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Classification of Elements and Periodicity in Properties

TOPIC 1 Modern Periodic Table

1. The atomic number of Unnilunium is _____ .
[NV, Sep. 06, 2020 (II)]

2. The atomic number of the element unnilennium is :
[Sep. 03, 2020 (I)]
(a) 109 (b) 102 (c) 108 (d) 119

3. The group number, number of valence electrons, and valency of an element with atomic number 15, respectively, are : **[April 12, 2019 (I)]**
(a) 16, 5 and 2 (b) 15, 5 and 3
(c) 16, 6 and 3 (d) 15, 6 and 2

4. The IUPAC symbol for the element with atomic number 119 would be : **[April 8, 2019 (II)]**
(a) uue (b) une (c) unh (d) uun

5. The element with Z=120 (not yet discovered) will be an/a:
[Jan. 12, 2019 (I)]
(a) Inner-transition metal (b) Alkaline earth metal
(c) Alkali metal (d) Transition metal

6. Similarity in chemical properties of the atoms of elements in a group of the periodic table is most closely related to:
(a) atomic numbers **[Online April 12, 2014]**
(b) atomic masses
(c) number of principal energy levels
(d) number of valence electrons

7. 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

TOPIC 2 Periodic Trends in Properties of Elements

8. The set that contains atomic numbers of only transition elements, is : **[Sep. 06, 2020 (I)]**
(a) 37, 42, 50, 64 (b) 21, 25, 42, 72
(c) 9, 17, 34, 38 (d) 21, 32, 53, 64

9. The correct order of the ionic radii of O^{2-}, N^{3-}, F^-, Mg^{2+}, Na^+ and Al^{3+} is : **[Sep. 05, 2020 (II)]**
(a) $N^{3-} < O^{2-} < F^- < Na^+ < Mg^{2+} < Al^{3+}$
(b) $Al^{3+} < Na^+ < Mg^{2+} < O^{2-} < F^- < N^{3-}$
(c) $Al^{3+} < Mg^{2+} < Na^+ < F^- < O^{2-} < N^{3-}$
(d) $N^{3-} < F^- < O^{2-} < Mg^{2+} < Na^+ < Al^{3+}$

10. The elements with atomic numbers 101 and 104 belong to, respectively : **[Sep. 04, 2020 (I)]**
(a) Group 11 and Group 4
(b) Actinoids and Group 6
(c) Actinoids and Group 4
(d) Group 6 and Actinoids

11. The process that is NOT endothermic in nature is :
[Sep. 04, 2020 (II)]
(a) $Ar(g) + e^- \rightarrow Ar^-(g)$ (b) $H(g) + e^- \rightarrow H^-(g)$
(c) $O^-(g) + e^- \rightarrow O^{2-}(g)$ (d) $Na(g) \rightarrow Na^+(g) + e^-$

12. The ionic radii of O^{2-}, F^-, Na^+ and Mg^{2+} are in the order:
[Sep. 04, 2020 (I)]
(a) $F^- > O^{2-} > Na^+ > Mg^{2+}$
(b) $O^{2-} > F^- > Na^+ > Mg^{2+}$
(c) $Mg^{2+} > Na^+ > F^- > O^{2-}$
(d) $O^{2-} > F^- > Mg^{2+} > Na^+$

13. Among the statements (I - IV), the **correct** ones are :
[Sep. 03, 2020 (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), (III) and (IV)
(c) (II), (III) and (IV) (d) (I), (II) and (III)

14. 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 : **[Sep. 03, 2020 (II)]**
(a) 5 (b) 4 (c) 3 (d) 2

15. In general, the property (magnitudes only) that shows an opposite trend in comparison to other properties across a period is : **[Sep. 02, 2020 (I)]**
(a) Ionization enthalpy (b) Electronegativity
(c) Electron gain enthalpy(d) Atomic radius

16. 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 : **[Sep. 02, 2020 (II)]**
(a) Z < Y < X (b) X < Y < Z
(c) X < Z < Y (d) Y < X < Z

