3 Classification of Elements and Periodicity in Properties

1. Na^+, Mg^{2+}, Al^{3+} and Si^{4+} are isoelectronic. The order of their ionic size is
(a) $Na^+ > Mg^{2+} < Al^{3+} < Si^{4+}$
(b) $Na^+ < Mg^{2+} > Al^{3+} > Si^{4+}$
(c) $Na^+ > Mg^{2+} > Al^{3+} > Si^{4+}$
(d) $Na^+ < Mg^{2+} > Al^{3+} < Si^{4+}$

2. Consider the following changes

$A \rightarrow A \quad e^- : E_1$ and $A \rightarrow A^2 \quad e^- : E_2$

The energy required to pull out the two electrons are E_1 and E_2 respectively. The correct relationship between two energies would be
(a) $E_1 < E_2$ (b) $E_1 = E_2$
(c) $E_1 > E_2$ (d) $E_1 \geq E_2$

3. The elements with zero electron affinity are
(a) Boron and Carbon
(b) Beryllium and Helium
(c) Lithium and Sodium
(d) Fluorine and Chlorine

4. Ionization energies of atoms A and B are 400 and 300 k cal mol^{-1} respectively. The electron affinities of these atoms are 80.0 and 85.0 k cal mol^{-1} respectively. Then which is the correct statement regarding electronegativity χ ?

Tricky

(a) $\chi_A \quad \chi_B$ (b) $\chi_A \quad \chi_B$
(c) $\chi_A \quad \chi_B$ (d) none of these

5. The set of three elements having successive atomic numbers and having the ionization energies of 2372, 520 and 890 kJ per mol is
(a) H, He, Li (b) He, Li, Be
(c) Li, Be, B (d) B, C, N

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

7. In the long form of the periodic table, the valence shell electronic configuration of $5s^2 5p^4$ corresponds to the element present in :
(a) Group 16 and period 6
(b) Group 17 and period 6
(c) Group 16 and period 5
(d) Group 17 and period 5

8. Consider the following ionization enthalpies of two elements 'A' and 'B'.

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

Which of the following statements is correct ?

Toughnut

(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'.

9. Sum of first three ionization energies of Al is 53.0 eV $atom^{-1}$ and the sum of first two ionization energies of Na is 52.2 eV $atom^{-1}$. Out of Al(III) and Na(II)

Critical Thinking

(a) Na (II) is more stable than Al (III)
(b) Al (III) is more stable than Na (II)
(c) Both are equally stable
(d) Both are equally unstable

10. Which pair of elements belongs to same group ?
(a) Elements with atomic no. 17 and 38
(b) Elements with atomic no. 20 and 40
(c) Elements with atomic no. 17 and 53
(d) Elements with atomic no. 11 and 33

11. In a given energy level, the order of penetration effect of different orbitals is

(a) $f < d < p < s$ (b) $s = p = d = f$

(c) $s < p < d < f$ (d) $p > s > d > f$

12. Consider the following changes :

(1) $M(s) \longrightarrow M(g)$

(2) $M(s) \longrightarrow M^{2+}(g) + 2e^-$

(3) $M(g) \longrightarrow M^{+}(g) + e^-$

(4) $M^{+}(g) \longrightarrow M^{2+}(g) + e^-$

(5) $M(g) \longrightarrow M^{2+}(g) + 2e^-$

The second ionization energy of M could be calculated from the energy values associated with:

(a) $1 + 3 + 4$ (b) $2 - 1 + 3$

(c) $1 + 5$ (d) $5 - 3$

13. The correct order of decreasing electronegativity values among the elements I-beryllium, II-oxygen, III-nitrogen and IV-magnesium is

