CHAPTER 3

Classification of Elements and Periodicity in Properties

Section-A JEE Advanced/ IIT-JEE

A Fill in the Blanks

1. The energy released when an electron is added to a neutral gaseous atom is called ..... of the atom. *(1982 - 1 Mark)*
2. On Mulliken scale, the average of ionization potential and electron affinity is known as ..... . *(1985 - 1 Mark)*

B True / False

1. In group IA, of alkali metals, the ionisation potential decreases on moving down the group. Therefore, lithium is a strongest reducing agent. *(1987 - 1 Mark)*
2. The decreasing order of electron affinity of F, Cl, Br is F > Cl > Br. *(1993 - 1 Mark)*
3. The basic nature of the hydroxides of group 13 (Gr. III B) decreases progressively down the group. *(1993 - 1 Mark)*

C MCQs with One Correct Answer

1. The correct order of second ionisation potential of carbon, nitrogen, oxygen and fluorine is *(1981 - 1 Mark)*
   (a) C > N > O > F (b) O > N > F > C
   (c) O > F > N > C (d) F > O > N > C
2. The element with the highest first ionization potential is *(1982 - 1 Mark)*
   (a) boron (b) carbon
   (c) nitrogen (d) oxygen
3. The first ionisation potential in electron volts of nitrogen and oxygen atoms are respectively given by *(1987 - 1 Mark)*
   (a) 14.6, 13.6 (b) 13.6, 14.6
   (c) 13.6, 13.6 (d) 14.6, 14.6
4. Atomic radii of fluorine and neon in Ångstorm units are respectively given by *(1987 - 1 Mark)*
   (a) 0.72, 1.60 (b) 1.60, 1.60
   (c) 0.72, 0.72 (d) None of these values
5. The electronegativity of the following elements increases in the order *(1987 - 1 Mark)*
   (a) C, N, Si, P (b) N, Si, C, P
   (c) Si, P, C, N (d) P, Si, N, C
6. The first ionisation potential of Na, Mg, Al and Si are in the order *(1988 - 1 Mark)*
   (a) Na < Mg > Al < Si (b) Na > Mg > Al > Si
   (c) Na < Mg < Al < Si (d) Na > Mg > Al < Si
7. Which one of the following is the strongest base?
   (a) AsH_3 (b) NH_3 *(1989 - 1 Mark)*
   (c) PH_3 (d) SbH_3
8. Which one of the following is the smallest in size?
   (a) N^{3-} (b) O^{2-} *(1989 - 1 Mark)*
   (c) F^- (d) Na^+
9. Amongst the following elements (whose electronic configurations are given below), the one having the highest ionization energy is : *(1990 - 1 Mark)*
   (a) [Ne] $3s^2 3p^1$ (b) [Ne] $3s^2 3p^3$
   (c) [Ne] $3s^2 3p^2$ (d) [Ne] $3d^{10} 4s^2 4p^3$
10. The statement that is not correct for the periodic classification of element is *(1992 - 1 Mark)*
    (a) The properties of elements are the periodic functions of their atomic numbers
    (b) Non-metallic elements are lesser in number than metallic elements
    (c) The first ionisation energies of elements along a period do not vary in a regular manner with increase in atomic number
    (d) For transition elements the *d*-subshells are filled with electrons monotonically with increase in atomic number.
11. Which has most stable +2 oxidation state : *(1995S)*
    (a) Sn (b) Pb
    (c) Fe (d) Ag

12. Which of the following has the maximum number of unpaired electrons? *(1996 - 1 Mark)*
(a) Mg^{2+} (b) Ti^{3+}
(c) V^{3+} (d) Fe^{2+}

13. The correct order of radii is *(2000S)*
(a) N < Be < B (b) $F^- < O^{2-} < N^{3-}$
(c) Na < Li < K (d) $Fe^{3+} < Fe^{2+} < Fe^{4+}$

14. The correct order of acidic strength is *(2000S)*
(a) $Cl_2O_7 > SO_2 > P_4O_{10}$ (b) $CO_2 > N_2O_5 > SO_3$
(c) $Na_2O > MgO > Al_2O_3$ (d) $K_2O > CaO > MgO$