17. B has a smaller first ionization enthalpy than Be. Consider the following statements:
(I) it is easier to remove 2*p* electron than 2*s* electron
(II) 2*p* electron of B is more shielded from the nucleus by the inner core of electrons than the 2*s* electrons of Be
(III) 2*s* electron has more penetration power than 2*p* electron
(IV) atomic radius of B is more than Be
(atomic number B = 5, Be = 4)
The correct statements are: **[Jan. 09, 2020 (I)]**
(a) (I), (II) and (IV) (b) (II), (III) and (IV)
(c) (I), (II) and (III) (d) (I), (III) and (IV)

18. The acidic, basic and amphoteric oxides, respectively, are: **[Jan. 09, 2020 (I)]**
(a) Na_2O, SO_3, Al_2O_3 (b) Cl_2O, CaO, P_4O_{10}
(c) N_2O_3, Li_2O, Al_2O_3 (d) MgO, Cl_2O, Al_2O_3

19. The first and second ionisation 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 the metal hydroxide? **[NV, Jan. 09, 2020 (II)]**
(a) 1 and 1 (b) 2 and 0.5
(c) 1 and 2 (d) 1 and 0.5

20. The first ionization energy (in kJ/mol) of Na, Mg, Al and Si respectively, are: **[Jan. 08, 2020 (I)]**
(a) 496, 737, 577,786 (b) 496, 577,737, 786
(c) 786,737,577,496 (d) 496, 577,786, 737

21. The increasing order of the atomic radii of the following elements is: **[Jan. 08, 2020 (II)]**
(i) C (ii) O
(iii) F (iv) Cl
(v) Br
(a) (ii) < (iii) < (iv) < (i) < (v)
(b) (iv) < (iii) < (ii) < (i) < (v)
(c) (iii) < (ii) < (i) < (iv) < (v)
(d) (i) < (ii) < (iii) < (iv) < (v)

22. The electron gain enthalpy (in kJ/mol) of fluorine, chlorine, bromine and iodine, respectively, are:**[Jan. 07, 2020 (I)]**
(a) –296, –325, –333 and –349
(b) –349, –333, –325 and –296
(c) –333, –349, –325 and –296
(d) –333, –325, –349 and –296

23. Within each pair of elements F & Cl, S & Se, and Li & Na, respectively, the elements that release more energy upon an electron gain are: **[Jan. 07, 2020 (II)]**
(a) Cl, Se and Na (b) Cl, S and Li
(c) F, S and Li (d) F, Se and Na

24. In comparison to boron, berylium has: **[April 12, 2019 (II)]**
(a) lesser nuclear charge and lesser first ionisation enthalpy.
(b) greater nuclear charge and lesser first ionisation enthalpy.
(c) greater nulear charge and greater first ionisation enthalpy.
(d) lesser nuclear charge and greater first ionisation enthalpy.

25. The element having greatest difference between its first and second ionization energies, is: **[April 9, 2019 (I)]**
(a) Ca (b) Sc (c) Ba (d) K

26. The correct order of the atomic radii of C, Cs, Al, and S is : **[Jan. 11, 2019 (I)]**
(a) C < S < A1 < Cs (b) S < C < Cs < Al
(c) S < C < Al < Cs (d) C < S < Cs < Al

27. The correct option with respect to the Pauling electronegativity values of the elements is: **[Jan. 11, 2019 (II)]**
(a) Te > Se (b) Ga < Ge
(c) Si < Al (d) P > S

28. The 71st electron of an element X with an atomic number of 71 enters into the orbital: **[Jan. 10, 2019 (II)]**
(a) 6*p* (b) 4*f* (c) 5*d* (d) 6*s*

29. In general, the properties that decrease and increase down a group in the periodic table, respectively, are: **[Jan. 9, 2019 (I)]**
(a) atomic radius and electronegativity.
(b) electron gain enthalpy and electronegativity.
(c) electronegativity and atomic radius.
(d) electronegativity and electron gain enthalpy.

