# CHEMISTRY

## WORKSHEET-13

STEP

A PROJECT BY PUNJAB GROUP

## Worksheet-13

### (A. Physical Chemistry)
### States of Matter (Solids)
### Atomic Structure

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**Q.1 A phenomenon in which a compound exists in more than one crystalline forms is called:**

A) Polymorphism C) Isomorphism
B) Allotropy D) Isomerism

**Q.2 Which of the following sets of solid elements A, B, C and D includes a giant metallic structure, a macromolecular structure and a simple molecular structure?**

A) Na, Mg, A*l* C) Al, S*i*, S
B) C, S*i*, Sn D) A*l*, S, Si

**Q.3 Face centered cubic structure is shown by:**

A) Cd C) Ag
B) Na D) Mg

**Q.4 Iodine is in the solid state and has greyish black colour. It has all of the following properties EXCEPT:**

A) It is a molecular solid
B) It shows face centered cubic structure
C) It has strong London dispersion forces
D) I – I bond distance in the crystal lattice is less than that of iodine in the gaseous state

**Q.5 Mark the incorrect statement about diamond which is allotropic form of carbon:**

A) It has two dimensional structure
B) It shows face centered cubic structure
C) It is a type of covalent solid
D) It is a non-conductor

**Q.6 Identify the incorrect statement about giant structure of NaCl:**

A) It shows face centered cubic structure
B) It has four formula units per unit cell in the crystal lattice
C) The distance between two adjacent ions of different kind in the crystal lattice is 2.75A$^{o}$

D) It is non-conductor in the solid state

**Q.7 All of the following pair of crystalline solids are correctly matched w.r.t type of bonding EXCEPT:**

| Options | Crystalline solids | Nature of bonding |
|---|---|---|
| A) | Diamond, SiC | Covalent bond |
| B) | MgO, NaCl | Ionic bond |
| C) | Al, Zn | Metallic bond |
| D) | $I_2$, HCl | London dispersion forces |

**Q.8 Which one of the following properties is not shown by molecular crystalline solids?**

A) They are soft

B) They have low densities

C) They all are soluble in non-polar solvents

D) They are mostly volatile

**Q.9 Which of the following statements about ionic solids, covalent solids and molecular solids is incorrect?**

| Opt. | Properties | Ionic solids | Covalent solids | Molecular solids |
|---|---|---|---|---|
| A) | Example | NaCl, CaO | Diamond, SiC | $I_2$, $CO_2$, HCl, Ice |
| B) | Basic component | Ions | Atom | Molecule |
| C) | Electrical conductivity | Non-conductor in solid state | Non-conductor except graphite | Non-conductor except HCl in $H_2O$ |
| D) | M.P and B.P | Very high M.Ps and B.Ps | Very low M.Ps and B.Ps | High M.Ps and B.Ps |

**Q.10 In crystal lattice of ice, each O-atom of water molecule is attached to:**

A) Four H-atoms C) Two H-atoms

B) One H-atom D) Three H-atoms

**Q.11 The nucleus of an atom contains:**

A) Always neutrons

B) Always protons and neutrons

C) Always protons only

D) Usually protons and neutrons

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**Q.12 In the periodic table elements are arranged in order of increasing their:**

A) Mass number C) Proton number

B) Reactivity D) Density

**Q.13 An atom with proton number of 19 and mass number of 40 is/has:**

A) Found in the Group - IIA

B) Found in the third period

C) Same number of protons and electrons

D) Same number of protons and neutrons

**Q.14 The neutron particle has:**

A) A mass of 1 gram

B) A mass approximately equal to that of proton

C) A charge equal but opposite to that of electron

D) It is present in all the atoms

**Q.15 Proton numbers of certain elements are given. Which represents an element which would not be in the same period as rest of the elements?**

A) 3 C) 9

B) 10 D) 12

**Q.16 Which of the following particles contains 20 neutrons 19 protons and 18-electrons?**

A) ${}^{39}_{19}K^{+}$ C) ${}^{39}_{19}K$

B) ${}^{40}_{18}Ar$ D) ${}^{39}_{20}Ca$

**Q.17 Which of the following statements is incorrect?**

A) Metals have 1 – 3 valence electrons

B) Non-metals have 4 – 7 valence electrons

C) Noble gases have 2 or 8 valence electrons

D) All the elements of IIIA group are metals

**Q.18 All of the following statements are correct EXCEPT:**

A) Group number is based on valence electrons

B) Period is based on number of shells involved in the electronic configuration

C) Electrons present in the inner shells are called valence electrons

D) Block of the elements in the modern Periodic table is based on partially filled atomic orbitals