15. Amongst H_2O, H_2S, H_2Se and H_2Te, the one with the highest boiling point is *(2000S)*
(a) H_2O because of hydrogen bonding
(b) H_2Te because of higher molecular weight
(c) H_2S because of hydrogen bonding
(d) H_2Se because of lower molecular weight

16. Identify the correct order of acidic strengths of CO_2, CuO, CaO, H_2O *(2002S)*
(a) $CaO < CuO < H_2O < CO_2$ (b) $H_2O < CuO < CaO < CO_2$
(c) $CaO < H_2O < CuO < CO_2$ (d) $H_2O < CO_2 < CaO < CuO$

D MCQs with One or More Than One Correct

1. The statements that **are true** for the long form of the periodic table are : *(1988 - 1 Mark)*
(a) it reflects the sequence of filling the electrons in the order of sub-energy level s, p, d and f.
(b) it helps to predict the stable valency states of the elements
(c) it reflects trends in physical and chemical properties of the elements
(d) it helps to predict the relative ionicity of the bond between any two elements.

2. Sodium sulphate is soluble in water whereas barium sulphate is sparingly soluble because : *(1989 - 1 Mark)*
(a) the hydration energy of sodium sulphate is more than its lattice energy
(b) the lattice energy of barium sulphate is more than its hydration energy
(c) the lattice energy has no role to play in solubility
(d) the hydration energy of sodium sulphate is less than its lattice energy.

3. Ionic radii of *(1999 - 3 Marks)*
(a) $Ti^{4+} < Mn^{7+}$ (b) $^{35}Cl^- < ^{37}Cl^-$
(c) $K^+ > Cl^-$ (d) $P^{3+} > P^{5+}$

E Subjective Problems

1. Arrange the following in :
(*i*) Decreasing ionic size : Mg^{2+}, O^{2-}, Na^+, F^- *(1985 - 1 Mark)*
(*ii*) Increasing acidic property : ZnO, Na_2O_2, P_2O_5, MgO *(1985 - 1 Mark)*
(*iii*) Increasing first ionization potential : Mg, Al, Si, Na *(1985 - 1 Mark)*
(*iv*) Increasing size : Cl^-, S^{2-}, Ca^{2+}, Ar *(1986 - 1 Mark)*
(*v*) Increasing order of ionic size : N^{3-}, Na^+, F^-, O^{2-}, Mg^{2+} *(1991 - 1 Mark)*
(*vi*) Increasing order of basic character : MgO, SrO, K_2O, NiO, Cs_2O *(1991 - 1 Mark)*
(*vii*) Arrange the following ions in order of their increasing radii : Li^+, Mg^{2+}, K^+, Al^{3+}.

2. The first ionization energy of carbon atom is greater than that of boron atom whereas, the reverse is true for the second ionization energy. *(1989 - 2 Marks)*

H Assertion & Reason Type Questions

1. Read the following statement and explanation and answer as per the options given below :
ASSERTION : The first ionization energy of Be is greater than that of B. *(2000S)*
REASON : 2*p* orbital is lower in energy than 2*s*
(a) If both assertion and reason are CORRECT, and reason is the CORRECT explanation of the assertion.
(b) If both assertion and reason are CORRECT, but reason is NOT the CORRECT explanation of the assertion.
(c) If assertion is CORRECT, but reason is INCORRECT.
(d) If assertion is INCORRECT, but reason is CORRECT.

