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Time : 6 Hour | STD 11 Science Chemistry | Total Marks : 200

kd 90+ ch-3 classification of elements and periodicity in properties

* **Choose The Right Answer From The Given Options.[1 Marks Each]** **[74]**

1. Which of the following elements will gain one electron more readily in comparison to other elements of their group?

(A) S(g) (B) Na(g) (C) O(g) (D) Cl(g)

Ans. :

a. S(g)

d. Cl(g)

Explanation:

For many elements energy is released when an electron is added to the atom and the electron gain enthalpy is negative.

For example: Group 17 elements (the halogens) have very high negative electron gain enthalpies because they can attain stable noble gas electronic configurations by picking up an electron.

2. Compound of a metal 'M' is M_2O_3. The formula of its nitride will be-

(A) M_3N (B) MN (C) M_3N_2 (D) M_2N_3

Ans. :

b. MN

Explanation:

Compound of a metal M formed M_2O_3. It represent that M have 3 valency electrons.

So the nitride formed will be MN.

3. The electronegativities of C, N, Si and Pare in order of:

(A) Si < P < C < N (B) Si < P < N < C

(C) P < Si < N < C (D) P < Si < C < N

Ans. :

a. Si < P < C < N

Explanation:

Si is largest in size, 'N' is smallest in size.

As the atomic size decreases, electronegativity increases.

4. An element belongs to 3rd period and group-13 of the periodic table. Which of the following properties will be shown by the element?

(A) Good conductor of electricity. (B) Liquid, metallic.

(C) Solid, metallic. (D) Solid, non metallic.

Ans. :

a. Good conductor of electricity.

c. Solid, metallic.

Explanation:

Group-13 third period element is Aluminum which is a metal. It is solid metallic and a good conductor of electricity.

5. Which of the following pairs show reverse properties on moving along a period from left to right and from top to bottom in a group?

(A) Atomic radius and electron gain enthalpy (negative value).

(B) Nuclear charge and ionisation enthalpy.

(C) Ionisation enthalpy and electron gain enthalpy (negative value).

(D) None of the above.

Ans. :

a. Atomic radius and electron gain enthalpy (negative value).

Explanation:

Atomic radius decreases from left to right in a period and increases from top to bottom in a group.

Similarly, the negative value of electron gain enthalpy decreases in a period and increases in a group.

So Atomic radius and electron gain enthalpy show reverse properties on moving along a period from left to right and in the group from top to bottom.

6. Which of the following compounds is/ are amphoteric in nature?

(A) Cl_2O_7 (B) Al_2O_3

(C) As_2O_3 (D) Both (b) and (c).

Ans. :

d. Both (b) and (c).

Explanation:

Al_2O_3 and As_2O_3 are amphoteric in nature.

Amphoteric oxides behave as acidic with bases and basic with acids.

7. Which of the following decreases in going down the halogen group?

(A) Ionic radius (B) Atomic radius

(C) Ionisation potential (D) Boiling point

Ans. :

c. Ionisation potential

Explanation:

On moving down the halogen group, the atomic radius, ionic radius and the boiling point increases with an increase in the atomic number. However, ionisation potential decreases. The effect of an increase in the atomic size and the shielding effect is much more than the effect of the increase in nuclear charge.

Hence, the electron becomes less and less firmly held to the nucleus on moving down the group. Hence, the ionization potential gradually decreases on moving down the group.

8. The oxide formed by the element on extreme right and in the left of periodic table are generally:

(A) Acidic, amphoteric respectively. (B) Acidic, basic respectively.

(C) Neutral, amphoteric respectively. (D) Basic, neutral respectively.

Ans. :

b. Acidic, basic respectively.

9. I.P. of sodium is 5.14 eV then I.P. of potassium will be:

(A) Equal to sodium (B) 5.68 eV

(C) 4.34 eV (D) 10.28 eV

Ans. :

c. 4.34 eV

Explanation:

I.P. of sodium is 5.14 eV then I.P. of potassium will be 4.34 eV. On moving down a group, the ionization potential decreases.