30. When the first electron gain enthalpy($\Delta_{eg}H$) of oxygen is – 141 kJ/mol, its second electron gain enthalpy is: **[Jan. 09, 2019 (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

31. The correct order of electron affinity is: **[Online April 15, 2018 (II)]**
(a) O > F > Cl (b) F > O > Cl
(c) F > Cl > O (d) Cl > F > O

32. For Na^+, Mg^{2+}, F^- and O^{2-}; the correct order of increasing Ionic radii is : **[Online April 15, 2018 (I)]**
(a) $O^{2-} < F^- < Na^+ < Mg^{2+}$ (b) $Na^+ < Mg^{2+} < F^- < O^{2-}$
(c) $Mg^{2+} < Na^+ < F^- < O^{2-}$ (d) $Mg^{2+} < O^{2-} < Na^+ < F^-$

33. Both lithium and magnesium display several similar properties due to the diagonal relationship; however, the one which is incorrect is : **[2017]**
(a) Both form basic carbonates
(b) Both form soluble bicarbonates
(c) Both form nitrides
(d) Nitrates of both Li and Mg yield NO_2 and O_2 on heating

34. The group having isoelectronic species is : **[2017]**
(a) O^{2-}, F^-, Na^+, Mg^{2+} (b) O^-, F^-, Na, Mg^+
(c) O^{2-}, F^-, Na , Mg^{2+} (d) O^-, F^-, Na^+, Mg^{2+}

35. Consider the following ionization enthalpies of two elements 'A' and 'B'. **[Online April 8, 2017]**

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'.

36. The electronic configuration with the highest ionization enthalpy is : **[Online April 9, 2017]**
(a) [Ne] $3s^2\,3p^1$ (b) [Ne] $3s^2\,3p^2$
(c) [Ne] $3s^2\,3p^3$ (d) [Ar] $3d^{10}\,4s^2\,4p^3$

37. Which of the following atoms has the highest first ionization energy? **[2016]**
(a) K (b) Sc (c) Rb (d) Na

38. The following statements concern elements in the periodic table. Which of the following is true ? **[Online April 10, 2016]**
(a) For Group 15 elements, the stability of +5 oxidation state increases down the group
(b) Elements of Group 16 have lower ionization enthalpy values compared to those of Group 15 in the corresponding periods.
(c) The Group 13 elements are all metals
(d) All the elements in Group 17 are gases.

39. 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

40. In the long form of the periodic table, the valence shell electronic configuration of $5s^25p^4$ corresponds to the element present in : **[Online April 10, 2015]**
(a) Group 16 and period 6
(b) Group 17 and period 6
(c) Group 16 and period 5
(d) Group 17 and period 5

41. Which of the following series correctly represents relations between the elements from X to Y? **[Online April 11, 2014]**
X → Y
(a) $_3Li \rightarrow {}_{19}K$ Ionization enthalpy increases
(b) $_9F \rightarrow {}_{35}Br$ Electron gain enthalpy (negative sign) increases
(c) $_6C \rightarrow {}_{32}Ge$ Atomic radii increases
(d) $_{18}Ar \rightarrow {}_{54}Xe$ Noble character increases

42. 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 April 12, 2014]**
(a) $O^{2-} < N^{3-} < S^{2-} < P^{3-}$ (b) $O^{2-} < P^{3-} < N^{3-} < S^{2-}$
(c) $N^{3-} < O^{2-} < P^{3-} < S^{2-}$ (d) $N^{3-} < S^{2-} < O^{2-} < P^{3-}$

43. Which one of the following has largest ionic radius? **[Online April 19, 2014]**
(a) Li^+ (b) O_2^{2-} (c) B^{3+} (d) F^-

44. 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

45. The order of increasing sizes of atomic radii among the elements O, S, Se and As is : **[Online April 22, 2013]**
(a) As < S < O < Se (b) Se < S < As < O
(c) O < S < As < Se (d) O < S < Se < As

46. Which is the correct order of second ionization potential of C, N, O and F in the following ? **[Online May 26, 2012; April 23, 2013]**
(a) O > N > F > C (b) O > F > N > C
(c) F > O > N > C (d) C > N > O > F

47. The electron affinity of chlorine is 3.7 eV. 1 gram of chlorine is completely converted to Cl^- ion in a gaseous state. (1 eV = 23.06 kcal mol^{-1}).
Energy released in the process is **[Online May 7, 2012]**
(a) 4.8 kcal (b) 7.2 kcal
(c) 8.2 kcal (d) 2.4 kcal

48. In which of the following arrangements, the sequence is not strictly according to the property written against it? **[2008, Online May 7, 2012]**
(a) $CO_2 < SiO_2 < SnO_2 < PbO_2$: increasing oxidising power
(b) $NH_3 < PH_3 < AsH_3 < SbH_3$: increasing basic strength
(c) HF < HCl < HBr < HI: increasing acid strength
(d) B < C < O < N: increasing first ionisation enthalpy.

