EXERCISE - 2 : PREVIOUS YEAR JEE MAINS QUESTION

1. Ce^{3+}, La^{3+}, Pm^{3+} and Yb^{3+} have ionic radii in the increasing order as. **(2002)**

(a) $La^{3+} < Ce^{3+} < Pm^{3+} < Yb^{3+}$

(b) $Yb^{3+} < Pm^{3+} < Ce^{3+} < La^{3+}$

(c) $La^{3+} < Ce^{3+} < Pm^{3+} < Yb^{3+}$

(d) $Yb^{3+} < Pm^{3+} < La^{3+} < Ce^{3+}$

Ans. (b)

Sol. Atomic number of elements:

(La^{3+} (57), Ce^{3+} (58) Pm^{3+} (61), Yb^{3+} (70)

(They are the member of Lanthanoid series as elements from 58 to 71 are related to Lanthanum.And, in this series as 'Z' increases, the size of element decreases (also applicable to their ionicform) due to poor shielding of electrons in 4f subshell known as Lanthanoid contraction.

(Thus, arranging them in decreasing order of ionic Radius

($La^{3+} > Ce^{3+} > Pm^{3+} > Yb^{3+}$.

2. According to the periodic law of elements, the variation in properties of elements is related to their **(2003)**

(a) atomic masses (b) nuclear masses

(c) atomic numbers

(d) nuclear neutron-proton number ratios

Ans. (c)

Sol. According to modified modern periodic law, the properties of elements are periodic functions of their atomic numbers.

3. The radius of La^{3+} (atomic number : La = 57) is 1.06 Å. Which one of the following given values will be closest to the radius of Lu^{3+} (atomic number : Lu = 71) ? **(2003)**

(a) 1.60Å (b) 1.40 Å

(c) 1.06 Å (d) 0.85 Å

Ans. (d)

Sol. Lutetium belongs to 4f series known as Lanthanoids and while going from lanthanum (57) to Lutetium size decreases, phenomenon known as Lanthanoid contraction due to poor shielding of electrons in f-orbital. Lanthanoid contraction is also observed in ionic form i.e.

(Thus, size of $La^{+3} > Lu^{+3}$

4. Which of the following groupings represents a collection of isoelectronic species ? **(2003)**

(At. No. Cs = 55, Br = 35)

(a) Ca^{2+}, Cs^{+}, Br (b) Na^{+}, Ca^{2+}, Mg^{2+}

(c) N^{3-}, F^{-}, Na^{+} (d) Be, Al^{3+}, Cl^{-}

Ans. (c)

Sol. Isoelectronic species are the neutral atoms, cations or anions of different elements which have the same number of electrons but different nuclear charge.

(Number of electrons in $N^{3-} = 7 + 3 = 10$.

(Number of electrons in $F^{-} = 9 + 1 = 10$

(Number of electrons in $Na^{+} = 11 - 1 = 10$

5. The atomic numbers of vanadium (V), chromium (Cr), manganese (Mn) and iron (Fe) are respectively. 23, 24, 25 and 26. Which one of these may be expected to have the highest second ionization enthalpy ? **(2003)**

(a) Fe (b) V

(c) Cr (d) Mn

Ans. (c)

Sol. The electronic configuration of chromium is $[Ar]3d^5\ 4s^1$ It loses one electron to form $[Ar]3d^5 4s^0$ in which 3d subshell is half-filled and stable. When another electron is removed, it is removed from half-filled 3d subshell and the stability of 3d subshell is lost. This requires higher energy.

6. Which of the following ions has the highest value of ionic radius ? **(2004)**

(a) Li^{+} (b) B^{3+}

(c) O^{2-} (d) F^{-}

Ans. (c)

Sol. This can be explained on the basis of

$\frac{z}{e}\left\{\frac{\text{atomic number}}{\text{no. of electrons}}\right\}$, whereas $\frac{z}{e}$ ratio increases, the size decreases and when $\frac{z}{e}$ ratio decreases the size increases.

For $Li^{+}, \frac{z}{e} = \frac{3}{2} = 1.5$

For $B^{3+}, \frac{z}{e} = \frac{5}{2} = 2.5$

For $O^{2-}, \frac{z}{e} = \frac{8}{10} = 0.8$

For $F^{-}, \frac{z}{e} = \frac{9}{10} = 0.9$

Hence, O^{2-} has highest value of ionic radius.

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

$(O(g) + e^{-} \rightarrow O^{-}(g);$ $(\Delta H^{\circ} = -142\ kJ\ mol^{-1}$

$(O^{-}(g) + e^{-} \rightarrow O^{2-}(g);$ $(\Delta H^{\circ} = 844\ kJ\ mol^{-1}$

(This is because **(2004)**

(a) Oxygen is more electronegative

(b) Oxygen has high electron affinity

(c) O^- ion will tend to resist the addition of another electron

(d) O^- has comparatively larger size than oxygen atom

Ans. (c)

Sol. The addition of second electron in an atom or ion is always endothermic. This is because anion formed resists addition of another electron.

8. Which one of the following sets of ions represents the collection of isoelectronic species ? **(2004)**

(a) $K^+, Ca^{2+}, Sc^{3+}, Cl^-$ (b) $Na^+, Ca^{2+}, Sc^{3+}, F^-$

(c) $K^+, Cl^-, Mg^{2+}, Sc^{3+}$ (d) $Na^+, Mg^{2+}, Al^{3+}, Cl^-$

Ans. (a)

Sol. Isoelectronic species are those which have same number of electrons.

