# CHAPTER - 3

# Periodic Properties

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| **DOBEREINER'S TRIADS** | When elements of same properties are kept in the increasing order of atomic weights, the atomic weight of middle element is equal to the mean atomic weight of remaining two elements.<br>Triad of atoms Mean of first and last element Li Na K $\frac{7+39}{2}=23$ |
| **NEWLAND'S RULE OF OCTAVE** | If the elements are arranged in the increasing order of atomic weights, on starting with an element, the first element will exhibit similarities with the eighth element |
| **LOTHAR MAYER'S VOLUME CURVES** | (a) The graphs drawn by plotting the atomic volumes against atomic weights are known as Lothar Mayer volume curves.<br>(b) The alkali metals have highest atomic volumes.<br>(c) Alkaline earth metals (Be, Mg, Ca, Sr, Ba, etc) which are relatively a little less electropositive. Occupy positions on the descending part of the curve.<br>(d) Halogens and the noble gases (except helium) occupy positions on the ascending part of the curve.<br>(e) Transition elements have very small volumes and therefore these are present at the bottoms of the curve. |
| **MENDELEEF'S PERIODIC LAW** | According to Mendeleef's periodic law, the physical and cemical properties of elements are peiodic function of their atomic weights. |
| **MODERN PERIODIC LAW AND MODERN PEIODIC TABLE** | (a) Mosley proved that the square root of frequency (v) of the rays proportional to the nuclear charge of the atom. This can be represented by the following expression.<br>(b) $\sqrt{v}=a(Z-b)$ where Z is nuclear charge on the atom and a and b are constants.<br>(b) The nuclear charge on an atom is equal to the atomic number.<br>(c) According to modern periodic law. "The properties of elements are the periodic functions of their atomic numbers". |
| **MODERN PERIODIC TABLE** | There is seven period and 18 groups in the modern periodic table. |

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| **s - BLOCK ELEMENTS** | (a) The elements of the periodic table in which the last electron enters in s-orbital, are called s-block elements.<br>(b) s-Orbital can accomodate a maximum of two electrons.<br>(c) Their general outermost configuration are $ns^1$ and $ns^2$ respectively, where n = (1 to 7) |
| **p - BLOCK ELEMENTS** | (a) The general outermost configuration of p-block elements are $ns^2\ p^{1-6}$.<br>(b) There are nine gaseous elements (Ne, Ar, Kr, Xe, Rn, $F_2$, $Cl_2$, $O_2$ and $N_2$) belonging to p-block. Gallium (Ga) and bromine (Br) are liquids. |
| **d - BLOCK ELEMENTS** | (a) The elements of the periodic table in which the last electron gets filled up in the d orbital, called d-block elements.<br>(b) The d block elements are placed in groups name 3 to 12 .<br>(c) The general configuration of these elements is $ns^{1-2}$, $(n-1)d^{1-10}$ where n = 4 to 7.<br>(d) All of these elements are metals<br>(e) Out of all the d block elements mercury is the only liquid. |
| **f - BLOCK ELEMENTS** | (a) The elements of the periodic table in which the last electron gets filled up in the antipenutimate f-orbital called as f-block elements.<br>(b) The f block elements are from atomic number 58 to 71 and from 90 to 103. |
| **DETERMIATION OF PERIOD NO.** | Write the electronic configuration and check the highest shell number. It will represent its period number. |
| **DETERMINATION OF GROUP NO** | (1) Write the electronic configuration<br>(2) Predict its block<br>**Case I :** If it is s-block element calculate electrons in ns subshell. It will be it's group no.<br>e.g. Ca(20) : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$<br>Period = 4 group 2<br>**Case II :** If it is d-block element, calculate electrons present in ns and (n–1) d-subshell. It will be its group no.<br>Cr (24) : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^5$<br>Period = 4, Group = 1 + 5 = 6<br>**Case III :** If it is p-block element, calculate no of electrons in ns, np-subshell and to this add 10. It will be its group no.<br>S(16) : $1s^2\ 2s^2\ sp^6\ 3s^2\ 3p^4$<br>Period = 3 ; group = 2 + 4 + 10 = 16<br>**Case IV :** If it is f-block elements, then they are always in group -3. |