**Q.19 Which of the following species has maximum number of unpaired electrons?**

A) $Fe^{+3}$ C) Zn

B) $Ni^{+2}$ D) $Cu^{+}$

**Q.20 The lowest principal quantum number that an electron can have is:**

A) 0 C) 1

B) 2 D) 3

**Q.21 The relative energy of 4s, 4p and 3d orbitals are in the order of:**

A) 3d < 4p < 4s C) 4s < 4p < 3d

B) 4s < 3d < 4p D) 4p < 3d < 4s

**Q.22 With the increase of value of principal quantum number (n), the shape of the s-orbitals remain same although their sizes:**

A) Increase

B) Decrease

C) Remain the same

D) May or may remain the same

**Q.23 All of the following are applications of quantum numbers EXCEPT:**

A) To find group of elements

B) To find block of elements

C) To find period of elements

D) To determine 1st ionization energy of elements

**Q.24 In a multi-electron atoms, the energy of the electrons in a particular orbital is determined by:**

A) n C) n + *l*

B) n + *l*, m D) n, *l*, m, s

**Q.25 The fact that the two electrons in an atomic orbital must have opposite spin as deduced from:**

A) Hund's Rule

B) Pauli's Exclusion Principle

C) Aufbau Rule

D) Heisenberg's Uncertainty Principle

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**Q.26 All of the following statements about ionization energy are correct EXCEPT:**

A) Successive ionization energies of an element increase

B) Atom of the element must be in the gaseous state before loss of electron

C) Elements which have stable electronic configuration have greater ionization energy

D) Ionization energy may or may not be endothermic process

**Q.27 Which of the following elements has greater first ionization energy?**

A) Si C) P

B) C*l* D) A*l*

**Q.28 Consider the following thermo-chemical equation:**

$$\underset{(s)}{Na} \longrightarrow \underset{(g)}{Na^{+}} + e^{-}$$

**The enthalpy change involved in the above ionization of the solid sodium into gaseous $Na^+$ ion is:**

A) $\Delta H_i$ C) $\Delta H_{at} + \Delta H_i$

B) $\Delta H_{sub}$ D) $\Delta H_{at}$

**Q.29 An atomic orbital may never be occupied by:**

A) 1 electron C) 2 electrons

B) 3 electrons D) Zero electron

**Q.30 Where in a periodic series do you find strong based formers?**

A) Inert gases C) Right

B) Middle D) Left

**Q.31 Which of the following is proper order of characteristic features of quantum numbers?**

A) Size, Shape, Orientation C) Shape, Size, Orientation

B) Orientation, Size, Shape D) Shape, Orientation, Size

**Q.32 Which of the following formula is used to determine number of electrons in a sub-shell?**

A) $2n^2$ C) $2(2l + 1)$

B) $l = n - 1$ D) $m = 2l + 1$

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Q.33 **Which of the following ions have more electrons than protons and more protons than neutrons?**

A) $D^{-1}$  C) $OD^-$

B) $He^+$  D) $OH^-$

Q.34 **Identify the incorrect statement about electron affinity:**

A) Elements having stable electronic configuration have high electron affinity

B) Elements of 3rd period have greater electron affinity than that of 2nd period

C) It is associated with element

D) Element must be in the gaseous state before gain of electron

Q.35 **In which of the following pair of elements, first element of the pair has comparatively greater electron affinity?**

A) F, Cl  C) N, P

B) S, O  D) B, Al

Q.36 **In which of the following pair of elements, 1st element of the pair has lower ionization energy?**

A) N , O  C) Mg , Al

B) Ne, F  D) S, P

Q.37 **Which of the following is correct electronic configuration of Copper (atomic number of Cu = 29)?**