($K^+ = 19 - 1 = 18$; $Ca^{2+} = 20 - 2 = 18$

($Sc^{3+} = 21 - 3 = 18$; $Cl^- = 17 + 1 = 18$

(Thus, all these ions have 18 electrons in them.

9. Among Al_2O_3, SiO_2, P_2O_3 and SO_2 the correct order of acid strength is. **2004)**

(a) $SO_2 < P_2O_3 < SiO_2 < Al_2O_3$

(b) $SiO_2 < SO_2 < Al_2O_3 < P_2O_3$

(c) $Al_2O_3 < SiO_2 < SO_2 < P_2O_3$

(d) $Al_2O_3 < SiO_2 < P_2O_3 < SO_2$

Ans. (d)

Sol. Non-metallic Oxides are acidic in nature. Metallic oxides are basic in nature. Of the options given, Al_2O_3 is metal oxide and Rest are Non-metal oxides.

Al_2O_3 has amphoteric character so, has acidic character also. While comparing acid strength of oxides involving element of same period,

Acidity $\propto$ Electronegativity of central element Arranging Al, Si, P, S in decreasing order of electronegativity.

S > P > Si > AI

Thus, Acid strength is

$SO_2 > P_2O_3 > SiO_2 > Al_2O_3$

10. 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.

Ans. (c)

Sol. As we move from left to right across a period, ionization enthalpy increases with increasing nuclear charge. So, the order of increasing ionization enthalpy should be

B < C < N < O.

But N ($1s^2\ 2s^2\ 2p^3$) has a stable half-filled electronic configuration. So, ionization enthalpy of nitrogen is greater than oxygen.

So, the correct order of increasing the first ionization enthalpy is B < C < O< N.

11. Following statements regarding the periodic trends of chemical reactivity of the alkali metals and the halogens are given. Which of these statements give the correct picture ? **(2006)**

(a) The reactivity decreases in the alkali metals but increases in the halogens with increase in atomic number down the group

(b) In both the alkali metals and the halogens the chemical reactivity decreases with increase in atomic number down the group

(c) Chemical reactivity increase with increase in atomic number down the group in both the alkali metals and halogens.

(d) In alkali metals the reactivity increases but in the halogens it decreases with increase in atomic number down the group

Ans. (d)

Sol. In alkali, as we move down the group size increases thus an ability to lose electrons increases thus reactivity increases.

However, the reactivity of halogens decreases with increase in atomic number due to following reasons:

(i) As the size increases, the attraction for an additional electron by the nucleus becomes less.

(ii) Due to decrease in electronegativity from F to I, the bond between halogen and other elements becomes weaker and weaker.

12. The increasing order of the first ionization enthalpies of the elements B, P, S and F (lowest first) is **(2007)**

(a) F < S < P < B (b) P < S < B < F

(c) B < P < S < F (d) B < S < P < F

Ans. (d)

Sol.

Element:	B	S	P	F
I.E(eV):	8.3	10.4	11.0	17.4

(In general, as we move from left to right in a period, the ionization enthalpy increases with increasing atomic number. The ionization enthalpy decreases as we move down a group. P. ($1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$) has a stable half-filled electronic configuration than S. ($1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$).

(For this reason, ionization enthalpy of P is higher than S.

13. The set representing the correct order of ionic radius is **(2009)**

(a) $Li^+ > Be^{2+} > Na^+ > Mg^{2+}$

(b) $Na^+ > Li^+ > Mg^{2+} > Be^{2+}$

(c) $Li^{2+} > Na^+ > Mg^{2+} > Be^{2+}$

(d) $Mg^{2+} > Be^{2+} > Li^+ > Na^+$

Ans. (b)

Sol. In a period, on moving from left to right, the ionic radius decreases. Hence, $Na^+ > Mg^{2+}$ and $Li^+ > Be^{2+}$.also In a group, on moving down from top to bottom, the ionic radius increases. Hence, $Na^+ > Li^+$ and $Mg^{2+} > Be^{2+}$

Ionic	$\rightarrow$	Na^+	>	Li^+	>	Mg^{2+}	>	Be^{2+}
Radius		1.02 Å		0.76 Å		0.72 Å		0.39 Å

14. 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) $O^{2-} > F^- > Na^+ > Mg^{2+} > Al^{3+}$

Ans. (d)

Sol. All the given species are isoelectronic. Among isoelectronic species, anions generally have greater size than cations. Also, greater, the nuclear charge (Z) of the ion, smaller the size. Thus,the order is:

$O^{2-} > F^- > Na^+ > Mg^{2+} > AI^{3+}$

15. 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) $K_2O < Na_2O < Al_2O_3 < MgO$

Ans. (a)

Sol. While moving from left to right in periodic table basic character of oxide of elements will decrease

$$\therefore \quad \underset{\text{Increasing basic strength}}{Al_2O_3 < MgO < Na_2O \longrightarrow}$$

(And while descending in the group basic character of corresponding oxides increases.

$$\therefore \quad \underset{\text{Increasing basic strength}}{Na_2O < K_2O \longrightarrow}$$

$\therefore$ Correct order is

$$Al_2O_3 < MgO < Na_2O < K_2O$$

16. 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 **(2011)**

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

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

Ans. (c)

Sol. Electron gain enthalpy with negative sign decreases down the group with an exception of Cl and F. Most negative electron gain enthalpy is of Cl followed by F, Br, I.

i.e. Cl > F > Br > I.

Exception in case of Cl and F is due to less repulsion to incoming electron in chlorine as compared to fluorine.