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| **ATOMIC RADIUS** | The distance of the outermost orbit from the nucleus of an atom is called atomic radius. |
| **SINGLE BOND COVALENT RADIUS, SBCR** | The Homonuclear diatomic molecules<br>$d_{A-B} = r_A + r_B$ or $2r_A$ $\qquad r_A = \frac{d_{A-A}}{2}$ |
| **VANDER WAALS RADIUS** | Average of the Half of the distance between the nuclei of two non bonded atoms in solid state called as vanderwaal's radius. |
| **PERIODICITY IN ATOMIC RADIUS** | **(a) In a period :** The number of orbit remains same on going from left to right in a period while effective nuclear charge increases. That's why atomic radius decreases along the period.<br>**(b) In a group :** The atomic radii increase on going downwards in a group because the number of orbits also increase on going from top to bottom in a group. |
| **IONIC RADIUS** | Ionic radius is the distance between the nucleus and the limit of the electron cloud scattered around the nucleus.<br>**Cationic Radius**<br>The size of a cation is smaller in comparison to the size of its corresponding atom. This is because of the fact that an atom on losing electrons/s effective nuclear charge increases.<br>$\text{size of cation} \propto \frac{1}{\text{Amount of positive charge or } Z_{eff}}$<br>**Anionic Radius**<br>Development of negative charge increases size of atom because of the following two reasons.<br>(1) Effective nuclear charge is decreased.<br>(2) Inter electronic repulsion in outer most shell is increased. |
| **SIZE OF ISOELECTRONIC SERIES** | The species, which have same number of electrons but different nuclear charges, constitute an isoelectronic series. Among various isoelectronic species greater the positive charge, smaller is the size and greater the negative charge greater is the size. |
| **IONISATION POTENTIAL** | (a) The energy required to remove the most loosely bound electron from the outermost orbit of an isolated gaseous atom is called as ionisation potential (IP). This ionisation is an endothermic or energy absorbing process. |

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| | (b) An electron cannot be removed directly from an atom in solid state. For this purpose, the solid state is converted to gaseous state and the energy required for this is called sublimation energy.<br>(c) $A \xrightarrow{I^{st}\ IP} A^{+1} \xrightarrow{II^{nd}\ IP} A^{+2} \xrightarrow{III^{rd}\ IP} A^{+3}$<br>Ist IP < IInd IP < IIIrd IP because as the electrons go out of the atom, the ionic size goes on decreasing and the effective nuclear charge goes on increasing. |
| **FACTORS AFFECTING IONISATION POTENTIAL** | **(a) Atomic Size :**<br>$\text{Ionisation potential} \propto \frac{1}{\text{atomic size}}$<br>**(b) Effective Nuclear Charge**<br>$\text{Ionisation potential} \propto \text{Effective nuclear charge}$<br>**(c) Shielding Effect :**<br>$\text{Ionisation potential} \propto \frac{1}{\text{shielding effect}}$<br>**(d) Stability of half filled and fully filled orbitals :** The atoms whose orbitals are half-filled ($p^3$, $d^5$, $f^7$) or fully-filled ($s^2$, $p^6$, $d^{10}$, $f^{14}$) have greater stability than the others. Therefore, they required greater energy to for removing out electron. However stability of fully filled orbitals is greater than that of the half filled orbitals<br>$\text{I.P. of fully} - \text{filled orbitals} > \text{I.P. of half} - \text{filled orbitals}$<br>**(e) Penetration power :**<br>$\text{Ionisation potential} \propto \text{penetration power}$ |
| **PERIODIC TABLE AND IONISATION POTENTIAL** | **In a period :** The value of ionisation potential normally increase on going from left to right in a period, because effective nuclear charge increases and atomic size decreases.<br>**Exceptions**<br>(1) In any period, elements of group 2 have higher I.P. than neighbouring elements because of high stabilityof subshell and more penetration of s-subshell<br>(2) In any period, elements of group 15 have higher IP than neighbouring elements because of higher stability of half filled p-subshell.<br>(3) The increasing order of the values of ionisation potential of the third period elements is<br>Na < Al < Mg < Si < S < P < Cl < Ar<br>(4) For 2nd ionisation potential in second period decreasing order is<br>Li > Ne > O > F > N > B > C > Be |

**In a group**

(1) The value of ionisation potential normally decreases on going from top to bottom in a group mainly because of atomic size increase.

(2) The value of ionisation potential is oscillating in group 13.

(3) The values of ionisation potential of noble gases are extremely high.

**ELECTRONEGATIVITY**

(a) The measure of the capacity of tendency of an atom to attract the shared pair of electrons of the covalent bond towards itself is called electronegativity of that atom.

(b) Electronegativity is a relative value that indicates the tendency of an atom to attract shared electrons more than the other atom bonded to it. Therefore it does not have any unit.

**NATURE OF OXIDES**

| Oxide | $Na_2O$ | MgO | $Al_2O_3$ | $SiO_2$ | $P_2O_5$ | $SO_3$ | $Cl_2O_7$ |
|---|---|---|---|---|---|---|---|
| $(X_O - X_A)$ | 2.6 | 2.3 | 2.1 | 1.8 | 1.5 | 1.1 | 0.5 |
| Nature | Strong basic | Basic | Amphoteric | Weak acidic | Acidic | Strong acidic | Strongest acidic |

**ELECTRON AFFINITY**

It is the change in energy when electron is added to gaseous, isolated, neutral atom .

