

4) The energy state of an electron in an atom.

5) The space within which the electrons of an atom move.

a) 1 and 5 b) 1, 2 and 3 c) 1 d) 1, 2, 3, 4 and 5.

1.18. Choose the **incorrect** statement:

a) The magnetic quantum number m_l has values from $-n$ to n.

b) The angular momentum quantum number l has values from 0 to n-1.

c) The principal quantum number n determines the size of the atomic orbital.

d) The angular momentum quantum number l determines the configuration and name of the atomic orbital.

1.19. Which one is **not acceptable** in the quantum mechanical atomic model?

a) In the ground state, electrons occupy energy levels from low to high, respectively.

b) In an atom, there are at least 2 electrons with the same 4 quantum numbers.

c) The angular momentum quantum number l defines the name and shape of the atomic orbital.

d) In each subshell, electrons make arrangement to have the maximum number of single electrons.

1.20. The distribution of electrons in a carbon atom in the stable state is:

$1s^2$ $2s^2$ $2p^2$

Based on:

a) Aufbau principle and Hund's rule.

b) Aufbau principle, Pauli exclusion principle, Hund's rule and Klechkowski's rule.

c) Aufbau Principle, Pauli exclusion principle and Hund's rule.

d) Hund's and Klechkowski's rules.

1.21. According to Aufbau principle a new electron enters the orbitals when:

a) $(n + l)$ is minimum b) $(n + l)$ is maximum

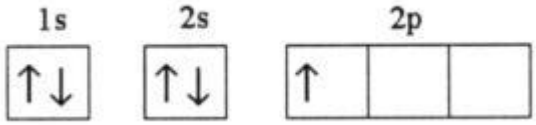
c) $(n + m_l)$ is minimum d) $(n + m_l)$ is maximum

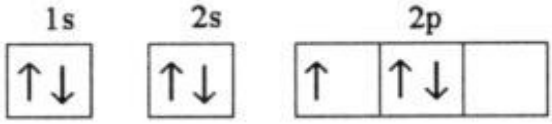
1.22. Which set of quantum numbers represents the outermost electrons in an atom with Z = 30?

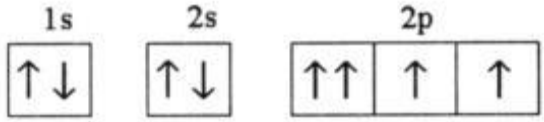
a) $n = 3$, $l = 2$, $m_l = -2$, $m_s = +1/2$ b) $n = 4$, $l = 0$, $m_l = 0$, $m_s = +1/2$ and $-1/2$

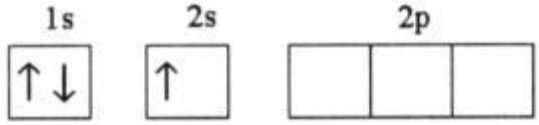
c) $n = 3$, $l = 2$, $m_l = +2$, $m_s = -1/2$ d) $n = 4$, $l = 0$, $m_l = 1$, $m_s = +1/2$ and $-1/2$

1.23. Which electron configuration represents a violation of the Pauli exclusion principle?

a) 

b) 

c) 

d) 

1.24. Which sets of the three quantum numbers are acceptable?

1) $n = 4$, $l = 3$, $m_l = -3$ 2) $n = 4$, $l = 2$, $m_l = +3$

3) $n = 4$, $l = 1$, $m_l = 0$ 4) $n = 4$, $l = 0$, $m_l = 0$

a) 1, 3, 4 b) 1, 4 c) 2, 3, 4 d) 3, 4

1.25. Which sets of the three quantum numbers are acceptable?

1) $n = 2$, $l = 1$, $m_l = -1$ 2) $n = 2$, $l = 2$, $m_l = +2$

3) $n = 4$, $l = 2$, $m_l = 3$ 4) $n = 1$, $l = 0$, $m_l = 0$

a) 1, 3, 4 b) 1, 4 c) 2, 3, 4 d) 3, 4

1.26. Names of the orbitals correspond to $n = 5$, $l = 2$; $n = 4$, $l = 3$; $n = 3$, $l = 0$, respectively:

a) 5*d*, 4*f*, 3*s* b) 5*p*, 4*d*, 3*s* c) 5*s*, 4*d*, 3*p* d) 5*d*, 4*p*, 3*s*

1.27. Orbital $3p_x$ is defined by the following quantum numbers:

a) only n, l, and m_l b) only n and m_l

c) only l and m_l d) n, l, m_l, m_s

1.28. The _____ orbital is degenerate with $5p_y$ in a multi-electron atom.

a) $5s$ b) $5p_x$ c) $4p_y$ d) $5d_{xy}$

1.29. Which of the following atom or ion does the outermost electron configuration $3s^2 3p^6$ represent:

a) X (Z = 17) b) X (Z = 19) c) X^- (Z = 17) d) X^+ (Z = 20)