A) [Ar] $3d^9$, $4s^2$  C) [Kr] $3d^9$ , $4s^2$

B) [Ar] $3d^{10}$, $4s^1$  D) [Kr] $3d^{10}$ , $4s^1$

Q.38 **Correct electronic configuration of potassium (atomic number K=19) is:**

A) [Ar] $4s^1$  C) [Kr] $4s^2$

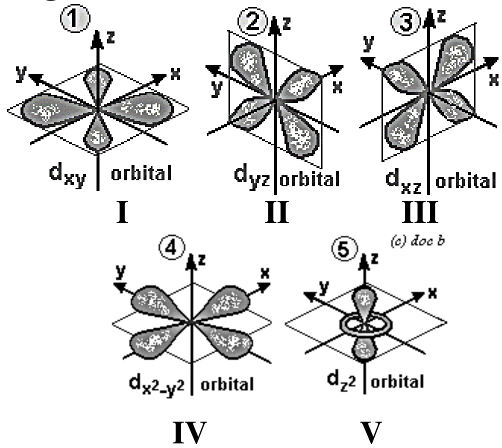
B) [Ne] $4s^2$  D) [Kr] $4s^1$

Q.39 **Which of the following atoms represent isotones?**

A) ${}^{12}_{6}C$, ${}^{13}_{6}C$, ${}^{14}_{6}C$  C) ${}^{40}_{18}Ar$, ${}^{42}_{20}Ca$, ${}^{43}_{21}Sc$

B) ${}^{40}_{18}Ar$, ${}^{40}_{20}Ca$, ${}^{41}_{21}Sc$  D) ${}^{14}_{7}N$, ${}^{16}_{8}O$, ${}^{18}_{9}F$

**Q.40 Followings are all the d-atomic orbitals.**




**Which of the following is collar shaped d-atomic orbital?**

A) I and II C) III and IV

B) V only D) IV only

**Q.41 Mark the incorrect statement:**

A) Number of protons in the nucleus of an atom is called proton number and it is shown by Z

B) Sum of protons and neutrons in the nucleus of an atom is called nucleon number (mass number) and is shown by A

C) Number of neutrons = A – Z

D) Number of protons and electrons in a cation is equal

**Q.42 Properties of three fundamental particles are given in the tabular form:**

| | Particles | Charge | Relative charge | Mass (kg) | Deflection under electric field |
|---|---|---|---|---|---|
| I | Proton | $+1.6022 \times 10^{-19}$ | +1 | $1.6726 \times 10^{-27}$ | Deflects toward negative pole |
| II | Neutron | 0 | 0 | $1.6705 \times 10^{-27}$ | Undeflected |
| III | Electron | $-1.6022 \times 10^{-19}$ | -1 | $9.1095 \times 10^{-31}$ | Deflects towards positive pole |

**Identify which one is not correctly matched:**

A) I C) III

B) II D) I and III

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**Q.43 Rutherford's model of atom failed because:**

A) The atom did not have a nucleus and electrons

B) It did not account for the attraction between protons and neutrons

C) It did not account for the stability of the atom

D) There is actually no space between the nucleus and the electrons

**Q.44 Bohr's hydrogen atomic model of atom is contradicted by:**

A) Planck's quantum theory

B) Heisenberg's uncertainty principle

C) Photoelectric effect

D) Dual nature of electrons

**Q.45 All of the following statements about Rutherford's atomic model are correct EXCEPT:**

A) Most of the part of atom is empty

B) Central part of the atom is positively charged which is called nucleus

C) He proposed the planetary model of atom (similar to the solar system)

D) All the particles are present in the nucleus except electrons

**Q.46 According to Planck's quantum theory of radiation, all of the following mathematical relationships are correct EXCEPT:**

A) $E \propto v$

C) $\bar{v} = \frac{1}{\lambda}$

B) $E \propto \frac{1}{\lambda}$

D) $E \propto \frac{1}{\bar{v}}$

**Q.47 According to Bohr's hydrogen atomic model, if electron is present in $2^{nd}$ shell (n = 2), the value of radius (for $2^{nd}$ orbit) is:**

A) $2.116A^o$

C) $2.135A^o$

B) $2.216A^o$

D) $2.345A^o$

**Q.48 Bohr's hydrogen atomic model theory is applicable for all of the following species EXCEPT:**

A) H

C) $Li^{+2}$

B) $He^{+1}$

D) $Be^{+2}$

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**Q.49** **Which of the following statements about Bohr's hydrogen atomic model is incorrect?**

A) $r_2 - r_1 < r_3 - r_2 < r_4 - r_3$

B) $E_2 - E_1 > E_3 - E_2 > E_4 - E_3$

C) Energy of electron is directly proportional to $n^2$ (n = shell number)