17. 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) $K^+, S^{2-}, Ca^{2+}, Cl^-$

Ans. (c)

Sol. For isoelectronic species as effective nuclear charge increases, ionic radii decrease. Nuclearcharge is maximum of the specie with maximum protons. Order of nuclear charge:

	Ca^{2+}	>	K^+	>	Cl^-	>	S^{2-}
Protons :	20		19		17		16
Electrons :	18		18		18		18

Thus, increasing order of ionic radii

$$Ca^{2+} < K^+ < CI^- < S^{2-}$$

18. 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

Ans. (c)

Sol. Ionization enthalpy decreases from top to bottom in a group while it increases from left to rightin a period.

19. The first ionisation potential of Na is 5.1 eV. The value of electron gain enthalpy of Na^+ will be **(2013)**

(a) – 2.55 eV (b) – 5.1 eV

(c) – 10.2 eV (d) + 2.55 eV

Ans. (b)

Sol. Electron gain enthalpy = - Ionisation potential
(= - 5.1 eV

20. Which of the following series correctly represents relations between the elements from X to Y?

(Online 2014 SET-2)

$X \rightarrow Y$	
(a) $_6C \rightarrow _{32}Ge$	Atomic radii increases
(b) $_9F \rightarrow _{35}Br$	Electron gain enthalpy with negative sign increases
(c) $_3Li \rightarrow _{19}K$	Ionization enthalpy increases
(d) $_{18}Ar \rightarrow _{54}Xe$	Noble character increases

Ans. (a)

Sol. (a) $_6C \longrightarrow _{32}Ge$ Atomic radius ↑es downward. It is correct.

(b) $_9F \longrightarrow _{35}Br$

Electron gain enthalpy ↓es downward.
It is incorrect.

(c) $_3Li \longrightarrow _{19}K$

$$I.E. \propto \frac{1}{size}$$

So I.E. ↓es
It is incorrect.

(d) $_{18}Ar \longrightarrow _{54}Xe$

Noble character ↓es downward because Xe start reacting with oxygen and fluorine.

21. Similarity in chemical properties of the atoms of elements in a group of the Periodic table is most closely related to:

(Online 2014 SET-3)

(a) number of principal energy levels
(b) number of valence electrons
(c) atomic numbers
(d) atomic masses

Ans. (b)

Sol. Chemical properties of elements are closely related with no. of electron present in valence shell.

22. Which of the following arrangements represents the increasing order (smallest to largest) of ionic radii of the given species O^{2-}, S^{2-}, N^{3-}, P^{3-} **(Online 2014 SET-3)**

(a) $O^{2-} < N^{3-} < S^{2-} < P^{3-}$ (b) $N^{3-} < O^{2-} < P^{3-} < S^{2-}$
(c) $N^{3-} < S^{2-} < O^{2-} < P^{3-}$ (d) $O^{2-} < P^{3-} < N^{3-} < S^{2-}$

Ans. (a)

Sol. In isoelectronic species larger anion have larger size.
So $O^{2-} < N^{3-}$ and $S^{2-} < P^{3-}$
So order is
$O^{2-} < N^{3-} < S^{2-} < P^{3-}$

23. Which one of the following has largest ionic radius ?

(Online 2014 SET-4)

(a) O_2^{2-} (b) Li^+
(c) F^- (d) B^{3+}

Ans. (a)

Sol. Oxygen is left to fluorine also have one extra -ve charge $\left(O_2^{2-}\right)$ then F^- have large size.

24. The ionic radii (in Å) of N^{3-}, O^{2-} and F^- are respectively :

(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

Ans. (a)

Sol. If there are isoelectronic species than large anion have large size.
i.e. $N^{3-} > O^{2-} > F^-$
So there value will be in same order

$$\begin{array}{ccccc} N^{3-} & > & O^{2-} & > & F^- \\ \downarrow & & \downarrow & & \downarrow \\ 1.71 & & 1.40 & & 1.36 \end{array}$$

25. Which of the following represents the correct order of increasing first ionization enthalpy for Ca, Ba, S, Se and Ar? **(Online 2015 SET-1)**

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

Ans. (b)

Sol. $I.E. \propto \frac{1}{size}, I.E. \propto stability$

(Ba < Ca < Se < S < Ar

same group same group noble gas

26. Which of the following atoms has the highest first ionization energy **(2016)**

(a) Na (b) K

(c) Sc (d) Rb

Ans. (c)

Sol. $I.E. \propto \frac{1}{size}$

So scandium have highest value among all.

27. Identify the correct order of the size of the following :

(Online 2016 SET-1)

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

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

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

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

Ans. (b)

Sol. In iso-electronic species

Size $\propto$ cation < Neutral < anion

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

28. The following statements concern elements in the periodic table. Which of the following is true?

(Online 2016 SET-2)

(a) All the elements in Group 17 are gases.

(b) The Group 13 elements are all metals.

(c) Elements of Group 16 have lower ionization enthalpy values compared to those of Group 15 in the corresponding periods.

(d) For Group 15 elements, the stability of +5 oxidation state increases down the group.

Ans. (c)

Sol. (a) It is incorrect, iodine is solid.

(b) (No, boron is not metal.

(c) (Yes, group 16 have lower I.E. than group 15 due to stability of group 15 electronic cofiguration.

(d) (No, down the group +3 is more stable due to inert pair effect.