(a) II > III > I > IV (b) III > IV > II > I

(c) I > II > III > IV (d) I > II > IV > III

14. What is the order of ionisation energies of the coinage metal

(a) Cu > Ag < Au (b) Cu > Ag > Au

(c) Cu < Ag < Au (d) Au > Ag < Cu

15. First three ionisation energies (in kJ/mol) of three representative elements are given below :

Element	IE_1	IE_2	IE_3
P	495.8	4562	6910
Q	737.7	1451	7733
R	577.5	1817	2745

Then incorrect option is :

(a) Q : Alkaline earth metal

(b) P : Alkali metals

(c) R : *s*-block element

(d) They belong to same period

16. What is the correct order of electronegativity?

(a) $M^- < M^{2-} < M^{3-} < M^{4-}$

(b) $M^- > M^{2-} > M^{3-} > M^{4-}$

(c) $M^- < M^{2-} > M^{3-} < M^{4-}$

(d) $M^{4-} < M^{2-} < M^{3-} < M^-$

17. The chemistry of lithium is very similar to that of magnesium even though they are placed in different groups. Its reason is:

(a) Both are found together in nature

(b) Both have nearly the same size

(c) Both have similar electronic configuration

(d) The ratio of their charge and size (i.e. charge density) is nearly the same

18. Which of the following sequence correctly represents the decreasing acidic nature of oxides ?

(a) $Li_2O > BeO > B_2O_3 > CO_2 > N_2O_3$

(b) $N_2O_3 > CO_2 > B_2O_3 > BeO > Li_2O$

(c) $CO_2 > N_2O_3 > B_2O_3 > BeO > Li_2O$

(d) $B_2O_3 > CO_2 > N_2O_3 > Li_2O > BeO$

19. Correct order of first IP among following elements Be, B, C, N, O is

(a) B < Be < C < O < N

(b) B < Be < C < N < O

(c) Be < B < C < N < O

(d) Be < B < C < O < N

20. In which of the following process highest energy is absorbed?

(a) $Cu \rightarrow Cu$ (b) $Br \rightarrow Br^-$

(c) $I \rightarrow I^-$ (d) $Li \rightarrow Li$

21. The correct order of acidic strength :

(a) $Cl_2O_7 > SO_2 > P_4O_{10}$

(b) $K_2O > CaO > MgO$

(c) $CO_2 > N_2O_5 > SO_3$

(d) $Na_2O > MgO > Al_2O_3$

22. An element of atomic weight 40 has 2, 8, 8, 2 as the electronic configuration. Which one of the following statements regarding this element is not correct?

(a) it belongs to II group of the periodic table

(b) it has 20 neutrons

(c) the formula of its oxide is MO_2

(d) it belongs to 4th period of the periodic table

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

$X \rightarrow Y$

(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

24. 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-}?

(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) $N^{3-} < S^{2-} < O^{2-} < P^{3-}$

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

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

26. Elements X, Y and Z have atomic numbers 19, 37 and 55 respectively. Which of the following statements is true about them ? Toughnut

(a) Their ionization potential would increase with increasing atomic number
(b) 'Y' would have an ionisation potential between those of 'X' and 'Z'
(c) 'Z' would have the highest ionization potential
(d) 'Y' would have the highest ionization potential.

27. An element X occurs in short period having configuration $ns^2 np^1$. The formula and nature of its oxide is

(a) XO_3, basic (b) XO_3 acidic
(c) X_2O_3, amphoteric (d) X_2O_3 basic

28. The decreasing order of the ionization potential of the following elements is

(a) Ne > Cl > P > S > Al > Mg
(b) Ne > Cl > P > S > Mg > Al
(c) Ne > Cl > S > P > Mg > Al
(d) Ne > Cl > S > P > Al > Mg

29. The incorrect statement among the following is

(a) the first ionization potential of Al is less than the first ionization potential of Mg
(b) the second ionization potential of Mg is greater than the second ionization potential of Na
(c) the first ionization potential of Na is less than the first ionization potential of Mg
(d) the third ionization potential of Mg is greater than the third ionization potential of Al.