D) According to him electrons not only revolve round the nucleus in circular orbit but also in elliptic orbit

**Q.50** **X-rays show all of the following properties EXCEPT:**

A) They are electromagnetic radiations

B) They travel with the velocity of light

C) They have greater frequency than gamma rays

D) They are used to diagnose fracture in the bones

| ANSWER KEY (Worksheet-13) | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | A | 14 | B | 27 | B | 40 | B |
| 2 | C | 15 | D | 28 | C | 41 | D |
| 3 | C | 16 | A | 29 | B | 42 | B |
| 4 | D | 17 | D | 30 | D | 43 | C |
| 5 | A | 18 | C | 31 | A | 44 | B |
| 6 | C | 19 | A | 32 | C | 45 | C |
| 7 | D | 20 | C | 33 | D | 46 | D |
| 8 | C | 21 | B | 34 | A | 47 | A |
| 9 | D | 22 | A | 35 | B | 48 | D |
| 10 | A | 23 | D | 36 | D | 49 | D |
| 11 | D | 24 | C | 37 | B | 50 | C |
| 12 | C | 25 | B | 38 | A | | |
| 13 | C | 26 | D | 39 | C | | |

## ANSWERS EXPLAINED

**Q.1 (A)** **A phenomenon in which a compound exists in more than one crystalline forms is called polymorphism.** That compound which exists in more than one crystalline forms is called a polymorphic, and these forms are called polymorphs of each other. Polymorphs have **same chemical properties** but they **differ in the physical properties**. **e.g. $CaCO_3$** shows **two crystalline** forms **trigonal and orthorhombic**. Polymorphs have same chemical properties, but they differ in the physical properties. The difference in physical properties is due to different structural arrangement of their particles.

**Q.2 (C)** **These substances** fulfill the condition because **Al** shows a giant **metallic structure**, **Si** shows **macromolecular structure** while **S** shows a simple **molecular structure.**

**Q.3 (C)** **Ag** shows **face centered cubic structure** while **Na** shows **body centered cubic structure, Cd** and **Mg** show **hexagonal closed packing structure.**

**Q.4 (D)** It is incorrect statement. **In fact, I – I bond distance in the crystal is greater than that of iodine in the gaseous state.**

- **Iodine** in the **solid** state is in the form of **crystal lattice.** Since **iodine molecules** have **greater size** so there is **greater polarizability greater charge** separation and thus there are stronger intermolecular force in the **iodine molecules.** So in the crystal lattice there is stretching in the iodine molecules due to greater polarizability.
- But in case of iodine in the gaseous state there is no polarizability, so iodine molecules are independent from each other.
- That is why **I – I (271.5ppm) bond length in crystal lattice is greater than that of iodine in the gaseous state i.e. (I – I)** has comparatively less bond length value **(266.6pm).**

**Q.5 (A)** In fact, **diamond has three dimensional** structure **but not two dimensional structure. Two dimensional structure** is **shown by graphite** (which is allotropic form of carbon).

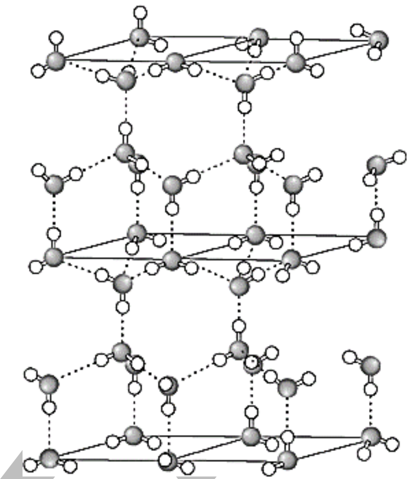
**Q.6 (C)** In crystal lattice of **NaCl,** the **distance between two nearest ions of the same kind i.e., $Cl^-$ ions is $5.63A^o$. So the distance between two adjacent ions of different kind is $5.63/2 = 2.815A^o$, but not $2.75A^o$.**

**Q.7 (D)** In fact, iodine molecules **have stronger London dispersion forces** in the **solid state.** But **HCl** has dipole-dipole forces because it is polar molecule whereas **iodine is a non-polar molecule.**