If energy is released than the sign of E.A is positive , while if absorbed than E.A is negative. This is against the normal thermodynamical conventions.

$$Cl(g) + 1e^- \longrightarrow Cl^- + Q$$

$$E.A = \text{positive}$$

**ELECTRON GAIN ENTHALPY**

The change in enthalpy when electron is added to a gaseous, isolated, neutral atom.

$$Cl(g) + 1e^- \longrightarrow Cl^- + Q$$

$$\Delta \text{ He.g} = \text{negative}$$

Mathematically,

$$-(\Delta Heg) \cong +(E.a)$$

# SOLVED EXAMPLES

**Example 1.**

Decreasing order of electronegativies of F, Cl, Br and Iis

(1) F < Cl < Br < I (2) I < Br < Cl < F

(3) Br < I > Cl > F (4) I < Br > Cl < F

**Solution :** **(2)** Electronegativity decreases in a group on going from top to bottom. Therefore I < Br < Cl < F

**Example 2.**

Electronegativity of which of the following is high?

(1) $-CH_3$ ($sp^3$) (2) $H_2C = CH_2$ ($sp^2$)

(3) CH ≡ CH(sp) (4) Equal in all

**Solution :** **(3)** Larger the s-character larger is the electronegative.

**Example 3.**

Which of the following is the most polar bond

(1) N – H (2) Cl – H (3) O – H (4) Br – H

**Solution :** **(3)** Difference of electronegativieis of O and H is very high.

Polarity of covalent bond ∝ Difference of electronegativies

**Example 4.**

Which of the following formula is incorrectly written

(1) $OF_2$ (2) $Cl_2O$ (3) BrCl (4) None of these

**Solution : (4)** In all the formulae less electronegative elements (cation) could be indicated followed by the more electronegative element (anion).

**Example 5.**

Which of the following is the period number of the element whose atomic number is 98.

(1) 4 (2) 7 (3) 5 (4) 6

**Solution :** **(2)**

**Example 6.**

The nuclei of atoms X, Y and Z have same number of protons, but different numbers of neutrons.

According to Mendeleef period table, the elements X, Y and Z.

(1) belong to same group (2) belong to different groups

(3) belong are isobars (4) are isotopes

**Solution :** **(2)** As they have different atomic masses, they are present in different groups

**Example 7.**

Which of the following is the artificial element in the periodic table

(1) Tc (2) Fe (3) Ru (4) Os

**Solution :** **(1)** $Tc^{243}$ is the first artificial element.

**Example 8.**

Which of the following should be the longest bond?

(1) S–H (2) O–H (3) N–H (4) P–H

**Solution :** **(4)** The atomic radius of P is largest out of O, S, N and P. Therefore P–H bond will be the longest one.

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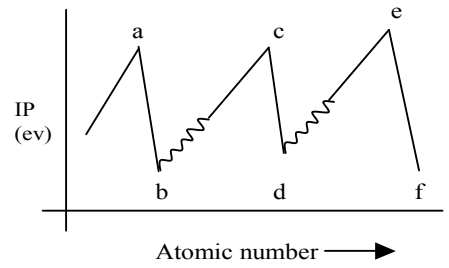
| **Example 9.** | What should be the order of size of $H^{-1}$, and $H^{+1}$ and H? |
| **Solution :** | $H^{+1} < H < H^{-1}$ |
| **Example 10.** | Which of the following has the largest size<br>(1) $N^{-3}$ (2) $O^{-2}$ (3) $Na^{+}$ (4) $Mg^{2+}$ |
| **Solution :** | **(1)** $N^{3-}$ has the largest negative charge. |
| **Example 11.** | Which of the following should be the order of increasing values of second ionisation potential of C, N, O and F<br>(1) C > N > F > O (2) C < F < N < O<br>(3) C < F < N < O (4) C < N < F < O |
| **Solution :** | **(4)** |
| **Example 12.** | $OF_2$ is called oxygen difluoride, whereas $Cl_2O$ is called dichlorine monoxide. Why? |
| **Solution :** | Electronegavitity of O in $OF_2$ is less than F. Therefore, there will be positive charge on oxygen and negative charge on fluorine. Whereas in Cl and O, electronegativity of Cl is less than that of O therefore there will be positive charge on Cl and negative charge on O. Positive charge is written first followed by negative charge. |
| **Example 13.** | What is the order of electronegativity different carbon atoms in the following molecule?<br>$\underset{III}{CH_3}-\underset{II}{CH_2}-\underset{I}{CH_2}-NO_2$ |
| **Solution :** | Greater the distance from $-NO_2$ lesser is the positive charge over C-atom and that's why lesser the electronegativity. Hence required order is III < II < I |
| **Example 14.** | The increasing order of atomic size of Li, Be, B and Ne is |
| **Solution :** | B < Be < Li < Ne<br>Inert gas is biggest in a period because its vanderwaal radius is considered. |
| **Example 15.** | The increasing order of atomic size As, Bi, Sn, Pb and Sb is |
| **Solution :** | As < Sb < Sn < Bi < Pb |
| | |