I Integer Value Correct Type

1. Among the following, the number of elements showing only one non-zero oxidation state is :
O, Cl, F, N, P, Sn, Tl, Na, Ti *(2010)*

Section-B JEE Main / AIEEE

1. According to the Periodic Law of elements, the variation in properties of elements is related to their **[2003]**
   (a) nuclear masses
   (b) atomic numbers
   (c) nuclear neutron-proton number ratios
   (d) atomic masses

2. Which one of the following is an amphoteric oxide ? **[2003]**
   (a) Na_2O (b) SO_2
   (c) B_2O_3 (d) ZnO

3. Which one of the following ions has the highest value of ionic radius ? **[2004]**
   (a) O^{2-} (b) B^{3+}
   (c) Li^+ (d) F^-

4. Among Al_2O_3, SiO_2, P_2O_3 and SO_2 the correct order of acid strength is **[2004]**
   (a) $Al_2O_3 < SiO_2 < SO_2 < P_2O_3$
   (b) $SiO_2 < SO_2 < Al_2O_3 < P_2O_3$
   (c) $SO_2 < P_2O_3 < SiO_2 < Al_2O_3$
   (d) $Al_2O_3 < SiO_2 < P_2O_3 < SO_2$

5. The formation of the oxide ion $O^{2-}_{(g)}$ requires first an exothermic and then an endothermic step as shown below

   $O_{(g)} + e^- = O^-_{(g)}$ $\Delta H° = -142$ kJmol^{-1} **[2004]**

   $O^-(g) + e^- = O^{2-}_{(g)}$ $\Delta H° = 844$ kJmol^{-1}

   This is because
   (a) O^- ion will tend to resist the addition of another electron
   (b) Oxygen has high electron affinity
   (c) Oxygen is more elecronegative
   (d) O^- ion has comparatively larger size than oxygen atom

6. Which of the following oxides is amphoteric in character? **[2005]**
   (a) SnO_2 (b) SiO_2
   (c) CO_2 (d) CaO

7. In which of the following arrangements, the order is NOT according to the property indicated against it? **[2005]**
   (a) Li < Na < K < Rb : Increasing metallic radius
   (b) I < Br < F < Cl : Increasing electron gain enthalpy (with negative sign)
   (c) B < C < N < O Increasing first ionization enthalpy
   (d) $Al^{3+} < Mg^{2+} < Na^+ < F^-$ Increasing ionic size

8. Following statements regarding the periodic trends of chemical reactivity of the alkali metals and the halogens are given. Which of these statements gives the correct picture?
   (a) Chemical reactivity increases with increase in atomic number down the group in both the alkali metals and halogens **[2006]**
   (b) In alkali metals the reactivity increases but in the halogens it decreases with increase in atomic number down the group
   (c) The reactivity decreases in the alkali metals but increases in the halogens with increase in atomic number down the group
   (d) In both the alkali metals and the halogens the chemical reactivity decreases with increase in atomic number down the group

9. In which of the following arrangements, the sequence is *not* strictly according to the property written against it? **[2008]**
   (a) HF < HCl < HBr , HI : increasing acid strength
   (b) $NH_3 < PH_3 < AsH_3 < SbH_3$: increasing basic strength
   (c) B < C < O < N : increasing first ionization enthalpy
   (d) $CO_2 < SiO_2 < SnO_2 < PbO_2$: increasing oxidising power

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

11. Which one of the following orders presents the correct sequence of the increasing basic nature of the given oxides? **[2011]**
    (a) $Al_2O_3 < MgO < Na_2O < K_2O$
    (b) $MgO < K_2O < Al_2O_3 < Na_2O$
    (c) $Na_2O < K_2O < MgO < Al_2O_3$
    (d) $K_2O < Na_2O < Al_2O_3 < MgO$

12. The increasing order of the ionic radii of the given isoelectronic species is : **[2012]**
    (a) $Cl^-, Ca^{2+}, K^+, S^{2-}$ (b) $S^{2-}, Cl^-, Ca^{2+}, K^+$
    (c) $Ca^{2+}, K^+, Cl^-, S^{2-}$ (d) $K^+, S^{2-}, Ca^{2+}, Cl^-$

13. Which of the following represents the correct order of increasing first ionization enthalpy for Ca, Ba, S, Se and Ar ? **[JEE M 2013]**

(a) Ca < S < Ba < Se < Ar (b) S < Se < Ca < Ba < Ar

(c) Ba < Ca < Se < S < Ar (d) Ca < Ba < S < Se < Ar

14. The first ionisation potential of Na is 5.1 eV. The value of electron gain enthalpy of Na^+ will be : **[JEE M 2013]**