49. Which among the following elements has the highest first ionization enthalpy? **[Online May 12, 2012]**
(a) Nitrogen (b) Boron
(c) Carbon (d) Oxygen

50. The correct order of electron gain enthalpy with negative sign of F, Cl, Br and I, having atomic numbers 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

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

52. Following statements regarding the periodic trends of chemical reactivity of alkali metals and 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, alkali metals and halogens chemical reactivity decreases with increase in atomic number down the group

53. The increasing order of the first ionization enthalpies of the elements B, P, S and F (Lowest first) is **[2006]**

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

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

54. Which of the following oxides is amphoteric in character? **[2005]**

(a) SnO_2 (b) SiO_2

(c) CO_2 (d) CaO

55. In which of the following arrangements, the order is NOT according to the property indicated against it?

(a) Li < Na < K < Rb : **[2005]**
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

56. Which one of the following ions has the highest value of ionic radius ? **[2004]**

(a) O^{2-} (b) B^{3+}

(c) Li^{+} (d) F^{-}

57. 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) $Al_2O_3 < SiO_2 < P_2O_3 < SO_2$

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

$O(g) + e^{-} = O^{-}(g)\ \Delta H^{0} = -142\ kJmol^{-1}$ **[2004]**

$O^{-}(g) + e^{-} = O^{2-}(g)\ \Delta H^{0} = 844\ kJmol^{-1}$

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

59. Which one of the following is an amphoteric oxide ? **[2003]**

(a) Na_2O (b) SO_2

(c) B_2O_3 (d) ZnO

Hints & Solutions

1. (101)

Un nil un ium
↓ ↓ ↓
1 0 1

IUPAC symbol = Unu

Atomic no. (Z) = 101

2. (a) un = 1

nil = 0

enn = 9

So, atomic number = 109

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

4. (a) Symbol for 1 is u and for 9 is e.

∴ IUPAC symbol for 119 is uue.

5. (b) Elements with Z = 120 will belong to alkaline earth metals.

Its electronic configuration may be represented as [Og] $8s^2$.

6. (a) If elements are arranged in order of their increasing atomic numbers, element coming at intervals of 2, 8, 8, 18, 18, 32 and 32 will have similar physical and chemical properties and thus grouped in one particular group.

7. (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.

8. (b) Elements with atomic number 21, 25, 42 and 72 belongs to transition metals.

9. (c) All are isoelectronic species, so more is the Z_{eff} less will be the ionic size.

∴ Correct order of ionic radii is

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

10. (c) $_{89}AC \longrightarrow {}_{103}Lr$

Belongs to actinoids series and they all belongs to 3rd group. So atomic no. 101 element is actinoids and atomic number 104 element belongs to 4th group.

11. (b) $Ar(g) + e^{-} \longrightarrow Ar^{-}(g)$ (endothermic)

$H(g) + e^{-} \longrightarrow H^{-}(g)$ (exothermic)

$Na(g) \longrightarrow Na^{+}(g) + e^{-}$ (endothermic)

$O^{-}(g) + e^{-} \longrightarrow O^{2-}(g)$ (endothermic)

- Electron gaining enthalpy (EGE) of H(g) is negative while that of Ar(g) is positive due to ns^2np^6 configuration.
- Second EGE is always positive for an atom.
- Ionization potential of an atom is positive.

12. (b)

	O^{2-}	F^{-}	Na^{+}	Mg^{2+}
Z	8	9	11	12
No. of e^{-}	10	10	10	10

In isoelectronic species greater is $Z_{effe.}$ smaller is radius so order is $O^{2-} > F^{-} > Na^{+} > Mg^{2+}$.

13. (a) Charge/ radius ratio of Be and Al is same because of diagonal relationship. Remaining statements are correct.

14. (c) As difference in 3rd and 4th ionisation energies is high so atom contains 3 valence electrons.

15. (d) On moving left to right along a period in the periodic table atomic radius decreases while electronegativity, electron gain enthalpy and ionisation enthalpy increases, along a period.

16. (b) On moving left to right in a period, the acidic character of oxides increases.

3rd period element oxides.