Hence, the ionization potential of potassium should be lower than the ionization potential of sodium.

10. The alkaline earth metal which shows properties similar to aluminium is:

(A) Ca (B) Be (C) Sr (D) Ba

Ans. :

b. Be

Explanation:

Beryllium and aluminum shows diagonal relationship with each other.

Hence, they exhibit similar properties.

11. A solution of $CuSO_4$ was kept in an iron pot. After few days the iron pot was found to have a number of holes in it. The balance equation of the reaction involve is:

(A) $2Fe + CuSO_4 \rightarrow Fe_2(SO_4)_3 + Cu$ (B) $Fe + CuSO_4 \rightarrow FeSO_4 + Cu$

(C) $3Fe + CuSO_4 \rightarrow Fe_3(SO_4)_4 + Cu$ (D) $Fe + CuSO_4 \rightarrow Fe_2SO_4 + Cu$

Ans. :

b. $Fe + CuSO_4 \rightarrow FeSO_4 + Cu$

12. The electronic configuration of gadolinium (Atomic number 64)

(A) $\left[Xe\right]\ 4f^3\ 5d^5\ 6s^2$ (B) $\left[Xe\right]\ 4f^7\ 5d^2\ 6s^1$

(C) $\left[Xe\right]\ 4f^7\ 5d^1\ 6s^2$ (D) $\left[Xe\right]\ 4f^8\ 5d^6\ 6s^2$

Ans. :

c. $\left[Xe\right]\ 4f^7\ 5d^1\ 6s^2$

Explanation:

The electronic configuration of La (Z = 57) is [Xe] 5dl $6s^2$. Therefore, further addition of electrons occurs in the lower energy 4f-orbital till it is exactly half-filled at Eu (Z = 63) Thus, the electronic configuration of Eu is [Xe] $4f^7$ $6s^2$. Thereafter, addition of next electron does not occur in the more stable exactly half-filled $4f^7$ shell but occurs in the little higher energy 5d-orbital. Thus, the electronic configuration of Gd (Z = 64) is $\left[Xe\right]\ 4f^7\ 5d^1\ 6s^2$

13. The first ionisation enthalpies of Na, Mg, Al and Si are in the order:

(A) Na < mg > Al < Si (B) Na > mg > Al > Si

(C) Na < Mg < Al < Si (D) Na > mg > Al < Si

Ans. :

a. Na < mg > Al < Si

Explanation:

The electronic configurations are as follows:

$_{1}1Na(3s)^{1}$, $_{1}2Mg(3s)^{2}$, $_{1}3AI(3s)^{2}(3p)^{1}$, $_{1}4Si(3s)^{2}(3p)^{2}$

The ionization energy of Mg will be larger than that of Na due to fully filled configuration $(3s)^2$

The ionization of Al will be smaller than that of Mg due to one electron extra than the stable configuration but smaller than Si due to increase in effective nuclear charge of Si.

⇒ Na < Mg > Al < Si

14. Alkaline earth (group 2 or IIA elements) differ from group 12 (or IIB) elements in the electronic configuration of their:

(A) Anitipenultimate shell (B) Innermost shell

(C) Outermost shell (D) Penultimate shell

Ans. :

d. Penultimate shell

Explanation:

Electronic configuration Alkaline earth (group 2 or IIA elements) is ns^2

Electronic configuration group 12 (or IIB) elements is $ns^2,(n-1)d^{10}$,

so these twogroups differ in their electronic configaration of penultimate shell.

15. IE of an element does not depend on:

(A) Its nuclear charge (B) The shielding effect

(C) Electron neutrality (D) Penetration effect

Ans. :

c. Electron neutrality

Explanation:

Factors affecting ionisation potential,

Atomic size: Larger the atomic size, smaller is the Ionisation Potential. It is due to that the size of atom increases the outermost electrons farther away from the nucleus and nucleus loses the attraction on that electrons and hence can be easily removed.

Effective nuclear charge (Z eff): Ionisation potential increases with the increase in nuclear charge between outermost electrons and nucleus.