(a) −2.55 eV (b) −5.1 eV

(c) −10.2 eV (d) +2.55 eV

15. The ionic radii (in Å) of N^{3-}, O^{2-} and F^- are respectively : **[JEE M 2015]**

(a) 1.71, 1.40 and 1.36 (b) 1.71, 1.36 and 1.40

(c) 1.36, 1.40 and 1.71 (d) 1.36, 1.71 and 1.40

3 Classification of Elements and Periodicity in Properties

Section-A : JEE Advanced/ IIT-JEE

A **1.** Electron affinity **2.** Electronegativity

B **1.** T **2.** F **3.** F

C **1.** (c) **2.** (c) **3.** (a) **4.** (a) **5.** (c) **6.** (a) **7.** (b)
8. (d) **9.** (b) **10.** (d) **11.** (b) **12.** (d) **13.** (b) **14.** (a)
15. (a) **16.** (a)

D **1.** (a, c, d) **2.** (a, b) **3.** (d)

E **1.** (i) $O^{2-} > F^{-} > Na^{+} > Mg^{2+}$; (ii) $Na_2O_2 < MgO < ZnO < P_2O_5$; (iii) $Na < Al < Mg < Si$; (iv) $Ca^{2+} < Ar < Cl^{-} < S^{2-}$;
(v) $Mg^{2+} < Na^{+} < F^{-} < O^{2-} < N^{3-}$; (vi) $NiO < MgO < SrO < K_2O < Cs_2O$; (vii) $Al^{3+} < Mg^{2+} < Li^{+} < K^{+}$

H **1.** (c)

I **1.** 2

Section-B : JEE Main/ AIEEE

1. (b) **2.** (d) **3.** (a) **4.** (d) **5.** (a) **6.** (a) **7.** (c)
8. (b) **9.** (b) **10.** (d) **11.** (a) **12.** (c) **13.** (c) **14.** (b) **15.** (a)

Section-A JEE Advanced/ IIT-JEE

A. Fill in the Blanks

1. **Electron affinity** **2.** **Electronegativity**

B. True / False

1. **True :** *Ionisation energy decreases on moving down in group IA from Li to Cs*, the reducing property should **increase** in the same order, *i.e.*, from Li to Cs which is found to be so except an *anomaly in lithium which is found to be the strongest reducing agent*; because of its **higher oxidation potential** (E°).

2. **False :** Halogens have high electron affinities which decrease as we move down the group. However, fluorine has lower value of E.A. than chlorine which is due to its small size and more repulsion between the electron added and electrons already present. Hence the order Cl > Br > F.

3. **False :** On moving down the group 13 (III) A the basic nature of hydroxides increases. The basic nature increases as the element becomes more electropositive or acquires more metallic character when we move down a group.

C. MCQs with One Correct Answer

1. **(c)** **NOTE :** Ionization potential is amount of energy required to take out most loosely bonded electron from neutral atom. Its value depends on stability of atom (electronic configuration)

$C - 1s^2\ 2s^2\ p^2$ $C^{+} - 1s^2\ 2s^2\ p^1$
$N - 1s^2\ 2s^2\ p^3$ $N^{+} - 1s^2\ 2s^2\ p^2$
$O - 1s^2\ 2s^2\ p^4$ $O^{+} - 1s^2\ 2s^2\ p^3$
$F - 1s^2\ 2s^2\ p^5$ $F^{+} - 1s^2\ 2s^2\ p^4$

(for second ionisation potential, IE_2)

As for IE_2 the electron in all the cases is to be removed from 2p orbital so it must follow the order

C < N < O < F (i.e. increase across a period)

But in case of O^{+}, the 2*p* orbital is half-filled and is more stable as compared to others. So the order becomes : C < N < F < O *or* O > F > N > C

2. **(c)** Amongst B, C, N and O; N has the highest first ionization energy, because of its half filled 2*p* orbital which is more stable.