$\underbrace{Na_2O \quad MgO}_{\text{Basic}} \quad \underbrace{Al_2O_3}_{\text{Amphoteric}} \quad \underbrace{SiO_2 \quad P_2O_5 \quad Cl_2O_7}_{\text{Acidic}}$

Acidic character $\propto$ Atomic No.

So, X have minimum atomic number while Z have maximum atomic number.

Thus, the correct order of the atomic number is

X < Y < Z

17. (c) $_5B : 1s^2\,2s^2\,2p^1$

$_4Be : 1s^2\,2s^2$

First ionisation enthalpy of B is lower than Be because Be has a stable electronic configuration. It required more energy to remove the first electron from 2*s* (in Be) than 2*p* (in B) because 2*s* e^{-} has more penetration power than 2*p*. Therefore options (I), (II) and (III) are correct. Atomic radius of B is less than Be.

18. **(c)** Generally, non-metal oxides are acidic in nature and metal oxides are basic in nature, Al_2O_3 is amphoteric.

19. **(d)** A large difference between first and second ionisation enthalpies (4560–496 = 4064 kJ mol^{-1}) confirms the metal to be an alkali metal and thus is monovalent and form hydroxide of the type M(OH).

$$MOH + HCl \rightarrow MCl + H_2O$$

1 mol 1 mol

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

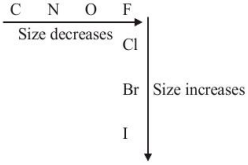
1 mol 1/2 mol

20. **(a)** All given elements belongs to period III and generally their ionisation energy will increase along the period but Mg will show higher ionisation potential compared to Al due to its stable configuration. Thus correct order of ionisation energy will be : Na < Al < Mg < Si.

Ionisation energy (kJ/mol) of the given metals are

Na : 496; Al : 577; Mg : 737; Si : 786

21. **(c)**



Correct increasing order of atomic radii is

F < O < C < Cl < Br

22. **(c)** Chlorine has highest electron gain enthalpy (most negative) among the given elements, the electron gain enthalpy decreases down the group i.e., moves to least negative.

23. **(b)** Generally, electron affinity decreases on moving down a group. Chlorine has more electron affinity than F because of very small size of fluorine. Therefore chlorine, sulphur and Li has higher electron affinity among given groups.

24. **(d)** Nuclear charge : B > Be

Be = $1s^2\,2s^2$ (more stable)

B = $1s^2\,2s^2\,2p^1$

$\therefore$ Ionisation energy of Be is greater than B due to ns^2 outer electronic configuration.

25. **(d)** Alkali metals have high difference in first and second ionisation energy as they achieve stable noble gas configuration after first ionisation.

26. **(a)** On going down the group, size increases while going from left to right in a period size decreases, so order is

C < S < Al < Cs.

27. **(b)** Correct order of electronegativity values of the elements is

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

28. **(c)** $_{71}X = [Xe]6s^2 4f^{14} 5d^1$

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

29. **(c)** Generally, electronegativity decreases down the group as the size increases. This can also be formulated as:

$$\text{Electronegativity} \propto \frac{1}{\text{size}}$$

30. **(d)** The second electron gain enthalpy of oxygen is positive as energy has to be added for the addition of another electron.

31. **(d)** On moving from left to right across a period, the electron affinity becomes more negative. On moving from top to bottom in a group, the electron affinity becomes less negative.

Chlorine has exceptionally more negative electron affinity than fluorine, because adding an electron to fluorine ($2p$ orbital) causes greater repulsion than adding an electron to chlorine ($3p$ orbital) which is larger in size.

32. **(c)** All species are isoelectronic (10e^-).

In isoelectronic series, when negative charge increases the radius of ion increases.

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

33. **(a)** Mg can form basic carbonate

$$3MgCO_3 . Mg(OH)_2 . 3H_2O\downarrow$$

While Li can form only carbonate (Li_2CO_3), not basic carbonate.

34. **(a)** Isoelectronic species have same no. of electrons.

Ions $\Rightarrow$	O^{2-}	F^-	Na^+	Mg^{2+}
	8+2	9+1	11−1	12−2
No. of $e^- \Rightarrow$	10	10	10	10

Therefore O^{2-}, F^-, Na^+, Mg^{2+} are isoelectronic.