**Q.8 (C) It is incorrect option.** In fact **polar molecular** crystals are **soluble** in **polar solvents e.g. HCl** in **$H_2O$** while **non-molecular solids** are **soluble** in **non-polar solvents e.g. iodine** is **soluble** in **carbon tetrachloride solvent.**

**Q.9 (D)** Covalent solids like **diamond, SiC, $(SiO_2)_n$** have **high melting and boiling point** as **compared** to **ionic compounds e.g. melting boiling** of **diamond is 3550°C** whereas **melting point of NaCl** is **801°C.**

**Q.10 (A) The presence of two hydrogen atoms and two lone electron pairs in each water molecule results in a three-dimensional tetralhedral structure in ice. Each oxygen atom in ice is surrounded tetrahedrally by four others. Hydrogen bonds link each pair of oxygen atoms shown in figure.**



- That is why in crystal lattice of ice each O-atom of water molecule is attached to four H-atoms.
- Empty spaces are created in the structures as shown in the figure. That is why when water freezes, it occupies 9% more space and its density decreases.
- The result in that ice floats on water. The structure of ice is just like that of a diamond because each atom of carbon in diamond is at the center of tetrahedron just like the oxygen of water molecules in ice.

**Q.11 (D)** The nucleus of an atom usually contains protons and neutrons **except hydrogen (protium)** which **does not have neutrons.** All the other elements have protons and neutrons.

**Q.12 (C)** In the modern periodic table elements are arranged in order of increasing proton number which is shown by Z.

**Q.13 (C)** The element with **proton number 19** and **mass number 20** is isotope of K. It has same number of protons and electrons.

**Q.14 (B) Neutron particle** has a mass approximately equal to that of proton as shown below.

- **Mass of neutrons = 1.6750 x $10^{-27}$ kg**
- **Mass of protons = 1.6726 x $10^{-27}$ kg**

**{By comparison it is clear that mass of neutron is almost equal to that of proton}**

**Q.15 (D)** The element having **atomic number 12** belongs to **third period** because it involves three shells in its electronic configuration such as **2, 8, 2 (K, L, M) i.e three shells.**

**Q.16 (A)** It has been explained in the tabular form **i.e.**

| Specie | Protons | Electrons | Neutrons |
|---|---|---|---|
| $^{39}_{19}K^{+}$ | 19 | 18 | 20 |

**Q.17 (D)** In fact all the elements of **IIIA group** are metals **(except Boron)** which is **non-metal.**

**Q.18 (C)** Electrons present in the inner shells are called core electrons which are responsible for shielding effect (screening effect). This effect is responsible for the decrease in force of attraction of the nucleus for the electrons present in the valence shell.

**Q.19 (A)** $\underset{(23e^{-})}{_{26}Fe^{+3}}$ = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^5$.

From the electronic configuration of a $Fe^{+3}$, it shows that there are five unpaired electrons in 3d-sub shell and it has the maximum number of unpaired electrons while others species has less number of unpaired electrons.

**Q.20 (C) Principal quantum number is shown by n. Its possible values are 1,2,3,4,5,6,7 so it is clear that it cannot be zero.**

**Q.21 (B)**

| Name of sub-shell | n | $\ell$ | n + $\ell$ | Order of filling of sub-shell |
|---|---|---|---|---|
| 4s | 4 | 0 | 4+0=4 | 4s < 3d < 4p |
| 4p | 4 | 1 | 4+1=5 | |
| 3d | 3 | 2 | 3+2=5 | |

**Q.22 (A) With the increase n value (principal quantum number), the size of s-orbital increases whereas the shape remains the same. e.g. the size of 2s-orbital is greater than 1s-orbital**

**1s 2s**

**Q.23 (D) e.g. it can be explained on the basis of electronic configuration as in nitrogen element $_7N$:**

- w.r.t… n value two shells (2,5) are involved (distribution of electron in shells), it shows that N belongs to 2nd period and VA group.
- w.r.t… n + $\ell$ rule ($1s^2$, $2s^2$, $2p^3$) it shows that nitrogen is p-block element
- By applying Hund's rule $\left(\mathbf{1s^2, 2s^2, 2\overset{\uparrow}{p}_x, 2\overset{\uparrow}{p}_y, 2\overset{\uparrow}{p}_z}\right)$ valency of **N = 3**
- It is clear that quantum numbers help us to determine **period, group, block, and valency** of the element but quantum numbers have no concern with ionization energy