30. The screening effect of inner electrons of the nucleus causes

(a) decrease in the ionization energy
(b) increase in the ionization energy
(c) no effect on the ionization energy
(d) increases the attraction of the nucleus for the electrons

31. The order of increasing sizes of atomic radii among the elements O, S, Se and As is :

(a) As < S < O < Se (b) Se < S < As < O
(c) O < S < As < Se (d) O < S < Se < As

32. Which is the correct order of second ionization potential of C, N, O and F in the following ?

(a) O > N > F > C (b) O > F > N > C
(c) F > O > N > C (d) C > N > O > F

33. The first (Δ_iH_1) and second (Δ_iH_2) ionization enthalpies (in kJ mol^{-1}) and the electron gain enthalpy ($\Delta_{eg}H$) (in kJ mol^{-1}) of the elements I, II, III, IV and V are given below. Critical Thinking

Element	Δ_iH_1	Δ_iH_2	$\Delta_{eg}H$
I	520	7300	−60
II	419	3051	−48
III	1681	3374	−328
IV	1008	1846	−295
V	2372	5251	+48

The most reactive metal and the least reactive non-metal of these are respectively

(a) I and V (b) V and II
(c) II and V (d) IV and V

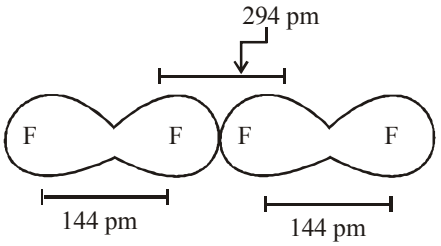
34. Aqueous solutions of two compounds $M_1 - O - H$ and $M_2 - O - H$ are prepared in two different beakers. If, the electronegativity of $M_1 = 3.4$, $M_2 = 1.2$, O = 3.5 and H= 2.1 then the nature of two solutions will be respectively :

(a) acidic, basic (b) acidic, acidic
(c) basic, acidic (d) basic, basic

35. An element having electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$ forms

(a) Acidic oxide (b) Basic oxide
(c) Amphoteric oxide (d) Neutral oxide

36. The van der Waal and covalent radii of fluorine atom respectively from the following figure are. Tricky



(a) 219 pm, 72 pm (b) 75 pm, 72 pm
(c) 147 pm, 72 pm (d) 147 pm, 144 pm

37. Consider the following four elements, which are represented according to long form of periodic table.

Here W, Y and Z are left, up and right elements with respect to the element 'X' and 'X' belongs to 16th group and 3rd period. Then according to given information the incorrect statement regarding given elements is: Toughnut

(a) Maximum electronegativity : Y
(b) Maximum catenation property : X
(c) Maximum electron affinity : Z
(d) Y exhibits variable covalency

38. The electron affinity of chlorine is 3.7 eV. 1 g 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

Critical Thinking

(a) 4.8 kcal (b) 7.2 kcal
(c) 8.2 kcal (d) 2.4 kcal

39. In which of the following arrangements, the sequence is not strictly according to the property written against it?
(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.

40. Which among the following elements has the highest first ionization enthalpy?
(a) Nitrogen (b) Boron
(c) Carbon (d) Oxygen

41. Which of the following is not the correct order for the stated property ?
(a) Ba > Sr > Mg; atomic radius
(b) F > O > N : first ionization enthalpy
(c) Cl > F > I; electron affinity
(d) O > Se > Te; electronegativity

42. The increasing order of electron affinity of N, P and As is Toughnut

(a) N < P < As (b) As < P < N
(c) As < N < P (d) As < N > P

43. Which of the following ionisation energy values for calcium show a sudden increase?
(a) Third (b) Second
(c) First (d) Fourth

44. The electronegativity follows the order
(a) F > O > Cl > Br (b) F > Cl > Br > O
(c) O > F > Cl > Br (d) Cl > F > O > Br

45. The first ionisation potential of aluminium is smaller than that of magnesium because
(a) Atomic size of Al > Atomic size of Mg.
(b) Atomic size of Al < Atomic size of Mg.
(c) Al has one electron in *p* - orbital
(d) None of these

46. Which one of the following statements is incorrect in relation to ionisation enthalpy?
(a) Ionisation enthalpy increases for each successive electron.
(b) The greatest increase in ionisation enthalpy is experienced on removal of electron from core noble gas configuration.
(c) End of valence electrons is marked by a big jump in ionisation enthalpy.
(d) Removal of electron from orbitals bearing lower *n* value is easier than from orbital having higher *n* value.