29. Consider the following ionization enthalpies of two elements 'A' and 'B' **(Online 2017 SET-1)**

Element	Ionization enthalpy (kJ/mol)		
	1st	2nd	3rd
A	899	1757	14847
B	737	1450	7731

Which of the following statements is **correct** ?

(a) Both 'A' and 'B' belong to group-1 where 'B' comes below 'A'.

(b) Both 'A' and 'B' belong to group-1 where 'A' comes below 'B'.

(c) Both 'A' and 'B' belong to group-2 where 'B' comes below 'A'.

(d) Both 'A' and 'B' belong to group-2 where 'A' comes below 'B'.

Ans. (c)

Sol. Element A have large difference in 2nd and 3rd I.E., so it became stable after loosing two electron, so it belongs to 2nd group same for B.

But Ist I.E. for A > B, so A comes above B.

30. The electronic configuration with the highest ionization enthalpy is : **(Online 2017 SET-2)**

(a) [Ne] $3s^2\ 3p^1$ (b) [Ne] $3s^2\ 3p^2$

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

Ans. (c)

Sol. [Ne] $3s^2\ 3p^3 \rightarrow$ stable electronic configuration

I.E. $\propto$ stability

31. Which one of the following is an acidic oxide ?

(Online 2017 SET-2)

(a) KO_2 (b) BaO_2

(c) SiO_2 (d) CsO_2

Ans. (c)

Sol. Non-metal form acidic oxide.So SiO_2 is acidic oxide other are metallic oxide i.e. basic.

32. For Na^{+}, Mg^{2+}, F^{-} and O^{2-}; the correct order of increasing ionic radii is : **(Online 2018 SET-1)**

(a) $O^{2-} < F^{-} < Na^{+} < Mg^{2+}$

(b) $Na^{+} < Mg^{2+} < F^{-} < O^{2-}$

(c) $Mg^{2+} < Na^{+} < F^{-} < O^{2-}$

(d) $Mg^{2+} < O^{2-} < Na^{+} < F^{-}$

Ans. (c)

Sol. Iso-electronic species $\rightarrow$ ionic radius

= Anion > Neutral > cation

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

33. The correct order of electron affinity is :

(Online 2018 SET-2)

(a) F > Cl > O (b) F > O > Cl

(c) Cl > F > O (d) O > F > Cl

Ans. (c)

Sol. $E.A. \propto \frac{1}{size}$ (in general)

So F > O but F < Cl (exception)

So Cl > F > O

34. The group number, number of valence electrons, and valency of an element with atomic number 15, respectively, are: **(12-03-2019 Shift-I)**

(a) 16, 5 and 2 (b) 15, 5 and 3

(c) 16, 6 and 3 (d) 15, 6 and 2

Ans. (b)

Sol. Phosphorus has atomic number 15. Its group number is 15, number of valence electrons is 5 and valency is 3.

35. In general, the properties that decrease and increase down a group in the periodic table, respectively, are: **(JEE Main 09-01-2019 Shift-I)**

(a) atomic radius and electronegativity

(b) electron gain enthalpy and electronegativity

(c) electronegativity and atomic radius

(d) electronegativity and electron gain enthalpy

Ans. (c)

Sol. Generally, electronegativity decreases down the group as the size increases.

36. The effect of lanthanide contraction in the lanthanide series of elements by enlarge means **(JEE Main 09-01-2019 shift-I)**

(a) increase in both atomic and ionic radii

(b) decrease in atomic radii and increase in ionic radii

(c) decrease in both atomic and ionic radii

(d) increase in atomic radii and decrease in ionic radii

Ans. (c)

Sol. Due to lanthanide contraction, size of atom as well as ion of lanthanide decreases

37. The transition element that has lowest enthalpy of atomization is: **(JEE Main 09-01-2019 shift-II)**

(a) Fe (b) Cu

(c) V (d) Zn

Ans. (d)

Sol. As zinc has no unpaired of electrons to take part in the bond, it has least enthalpy of atomization amongst the given transition elements.

38. When the first electron gain enthalpy of oxygen is -141 kJ/mol, its second electron gain enthalpy is: **(JEE Main 09-01-2019 Shift-II)**

(a) a more negative value than the first

(b) almost the same as that of the first

(c) negative, but less negative than the first

(d) a positive value

Ans. (d)

Sol. The second electron gain enthalpy of oxygen is positive as energy has to be added for the addition of another electron.

39. The effect of lanthanoid contraction in the lanthanoid series of elements by and large means: **(JEE Main 10-01-2019Shift-I)**

(a) increase in both atomic and ionic radii

(b) decrease in atomic radii and increase in ionic radii

(c) decrease in both atomic and ionic radii

(d) increase in atomic radii and decrease in ionic radii

Ans. (c)

Sol. Due to lanthanoid contraction, size of atom as well as ion of lanthanoid decreases.

40. The 71st electron of an element X with an atomic number of 71 enters into the orbital: **(JEE Main 10-01-2019 shift-I)**

(a) 6p (b) 4f

(c) 5d (d) 6s

Ans. (c)

Sol. ${}_{71}X = [Xe]6s^2 4f^{14} 5d^1$

$\therefore$ Orbital occupied by last e^- is 5d

41. The correct option with respect to the Pauling electronegativity values of the elements is: **(JEE Main 11-01-2019 shift-II)**

(a) Te > Se (b) Ga < Ge

(c) Si < Al (d) P > S

Ans. (b)

Sol. Correct order of electronegativity values of the elements is

Si > Al; S > P; Se > Te; Ge > Ga

42. The IUPAC symbol for the element with atomic number 119 would be: **(JEE Main 08-04-2019 shift-II)**

(a) Uue (b) Une

(c) Unh (d) Uun

Ans. (a)

Sol. Symbol for 1 is u and for 9 is e.