# MULTIPLE CHOICE QUESTIONS

## LEVEL - I

1. If an element with atomic number 116 is discovered, the position of the element in the Periodic Table will be
   (1) 6th group (2) 7th group
   (3) 16th group (4) 17th group
2. Among the following, the typical element is
   (1) O (2) H
   (3) Cr (4) S
3. The element 'X' is present in $f-block$, but it has no $(n-2)f$ electrons, the element 'X' is
   (1) Ce (2) Th
   (3) Pa (4) Rf
4. The electronic configuration of an element is $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$. The atomic number of the element which is just below the above element in the Periodic Table is
   (1) 31 (2) 41
   (3) 55 (4) 39
5. The pair of elements having deviated configurations from Aufbau principle is
   (i) Cr, Cu (ii) Pd, Pt
   (iii) Co, Ni (iv) La, Ac
   (1) Only (i) is correct
   (2) Only (i) and (ii) are correct
   (3) Only (i) and (iv) are correct
   (4) (i), (ii), (iv) are correct
6. The general electronic configuration $(n-1)d^7 ns^2$ indicates that the particular element belongs to
   (1) VIII B group (2) VII B group
   (3) IIB group (4) IX B group
7. An element 'X' belongs to VI A group. The most important ion of this element, is
   (1) $X^{6+}$ (2) $X^{1-}$
   (3) $X^{2-}$ (4) $X^{3-}$
8. Among the following, the energy change is positive in
   (1) $O^- + e^- \rightarrow O^{2-}$ (2) $N + e^- \rightarrow N^-$
   (3) $Mg + e^- \rightarrow Mg^-$ (4) All are positive
9. Among the following, the reaction having nearly same energy change with $Cu \longrightarrow Cu^+$, is
   (1) $Ni \longrightarrow Ni^+$ (2) $K \longrightarrow K^+$
   (3) $Na \longrightarrow Na^+$ (4) None of these
10. 


Pick out the correct statement(s) about the above graph.
(i) (a), (c) and (e) are alkali metals
(ii) (b), (d) and (f) are inert gases
(iii) (a), (c) and (e) are inert gases
(iv) (b), (d) and (f) are alkali metals
(1) (i), (ii) are correct
(2) (iii), (iv) are correct
(3) only (iii) is correct
(4) only (iv) is correct

11. The Pauling's and Mullikan's electronegativity are related by

(1) $(EA)_{Pauling} = \frac{(EA)_{Mullikan}}{2.8}$

(2) $(EA)_{Pauling} = (EA)_{Mullikan} \times 2.8$

(3) $(EA)_{Pauling} = \frac{(EA)_{Mullikan}}{2}$

(4) $(EA)_{Pauling} = (EA)_{Mullikan} \times 2$

12. The effective nuclear charge for an electron in $_8O^{16}$ will be

(1) 3.55 (2) 4.2

(3) 9.3 (4) 8

13. The electron affinity of the inert gases are

(1) zero (2) maximum

(3) moderate (4) very least

14. The correct order of increasing ionic character is

(1) $BeCl_2 < MgCl_2 < CaCl_2 < BaCl_2$

(2) $BeCl_2 < MgCl_2 < BaCl_2 < CaCl_2$

(3) $BeCl_2 < BaCl_2 < MgCl_2 < CaCl_2$

(4) $BaCl_2 < CaCl_2 < MgCl_2 < BeCl_2$

15. If Aufbau rule is not followed, the element calcium will be present in

(1) s-block (2) p-block

(3) d-block (4) f-block

16. The correct order of electron affinity values of B, C, N and O, is

(1) O > C > N > B (2) B < N > C > O

(3) O > C > B > N (4) O < B > C > N

17. The hydration energy of $Mg^{2+}$ is larger than that of

(1) $Al^{3+}$ (2) $Na^{+}$

(3) $Si^{4+}$ (4) $Mg^{3+}$

18. The statement that is not correct for the periodic classification of elements is

(1) The properties of elements are the periodic functions of their atomic numbers

(2) Non-metallic elements are lesser in number than metallic elements

(3) The IP, values of elements along a period do not vary in a regular manner with increasing atomic

(4) Atomic size of transition metal vary in regular manner

19. If the ionic radii of each of $K^+$ and $F^-$ are $1.34A^0$, then the atomic radii of K and F will be, respectively

(1) $1.34A^0, 1.34A^0$ (2) $0.72A^0, 1.96A^0$

(3) $1.96A^0, 0.72A^0$ (4) $1.96A^0, 1.34A^0$

20. If stability is attained with 7 electrons instead of 8 electrons, then the formulae of nitrides of Mg and Al are respectively?