Screening effect: Higher is the screening effect on the outer electrons causes less attraction from the nucleus and can be easily removed, which is leading to the lower value of Ionisation potential.

Penetration power of subshells and stability of half-filled and fully filled orbitals.

16. The element with positive electron gain enthalpy is:

(A) Hydrogen. (B) Sodium. (C) Oxygen. (D) Neon.

Ans. :

d. Neon.

Explanation:

It has positive electron enthalpy due to stable electron gain enthalpy, there is repulsion between electron to be added and valence electrons.

17. The polarizing power of the following anions N^{3-}, O^{2-} and F^{-}, follow the order.

(A) $N^{3-} < F^{-} < O^{2-}$ (B) $O^{2-} < N^{3-} < F^{-}$

(C) $O^{2-} < F^{-} < N^{3-}$ (D) $N^{3-} > O^{2-} > F^{-}$

Ans. :

d. $N^{3-} > O^{2-} > F^{-}$

Explanation:

Larger the anion, more will be the polarizing power.

18. Which one of the following is correct order of electron gain enthalpy?

(A) S < O < Cl < F (B) Cl < F < S < O

(C) F < Cl < O < S (D) O < S < F < Cl

Ans. :

d. O < S < F < Cl

Explanation:

Oxygen and fluorine has exceptionally small size, therefore more interelectronic repulsion that is why have lower electron gain enthalpy than S and Cl respectively.

19. The property which regularly increases down the group in the periodic table is:

(A) Ionisation energy (B) Electronegativity

(C) Reducing nature (D) Electron affinity

Ans. :

c. Reducing nature

Explanation:

The metallic character is used to define the chemical property that metallic elements present. Generally, metals tend to lose electrons to form cations. Nonmetals tend to gain electrons to form anions.

They also have a high oxidation potential therefore they are easily oxidized and are strong reducng agents.

Thus the property which regularly increases down the group in the periodic table is Reducing nature.

20. Who developed the long form of the periodic table?

(A) Niels Bohr. (B) Moseley.

(C) Mendeleef. (D) Lothar Meyer.

Ans. :

a. Niels Bohr.

21. Arrange Be, Ca, Ba, Ra in increasing order of ionisation energy:

(A) Be < Ra < Ca < Ba (B) Ba < Ca < Ra < Be

(C) Ra < Ba < Ca < Be (D) Ba < Ra < Ca < Be

Ans. :

c. Ra < Ba < Ca < Be

Explanation:

Atomic number of Beryllium - 4

Atomic number of Calcium - 20

Atomic number of Barium - 56

Atomic number of Radium – 88

From the atomic numbers, we can easily say that Beryllium is the starting element in II A group and Radium is the last element in II A group.

We know that as we are moving from top to bottom in the periodic table the atomic size of the atoms increases.

So, the increasing order of ionization energy of given elements is as follows.

Ra < Ba < Ca < Be.

22. Which is incorrect configuration for s-block elements?

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

(C) Both A and B (D) None of these

Ans. :

c. Both A and B

Explanation:

$[Ar]3d^{10}4s^2$ - Last filling electron is in 3d.

$[Ar]3d^{10}4s^1$ - Last filling electron is in 3d.

Thus, both are d-block element.

$[Ar]4s^{1-2}$ is a configuration of s-block.

23. In which of the following, which of the following is incorrect:

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

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

(C) Al < Mg < Na < F increasing ionic size)

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

Ans. :

a. I < Br < Cl < F (increasing electron gain enthalpy)

Explanation:

It is incorrect because 'F' has lower electron gain enthalpy than Cl.

24. General outer electronic configuration of d-block elements is:

(A) $(n - 1)d^{1-10}\ ns^3$ (B) $(n + 1)d^{1-10}\ ns^{0-2}$

(C) $(n - 1)d^{1-10}\ ns^{0-2}$ (D) $(n - 1)d^0\ ns^{0-2}$

Ans. :

c. $(n - 1)d^{1-10}\ ns^{0-2}$

Explanation:

d-block elements are elements of group 3 to 12 in the centre of the periodic table.