$\therefore$ IUPAC symbol for 119 is Uue

43. The correct order of the first ionization enthalpies is:(JEE Main 10-04-2019 shift-II)

(a) Ti < Mn < Zn < Ni (b) Ti < Mn< Ni < Zn

(c) Mn < Ti < Zn < Ni (d) Zn < Ni < Mn < Ti

Ans. (b)

Sol. IE_1 increases on moving left to right in a period.

$\therefore$ Ti < Mn < Ni < Zn

44. The pair that has similar atomic radii is: (JEE Main 12-04-2019 shift-II)

(a) Mn and Re

(b) Ti and Hf

(c) Sc and Ni

(d) Mo and W

Ans. (d)

Sol. Mo and W belong to group-6 and period 5 (4d series) and 6(5d series) respectively. Due to lanthanoid contraction, radius of Mo and W are almost same i.e., 0.140 nm and 0.141 nm respectively.

45. The electron gain enthalpy (ln kJ/mol) of fluorine, chlorine, bromine, and iodine, respectively, are: **(JEE Main 07-01-2020 shift-I)**

(a) –333, –325, –349 and –296

(b) –333, –349, –325 and –296

(c) –296, –325, –333 and –349

(d) –349, –333, –325 and –296

Ans. (b)

Sol. Cl > F > Br > I

46. Within each pair of elements F & Cl, S & Se and Li & Na, respectively, the elements that release more energy upon an electron gain are: **(JEE Main 07-01-2020 shift-I)**

(a) Cl, Se and Na (b) Cl, S and Li

(c) F, S and Li (d) F, Se and Na

Ans. (b)

Sol.

Element	**(First Electron gain enthalpy.(kJ/mol)**
Li	(–60)
Na	(–53)
F	(–320)
S	(–200)
Cl	(–340)
Se	(–195)

Despite F being more electronegative than Cl, due to the small size of F, Cl would have a more negative value of electron gain enthalpy because of inter-electronic repulsions. As we go down the group. The negative electron gain enthalpy decreases.

47. The first ionization energy (in kJ/mol) of Na, Mg, Al and Si, respectively, are: **(JEE Main 08-01-2020 shift-I)**

(a) 496, 737, 577, 786

(b) 796, 577, 737, 786

(c) 496, 577, 786, 737

(d) 786, 737, 577, 496

Ans. (a)

Sol. The expected order is Na < Mg < Al < Si

But the actual/experimental order turns out to be Na < Al < Mg < Si, because of the fully filled s-subshell of magnesium and the s^2p^1 configuration of Al which makes it relatively easy for Al to lose its outermost electron.

48. The increasing order of the atomic radii of the following elements is: **(JEE Main 08-01-2020 shift-II)**

A. C B. O

C. F D. Cl

E. Br

(a) B < C < D < A < E (b) C < B < A < D < E

(c) A < B < C < D < E (d) D < C < B < A < E

Ans. (b)

Sol. Across the period size decreases, so the order that follows is: C > O > N > F

Down the group size increases and the order is: Br > Cl > F

Change in size down the group is much more significant as compared to across the period.

So, the overall order of radius of elements is:

Br > Cl > C > O > F.

49. B has a smaller first ionization enthalpy than Be. Consider the following statements:

(i) It is easier to remove 2p electron than 2s electron

(ii) 2p electron of B is more shielded from the nucleus by the inner core of electrons that the 2s electron of Be

(iii) 2s electron has more penetration power than 2p electron

(iv) Atomic radius of B is more than Be

(Atomic number B = 5, Be = 4)

The correct statements are:

(JEE Main 09-01-2020 shift-I)

(a) (i), (ii) and (iii) (b) (i), (iii) and (iv)

(c) (ii), (iii) and (iv) (d) (i), (ii) and (iv)

Ans. (a)

Sol. Be (4): $1s^2\ 2s^2$

B. (5): $1s^2\ 2s^2\ 2p^1$

The electron in $2p^1$ can easily be extracted

The penetrating power is of the order: s > p > d > f

The shielding power order: s > p > d > f

As we move along the period, the size decreases, as Z_{eff} increases. Hence the radius of B is smaller than the radius of Be.

50. The first and second ionization enthalpies of a metal are 496 and 4560 kJ mol^{-1} respectively. How many moles of HCl and H_2SO_4, respectively, will be needed to react completely with 1 mole of metal hydroxide?

(JEE Main 09-01-2020 shift-II)

(a) 1 and 2 (b) 1 and 0.5

(c) 1 and 1 (d) 2 and 0.5

Ans. (b)

Sol. The given data for ionization energies clearly shows that $IE_2 >> IE_1$. So, the element belongs to the first group. Therefore, we can say that this element will be monovalent and hence forms a monoacidic base of the type MOH.

$MOH + HCl \rightarrow MCl + H_2O$

$2MOH + H_2SO_4 \rightarrow M_2SO_4 + 2H_2O$

So, from the above equation we can say that,

1 mole of metal hydroxide requires 1 mole of HCl and 0.5 mole of H_2SO_4.

51. In general, the property (magnitudes only) that shows an opposite trend in comparison to other properties across a period is: **(JEE Main 02-09-2020 shift-I)**

(a) Ionization enthalpy

(b) Electronegativity

(c) Atomic radius

(d) Electron gain enthalpy

Ans. (c)

Sol. Ionization energy, electronegativity & electron gain enthalpy increase across a period but atomic radius decreases.

