Chapter 3

Classification of Elements and Periodicity in Properties

Solutions

SECTION - A

Objective Type Questions

(Modern Periodic Law and The Present form of The Periodic Table)

1. Ca^{2+} is isoelectronic with

   (1) Mg^{2+} (2) Kr (3) Ar (4) Na^{+}

Sol. Answer (3)

Isoelectronic means same number of electrons.

Ca^{2+} = 18

Ar = 18

2. An atom of an element has electronic configuration 2, 8, 1. Which of the following statement is correct?

   (1) The valency of element is 7

   (2) The element exists as a triatomic molecule

   (3) The element is metalloid

   (4) The element forms basic oxide

Sol. Answer (4)

Electronic configuration indicates that 1 e^{-} is present in outermost shell.

It will easily lose electrons

$\therefore$ It is metal and form basic oxide

$$2\,Na + \frac{1}{2}O_2 \longrightarrow Na_2O$$

3. The symbol of element with atomic number Z = 109

   (1) Unp (2) Uns (3) Uno (4) Une

Sol. Answer (4)

109 = Une

4. Pd has exceptional electronic configuration of $4d^{10}\ 5s^0$. It belong to

(1) 4^{th} period, group 11 (2) 5^{th} period, group 10

(3) 6^{th} period, group 9 (4) 3^{rd} period, group 16

Sol. Answer (2)

Pd = $4d^{10}$, $5s^0$ member of 4d series i.e., 5^{th} period and 10^{th} group.

5. All elements in the third period have

(1) Three complete shells (2) Three complete subshells

(3) Three valence electrons (4) Three electrons less than octet

Sol. Answer (2)

3rd period = $3d^{10}$, $3s^2$, $3p^6$ three subshells are last electrons enters in *d*-subshell.

$\therefore$ It is *d*-block elements.

6. Which one of the following represents a d-block element?

(1) [Rn] $6d^{10}\ 7s^2\ 7p^2$ (2) [Xe] $4f^1\ 5d^1\ 6s^2$

(3) [Xe] $4f^{14}\ 5d^1\ 6s^2$ (4) [Xe] $5d^1\ 6s^2$

Sol. Answer (4)

Last electrons enters in d-subshell

$\therefore$ It is d-block elements.

7. Which of the following set of atomic number represents only representative elements?

(1) 55, 12, 48, 53 (2) 13, 23, 54, 83

(3) 3, 33, 53, 87 (4) 22, 33, 55, 66

Sol. Answer (3)

Representative element includes S $\propto$ p-block

Li at no. = 3 $1s^2, 2s^2$

As at 33 $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^{10}, 4p^3$

I at 53 $5s^2, sp^5$

Fr at 87 $7s^1$

8. Which of the following pairs of atomic numbers represents elements belonging to the same group?

(1) 11 and 20 (2) 12 and 30 (3) 13 and 31 (4) 14 and 33

Sol. Answer (3)

Atomic number 13 = Al group 13

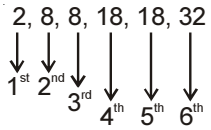
Atomic number 31 = Ga group 13

9. Total number of elements present in 5th period of modern periodic table is

(1) 2 (2) 8 (3) 18 (4) 32

Sol. Answer (3)

Total number of 18 elements are present in fifth period *i.e.,*



(Periodic Trends in Physics Properties)

10. The electronegativity follows the order

(1) F > O > Cl > Br (2) F > Cl > Br > O

(3) O > F > Cl > Br (4) Cl > F > O > Br

Sol. Answer (1)

F > O > Cl > Br $\left[\begin{array}{l}\text{down the group } e^- \text{ negativity decreases}\\ \text{left to right } e^- \text{ negativity increases}\end{array}\right]$

$\therefore$ F have more electron affinity than 'O',

$\left[\begin{array}{l}\text{O have more than Cl due to same}\\ \text{Cl and Br have less}\end{array}\right]$

11. The correct order of shielding effect of *s*, *p*, *d* and *f* orbitals is

(1) $s > p > d > f$ (2) $s < p < d > f$ (3) $s < p < d < f$ (4) $s > p < d < f$

Sol. Answer (1)

s is more closer to nucleus *i.e.,* shielding effect α distance from nucleus.

$\therefore$ s > p > d > f

12. Which of the following statement is incorrect?

(1) The ionization potential of nitrogen is greater than that of oxygen

(2) The electron affinity of fluorine is greater than that of chlorine

(3) The ionization potential of Mg is greater than aluminium

(4) The electronegativity of fluorine is greater than that of chlorine

Sol. Answer (2)

Electron affinity of F is less than chlorine because of smaller size more will be the repulsion towards new electron.