**Q.24 (C)** In a multi-electron atoms, the energy of the electrons in a particular orbital is determined by n + $\ell$ rule, which is in accordance to Aufbau principle **which states that the electrons should be filled in the energy sub-shells in order of increasing energy values.** It can be explained with the help of following example.

| Rule | 3d | 4s |
|---|---|---|
| $n + \ell$ | $n = 3,\ \ell = 2$ | $n = 4,\ \ell = 0$ |
| | $n + \ell = 3 + 2 = 5$ | $n + \ell = 4 + 0 = 4$ |

**Conclusion:**

**$n + \ell$ rule shows that energy of 4s sub-shell is less than that of 3d. So 4s sub-shell is preferentially filled first than that of 3d.**

**Q.25 (B)** **This principle can be stated as follows. It is impossible for two elections residing in the same atomic orbital of a poly-electrons atom to have the same values of four quantum numbers or two electrons in the same atomic orbital should have opposite spins $(\uparrow\downarrow)$.**

**Q.26 (D)** **Ionization energy is always endothermic process because energy always has to be supplied to remove electron from the outermost shell of an isolated atom in the gaseous state. Atom can be neutral or it may carry positive charge. In either case energy has to be supplied.**

**Q.27 (B)** Electronic configuration of $_{17}$**Cl ($1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^5$)** shows that p-sub shell is near to completion and it is very close to electronic configuration of **Ar**. That is why chlorine (Cl) element has greater first ionization energy than that of other elements. First ionization energy of elements are given in the tabular form for comparison:

| Elements | First ionization energy ($kJmol^{-1}$) |
|---|---|
| Cl | 1251 |
| P | 1012 |
| Si | 787 |
| Al | 578 |

**Q.28 (C)**

$$Na_{(s)} \longrightarrow Na(g) \qquad \Delta H^\circ_a = +108kJmol^{-1}$$

$$Na_{(g)} \longrightarrow Na^+_{(g)} + e^- \qquad \Delta H^\circ_i = +496kJmol^{-1}$$

$$\therefore\ \underset{(s)}{Na} \longrightarrow \underset{(g)}{Na^+} + e^-$$

$$\Delta H^\circ_{at} + \Delta H^\circ_i = +108kJmol^{-1} + 496kJmol^{-1}$$

**Conclusion:**

It shows that for the conversion of sodium atom from its solid state into gaseous cationic form, sum of $\Delta H^o_{at} + \Delta H_i$ is required.

**Q.29 (B)** The volume of space in which there is 95% chance of finding an electron is called atomic orbital'. An atomic orbital can accommodate maximum two electrons with opposite spin according to **Pauli's Exclusions Principle.** It can never accommodate three electrons.

**Q.30 (D)** The elements which lie on the extreme left side of the periodic table form the strongest bases such as the elements of **IA group (NaOH, KOH, RbOH, CsOH).**

**Q.31 (A)**

| n | $\ell$ | m |
|---|---|---|
| It tells about **size** of atomic orbitals | It shows **shape** of atomic orbital | It tells about **orientation** of atomic orbitals |
| **Conclusion:** So three quantum numbers n, $\ell$, m depicts **size, shape and orientation.** | | |

**Q.32 (C) This formula helps us to determine number of electrons in a sub-shell e.g.**

| Formula | Example |
|---|---|
| $2(2\ell+1)$ | $\ell$ value of d-sub shell = 2 so d-sub shell has number of electrons = 2 (2 x 2 +1) =10 Electrons |

**Q.33 (D) It can be explained with the help of table.**

| Ions | Protons | Electrons | Neutrons |
|---|---|---|---|
| $D^-$ | 1 | 2 | 1 |
| $He^+$ | 2 | 1 | 2 |
| $OD^-$ | 9 | 10 | 9 |
| **$OH^-$** | **9** | **10** | **8** |

**Q.34 (A)** Those elements which have stable electronic configuration have comparatively low electron affinity

- e.g. Neon has stable electronic configuration and its first electron affinity value is only +29 $kJmol^{-1}$. On the other hand its first ionization energy value is **+2081$kJmol^{-1}$** which shows that it is comparatively greater value.

**Q.35 (B)** The elements of third period have comparatively greater electron affinity than that of second period elements.