52. The metal mainly used in devising photoelectric cells is:

(JEE Main 02-09-2020 Shift-I)

(a) Li (b) Cs

(c) Rb (d) Na

Ans. (b)

Sol. 'Cs' is used in photoelectric cell as its ionization energy is lowest.

53. Three elements X, Y and Z are in the 3rd period of the periodic table. The oxides of X, Y and Z, respectively, are basic, amphoteric and acidic. The correct order of the atomic numbers of X, Y and Z is:

(JEE Main 02-09-2020 shift-II)

(a) X < Y < Z (b) Y > X > Z

(c) Z < Y < X (d) X < Z < Y

Ans. (a)

Sol.

X	<	Y	<	Z
Mg		*Al*		*Si*
Basic oxide		amphoteric		acidic oxide

54. The atomic number of the element Unnilennium is:

(JEE Main 03-09-2020 shift-I)

(a) 109 (b) 102

(c) 119 (d) 108

Ans. (a)

Sol.

1	0	9
un	*nil*	*enn*

Hence correct name Unnilennium

55. The five successive ionization enthalpies of an element are 800, 2427, 3658, 25024 and 32824 kJ mol^{-1}. The number of valence electrons in the element is:

(JEE Main 03-09-2020 shift-II)

(a) 2 (b) 4

(c) 3 (d) 5

Ans. (c)

Sol. Fourth & Fifth I.E. are very high (periodic properties) indicating presence of three valence shell electrons.

56. Among the statements (I-IV), the correct ones are: **(JEE Main 03-09-2020 shift-II)**

(I) Be has smaller atomic radius compared to Mg.

(II) Be has higher ionization enthalpy than Al

(III) Charge/radius ratio of Be is greater than that of Al.

(IV) Both Be and Al form mainly covalent compounds.

(a) (I), (II) and (IV)

(b) (I), (II) and (III)

(c) (II), (III) and (IV)

(d) (I), (III) and (IV)

Ans. (a)

Sol. (1) Be < Mg [Atomic size order]

(2) I.E: Be > Al [Due to fully filled configuration of Be]

(3) Be and Al both form covalent compounds because according to Fajan's rule both have more covalent character.

57. The ionic radii of O^{-2}, F^-, Na^+ and Mg^{2+} are in the order: (JEE Main 04-09-2020 shift-I)

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

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

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

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

Ans. (c)

Sol. In isoelectronic series

$$\text{Atomic size} \propto \frac{1}{\text{Atomic no.}}$$

$$\therefore O^{-2} > F^- > Na^+ > Mg^{+2}$$

Hence. (c) is the correct option

58. The elements with atomic numbers 101 and 104 belong to, respectively: **(JEE Main 04-09-2020 shift-I)**

(a) Actinoids and Group 6

(b) Group 11 and Group 4

(c) Group 6 and Actinoids

(d) Actinoids and Group 4

Ans. (d)

Sol.

$$Z = 101 \rightarrow [R_n]^{86}\ 7s^2 5f^{13}$$
$$\downarrow$$
Actinoids

$$Z = 104 \rightarrow [R_n]^{86}\ 7s^2 5f^{14} 6d^2$$
$$\downarrow$$
4th group element

Actinoids & 4th group

59. The atomic number of Unnilunium is ……. **(JEE Main 06-09-2020 shift-II)**

Ans. (101.00)

Sol. Un – 1

Nil – 0

Un – 1

This is the naming rule of elements having atomic no. more than 100

60. The correct order of the ionic radii of O^{2-}, N^{3-}, F^-, Mg^{2+} Na^+ and Al^{3+} is: **(2020-09-05 Shift-II)**

(a) $N^{3-} < O^{2-} < F^- < Na^+ < Mg^{2+} < Al^{3+}$

(b) $Al^{3+} < Na^+ < Mg^{2+} < O^{2-} < F^- < Al^{3+}$

(c) $Al^{3+} < Mg^{2+} < Na^+ < F^- < O^{2-} < N^{3-}$

(d) $N^{3-} < F^- < O^{2-} < Mg^{2+} < Na^+ < Al^{3+}$

Ans. (c)

Sol. All are isoelectronic species, so more is the Z_{eff} less will be the ionic size.

$\therefore$ Correct order of ionic radii is

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

61. Consider the elements Mg, Al, S, P and Si, the correct increasing order of their first ionization enthalpy is **(2021-02-24-shift-I)**

(a) Al < Mg < Si < S < P

(b) Mg < Al < Si < S < P

(c) Mg < Al < Si < P < S

(d) Al < Mg < S < Si < P

Ans. (a)

Sol. Ionization energy increases along the period generally & ionization energy is directly proportional to fully filled /

half-filled configuration.

By using the above rule option: (i) is correct.