(1) $Mg_2N_3, Al_2N_4$ (2) $Mg_3N_2, AlN$

(3) $MgN, AlN$ (4) $MgN, Al_3N_2$

## LEVEL - II

1. Among the following which one represents a collection of isoelectronic species?

(1) $NO^+, C_2^{2-}, O_2, CO$

(2) $N_2, C_2^{2-}, CO, NO$

(3) $CO, N_2, CN^-, C_2^{2-}$

(4) $NO, CN^-, N_2, O_2^-$

2. Aqueous solutions of two compounds $X-OH$ and $Y-OH$ are prepared in two different vessels. If the electronegativites of X and Y are 3.0 and 0.7, respectively then the nature of two solutions will be

(1) acidic, acidic (2) acidic, basic

(3) basic, acidic (4) basic, basic

3. The density of potasium is less than sodium. It is due to
(i) the unusual large increase in atomic size
(ii) the presence of a number of vacant orbitals
(iii) greater interatomic distance in the crystal lattice
(1) All are correct (2) Only (i) is correct
(3) Only (ii) is correct (4) Only (iii) is correct

4. Among the following the ion with the highest electronical conductivity in aqueous solution is
(1) Li (2) $Na^+$
(3) $Rb^+$ (4) $Cs^+$

5. The atomic as well as ionic radii of Nb and Ta are almost same. It is due to
(1) the presence of elements in the same group
(2) same charge/size ratio
(3) lanthanide contraction
(4) actinide contraction

6. Which of the following pairs is chemically similar?
(1) $Cu - Ag$ (2) $Hf - La$
(3) $Cu - Au$ (4) $Zr - Hf$

7. The correct order of stability of oxidation states for Sn and Pb is/are
(i) $Pb^{2+} > Pb^{4+}, Sn^{2+} > Sn^{4+}$
(ii) $Pb^{2+} < Pb^{4+}, Sn^{2+} < Sn^{4+}$
(iii) $Pb^{2+} > Pb^{4+}, Sn^{2+} < Sn^{4+}$
(iv) $Pb^{2+} < Pb^{4+}, Sn^{2+} > Sn^{4+}$
(v) $Sn^{2+} < Pb^{2+}$
(vi) $Sn^{2+} > Pb^{2+}$
(1) Only (iii) and (v) are correct
(2) Only (i) and (v) are correct
(3) Only (i) and (vi) are correct
(4) Only (ii) and (v) are correct

8. The atomic radii of fluorine and neon (in $\overset{0}{A}$) will be, respectively
(1) 0.72,1.60 (2) 1.60,1.60
(3) 0.72, 0.72 (4) 0.82, 0.82

9. The 1st ionisation potentials of nitrogen and oxygen (in eV), respectively will be
(1) 13.6, 14.6 (2) 14.6, 14.6
(3) 13.6, 13.6 (4) 14.6, 13.6

10. Match the following

| List I | List II |
|---|---|
| (i) BaO | (a) acidic |
| (ii) $Al_2O_3$ | (b) amphoteric |
| (iii) BeO | (c) basic |
| (iv) $SO_3$ | |

The correct match is

| | (i) | (ii) | (iii) | (iv) |
|---|---|---|---|---|
| (1) | c | b | b | a |
| (2) | a | b | b | c |
| (3) | c | b | c | a |
| (4) | a | b | c | c |

11. Match the following

| List I | List II |
|---|---|
| (i) 57 | (a) s-block |
| (ii) 60 | (b) p-block |
| (iii) 56 | (c) d-block |
| (iv) 52 | (d) f-block |

The correct match is

| | (i) | (ii) | (iii) | (iv) |
|---|---|---|---|---|
| (1) | c | d | a | b |
| (2) | d | c | b | a |
| (3) | a | b | c | d |
| (4) | a | b | d | c |

12. The electronic configuration of certain four elements are
A: $1s^2 2s^2 2p^4$ B: $1s^2 2s^2 2p^6 3s^1$
C: $1s^2 2s^2 2p^6 3s^2 3p^5$ D: $1s^2 2s^2 2p^6 3s^2$
The formulae of the formed ionic compounds among the elements are
(1) AB, $A_2B$, $B_2C$, CD
(2) $B_2A, DA, BC, DC_2$
(3) $AB, AB_2, CD, CD_2$
(4) $AD, BC, A_2B, C_2D$

13. If x, y and z are, respectively the ionisation potential, electron-affinity and electronegativity of an element, then 'x' is equal to

(1) $\frac{y+z}{2}$ (2) $2z-y$

(3) $2y-z$ (4) $y-2z$

14. The atom present in 5 g of a gaseous substance X [At. wt. = 20] are converted into " $X^+$ (g)" by energy $E_1$. Atoms present in 10 g of same substance are converted into "$X^-(g)$" by energy $E_2$. The electron affinity and ionisation potential of 'X' are [where $N_0$ is Avogadro number] respectively,

(1) $\frac{4E_1}{N_0}, \frac{2E_2}{N_0}$ (2) $\frac{2E_1}{N_0}, \frac{4E_2}{N_0}$

(3) $\frac{2E_2}{N_2}, \frac{4E_1}{N_0}$ (4) $\frac{4E_2}{N_0}, \frac{2E_1}{N_0}$