So, general outer electronic configuration = $(n - 1)d^{1-10}\ ns^{0-2}$.

25. The correct order of electronegativity of Na, O and F is:

(A) Na > O > F (B) O > F > Na

(C) O > Na > F (D) F > O > Na

Ans. :

d. F > O > Na

Explanation:

The order of EN of Na, O and F is F > O > Na.

26. Considering the elements F, Cl, O and N the correct order of their chemical reactivity in terms of oxidizing property is:

(A) F>Cl>O>N (B) F>O>Cl>N (C) Cl>F>O>N (D) O>F>N>Cl

Ans. :

b. F>O>Cl>N

Considering the elements F, Cl, O and N, the correct order of their chemical reactivity in terms of oxidizing property is F>O>Cl>N.

N, O and F are present in the same period. On moving from left to right in a period, the oxidizing power generally increases.

F and Cl are present in the same group.

On moving from top to bottom in a group, the oxidizing power generally decreases.

Oxidizing property of O is more than Cl.

27. In the P^{3-}, S^{2-} and Cl^{-} ions, the increasing order of size is:

(A) Cl^{-}, S^{2-}, P^{3-} (B) P^{3-}, S^{2-}, Cl^{-}

(C) S^{2-}, Cl^{-}, P^{3-} (D) S^{2-}, P^{3-}, Cl^{-}

Ans. :

a. Cl^{-}, S^{2-}, P^{3-}

Explanation:

In Isoelectronic species, higher the nuclear charge, smaller the size.

28. The properties of _____ were predicted by Mendeleev before their isolation.

(A) Co and Ni

(B) I and Te

(C) Sc, Ga and Ge

(D) Cl, Ar and K

Ans. :

c. Sc, Ga and Ge

Explanation:

Mendeleev has the foresight to leave some gaps in the periodic table for 3 elements and these elements are discovered later and included in the table.

Those three elements are:

Eka-boron is presently known as scandium (Sc).

Eka-silicon is presently known as germanium (Ge).

Eka-aluminium is presently known as gallium(Ga).

29. Which one of the following arrangement represents the correct order of electron gain enthalpy of the given atomic species?

(A) Cl < F < S < O (B) S < O < F < Cl

(C) S < O < Cl < F (D) F < Cl < O < S

Ans. :

b. S < O < F < Cl

30. Which of the following sets contain only isoelectronic ions?

(A) Zn^{2+}, Ca^{2+}, Ga^{3+}, Al^{3+}

(B) K^+, Ca^{2+}, Sc^{3+}, Cl^-

(C) P^{3-}, S^{2-}, Cl^-, K^+

(D) Ti^{4+}, Ar, Cr^{3+}, V^{5+}

Ans. :

b. K^+, Ca^{2+}, Sc^{3+}, Cl^-

c. P^{3-}, S^{2-}, Cl^-, K^+

Explanation:

a. Zn^{2+} (30 - 2 = 28), Ca^{2+} (20 - 2 = 18), Ga^{3+} (31- 3 = 28), Al^{3+} (13 - 3 = 10) are not isoelectronic.

b. K^+ (19 - 1 = 18), Ca^{2+} (20 - 2 = 18), Sc^{3+}(21 - 3 = 18), Cl^- (17 + 1 = 18) are isoelectronic.

c. P^{3-} (15 + 3 = 18), S^{2-} (16 + 2 = 18), Cl^- (17 + 1 = 18), K^+ (19 - 1 = 18) are isoelectronic.

d. Ti^{4+} (22 - 4 = 18), Ar (18), Cr^{3+} (24 - 3 = 21), V^{5+} (23 - 5 = 18) are not isoelectronic.

31. The 100th element is named in honor of:

(A) Einstein (B) Bohr (C) Fermi (D) Curie

Ans. :

c. Fermi

Explanation:

The 100th element is 'Fermium'.

It is named in honor of Scientist Fermi.