62. Match List-I with List-II. **(2021-02-26-shift-I)**

List-1	**List-2**
Electronic configuration	$\Delta_i H$ in kJ mol–1 (of elements)
((a) $1s^2 2s^2$	(i) 801
(b) $1s^2 2s^2 2p^4$	(ii) 899
(c) $1s^2 2s^2 2p^3$	(iii) 1314
(d) $1s^2 2s^2 2p^1$	(iv) 1402

(Choose the most appropriate answer from the options given below :

(a) (a) → (ii), (b) → (iii), (c) → (iv), (d) → (i)

(b) (a) → (i), (b) → (iii), (c) → (i), (d) → (ii)

(c) (a) → (iv), (b) → (i), (c) → (ii), (d) → (iii)

(d) (a) → (i), (b) → (iv), (c) → (iii), (d) → (ii)

Ans. (a)

Sol. Order of IE is B < Be < O < N

63. The correct order of electron gain enthalpy is **(2021-02-26-shift-II)**

(a) S > Se > Te > O (b) Te > Se > S > O

(c) S > O > Se > Te (d) O > S > Se > Te

Ans. (a)

Sol. The order of electron gain enthalpy is S > Se > Te > O

64. Which pair of oxides is acidic in nature? **(2021-02-26-shift-II)**

(a) N_2O, BaO (b) CaO, SiO_2

(c) B_2O_3, SiO_2 (d) B_2O_3, CaO

Ans. (c)

Sol. B_2O_3 & SiO_2 are non metal oxide & hence are acidic in nature

65. The ionic radius of Na^+ ion is 1.02 Å. The ionic radii (in Å) of Mg^{2+} and Al^{3+}, respectively, are : **(2021-03-18-shift-I)**

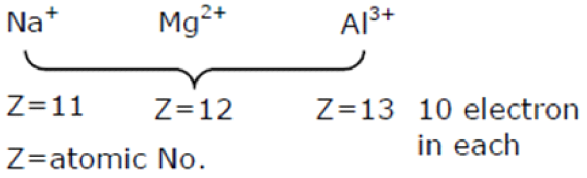
(a) 1.05 and 0.99 (b) 0.72 and 0.54

(c) 0.68 and 0.72 (d) 0.85 and 0.99

Ans. (b)

Sol. For iso-electronic system

$$r \propto \frac{1}{Z_{eff}}$$



66. The first ionization energy of magnesium is smaller as compared to that of elements X and Y, but higher than that of Z. The elements X, Y and Z, respectively, are : **(2021-03-18-shift-II)**

(a) chlorine, lithium and sodium

(b) neon, sodium and chlorine

(c) argon, lithium and sodium

(d) argon, chlorine and sodium

Ans. (d)

Sol. Order of I.E.

3rd period →

Na < Al < Mg < Si < S < P < Cl < Ar

67. Outermost electronic configuration of a group 13 element, E, is $4s^2,4p^1$. The electronic configuration of an element of p-block period-five placed diagonally to element, E is. **(2021-07-20-shift-II)**

(a) $[Kr]3d^{10}4s^24p^2$ (b) $[Ar]3d^{10}4s^24p^2$

(c) $[Xe]5d^{10}\ 6s^26p^2$ (d) $[Kr]4d^{10}5s^25p^2$

Ans. (d)

Sol.

	13th	14th	15th
2nd Period	B ($2s^22p^1$)	C	N
3rd Period	Al ($3s^23p^1$)	Si	P
4th Period	Ga ($4s^24p^1$)	Ge	As
5th Period	In ($5s^25p^1$)	Sn	Sb

That element is Sn ⟹ $[Kr]\ 4d^{10}\ 5s^2\ 5p^2$

68. Which one of the following statements for D.I. Mendeleev, is **incorrect**? **(2021-07-22-shift-II)**

(a) He authored the textbook – Principles of Chemistry.

(b) At the time, he proposed Periodic Table of elements structure of atom was known.

(c) Element with atomic number 101 is named after him.

(d) He invented accurate barometer.

Ans. (b)

Sol.

(a) Dmitri Ivanovich Mendeleev taught at the University of St. Petersburg where he was appointed Professor of General Chemistry in 1867. Preliminary work for his great textbook "Principles of Chemistry" led Mendeleev to propose the Periodic Law and to construct his Periodic Table of elements.

(b) At that time, the structure of atom was unknown and Mendeleev's idea to consider that the properties of the elements were in some way related to their atomic masses was a very imaginative one.

(c) Mendeleev's name has been immortalized by naming the element with atomic number 101, as Mendelevium.

(d) Mendeleev was a versatile genius. He worked on many problems connected with Russia's natural resources. He invented an accurate barometer.

69. The ionic radii of K^+, Na^+, Al^{3+} and Mg^{2+} are in the order: **(2021-07-25-shift-I)**

(a) $Na^+ < K^+ < Mg^{2+} < Al^{3+}$

(b) $Al^{3+} < Mg^{2+} < K^+ < Na^+$

(c) $Al^{3+} < Mg^{2+} < Na^+ < K^+$

(d) $K^+ < Al^{3+} < Mg^{2+} < Na^+$

Ans. (c)

Sol. K^+ will have the largest size as it has a greater number of shells than the other three ions which are isoelectronic. Among isoelectronic species, size decreases with increasing nuclear charge. Thus, the correct order of ionic radii is - $Al^{3+} < Mg^{2+} < Na^+ < K^+$.

70. The ionic radii of F^- and O^{2-} respectively are 1.33 Å and 1.4 Å, while the covalent radius of N is 0.74 Å. The correct statement for the ionic radius of N^{3-} from the following is: **(2021-07-25-shift-II)**

(a) It is smaller than F^- and N

(b) It is bigger than O^{2-} and F^-

(c) It is bigger than F^- and N, but smaller than of O^{2-}

(d) It is smaller than O^{2-} and F^-, but bigger than of N

Ans. (b)

Sol. F^-, O^{2-} and N^{3-} are isoelectronic. Size increases with increase in magnitude of negative charge. Thus, order will be $N^{3-} > O^{2-} > F^-$. Also, size of anions is bigger than the size of neutral atoms. Thus, $N^{3-} > N$.