- Because each atom of the elements of the second period has comparatively smaller size due to stronger nucleus hold and overcrowding of electrons.
- Due to these reasons electron affinity of second period elements is comparatively less than that of third period elements as shown in the tabular form.

| Electronic affinity ($kJmol^{-1}$) of 2nd Period | Electronic affinity ($kJmol^{-1}$) of 3rd Period |
|---|---|
| **O = -141** | **S = -200** |
| **F = -322** | **Cl = -342** |

**Q.36 (D)** Ionization energy of **phosphorus (P) is greater than** that of **sulphur (S)** because in case of phosphorus **3p-sub** shell is half filled as shown in the electronic configuration **($_{15}P=1s^2, 2s^2, 2p^6, 3s^2, 3p^3$)** whereas in case of **sulphur (S)** it has four electrons in **3p sub**-shell which is not half filled as shown in electronic configuration of **($_{16}S = 1s^2, 2s^2, 2p^6, 3s^2, 3p^4$).**

- By comparison it is clear that the element which has half-filled p-sub shell has stable electronic configuration and has greater first ionization energy.

| Elements | Electronic configuration (E.C) | Cause of stability | First I.E $kJmol^{-1}$ |
|---|---|---|---|
| $_{15}P$ | $1s^2, 2s^2, 2p^6, 3s^2, 3p^3$ | p-sub shell is Half filled more stable E.C | (1012) More first I.E |
| $_{16}S$ | $1s^2, 2s^2, 2p^6, 3s^2, 3p^4$ | p-sub shell is not half filled | (1000) Less first I.E |

**Conclusion:** Greater is the stable electronic configuration, more is first ionization energy.

**Q.37 (B)** In 3d-series Cr and Cu show abnormal electronic configuration. General configuration of **Cr** should be **(Ar) $3d^4$, $4s^2$,** since **3d sub**-shell is near to half filled, so that is why 3d orbital snatches one electron from 4s and shows electronic configuration **(Ar) $3d^5$, $4s^1$.**

- **Similarly** general electronic configuration of **Cu** should be **(Ar) $3d^9$, $4s^2$,** since **3d sub-shell** is near to complete filled, so that is why 3d orbital snatches one electron from 4s and shows electronic configuration **(Ar) $3d^{10}$, $4s^1$. This detail is shown in tabular form**.

| Elements | Electronic configuration |
|---|---|
| $_{24}Cr$ | (Ar) $3d^5$, $4s^1$ |
| $_{29}Cu$ | (Ar) $3d^{10}$, $4s^1$ |

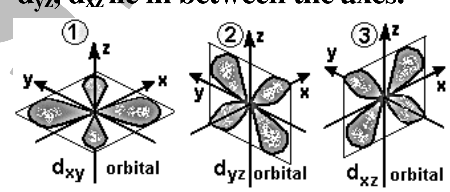
**Q.38 (A)** Detail electronic configuration of $_{19}K$ is shown as ( $\underbrace{1s^2,2s^2,2p^6,3s^2,3p^6}_{Ar(core)}$ $,4s^1$) so overall shortly it can be shown as **[Ar] $4s^1$.**

**Q.39 (C)** $^{40}_{18}Ar, ^{42}_{20}Ca, ^{43}_{21}Sc$ are **isotones as shown in the tabular form for comparison.** **$^{14}_{6}C$ and $^{16}_{8}O$ are also known as isotones, because they have same number of neutrons.**

| Nuclide | Protons (Z) | Mass number (A) | Neutrons (A-Z) |
|---|---|---|---|
| $^{40}_{18}Ar$ | 18 | 40 | 22 |
| $^{42}_{20}Ca$ | 20 | 42 | 22 |
| $^{43}_{21}Sc$ | 21 | 43 | 22 |

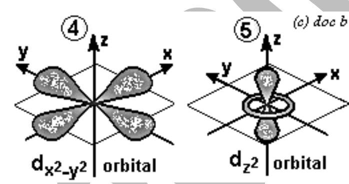
**Q.40 (B) d sub-shell has five atomic orbitals such as $d_{xy}, d_{yz}, d_{xz}, d_{z^2}$, and $d_{x^2-y^2}$.**

- **Out of these five d-atomic orbitals, three atomic orbitals $d_{xy}$, $d_{yz}$, $d_{xz}$ lie in between the axes.**




I. II. III.

- **Whereas two d-atomic orbitals $d_{x^2-y^2}$ and $d_{z^2}$ are present on the axes as shown in the diagram.**
- **d-orbitals which lie on the x-axes**




**Collar shaped**

**IV V**

- **From the diagram it is clear that $d_{z^2}$ atomic orbital is collar shaped.**

**Q.41 (D)** In any cation number of electrons is always less than that of protons. The number of protons in a neutral atom or its cation is always same.

