CHAPTER 3

Classification of Elements and Periodicity in Properties

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 **[2004]**

$O_{(g)} + e^- = O^-_{(g)}$ $\Delta H° = -142$ kJmol^{-1}
$O^-(g) + e^- = O^{2-}_{(g)}$ $\Delta H° = 844$ 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? **[2006]**

(a) Chemical reactivity increases with increase in atomic number down the group in both the alkali metals and halogens
(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. The correct order of electron gain enthalpy with negative sign of F, Cl, Br and I, having atomic number 9, 17, 35 and 53 respectively, is : **[2011RS]**

(a) F > Cl > Br > I (b) Cl > F > Br > I

(c) Br > Cl > I > F (d) I > Br > Cl > F

12. Which of the following represents the correct order of increasing first ionization enthalpy for Ca, Ba, S, Se and Ar ? **[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

13. 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

14. Which of the following atoms has the highest first ionization energy? **[JEE M 2016]**

(a) K (b) Sc

(c) Rb (d) Na

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

SOLUTIONS

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.

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

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 15th 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. (b) As we move down in a group electron gain enthalpy becomes less negative because the size of the atom increases and the distance of added electron from the nucleus increases. Negative electron gain enthalpy of F is less than Cl. This is due to the fact that when an electron is added to F, the added electron goes to the smaller n = 2 energy level and experiences significant repulsion from the other electrons present in this level. In Cl, the electron goes to the larger n = 3 energy level and consequently occupies a larger region of space leading to much less electron–electron repulsion. So the correct order is

$$Cl > F > Br > I.$$

12. (c) On moving down a group size increases hence ionisation enthalpy decreases, hence Se < S and Ba < Ca. Further, Ar being an inert gas has maximum IE.

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

14. (b) Alkali metals have the lowest ionization energy in each period on the other hand Sc is a d - block element.

Transition metals have smaller atomic radii and higher nuclear charge leading to high ionisation energy.