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 ?
(a) Na_2O (b) SO_2 **[2003]**
(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

$$O_{(g)} + e^- = O^-_{(g)} \quad \Delta H^\circ = -142 \text{ kJmol}^{-1} \quad \textbf{[2004]}$$

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

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?
(a) SnO_2 (b) SiO_2 **[2005]**
(c) CO_2 (d) CaO

7. In which of the following arrangements, the order is NOT according to the property indicated against it?
(a) $Li < Na < K < Rb$: Increasing metallic radius **[2005]**
(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