13. Increase in atomic size down the group is due to

(1) Increase in number of orbit

(2) Increase in number of protons and neutrons

(3) Increase in number of protons

(4) Increase in number of protons, neutrons and electrons

Sol. Answer (1)

On moving down the group no. of shells are added

$\therefore$ Size increases

14. In which of the following pairs the radii of second species is greater than that of first?

(1) K, Ca

(2) H, He

(3) Mg^+, Mg^{2+}

(4) O^{2-}, O^-

Sol. Answer (2)

He has more size than 'H' because of ($1s^2$) completely filled *s*-subshell.

15. The successive ionization energies for element X is given below

IE_1 : 250 kJ mol^{-1}

IE_2 : 820 kJ mol^{-1}

IE_3 : 1100 kJ mol^{-1}

IE_4 : 1400 kJ mol^{-1}

Find out the number of valence electrons for the element X.

(1) 3 (2) 4 (3) 2 (4) 1

Sol. Answer (4)

Difference between IE_1 and IE_2 is high then the number of valence electron in the element is one.

16. If you are given Avogadro's number of atoms of a gas 'X'. If half of the atoms are converted into $X_{(g)}^{+}$ by energy ΔH. The IE of X is

(1) $\frac{2\Delta H}{N_A}$

(2) $\frac{2N_A}{\Delta H}$

(3) $\frac{\Delta H}{2N_A}$

(4) $\frac{N_A}{\Delta H}$

Sol. Answer (1)

$\frac{1}{2}N_A$ atoms have ionisation energy = ΔH

N_A atom have ionisation energy = $\frac{\Delta H \times 2}{N_A}$

17. Find the formula of halide of a metal whose successive ionization enthalpies are x, 2x, 5x, 100x kJ mol^{-1} respectively

(1) MX (2) MX_2 (3) MX_3 (4) M_2X

Sol. Answer (3)

There is large difference between 3rd and 4th I.E.

$\therefore$ +3 oxidation state will be more stable and the formula of halide is MX_3.

18. Which of the following equation represents first enthalpy of ionization ?

(1) $Hg_{(s)} \longrightarrow Hg^{+}_{(g)} + e^{-}$ (2) $Hg_{(l)} \longrightarrow Hg^{+}_{(g)} + e^{-}$

(3) $Hg_{(g)} \longrightarrow Hg^{+}_{(g)} + e^{-}$ (4) $Hg^{+}_{(g)} \longrightarrow Hg_{(g)}^{2+} + e^{-}$

Sol. Answer (3)

I.E. is the amount of energy required to remove an electron from an isolated gaseous atom.

19. The energy required to convert all atoms present in 1.2 g magnesium to Mg^{2+} ions if IE, and IE_2 of magnesium are 120 kJ mol^{-1} and 240 kJ mol^{-1} respectively

(1) 18 kJ (2) 36 kJ (3) 360 kJ (4) 24 kJ

Sol. Answer (1)

Moles of Mg = $\frac{1.2}{24} = 0.05$ moL

$Mg \rightarrow Mg^{2+} + 2e^{-}$ I.E. = $I.E_1 + I.E_2 = 120 + 240$

1 moL $\xrightarrow{\text{energy required}}$ = 360 kJ/moL

0.05 moL $\xrightarrow{\text{energy required}}$ = 360 × 0.05 = 18 kJ

20. The process requiring absorption of energy is

(1) $F \rightarrow F^-$ (2) $H \rightarrow H^+$

(3) $Cl \rightarrow Cl^-$ (4) $O \rightarrow O^-$

Sol. Answer (2)

I.Energy is the absorption of energy.

21. The least electronegative element has the following electronic configuration

(1) ns^2np^5 (2) ns^2np^4 (3) ns^2np^3 (4) ns^2np^6

Sol. Answer (4)

Full filled electronic configuration element do not attract electron

i.e., ns^2, np^6

22. Which of the following is correct order of metallic character for Si, Be, Mg, Na and P?

(1) P < Si < Be < Na < Mg (2) P < Si < Be < Mg < Na

(3) Na > Be > Mg > Be > P (4) Na > Si > Mg > Be > P

Sol. Answer (2)

Left to right metallic character decreases

Top to bottom metallic character increases

$\therefore$ P (less metallic due to smaller size) < Si < Be < Mg < Na (more metallic due to large size)

23. With which of the following electronic configuration an atom has the lowest ionization enthalpy?

(1) $1s^2\ 2s^2\ 2p^3$ (2) $1s^2\ 2s^2\ 2p^6\ 3s^1$

(3) $1s^2\ 2s^2\ 2p^6$ (4) $1s^2\ 2s^2\ 2p^5$

Sol. Answer (2)

24. The electronic configuration having maximum difference in first and second ionization energies is

(1) $1s^2\ 2s^2\ 2p^6\ 3s^2$ (2) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$

(3) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$ (4) $1s^2\ 2s^2\ 2p^6\ 3s^1$

Sol. Answer (4)

After removing 1 e^- it will get stable noble gas configuration.