3. **(a)** Ionisation potential of nitrogen is more than that of oxygen. This is because nitrogen has more stable **half-filled** *p*-orbitals. ($N = 1s^2, 2s^2, 2p^3$, $O = 1s^2, 2s^2, 2p^4$)

4. **(a)** **TIPS/Formulae :**

(i) Noble gases do not have covalent radii. They have only vander waal's radii.

(ii) Covalent radii is always larger than corresponding van-der Waal's radii

Atomic radius of neon being van der Waal's radius is larger than that of fluorine which is in fact is its covalent radius.

5. (c) **NOTE :** Electronegativity increases on moving from left to right in a period and decreases on moving from top to bottom in a group.

Si and P are placed in the 3rd period while C and N are placed in the 2nd period. Elements in 2nd period have higher electronegativities than those in the 3rd period. Since N has smaller size and higher nuclear charge than C, its electronegativity is higher than that of C. Similarly, the electronegativity of P is higher than that of Si. Thus, the overall order is : Si, P, C, N.

6. (a) **NOTE :** First ionisation potential increases from left to right in a period. But Mg is more stable than Al due to fully filled-3s orbitals.

IE_1 of Mg is higher than that of Na because of increased nuclear charge and also that of Al because in Mg a 3 *s*-electron has to be removed while in Al it is the 3 *p*-electron. The IE_1 of Si is, however, higher than those of Mg and Al because of its increased nuclear charge. Thus, the overall order is Na < Mg > Al < Si.

7. (b) Nitrogen, being smallest in size, can give up its lone pair of electrons most easily.

8. (d) **TIPS/Formulae :**

For isoelectronic ions, ionic size $\propto \frac{1}{\text{atomic number}}$

Species	No. of e⁻	At. No.
N^{-3}	10	7
O^{-2}	10	8
F^-	10	9
Na^+	10	11

$\therefore$ Na^+ is largest in size.

9. (b) **NOTE :** Ionisation energy increases with increasing atomic number in a period, while it decreases on moving down a groups. IE of element with electronic configuration (*d*) is lowest because of its biggest size. Among the remaining three elements of the same period (3rd). IE of element with electronic configuration (*b*) is the highest due to greater stability of the exactly half-filled 3 *p*-subshell.

10. (d) The electrons are not filled in d-subshell monotonically with increase in atomic number, among transition elements.

11. (b) **TIPS/Formulae :**

(i) Ion having half filled or full filled orbital have extra stability.

(ii) Larger the size of cation more will be its stability

Pb^{2+} ($5d^{10}$ $6s^2$), has the most stable +2 oxidation state because here the *d*-orbital is completely filled and is more stable than Fe^{2+} ($3d^6$). Again Ag^+ ($4d^{10}$) is more stable as here again the *d*-orbital is completely filled and Ag^{2+} is not easily obtained. Pb^{2+} is more stable compared to Sn^{2+} ($4d^{10}$ $5s^2$) because of its large size.

12. (d) The electronic configuration of the given ions are as follows.

$_{12}Mg^{2+} = 1s^2, 2s^2 2p^6$ (No unpaired electron)

$_{22}Ti^{3+} = 1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^1$ (One unpaired electron)

$_{23}V^{3+} = 1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^2$

(Two unpaired electrons)

$_{26}Fe^{2+} = 1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^6$

(Four unpaired electrons)

13. (b) Effective nuclear charge (i,e. Z/e ratio) decreases from F^- to N^{3-}, hence the radii follows the order:

$F^- < O^{2-} < N^{3-}$. Z/e for $F^- = 9/10 = 0.9$, for $O^{2-} = 8/10 = .8$, for $N^{3-} = 7/10 = 0.7$

14. (a) Non-metallic oxides are acidic and acidic character decreases with increase in metallic character.

15. (a) **TIPS/Formulae :**

(i) Hydrogen bonding increases the boiling point.

(ii) Hydrogen bonds are formed in compounds having F or O or N with hydrogen

S, Se, Te cannot undergo hydrogen bond formation because of their larger size and lower electronegativity values.

16. (a) Non-metallic oxides are acidic and metallic oxides are basic. Thus the acidic order is

$CaO < CuO < H_2O < CO_2$.