15. Two elements X, Y have similar properties, because

(1) they may belong to the same period
(2) they may have equal charge/size ratio
(3) they may have almost identical ionic radii
(4) All are correct

16. The formation of $S^{2-}(g)$ starting from S(g) is endothermic by 710 kJ/mol. If $EA_1$ of 'S' is -160 kJ/mol. The $EA_2$ of sulphur is

(1) + 550 kJ/mol (2) +870 kJ/mol
(3) - 550 kJ/mol (4) -870 kJ/mol

17. The element with atomic number 105 belongs to

(1) III B (2) IV B
(3) V B (4) VI B

18. The amphoteric oxide among the following is

(1) BeO (2) ZnO
(3) SnO (4) all of these

19. Which of the following is the correct order of ionisation energies?

(1) $F^- > F > Cl^- > Cl$

(2) $F > F^- > Cl > Cl^-$

(3) $F > F^- > Cl^- > Cl$

(4) $F^- > F > Cl > Cl^-$

20. Among the following, the biggest ion is

(1) $F^-$ (2) $O^{2-}$

(3) $Cs^+$ (4) $Ba^{2+}$

21. Among the following, the set of elements having almost equal atomic sizes are

(1) Li, Be, B, C (2) Fe, Co, Ni, CN
(3) F, Cl, Br, I (4) Si, P, S, Cl

22. The electron affinity and ionisation potential of an element 'X' is $1.14\times10^{-18}$ and $1.57\times10^{-18}$ J/atom, respectively. The electronegativity of 'X' is

(1) 3.5 (2) 3.0
(3) 2.5 (4) 2.1

23. Ionisation potential of "$X^-(g)$" is numerically equal to the electron affinity of

(1) X (g) (2) $X^-(g)$

(3) $X^+(g)$ (4) $X^{2-}(g)$

24. The most basic oxide among the following is

(1) $Na_2O$ (2) MgO

(3) CaO (4) $K_2O$

25. The correct order of radii of following ionic species is

(1) $Ca^{2+} > K^+ > Cl^- > S^{2-}$

(2) $K^+ < Ca^{2+} < Cl^- < S^{2-}$

(3) $Cl^- > S^{2-} > Ca^{2+} > K^+$

(4) $Ca^{2+} < K^+ < Cl^- < S^{2-}$

26. The $IP_1$ values of four elements with atomic numbers 15, 16, 17 and 18 are $I_1$, $I_2$, $I_3$ and $I_4$ respectively. The order of IP values is
(1) $I_1 < I_2 < I_3 < I_4$ (2) $I_2 < I_1 < I_3 < I_4$
(3) $I_2 < I_1 < I_4 < I_3$ (4) $I_4 < I_2 < I_1 < I_3$

27. The second ionisation potential values of Mg, Al, Si, P are in the order of
(1) Mg < Al < Si < P (2) Al < Mg < Si < P
(3) Mg < Si < Al < P (4) Si < Al < Mg < P

28. Among the elements A, B, C and D having the atomic numbers 7, 8, 9, 10 respectively, the elements with largest atomic size and the highest IP are, respectively
(1) A, D (2) D, D
(3) A, C (4) D, C

29. Pick up the correct statement regarding the ionisation potential values:
(i) $IP_1$ of 'N' is more than $IP_1$ of 'O'.
(ii) $IP_2$ of 'B' is more than $IP_2$ of 'C'.
(iii) $IP_2$ of 'Na' is more than IP of 'Ne'.
(iv) $IP_3$ of 'Ca' is more than IP of 'Ar'.
(1) All are correct (2) (i), (ii) are correct
(3) (i), (iii), (iv) are correct
(4) (i), (ii), (iii) are correct

30. The successive ionisation potential values of an element are 8.2, 25.9, 37.9, 259.3 and 340.2 eV, respectively. The group number of element in the Periodic Table is
(1) II (2) III
(3) IV (4) V

## LEVEL - III

1. Mark out the incorrect match: (electronic configuration nature of element)
(1) $3s^2 3p^6$ : non-metal
(2) $5s^2 4d^{10} 5p^5$ : non-metal
(3) $4s^2 3d^7$ : metals
(4) $3s^2 3p^2$ : non-metal

2. An atom having electronic configuration as $6s^1 4f^{14} 5d^{10}$, must be
(1) an alkali metal
(2) an alkaline earth metal
(3) a coinage metal
(4) a lanthanide

3. Elements, A, B, C, D and E have the following electronic configurations
$A : [Ar] 3d^{10} 4s^1$
$B : [Ar] 3d^{10} 4s^2 4p^6 5s^1$
$C : [Ar] 3d^{10} 4s^2 4p^6 4d^{10} 5s^1$
$D : [Ar] 3d^{10} 4s^2 4p^6 4d^5 5s^1$
Which two elements fall into the same group?
(1) B and C (2) A and C
(3) B and D (4) A and B