- In a chemical reaction there is always exchange of electrons. In a cation number of electrons decreases than that of protons, because in a cation formation there is loss of electron.
  - In anion the number of electrons exceeds than that of protons, because in this case atom gains electrons.

**Q.42 (B)** The mass of a neutron is always greater than that of a proton as shown by the value. The mass of proton is (1.6726 x $10^{-27}$kg) and that of neutron is (1.6750 x $10^{-27}$kg) as shown in the table.

| Particles | Mass (kg) | Mass (amu) |
|---|---|---|
| Proton | 1.6726 x $10^{-27}$ | 1.0073 |
| Neutron | 1.6750 x $10^{-27}$ | 1.0087 |

**Q.43 (C) Rutherford's planet-like picture** was defective and **unsatisfactory** because the **moving electron** must be accelerated **towards** the nucleus. Therefore, the radius of the shell having electron should become

**smaller** and **smaller** and the **electron should fall into the nucleus.** Thus, an atomic structure as proposed by Rutherford would collapse. **Due to this reason, Rutherford failed to explain the stability of atom.**

**Q.44 (B)** According to Bohr's theory, an electron is a material particle and its position as well as momentum can be determined with great accuracy. But with the advent of the concept of wave nature of electron, it has not been possible for us to measure simultaneously the exact position and velocity of electron. This was **suggested by Heisenberg, in 1927.** Due to above mentioned reason, Bohr's H-atomic model is contradicted by Heisenberg's uncertainty principle.

**Q.45 (C)** In fact, Rutherford **planet like picture** was **defective** and **unsatisfactory.**

- **Solar** system follows **Newton's law** of **gravitation which states that a particle attracts every other particle in the universe using a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centers. i.e. mathematical equation of Gravitational force between two objects is shown below:**

$$F = G\frac{m_1m_2}{r^2}$$

- **But protons and electrons** are **charged** particles. **Protons** are present in the **nucleus** and **electrons revolve** around the **nucleus.** They attract each other (unlike solar system) by the columbic force of attraction.
- **According to Coulomb's law, the coulombic force is directly proportional to the product of charges and inversely proportional to square of distance between them as shown by the equation:**

$$\mathbf{F_c = \frac{Ze^2}{4\pi\varepsilon_o r^2}}$$

**Q.46 (D)** In fact, the amount of energy (E) is directly proportional to wave number ($\bar{v}$).

| Term | Symbol | Definition | Unit |
|---|---|---|---|
| **Frequency** | $v$ | It is the number of wave passing through a point per second. | Hz, $s^{-1}$ |
| **Wave length** | $\lambda$ | It is the distance between two consecutive crests or troughs | cm, mm etc |
| **Wave number** | $\bar{v}$ | It is the number of waves per unit length and is reciprocal to wavelength ($\bar{v} = \frac{1}{\lambda}$). | $cm^{-1}$, $mm^{-1}$ etc |

**The SI unit of frequency is the hertz (Hz), named after the German physicist Heinrich Hertz; one hertz means that an event repeats once per second. A previous name for this unit was cycles per second (cps). The SI unit for time period is the second.**

**Q.47 (A)** According to **Bohr's hydrogen atomic model,** mathematically radius **$r_n$ = 0.529A$^o$ ($n^2$).** For hydrogen atom if **n = 2** then the value of radius for **$n_2$ ($2^{nd}$ shell)** from the nucleus of an atom is **2.116A$^o$.**

**Q.48 (D) Bohr's hydrogen atomic model theory is applicable only for single electron system. But $Be^{+2}$ has two electrons, so for $Be^{+2}$ ion it is not applicable.**

**Q.49 (D)** This was stated by **Sommerfeld in 1915** but **not** by Bohr. **Sommerfeld** suggested the moving electrons might describe in addition to the circular orbits elliptic orbits as well wherein the nucleus lies at one of the focii of the ellipse.

**Q.50 (C) In fact,** frequency of **gamma rays** is **greater** than that **of X-rays.**

STEP

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