47. Highest electron affinity is shown by
(a) O^- (b) F^- (c) Cl_2 (d) F_2

48. Which of the following order is wrong?
(a) NH_3 PH_3 AsH_3 — Acidic
(b) Li Be B C — IE_1
(c) Al_2O_3 MgO Na_2O K_2O — Basic
(d) Li Na K Cs — Ionic radius

49. The electronic configuration of an element is . The atomic number and the group number of the element '*X*' which is just below the above element in the periodic table are respectively
(a) 23 and 5 (b) 23 and 15
(c) 33 and 15 (d) 33 and 5

50. Consider the following information about element P and Q: Tricky

	Period number	Group number
P	2	15
Q	3	2

(a) QP (b) Q_2P_3 (c) Q_3P_2 (d) Q_2P

51. Which one of the following statements is incorrect ?
(a) Greater the nuclear charge, greater is the electron affinity
(b) Nitrogen has zero electron affinity
(c) Electron affinity decreases from fluorine to iodine in 17th group
(d) Chlorine has highest electron affinity

52. Which of the following statements is wrong ?

(a) van der Waal's radius of iodine is more than its covalent radius

(b) All isoelectronic ions belong to same period of the periodic table

(c) $I.E._1$ of N is higher than that of O while $I.E._2$ of O is higher than that of N

(d) The electron gain enthalpy of N is almost zero while that of P is 74.3 kJ mol^{-1}

53. Electron affinity is positive for

(a) $O(g) + e^- \rightarrow O^-(g)$

(b) $S(g) + e^- \rightarrow S^-(g)$

(c) $O^+(g) + e^- \rightarrow O(g)$

(d) $O^-(g) + e^- \rightarrow O^{2-}(g)$

54. Which one of the following ionic species has the greatest proton affinity to form stable compound?

(a) Cl^- (b) F^- (c) I^- (d) Br^-

55. Which property decreases from left to right across the periodic table and increases from top to bottom?

(i) Atomic radius (ii) Electronegativity

(iii) Ionisation energy (iv) Metallic character

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

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

56. The basic character of MgO, BaO, Na_2O and FeO follow the order

(a) $MgO < FeO < BaO < Na_2O$

(b) $FeO < MgO < Na_2O < BaO$

(c) $FeO < MgO < BaO < Na_2O$

(d) $Na_2O < MgO < FeO < BaO$

57. If the ionization enthalpy and electron gain enthalpy of an element are 275 and 86 kcal mol^{-1} respectively, then the electronegativity of the element on the Pauling scale is: Tricky

(a) 2.8 (b) 0.0 (c) 4.0 (d) 2.6

58. Which transition involves maximum amount of energy ?

(a) $M^-(g) \longrightarrow M(g)\ e^-$

(b) $M^-(g) \longrightarrow M^+(g)\ 2e^-$

(c) $M\ (g) \longrightarrow M^2\ (g)\ e^-$

(d) $M^2\ (g) \longrightarrow M^3\ (g)\ e^-$

59. Which ionisation potential *(IP)* in the following equations involves the greatest amount of energy ?

(a) $Na \rightarrow Na^+\ e^-$ (b) $K \rightarrow K^2\ e^-$

(c) $C^2 \rightarrow C^3\ e^-$ (d) $Ca \rightarrow Ca^2\ e^-$

60. Consider the following ionisation reactions :

I.E. ($kJ\ mol^{-1}$) I.E. ($kJ\ mol^{-1}$)