25. The electronic configurations of the elements X, Y, Z and J are given below. Which element has the highest metallic character?

(1) X = 2, 8, 4 (2) Y = 2, 8, 8

(3) Z = 2, 8, 8, 1 (4) J = 2, 8, 8, 7

Sol. Answer (3)

Element Z have 1 electron in 4^{th} shell

$\therefore$ it will easily lose to get noble gas configuration.

SECTION - B

Previous Years Questions

1. The element Z = 114 has been discovered recently. It will belong to which of the following family group and electronic configuration? **[NEET-2017]**

   (1) Halogen family, [Rn] $5f^{14}6d^{10}7s^27p^5$

   (2) Carbon family, [Rn] $5f^{14}6d^{10}7s^27p^2$

   (3) Oxygen family, [Rn] $5f^{14}6d^{10}7s^27p^4$

   (4) Nitrogen family, [Rn] $5f^{14}6d^{10}7s^27p^6$

Sol. Answer (2)

Z = 114 belong to Group 14, carbon family

2. In which of the following options, the order of arrangement does **not** agree with the variation of property indicated against it? **[NEET-2016]**

   (1) Li < Na < K < Rb (increasing metallic radius)

   (2) $Al^{3+} < Mg^{2+} < Na^+ < F^-$ (increasing ionic size)

   (3) B < C < N < O (increasing first ionisation enthalpy)

   (4) I < Br < Cl < F (increasing electron gain enthalpy)

Sol. Answer (3 & 4)

For option (3) :

The correct order for 1st ionisation energy is B < C < O < N.

For option (4) :

The correct order for magnitude of electron gain enthalpy is I < Br < F < Cl

3. The species Ar, K^+ and Ca^{2+} contain the same number of electrons. In which order do their radii increase? **[AIPMT-2015]**

   (1) $K^+ < Ar < Ca^{2+}$

   (2) $Ar < K^+ < Ca^{2+}$

   (3) $Ca^{2+} < Ar < K^+$

   (4) $Ca^{2+} < K^+ < Ar$

Sol. Answer (4)

4. Which of the following orders of ionic radii is correctly represented ? **[AIPMT-2014]**

   (1) $H^- > H^+ > H$

   (2) $Na^+ > F^- > O^{2-}$

   (3) $O^{2-} > F^- > Na^+$

   (4) $Al^{3+} > Mg^{2+} > N^{3-}$

Sol. Answer (3)

5. Identify the **wrong** statement in the following. **[AIPMT (Prelims)-2012]**

   (1) Atomic radius of the elements increases as one moves down the first group of the periodic table

   (2) Atomic radius of the elements decreases as one moves across from left to right in the 2nd period of the periodic table

   (3) Amongst isoelectronic species, smaller the positive charge on the cation, smaller is the ionic radius

   (4) Amongst isoelectronic species, greater the negative charge on the anion, larger is the ionic radius

Sol. Answer (3)

In isoelectronic species *i.e.,* same number of electrons.

$$\left\{\begin{matrix}\text{more the positive charge; smaller will be the size}\\ \text{more the negative charge; larger will be the size}\end{matrix}\right\}$$

6. What is the value of electron gain enthalpy of Na^+ if IE_1 of Na = 5.1 eV? **[AIPMT (Mains)-2011]**

(1) +2.55 eV (2) +10.2 eV

(3) –5.1 eV (4) –10.2 eV

Sol. Answer (3)

Electron gain enthalpy is negative of I.E. *i.e.,* –5.1 eV

7. Which of the following represents the correct order of increasing electron gain enthalpy with negative sign for the elements O, S, F and Cl ? **[AIPMT (Prelims)-2010]**

(1) Cl < F < O < S (2) O < S < F < Cl

(3) F < S < O < Cl (4) S < O < Cl < F

Sol. Answer (2)

8. The correct order of the decreasing ionic radii among the following is electronic species are

[AIPMT (Prelims)-2010]

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

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

Sol. Answer (3)

9. Among the elements Ca, Mg, P and Cl, the order of increasing atomic radii is **[AIPMT (Mains)-2010]**

(1) Mg < Ca < Cl < P (2) Cl < P < Mg < Ca

(3) P < Cl < Ca < Mg (4) Ca < Mg < P < Cl

Sol. Answer (2)