4. Following the Pauling equation, the extra bond energy (in kcal $mol^{-1}$) for $H-Cl$ bond is
[Given : electronegativity : H - 2.1, Cl - 3.0]
(1) 18.72 (2) 4.326
(3) 21.52 (4) 11.21

5. Which of the following is the correct decreasing order of radii?
(1) $Al^{3+}\ Na^+\ Ne\ F^-\ N^{3-}$
(2) $Ne\ Al^{3+}\ Na^+\ F^-\ N^{3-}$
(3) $N^{3-}\ F^-\ Ne\ Na^+\ Al^{3+}$
(4) $Ne\ N^{3-}\ F^-\ Na^+\ Al^{3+}$

6. Which of the following involves maximum amount of energy?
(1) $N + e^- \rightarrow N^-$ (2) $O + e^- \rightarrow O^-$
(3) $O^- + e^- \rightarrow O^{2-}$ (4) $F + e^- \rightarrow F^-$

7. The correct increasing order of electron affinity is
(1) Li Be B C (2) Si P S Cl
(3) Cl F Br I (4) Mg Na Al Si

8. Alkali metals are soluble in liquid $NH_3$. As the concentration of metal increases, solution turns blue to bronze. If reflects the change in magnetic property of the solution
(1) diamagnetic to paramagnetic
(2) Paramagnetic to diamagnetic
(3) weak to intense paramagnetic
(4) no change in magnetic property

9. The second ionisation energy $(IE_{II})$ for fluorine is more than nitrogen because of
(1) higher effective nuclear charge
(2) stable electronic configuration
(3) higher oxidation state
(4) low screening effect constant

10. Which of the following nitrates does not give an oxide on heating?
(1) $Cu(NO_3)_2$ (2) $Ca(NO_3)_2$
(3) $LiNO_3$ (4) $KNO_3$

11. Alkaline earth metal carbonates are sparingly soluble. On moving down the group solubility of alkaline earth metal carbonates
(1) increases (2) decreases
(3) remain constant (4) none of these

12. $B(OH)_3 + 2H_2O \square \quad H_3O^+ + \left[B(OH)_4\right]^-$ ; $pK_1$

$3B(OH)_3\,(high) \square \quad H_3O^+ + \left[B_3O_3(OH)_4\right]^- + H_2O; pK_2$ concentration

Compare $pK_1$ & $pK_2$
(1) $pK_1 > pK_2$ (2) $pK_1 < pK_2$
(3) $pK_1 = pK_2$ (4) None of these

13. On increasing temperature, the ionic characteristic of $AlCl_3$
(1) increase (2) decrease
(3) is not affected
(4) first increases then decreases

14. In $BF_3$, the $B-F$ bond length is $1.30\overset{0}{A}$, when allowed to be treated with $Me_3N$, it forms an adduct, $Me_3N \rightarrow BF_3$, the bond length of B - F in the adduct is
(1) greater than $1.30\overset{0}{A}$
(2) smaller than $1.30\overset{0}{A}$
(3) equal to $1.30\overset{0}{A}$
(4) none of these

15. Mark out the correct increasing order of radius.
(1) $As^{3-} < Br^- < K^+ < Mg^{2+}$
(2) $Mg^{2+} < K^+ < Br^- < As^{3-}$
(3) $Mg^{2+} < K^+ < As^{3-} < Br^-$
(4) $K^+ < Mg^{2+} < Br^- < As^{3-}$

16. How many elements would be in the second period the periodic table if the spin quantum numbers could have the value $-\frac{1}{2}, 0,$ or $+\frac{1}{2}$?
(1) 8 only (2) 10 only
(3) 12 only (4) 13 only

17. The set reprsenting the correct order of ionic radius is **[AIEEE 2009]**
(1) $Li^+ > Be^{2+} > Na^+ > Mg^{2+}$
(2) $Na^+ > Li^+ > Mg^{2+} > Be^{2+}$
(3) $Li^+ > Na^+ > Mg^{2+} > Be^{2+}$
(4) $Mg^{2+} > Be^{2+} > Li^+ > Na^+$

18. The correct sequence which shows decreasing order of the ionic radii of the elements is
(1) $O^{2-} > F^- > Na^+ > Mg^{2+} > Al^{3+}$
(2) $Al^{3+} > Mg^{2+} > Na^+ > F^- > O^{2-}$
(3) $Na^+ > Mg^{2+} > Al^{3+} > O^{2-} > F^-$
(4) $Na^+ > F^- > Mg^{2+} > O^{2-} > Al^{3+}$. **[2010]**

19. In context of the lanthanoids, which of the following statements is not correct?
(1) There is a gradual decrease in the radii of the members with increasing atomic number in the series.
(2) All the members exhibit +3 oxidation state.
(3) Because of similar properties the separation of lanthanoids is not easy
(4) Availability of 4f elements results in the formation of compounds in +4 state for all the members of the series. **[2011]**