$A(g) \rightarrow A^+(g) + e^-, A_1$ $A(g) \rightarrow A^+(g) + e^-, A_1$

$B^+(g) \rightarrow B^{2+}(g) + e^-, B_2C(g) \rightarrow C^+(g) + e^-, C_1$

$C^+(g) \rightarrow C^{2+}(g) + e^-, C_1C^{2+}(g) \rightarrow C^{3+}(g) + e^-, C_3$

If monovalent positive ion of A, divalent positive ion of B and trivalent positive ion of C have zero electron. Then incorrect order of corresponding I.E. is : Toughnut

(a) $C_3 > B_2 > A_1$ (b) $B_1 > A_1 > C_1$

(c) $C_3 > C_2 > B_2$ (d) $B_2 > C_3 > A_1$

Answer KEY

1	(c)	**7**	(c)	**13**	(a)	**19**	(a)	**25**	(a)	**31**	(d)	**37**	(d)	**43**	(a)	**49**	(c)	**55**	(d)
2	(a)	**8**	(c)	**14**	(a)	**20**	(a)	**26**	(b)	**32**	(b)	**38**	(d)	**44**	(a)	**50**	(c)	**56**	(c)
3	(b)	**9**	(b)	**15**	(c)	**21**	(a)	**27**	(c)	**33**	(c)	**39**	(b)	**45**	(c)	**51**	(c)	**57**	(a)
4	(b)	**10**	(c)	**16**	(b)	**22**	(c)	**28**	(b)	**34**	(a)	**40**	(a)	**46**	(d)	**52**	(b)	**58**	(d)
5	(b)	**11**	(a)	**17**	(d)	**23**	(c)	**29**	(b)	**35**	(b)	**41**	(b)	**47**	(a)	**53**	(d)	**59**	(b)
6	(a)	**12**	(d)	**18**	(b)	**24**	(a)	**30**	(a)	**36**	(c)	**42**	(c)	**48**	(b)	**54**	(b)	**60**	(d)

Hints & Solutions

1. **(c)** Among the isoelectronic species, the cation having more positive charge would be the smaller in size.

2. **(a)** IE_1 is always less than IE_2.

3. **(b)** Fully filled electronic configuration.

4. **(b)** Electronegativity of an atom $\frac{IE \quad EA}{2 \times 62.5}$

where IE and EA are in k cal mol^{-1}.

5. **(b)** He (Z = 2) is a noble gas and has highest I.E. The I.E. of Be (Z = 4) is more than that of Li (Z = 3)

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. **(c)** Tellurium (Te) has $5s^25p^4$ valence shell configuration. It belongs to group 16 and present in period 5 of the periodic table.

8. **(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 Cs = 374 $kJmol^{-1}$), 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*.

9. **(b)** Ionization energy is not the only the criteria for the stability of an oxidation state.

10. **(c)** Atomic no. 17 (Cl) and 53 (I) are present in the same group

11. **(a)** Penetration effect order is $s > p > d > f$.

12. **(d)** Second ionization energy is amount of energy required to take out an electron from the monopositive cation.

13. **(a)** Electronegativity values of given elements are as follows:

Be – 1.5 (I) Mg – 1.2 (IV)

O – 3.5 (II) N – 3.0 (III)

i.e. II > III > I > IV

14. **(a)** $Cu = 3d^{10}4s^1$, $Ag = 4d^{10}5s^1$, $Au = 4f^{14}5d^{10}6s^1$

In all the above given cases, unpaired *s*-electron has to be removed. In the case of Cu, a 4*s* electron is to be removed which is closer to the nucleus than the 5*s* electron of Ag.

So, IE_1 of Cu > IE_1 of Ag.

However, in case of Au, due to imperfect screening effect of 14 e^-*s* of 4*f* orbitals, the nuclear charge increases and therefore 5*s* e^- of Au is more tightly held.