Mg P Cl } left to right size decreases

Ca } down the group size increases

i.e., Ca > Mg > P > Cl

10. Amongst the elements with following electronic configurations, which one of them may have the highest ionization energy? **[AIPMT (Prelims)-2009]**

(1) Ne $[3s^2 3p^2]$ (2) Ar $[3d^{10} 4s^2 4p^3]$

(3) Ne $[3s^2 3p^1]$ (4) Ne $[3s^2 3p^3]$

Sol. Answer (4)

Half filled stability $3s^2\ 3p^3$

11. Identify the correct order of the size of the following **[AIPMT(Prelims)-2007]**

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

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

Sol. Answer (3)

12. Which one of the following arrangements represents the correct order of electron gain enthalpy (with negative sign) of the given atomic species ? **[AIPMT (Prelims)-2005]**

(1) Cl < F < S < O (2) O < S < F < Cl

(3) S < O < Cl < F (4) F < Cl < O < S

Sol. Answer (2)

Cl have more electron gain enthalpy than F $\{$due to smaller size of F and 'O' it will show repulsion$\}$

S have more electron gain enthalpy than O

$\therefore$ Order will be O < S < F < Cl

13. Which one of the following arrangements represents the correct order of least negative to most negative electron gain enthalpy for C, Ca, Al, F and O?

(1) Ca < Al < C < O < F

(2) Al < Ca < O < C < F

(3) Al < O < C < Ca < F

(4) C < F < O < Al < Ca

Sol. Answer (1)

C < O < F

Left to right electronegativity increases

Down the group electronegativity decreases

$\therefore$ Ca < Al < C < O < F

14. The electronic configuration of an element is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^2$. What is the atomic number of the element, which is just below the above element in the periodic table?

(1) 36 (2) 49 (3) 50 (4) 54

Sol. Answer (3)

Atomic number of element = 32, below element have atomic number 32 + 18 = 50.

15. Which of the following ion is the largest in size?

(1) K^+ (2) Ca^{2+} (3) Cl^- (4) S^{-2}

Sol. Answer (4)

All are isoelectronic and more the negative charge more will be the size.

16. The electronic configuration of inner transition elements is

(1) ns^1

(2) $ns^2np^5nd^{10}$

(3) $ns^{0-2}\ (n-1)\ d^{1-10}\ (n-2)\ f^{1-14}$

(4) $ns^2\ (n-1)\ d^{0-1}\ (n-2)\ f^{1-14}$

Sol. Answer (4)

$ns^2(n-1)d^{0-1}(n-2)f^{1-14}$

17. Which of the following has the smallest size?

(1) Al^{3+} (2) F^- (3) Na^+ (4) Mg^{2+}

Sol. Answer (1)

More the positive charge smaller will be the size for isoelectronic elements.

18. Which one of the following is correct order of the size of aluminium species?

(1) $Al > Al^{+} > Al^{2+}$

(2) $Al^{2+} > Al^{+} > Al$

(3) $Al^{2+} = Al^{+} = Al$

(4) All of these

Sol. Answer (1)

Size of positive charge atom *i.e.,* cation is always lesser than parent atom due to increase in effective nuclear charge *i.e.,* $Al > Al^{\oplus} > Al^{2+}$

19. The first ionization potentials (eV) of N and O respectively are

(1) 8.29, 8.29 (2) 11.32, 11.32

(3) 8.29, 11.32 (4) 11.32, 8.21

Sol. Answer (4)

N ($2s^2$, $2p^3$) have half filled more ionisation than 'O' ($2s^2$, $2p^4$) stability potential not half filed

$\therefore \quad \left\{\begin{matrix} N = 11.32\ eV \\ O = 8.21\ eV \end{matrix}\right\}$

20. Correct order of Ist ionization potential among elements Be, B, C, N, O is

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

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

Sol. Answer (1)

Left to right in period I.E increases and half filled have more I.E.

1st I.E [B < Be (more I.E. due to half filled) < C < O < N (more I.E. than 'O' due to half filled)]

21. An atom has electronic configuration $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3\ 4s^2$, you will place it in which group of periodic table?

(1) Fifth (2) Fifteenth

(3) Second (4) Third

Sol. Answer (1)

$3d^3$, $4s^2$ = 5 placed in fifth group

22. Ionic radii are

(1) Inversely proportional to effective nuclear charge

(2) Inversely proportional to square of effective nuclear charge

(3) Directly proportional to effective nuclear charge

(4) Directly proportional to square of effective nuclear charge

Sol. Answer (1)

$$\text{Ionic radii} \propto \frac{1}{\text{effective nuclear charge}}$$

23. Four successive members of the first row transition elements are listed below with their atomic numbers. Which one of them is expected to have the highest third ionisation enthalpy?