## ANSWERS (PERIODIC PROPERTIES)

**LEVEL - I**

| | | | | |
|---|---|---|---|---|
| 1. (3) | 5. (4) | 9. (1) | 13. (1) | 17. (2) |
| 2. (4) | 6. (1) | 10. (2) | 14. (1) | 18. (4) |
| 3. (2) | 7. (3) | 11. (1) | 15. (3) | 19. (3) |
| 4. (2) | 8. (4) | 12. (2) | 16. (3) | 20. (1) |

**LEVEL - II**

| | | | | |
|---|---|---|---|---|
| 1. (3) | 7. (1) | 13. (2) | 19. (1) | 25. (4) |
| 2. (2) | 8. (1) | 14. (3) | 20. (2) | 26. (2) |
| 3. (1) | 9. (4) | 15. (2) | 21. (2) | 27. (3) |
| 4. (4) | 10. (1) | 16. (2) | 22. (2) | 28. (1) |
| 5. (3) | 11. (1) | 17. (3) | 23. (1) | 29. (1) |
| 6. (4) | 12. (2) | 18. (4) | 24. (4) | 30. (2) |

**LEVEL - III**

| | | | | |
|---|---|---|---|---|
| 1. (4) | 5. (3) | 9. (1) | 13. (2) | 17. (2) |
| 2. (3) | 6. (3) | 10. (4) | 14. (1) | 18. (1) |
| 3. (2) | 7. (4) | 11. (2) | 15. (2) | 19. (4) |
| 4. (1) | 8. (2) | 12. (2) | 16. (3) | |

## SOLUTIONS (LEVEL - III)

1. $3s^2 3p^2$ 3rd period, Group - 14

   That's silicon - Metalloid

2. $6s^1 4f^{14} 5d^{10}$ - Au (Gold) - Coinage metal

3. A : [Ar] $3d^{10} 4s^1 : Cu$

   B : [Ar] $3d^{10} 4s^2 4p^6 4d^{10} 5s^1$ : [Kr] $4d^{10} 5s^1$ : [Ag]

4. $\Delta x = 0.208\sqrt{\Delta}$

   $\Delta$ = Extra bond energy

   $$\Delta = \left(\frac{\Delta x}{0.208}\right)^2 = \left(\frac{0.9}{0.208}\right)^2$$

   $$= (4.326)^2 = 18.72$$

5. Higher the nuclear charge, higher the attraction, smaller the size. (For isoelectronic species)

6. $O^{-e} + e^- \rightarrow O^{2-} \quad \Delta H = +702 kjmol^{-1}$

   electron is added to uninegative $O^-$. Energy is given to overcome the repulsive interaction.

   $N + e^- \rightarrow N^- \quad \Delta H = 0$

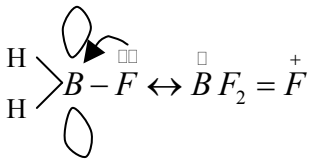
   $O + e^- \rightarrow O^- \quad \Delta H = -141 kJ/mol$

   $F + e^- \rightarrow F^- \quad \Delta H = -328 kJ/mol$

   Involved amount of energy is being asked, not the energy released or energy absorbed.

7. Electron affinity is energy released, Mg requires energy, thus negative electron affinity is said for magnesium. Hence, Mg < Na < Al < Si.
8. Increase in concentration compels the pairing of electron in solution cavity, thus it is diamagnetic.
9. Size decreases, effective nuclear charge increases resultantly the ionisation energy.
10. $2KNO_3 \rightarrow 2KNO_2 + O_2$
12. See the structure of $[B_3O_3(OH)_4]^-$.
13. At low temperature,

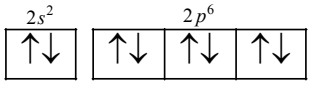
    $AlCl_3$ exists as close packed lattice of $Cl^-$ with $Al^{3+}$ occupying octahedral voids. On increasing temperatur volume increases, $AlCl_3$ converst into dimeric $Al_2Cl_6$.

14. 

    Due to backbonding, double bond charcteristic (shorter bond length) is there but due to adduct formation, there is no scope for back bonding, thus $B-F$ bond length is bigger

    $BF_3$ $Me_3N-BF_3$

    B is $sp^2$ hybridised. B is $sp^3$ hybridised.
15. $As^{3-}$ and $Br^-$ are isoelectronic species.
16. If s could have the value $-\frac{1}{2}, 0, +\frac{1}{2}$ then an orbital can have 3 electorns. The second period starts with $2s^1$ to $2s^2 2p^6 (8e^-)$

    4 orbitals are involved thus can have 12 electrons and 12 elements can be there.
18. All ions have same number of electrons i.e. 10 electrons but are having different number of protons in their nuclei. Greater the nuclear charge smaller the size.
19. Lanthanoids exhibit +3 oxidation state without an exception.