Thus, the order of IE_1 is Cu > Ag < Au.

15. **(c)** R is *p*-block element, because difference between IE_2 and IE_3 is not very high as compared to between IE_1 and IE_2; hence stable oxidation state of R will be higher than +2.

16. **(b)** Higher the positive charge the greater is the EN and higher the negative charge the lesser is the EN. So, EN order is

$M^- > M^{2-} > M^{3-} > M^{4-}$

17. **(d)** Due to diagonal relationship.

18. **(b)** On passing from left to right in a period, acidic character of the normal oxides of the elements increases with increase in electronegativity.

19. **(a)** Be – $1s^22s^2$; B – $1s^22s^22p^1$; C – $1s^22s^22p^2$; N – $1s^22s^22p^3$; O – $1s^22s^22p^4$. IP increases along the period. But IP of Be > B. Further IP of O < N because atoms with fully or partly filled orbitals are most stable and hence have high ionisation energy.

20. **(a)** Cu has completely filled *d*-orbital, so highest energy is absorbed when it converts to Cu^+ ion.

21. **(a)** Acidic character of oxide Non-metallic nature of element.

Non-metallic character increases along the period. Hence order of acidic character is

$Cl_2O_7 > SO_2 > P_4O_{10}$.

22. (c) Its valency is 2. So it will form MO type compound.

23. (c) On moving down a group atomic radii increases.

24. (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 $O^{2-} < N^{3-} < S^{2-} < P^{3-}$

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

26. (b) Elements X, Y, Z with atomic numbers 19, 37, 55 lie in group 1 (alkali metals). On moving down a group from the size of atoms increases, the outermost electrons become less strongly held. So the ionization energy decreases. Therefore, IE of Y could be between those of X and Z.

	X	Y	Z
	K (19)	Rb (37)	Cs (55)
I.E.	4.3	4.2	3.9

27. (c) $ns^2\,np^1$ is the electronic configuration of III A period. Al_2O_3 is amphoteric oxide

28. (b) Closed shell (Ne), half filled (P) and completely filled configuration (Mg) are the cause of higher value of I.E.

29. (b) IE_2 of Mg is lower than that of Na because in case of Mg^+, 3*s*-electron has to be removed where as in case of Na^+, an electron is removed from the stable inert gas configuration which is difficult.

30. (a) Higher the screening effect, lower is the I.E.

31. (d) On moving down in a group atomic radii increases due to successive addition of extra shell hence

O < S < Se

Further As is in group 15 having one less electron in its *p* orbital hence have higher atomic radii than group 16 elements.

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

32. (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 O > F > N > C

33. (c) I represents Li, II represents K
III represents Br, IV represents I
V represents He
So, amongst these, II represents most reactive metal and V represents least reactive non-metal.

34. (a) The electronegativity difference between M_1 and O is 0.1, which indicates M_1– O bond will be covalent, since O–H bond having more ionic character thus bond will break and H^+ ions gets release and acidic solution is formed and whereas difference between electronegativity of M_2O is 2.3, thus, M_2–OH bond will break. Hence, solution will be basic in nature.

35. (b) It is electronic configuration of alkali metal. Hence it will form basic oxide.

36. (c) Covalent radius is radius of an atom in its bound state i.e., in fluorine it is half of distance between two covalently bonded fluorine atoms; van der Waal radii is one-half of the distance between the nuclei of two identical non-bonded isolated atoms. These atoms are attracted toward each other through weak van der Waal's force hence van der Waal radii are very large.