(1) Vanadium (Z = 23)

(2) Chromium (Z = 24)

(3) Manganese (Z = 25)

(4) Iron (Z = 26)

Sol. Answer (3)

Mn = 25 = $4s^2$, $3d^5$ after removing 2 electrons from 4s Mn will get stable configuration *i.e.,* $3d^5$

3rd I.E. will be more

24. The element with highest electronegativity will belong to

(1) Period 2, group 17 (2) Period 3, group 17

(3) Period 2, group 18 (4) Period 2, group 1

Sol. Answer (1)

Most electronegative is 'F', which belongs to group 17 and period 2.

25. The first, second and third ionisation energies of Al are 578, 1817 and 2745 kJ mol^{-1} respectively. Calculate the energy required to convert all the atoms of Al to Al^{+3} present in 270 mg of Al vapours

(1) 5140 kJ (2) 51.40 kJ (3) 2745 kJ (4) 514.0 kJ

Sol. Answer (2)

Moles of Al = $\frac{270\times10^{-3}}{27} = 10^{-2}$ moles

$Al \longrightarrow Al^{3+} + 3l^{-}$

Total I.E. = 578 + 1817 + 2745 = 5140 kJ/mol

for 1 mol have I.E = 5140

10^{-2} mol have I.E will be = $5140 \times 10^{-2} = 51.40$ kJ

26. The size of ionic species is correctly given in the order

(1) $Na^{+} > Mg^{+2} > Cl^{+7} > Si^{4+}$ (2) $Na^{+} > Mg^{+2} > Si^{4+} > Cl^{+7}$

(3) $Cl^{+7} > Si^{+4} > Mg^{+2} > Na^{+}$ (4) $Cl^{+7} > Na^{+} > Mg^{+2} > Si^{+4}$

Sol. Answer (2)

For isoelectronic more than negative charge smaller will be the size

$\therefore$ $Na^{+} > Mg^{2+} > Si^{4+} > Cl^{+7}$

27. Match the following, regarding nature of the oxides

Column-I	**Column-II**
a. H_2O	(i) Basic
b. Na_2O	(ii) Amphoteric
c. ZnO	(iii) Acidic
d. SO_3	(iv) Neutral

(1) a(ii), b(i), c(iii), d(iv) (2) a(iv), b(i), c(iii), d(ii)

(3) a(iv), b(i), c(ii), d(iii) (4) a(ii), b(i), c(iv), d(iii)

Sol. Answer (3)

$H_2O \longrightarrow$ Neutral ZnO = amphoteric

$Na_2O \longrightarrow$ Basic SO_3 = Acidic

28. Be^{2+} is isoelectronic with which of the following ions?

(1) H^+ (2) Li^+ (3) Na^+ (4) Mg^{2+}

Sol. Answer (2)

	e^-		e^-
H	1	H^+	0
Li	3	Li^+	2
Be	4	Be^{2+}	2

SECTION - C

Assertion-Reason Type Questions

1. A : Be and Al show diagonal relationship.

   R : Be and Al are diagonal to each other in the periodic table.

Sol. Answer (2)

2. A : The first ionisation energy of Al is lower than magnesium.

   R : Atomic radius of Al is smaller then magnesium.

Sol. Answer (2)

3. A : He and Be have similar outer shell electronic configuration of type ns^2.

   R : Both are chemically inert.

Sol. Answer (3)

4. A : Electron affinity of oxygen is higher than sulphur.

   R : Number of valence orbitals containing electrons are different.

Sol. Answer (4)

5. A : Ionization enthalpy decreases on moving down the group.

   R : Force of attraction between nucleus and electrons decreases on moving down the group.

Sol. Answer (1)

6. A : Atomic radii decreases in a period upto halogen.

   R : van der Waal radii of Cl is larger than its covalent radii.

Sol. Answer (2)

7. A : Lanthanum (Z : 57) is lanthanoid.

   R : Valence electrons are present in 4*f* orbital.

Sol. Answer (4)

8. A : Na_2O is more basic than Al_2O_3.

   R : Sodium is less electropositive than aluminium.

Sol. Answer (3)

9. A : F is most electronegative element of periodic table.

R : Cl is having highest electron affinity.

Sol. Answer (2)

10. A : Cu, Ag, Au are known as coinage metal.

R : Coinage metals are *d*-block metals.

Sol. Answer (2)

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