71. The **CORRECT** order of first ionisation enthalpy is: **(2021-07-27-shift-II)**

(a) Mg < S < Al < P (b) Mg < Al < S < P

(c) Al < Mg < S < P (d) Mg < Al < P < S

Ans. (c)

Sol. In general, the ionisation enthalpy increases from left to right in the periodic table.

Due to fully filled $3s^2$ configuration, the first ionisation energy of Mg > Al.

Due to half filled $3p^3$ configuration, the first ionisation energy of P > S.

72. Match **List-I** with **List-II**: **(2021-07-27-shift-I)**

List – I	**List – II**
(a) NaOH	(i) Acidic
(b) $Be(OH)_2$	(ii) Basic
(c) $Ca(OH)_2$	(iii) Amphoteric
(d) $B(OH)_3$	
(e) $Al(OH)_3$	

(Choose the **most appropriate** answer from the options given below:

(a) (a)- (ii), (b)-(ii), (c)- (iii), (d)- (ii), (e)- (iii)

(b) (a)-(ii), (b)- (iii), (c)-(ii), (d)-(i), (e)-(iii)

(c) (a)-(ii), (b)-(ii), (c)-(iii), (d)-(i), (e)-(iii)

(d) (a)-(ii), (b)-(i), (c)-(ii), (d)-(iii), (e)-(iii)

Ans. (b)

Sol. NaOH $\Rightarrow$ Basic

$Be(OH)_2 \Rightarrow$ Amphoteric

$Ca(OH)_2 \Rightarrow$ Basic

$B(OH)_3 \Rightarrow$ Acidic

$Al(OH)_3 \Rightarrow$ Amphoteric

73. The correct order of ionic radii for the ions, P^{3-}, S^{2-}, Ca^{2+}, K^+, Cl^- is: **(2021-08-27-shift-II)**

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

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

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

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

Ans. (a)

Sol. $P^{3-} > S^{2-} > Cl^- > K^+ > Ca^{2+}$

Correct order of ionic radii)

All the given species are isoelectronic species. In isoelectronic species size increases with increase of negative charge and size decreases with increase in positive charge.

74. Given below are two statements: one is labelled as **Assertion (A)** and the other is labelled as **Reason (R).**

Assertion (A): Metallic character decreases and non-metallic character increases on moving from left to right in a period.

Reason (R): It is due to increase in ionisation enthalpy and decrease in electron gain enthalpy when one moves from left to right in a period.

(In the light of the above statements, choose the most appropriate answer from the options given below: **(2021-08-31-shift-I)**

(a) **(A)** is false but **(R)** is true.

(b) **(A)** is true but **(R)** is false

(c) (Both **(A)** and **(R)** are correct and **(R)** is the correct explanation of **(A)**

(d) (Both **(A)** and **(R)** are correct but **(R)** is not the correct explanation of **(A)**

Ans. (b)

Sol. From left to right in periodic table - Metallic character decreases, Non-metallic character increases

($\Rightarrow$ It is due to increase in ionization enthalpy and increase in electron gain enthalpy

75. Number of amphoteric compounds among the following is _____. **2021-02-24-shift-I)**

(a) BeO (b) BaO

(c) $Be(OH)_2$ (d) $Sr(OH)_2$

Ans. (2)

Sol. $Be(OH)_2$, BeO are amphoteric compounds

76. The characteristics of elements X, Y and Z with atomic numbers, respectively, 33, 53 and 83 are: **(2021-03-16-shift-II)**

(a) X and Y are metalloids and Z is a metal

(b) X, Y and Z are metals

(c) X and Z are non-metals and Y is a metalloid

(d) X is a metalloid, Y is a non-metal and Z is a metal

Ans. (d)

Sol. Atomic No., Element

(1) 33 $\rightarrow$ As (Metalloid)

(2) 53 $\rightarrow$ I (Non metal)

(3) 83 $\rightarrow$ Bi (Metal)

77. Identify the elements X and Y using the ionisation energy values given below :**Ionization energy (kJ/mol)** **(2021-03-18-shift-II)**

	1st	**2nd**
X	495	4563
Y	731	1450

(a) X = F; Y = Mg (b) X = Mg; Y = F

(c) X = Mg; Y = Na (d) X = Na; Y = Mg

Ans. (d)

Sol. 2nd I. E of Alkali metals is higher than their respective period.

78. The absolute value of the electron gain enthalpy of halogens satisfies: **(2021-03-17-shift-I)**

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

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

Ans. (a)

Sol. Chlorine has higher electron gain enthalpy then flourine

due to less electron density. Down the group in halogen electron gain enthalpy decreases.

79. The set of elements that differ in mutual relationship from those of the other sets is : **(2021-03-17-shift-II)**

(a) B - Si (b) Li - Mg

(c) Be - Al (d) Li - Na

Ans. (d)

Sol. Li and Na does not have diagonal relationship.

80. The set, in which compounds have different nature is: **(2021-07-20-shift-I)**

(a) $B(OH)_3$ and H_3PO_3

(b) $B(OH)_3$ and $Al(OH)_3$

(c) NaOH and $Ca(OH)_2$

(d) $Be(OH)_2$ and $Al(OH)_3$

Ans. (b)

Sol. $B(OH)_3$ - Acidic

H_3PO_3 - Acidic

$Al(OH)_3$ - Amphoteric

NaOH - Basic

$Ca(OH)_2$ - Basic

$Be(OH)_2$ - Amphoteric