1.30. Number of unpaired electrons in N^{2+} in the ground state is:

a) 0 b) 1 c) 2 d) 3

1.31. The total number of orbitals associated with the fith shell 5 is:

a) 25 b) 10 c) 20 d) 16

1.32. Maximum number of electrons in a subshell can be:

a) $2l + 1$ b) $4l - 2$ c) $2n^2$ d) $4l + 2$

1.33. Maximum number of electrons in a subshell with $n = 4$ and $l = 3$ is:

a) 10 b) 14 c) 16 d) 12

1.34. Determine the maximum number of electrons and the principal quantum number n of L and N -shells, respectively:

a) L-shell:18 e, $n = 3$; N-shell: 32 e, $n = 4$.

b) L-shell: 8 e, $n = 2$; N-shell: 32 e, $n = 4$.

c) L-shell: 8 e, $n = 2$; N-shell: 18 e, $n = 3$.

d) L-shell: 18 e, $n = 3$; N-shell: 32 e, $n = 5$.

1.35. The last electron of an S atom (Z = 16) has the set of quantum numbers (conventionally, electrons fill into orbitals in the order of m_l from $+l$ to $-l$):

a) $n = 3$, $l = 2$, $m_l = -2$, $m_s = +1/2$ b) $n = 3$, $l = 2$, $m_l = +2$, $m_s = -1/2$

c) $n = 3$, $l = 1$, $m_l = -1$, $m_s = +1/2$ d) $n = 3$, $l = 1$, $m_l = +1$, $m_s = -1/2$

1.36. Choose the appropriate magnetic quantum number m_l of an electron in an atom which has $n = 4$, $l = 2$ and $m_s = -1/2$.

a) -2 b) 3 c) -3 d) -4

1.37. The lowest orbital energy is reached when the number of electrons with the same spin is maximized. This statement describes _____.

a) Pauli exclusion principle b) deBroglie hypothesis

c) Heisenberg uncertainty principle d) Hund's rule

1.38. The valence electron configuration of Co^{3+} ion (Z = 27) in the ground state is:

a) $3d^6$ (no single electrons). b) $3d^4 4s^2$ (exist single electrons).

c) $3d^6$ (exist single electrons). d) $3d^4 4s^2$ (no single electron).

1.39. Determine the valence electron configuration in the ground state of the atom which has position in the periodic table is 47:

a) $4d^{10} 5s^2\ 5p^1$ b) $4d^9 5s^2$ c) $4d^{10} 5s^1$ d) $4d^{10}$

1.40. The valence electron configuration of Fe^{3+} ion (Z= 26) in the ground state is:

a) $3d^4 4s^1$ b) $3d^3 4s^2$ c) $3d^6$ d) $3d^5$

1.41. The electron configuration of Cu^{2+} ion (Z = 29) in the ground state is:

a) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^9 4s^0$ b) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7 4s^2$

c) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8 4s^1$ d) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^0$

1.42. Choose the **correct** statement(s). The 1*s* orbital of the H atom is spherical, that is:

1) The probability of finding the 1*s* electron of H atom is the same in all directions in space.

2) The distance between the 1*s* electron and the H nucleus is always constant.

3) The 1*s* electron moves only in the space inside the sphere.

a) 1 b) 2 c) 3 d) 1, 2, 3

1.43. Choose the **correct** statements. In the same atom:

1) The radius of 2*s* orbital is larger than that of 1*s* orbital.

2) The 2*s* atomic orbital (AO) is greater in the energy of electrons than the 1*s* AO.

3) The maximum probability of finding an electron of $2p_x$ AO is along the *x*-axis.

4) The $2p_z$ AO is greater in the energy of electrons than the $2p_x$ AO.

a) 1, 2, 3 b) 4 c) 2, 3, 4 d) 3, 4

1.44. Electrons have the same principal quantum number, which are least affected by shielding effect:

a) *f* electrons b) *s* electrons c) *p* electrons d) *d* electrons

1.45. Choose the **incorrect** statement(s). In a multi-electron atom:

1) The maximum probability of finding an electron of the $3d_{xy}$ orbital is along the *x* and *y* axes.

2) The 2*s* orbital is larger in radius than the 1*s* orbital.

3) The energy of an electron depends on both the principal quantum number and azimuthal quantum number.

4) The $4d_{z^2}$ orbital is greater in energy than the $4d_{x^2-y^2}$ orbital.

a) 1, 3 b) 2, 3 c) 1, 4 d) 3, 4

Answers for Chapter 1										
Question	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.10
Answer	D	A	D	C	B	D	D	A	A	C
Question	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20
Answer	B	A	D	C	D	A	C	A	B	B
Question	1.21	1.22	1.23	1.24	1.25	1.26	1.27	1.28	1.29	1.30
Answer	A	B	C	A	B	A	A	B	C	B
Question	1.31	1.32	1.33	1.34	1.35	1.36	1.37	1.38	1.39	1.40
Answer	A	D	B	B	D	A	D	C	C	D
Question	1.41	1.42	1.43	1.44	1.45					
Answer	A	A	A	B	C					