37. (d)

W : Phosphorus	Y : Oxygen	X : Sulphur	Z : Chlorine
Electronegativity	O > Cl > S > P	Catenation :	S > P > O > Cl
Electron Affinity :	Cl > O > S > P	Oxygen exhibits covalency of two only	

38. (d) Number of moles $\frac{1}{35.5}$

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

3.7 eV = 3.7 × 23.06 kcal mol^{-1}

i.e. 1 mole realease energy

= 3.7 × 23.06 kcal

$\therefore$ Energy released

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

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

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

41. **(b)** On moving along the period, ionization enthalpy increases.
In second period, the order of ionization enthalpy should be as follows : F > O > N
But N has half-filled structure, therefore, it is more stable than O. That's why its ionization enthalpy is higher than O. Thus, the correct order of IE is
F > N > O.

42. **(c)** Phosphorus has vacant '*d*'-orbitals due to which it has higher electron affinity than nitrogen. As also has vacant *d*-orbitals but its atomic size is very big thus its electron affinity will be lesser than N.

43. **(a)** $Ca = 3s^2\ 3p^6\ 4s^2$
$Ca^{2+} = 3s^2\ 3p^6\ 4s^0$
(Stable noble gas configuration)
Hence, there would be sudden increase in IE_3 value.

44. **(a)** F and O belong to 2nd period whereas Cl and Br belong to 3rd and 4th periods respectively. Hence the sequence of the E.N. is F > O > Cl > Br

45. **(c)** Al ($3s^2\ p^1$) and Mg ($3s^2$). Lower energy is required to remove $3p^1$ electron than $3s^1$ electron (penetrating effect is $s > p > d > f$). Secondly Mg has stable electronic configuration than Al

46. **(d)** As the value of *n* increases, the nuclear attraction over the outermost shell decreases, therefore removal of an electron will be easier.

47. **(a)** Due to inert gas configuration molecules F_2, Cl_2 and anion F^- have almost zero electron affinity.

48. **(b)** The right sequence of $I.E_1$ of Li < B < Be < C.

49. **(c)** Atomic number of the given element = 15 ; atomic number of element 'X' will be
18 + 15 = 33;
group no. of 'X' = 10 + 5 (valence electrons) = 15 , period = 4^{th}

50. **(c)** P is a trivalent non-metal and Q is a divalent metal.
Hence formula of compound is Q_3P_2.

51. **(c)** Electron affinity of ^9F is less than that of ^{17}Cl

52. **(b)** In the isoelectronic species, all isoelectronic anions belong to the same period and cations to the next period.

53. **(d)** O^- ion repel the incoming electron thus energy is required to add incoming electron.

54. **(b)** Proton affinity decreases in moving across the period from left to right due to increase in charge, within a group the proton affinities decreases from top to bottom.

55. **(d)** Atomic radius and metallic character decreases from left to right across the period and increases from top to bottom down the group.

56. **(c)** The basic character of metal oxides decreases from left to right in a period and increases down the group.

57. **(a)** I.E. + E.A. = 275 + 86 = 361 kcal mol^{-1}
$= 361 \times 4.184 = 1510.42\ kJ\ mol^{-1}$

$$\therefore \text{ Electronegativity} = \frac{1510.42}{540}$$

$= 2.797 = 2.8$

58. **(d)** The energy involved is ionisation energy (I.E.). Further the 3rd ionisation energy will be greater than the 2nd and 1st.

59. **(b)** $K^+ \rightarrow K^2\ \ e^-$. Since e^- is to be removed from stable configuration.

60. **(d)** $A \Rightarrow H(1s^1)$
$B \Rightarrow He(1s^2)$
$C \Rightarrow Li(1s^2 2s^1)$

$A_1 = IE_1(A)$	$B_2 = IE_2(B)$
$B_1 = IE_1(B)$	$C_2 = IE_2(C)$
$C_1 = IE_1(C)$	$C_3 = IE_3(C)$
$B_1 > A_1 > C_1$	$C_3 > B_2 > A_1$
He > H > Li	Li^{2+} He^+ H
$1s^2$ $1s^1$ $2s^1$	$1s^1$ $1s^1$ $1s^1$
$C_3 > C_2 > B_2$	Li^{2+} Li^+ He^+
$1s^2$ $1s^2$ $1s^1$	