D. MCQs with One or More than One Correct

1. (a,c,d) Periodic table does not help to predict the stable valency states of the elements.

2. (a, b) **TIPS/Formulae :**

For dissolution, Hydration energy > Lattice energy.

$BaSO_4$ is sparingly soluble in water because its hydration energy is lesser than the lattice energy and thus ions are not separated from each other. On the contrary in Na_2SO_4, the hydration energy is more than its lattice energy. Thus ions are separated from each other and pass in solution state.

3. (d) Higher the (+) charge, smaller will be radii.

E. Subjective Problems

1. (*i*) $O^{2-} > F^- > Na^+ > Mg^{2+}$

NOTE : All the above ions are isoelectronic having 10 electron each.

In such case the greater the nuclear charge, the greater is the attraction for electrons and smaller is the ionic radius. Hence O^{2-} has the highest and Mg^{2+} has the least ionic size.

(*ii*) $\overset{+1}{Na_2}O_2 < \overset{+2}{Mg}O < \overset{+2}{Zn}O < \overset{+5}{P_2}O_5$

Among oxides the acidic strength increases with oxidation state. So Na_2O_2 is least acidic and P_2O_5 is

most acidic. Further Na_2O_2 and MgO are basic, ZnO is amphoteric and P_2O_5 is acidic.

(*iii*) The first ionization potential of the 3rd period elemens follows the order :

$$Na < Al < Mg < Si$$

NOTE : Ionisation energy **increases across a period** but not regularly. Mg ($1s^2$, $2s^2p^6$, $3s^2$) is more stable because the electron is to be removed from 3*s* which is difficult as compared to Al ($1s^2$, $2s^2p^6$, $3s^2p^1$) where electron is to be removed from 3*p*.

(*iv*) $Ca^{2+} < Ar < Cl^- < S^{2-}$; All of these are isoelectronic. In such cases the greater the nuclear charge, the greater is the attraction for electrons and smaller is ionic size.

$$\text{ionic radius} \propto \frac{1}{\text{effective nuclear charge}}$$

(*v*) Increasing order of ionic size :

$Mg^{2+} < Na^+ < F^- < O^{2-} < N^{3-}$

NOTE : All the above ions are isoelectronic having 10 electrons each.

In such a case the greater the nuclear charge, the greater is the attraction for electrons and smaller is the ionic radius. Hence N^{3-} has the highest and Mg^{2+} has the least ionic size.

(*vi*) Increasing order of basic character :

$NiO < MgO < SrO < K_2O < Cs_2O$

The basic character of oxides increases when we move down the group. So, $K_2O < Cr_2O$ and $MgO < SrO$.

Further higher the group number lesser is the basic character. Hence NiO is the least basic.

(*vii*) $Al^{3+} < Mg^{2+} < Li^+ < K^+$

In these Al^{3+} & Mg^{2+} are isoelectronic species, so in these size decreases with increase in atomic number because increase in atomic number decreases Z_{eff}.

$$\text{Size} \propto \frac{1}{Z_{eff}}$$

In Li^+ & K^+, K^+ is bigger in size than Li^+ because on moving from top to bottom in a group, the group size increases.

2. C ($1s^22s^2p^2$) has half filled orbitals in its excited state ($C \rightarrow 1\underline{s}^2 2s^1p^3$) due to which it becomes more stable and hence IE_1 for C is greater than B.

Further for second ionization energy (IE_2) in C^+ ($1s^22s^2p^1$) the electron is to be removed from 2*p* which is easy as compared to B^+ ($1s^22s^2$), where it has to be removed from 2*s*.

H. Assertion & Reason Type Questions

1. (c) Assertion is correct but reason is incorrect because the energy of 2*s* orbital is less than 2*p* orbital.

I. Integer Value Correct Type

1. Fluorine generally shows 0 and –1 oxidation states while sodium shows 0 and + 1 oxidation state.

Section-B JEE Main/ AIEEE

1. (b) According to modern periodic law, the properties of the elements are repeated after certain regular intervals when these elements are arranged in order of their increasing atomic numbers.