35. **(c)** Generally, the ionization enthalpies or energy increases from left to right in a period and decreases from top to bottom in a group. Several factor such as atomic radius, nuclear charge, shielding effect are responsible for change of ionization enthalpies.

Here, Ist ionization enthalpy of A and B is greater than

group I (Li 520 kJmol^{-1} to Cs374 kJmol^{-1}), which means element *A* and *B* belong to group –2 and all three given ionization enthalpy values are less for element *B* means *B* will come below *A*.

36. **(c)** The smaller the atomic size, larger is the value of IP. Further the atoms having half filled or fully filled orbitals are comparatively more stable, hence more energy is required to remove the electron from such atoms.

37. **(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.

38. **(b)** Due to extra stable half-filled *p*-orbital electronic configurations of Group 15 elements, larger amount of energy is required to remove electrons compared to Group 16 elements.

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

40. **(c)** Tellurium (Te) has $5s^2 5p^4$ valence shell configuration. It belongs to group 16 and present in period 5 of the periodic table.

41. **(c)** On moving down in a group atomic radii increases.

42. **(a)** For isoelectronic species ionic radii decreases as the charge on ion decreases. Further on moving down in a group ionic radii increases. Hence the correct order is $O^{2-} < N^{3-} < S^{2-} < P^{3-}$

43. **(a)** On moving along a period ionic radii decreases due to increase in effective nuclear charge.

44. **(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.

45. **(d)** On moving down in a group atomic radii increases due to successive addition of extra shell hence, order is

$$O < S < Se$$

Further, As is in group 15 having one less electron in its *p* orbital compared to group 16, hence as has higher atomic radii than group 16 elements.

i.e., O < S < Se < As

46. **(b)** The second ionization potential means removal of electron from cation

$C^+ = 1s^2 2s^2 2p^1$; $N^+ = 1s^2 2s^2 2p^2$

$O^+ = 1s^2 2s^2 2p^3$; $F^+ = 1s^2 2s^2 2p^4$

Therefore, the correct order is

O > F > N > C

47. **(d)** Number of moles of chlorine $= \frac{1}{35.5}$ mol

Given, 1 eV = 23.06 kcal mol^{-1}

3.7 eV = 3.7 × 23.06 kcal mol^{-1}

i.e. 1 mole of chlorine releases energy

= 3.7 × 23.06 kcal

$\therefore$ $\frac{1}{35.5}$ mole of chlorine will release energy

$= \frac{1}{35.5} \times 3.7 \times 23.06$ kcal $= 2.4$ kcal

48. **(b)** Correct order of increasing basic strength is $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$

49. **(a)** Due to stable $2s^2\ 2p^3$ configuration (half filled *p*-orbital). Nitrogen atom has highest energy.

50. **(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

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

51. **(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.

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

Note: On moving down in 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.

53. **(b)** The correct order of ionisation enthalpies is

$$F > P > S > B$$

Note: On moving along a period ionization enthalapy increases from left to right and decreases from top to bottom in a group. But this trend breaks up in case of such element having fully or half filled stable orbitals.

In this case, P has a stable half filled electronic configuration, hence its ionisation enthalapy is greater in comparision to S. Therefore the correct order is

$$B < S < P < F.$$

54. **(a)** CaO is basic as it forms strong base $Ca(OH)_2$ on reaction with water.

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

CO_2 is acidic as it dissolves 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.

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

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

55. **(c)** In a period the value of ionisation potential increases from left to right with breaks where the atoms have somewhat stable configuration. In the given list N has half-filled stable orbitals. Hence N has highest ionisation energy. Thus the correct order is

$$B < C < O < N$$

and not as given in option (c)

56. **(a)** O^{2-} and F^- are isoelectronic ($10e^-$). Hence have same number of electron but different number of proton, F^- has 9 proton whereas O^{2-} has 8 proton. Therefore F^- has greater nuclear charge compared to O^{2-}. So O^{2-} will have greater ionic radius, i.e. $O^{2-} > F^-$

Further Li^+ and B^{3+} are also isoelectronic ($2e^-$) therefore, no. of proton in Li is 3 and in B is 5, So,

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

Hence, the correct order of atomic size is

$$O^{2-} > F^- > Li^+ > B^{3+}$$

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

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

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

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

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

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