2. (d) Na_2O (basic), SO_2 and B_2O_3 (acidic) and ZnO is amphoteric.

3. (a) O^{--} and F^- are isoelectronic. Hence have same number of shells, therefore greater the nuclear charge smaller will be the size i.e.

$$O^{--} > F^-$$

further Li^+ and B^{3+} are isoelectronic. therefore

$$Li^+ > B^{3+}$$

Hence the correct order of atomic size is.

$$O^{--} > F^- > Li^+ > B^{3+}$$

4. (d) As the size increases the basic nature of oxides changes to acidic nature i.e., acidic nature increases.

$$\underset{\text{Acidic}}{SO_2} > \underset{\text{Weak acidic}}{P_2O_3} > \underset{\text{Amphoteric}}{SiO_2} > Al_2O_3$$

SO_2 and P_2O_3 are acidic as their corresponding acids H_2SO_3 and H_3PO_3 are strong acids.

5. (a) O^- ion exerts a force of repulsion on the incoming electron. The energy is required to overcome it.

6. (a) CaO is basic as it form strong base $Ca(OH)_2$ on reaction with water.

$$CaO + H_2O \longrightarrow Ca(OH)_2$$

CO_2 is acidic as it dissolve in water forming unstable carbonic acid.

$$H_2O + CO_2 \longrightarrow H_2CO_3$$

Silica (SiO_2) is insoluble in water and acts as a very weak acid.

SnO_2 is amphoteric as it reacts with both acid and base.

$$SnO_2 + 2H_2SO_4 \longrightarrow Sn(SO_4)_2 + 2H_2O$$

$$SnO_2 + 2KOH \longrightarrow K_2SnO_3 + H_2O$$

7. (c) In a period the value of ionisation potential increases from left to right with breaks where the atoms have some what stable configuration. In this case N has half filled stable orbitals. Hence has highest ionisation energy. Thus the correct order is

$$B < C < O < N$$

and not as given in option (c)

8. **(b)** The alkali metals are highly reactive because their first ionisation potential is very low and hence they have great tendency to loses electron to form unipositive ion.

NOTE : On moving down group- I from Li to Cs ionisation enthalpy decreases hence the reactivity increases. The halogens are most reactive elements due to their low bond dissociation energy, high electron affinity and high enthalpy of hydration of halide ion. However their reactivity decreases with increase in atomic number

9. **(b)** In hydrides of 15^{th} group elements, basic character decreases on descending the group i.e.

$NH_3 > PH_3 > AsH_3 > SbH_3$.

10. **(d)** All the given species contains 10 e^- each i.e. isoelectronic.

For isoelectronic species anion having high negative charge is largest in size and the cation having high positive charge is smallest.

11. **(a)** On moving across a period ionisation energy increases hence the electropositive nature of metals decreases therefore the ease of formation of ion also decreases and hence the basic character decreases. Further basic character of alkali metals oxides increases from Li_2O to Cs_2O. Hence the correct order will be

$$Al_2O_3 < MgO < Na_2O < K_2O$$

12. **(c)** Among isoelectronic species ionic radii increases as the charge increases.

Order of ionic radii $Ca^{2+} < K^+ < Cl^- < S^{2-}$

The number of electrons remains the same but nuclear charge increases with increase in the atomic number causing decrease in size.

13. **(c)** On moving along a period from left to right I.E. increases and on moving down a group I.E. decreases.

hence correct order is :

$$Ba < Ca < Se < S < Ar$$

14. **(b)** $\because$ For $Na \longrightarrow Na^+ + e^-$ $\quad IE_1 = 5.1\ eV$

$\therefore$ For $Na^+ + e^- \longrightarrow Na$ $\quad EF = -5.1\ eV$

(because the reaction is reverse)

15. **(a)** For isoelectronic species, size of anion increases as negative charge increases. Thus the correct order is

$$\underset{(1.71)}{N^{3-}} > \underset{(1.40)}{O^{2-}} > \underset{(1.36)}{F^-}$$