32. Arrange the following elements in order of their increasing ionization energies O, S, Se, Te, Po.

(A) Se, Te, S, Po, O

(B) O, S, Se, Te, Po

(C) Po, Te, Se, S, O

(D) Te, O, S, Po, Se

Ans. :

c. Po, Te, Se, S, O

Explanation:

Ionization energy decreases from top to bottom in a group due to increase in the size of atom.Due to increase in size of atom its ionization energy decreases from top to bottom,

So increasing order will be Po<Te<Se<S<O.

33. Which of the following is the correct order of size of the given species:

(A) $I > I^- > I^+$

(B) $I^+ > I^- > I$

(C) $I > I^+ > I^-$

(D) $I^- > I > I^+$

Ans. :

d. $I^- > I > I^+$

Explanation:

Anion is bigger than the parent atom and cation is smaller than the parent atom.

Thus, $I^- > I > I^+$

34. In Mendeleev's periodic table, gaps were left for the elements to be discovered later. Which of the following elements found a place in the periodic table later?

(A) Germanium (B) Chlorine

(C) Oxygen (D) Silicon

Ans. :

a. Germanium

Explanation:

Chlorine, oxygen and silicon were included in Mendeleev's periodic table. Germanium was discovered later which fit into the empty spaces left by Mendeleev and matched to the expected properties.

35. Which group of elements does not show diagonal relationship?

(A) Li, Mg (B) Be, Al (C) B, Si (D) C, P

Ans. :

d. C, P

Explanation:

In addition to horizontal and vertical trends, there is a diagonal relationship between elements such as Li and Mg, Be and Al, B and Si.

A diagonal relationship is said to exist between certain pairs of diagonally adjacent elements in the second and third periods of the periodic table.

But C,P doesn't show diagonal relationship.

36. Anomalous pair among the following is:

(A) Boron - silicon (B) Aluminium - nickel

(C) Beryllium - indium (D) Cobalt - nickel

Ans. :

d. Cobalt - nickel

Explanaion:

Introduction to Mendeleev's Periodic table:

The pair of the element in the periodic table where the element occurring before has more atomic mass than the later occurring one. It is also considered to be a drawback of Mendeleev's periodic table.

Reasons of anomalous:

The size of an atom is less

Electronegativity is very high as a result ionization enthalpy increases.

The charge to radius ratio is large.

The below image shows the anomalous pairs of elements in Mendeleev's periodic table;

Discrepancies in Mendeleev's periodic table Chemistry, knowledgeuniverseonline.com

37. Electronic configurations of four elements A, B, C and D are given below:

A. $1s^2\ 2s^2\ 2p^6$ B. $1s^2\ 2s^2\ 2p^4$ C. $1s^2\ 2s^2\ 2p^6\ 3s^1$ D. $1s^2\ 2s^2\ 2p^5$

Which of the following is the correct order of increasing tendency to gain electron:

(A) A < C < B < D

(B) A < B < C < D

(C) D < B < C < A

(D) D < A < B < C

Ans. :

a. $1s^2\ 2s^2\ 2p^6$

Explanation:

A – $1s^2\ 2s^2\ 2p^6$ – Noble gas configuration.

B – $1s^2\ 2s^2\ 2p^4$ – 2 electrons short of stable configuration.

C – $1s^2\ 2s^2\ 2p^6\ 3s^1$ – Requires one electron to complete 5-orbital.

D – $1s^2\ 2s^2\ 2p^5$ – Requires one electron to attain noble gas configuration.

Noble gases have no tendency to gain electrons since all their orbitals are completely filled. Thus, element A has the least electron gain enthalpy.

Since element D has one electron less and element B has two electrons less than the corresponding noble gas configuration, hence, element D has the highest electron gain enthalpy followed by element B.

Since, element C has one electron in the 5-orbital and hence needs one more electron to complete it, therefore, electron gain enthalpy of C is less than that of element B. Combining all the facts given above, the electron gain enthalpies of the four elements increase in the order A < C < B < D.

38. Which of the following statements is incorrect?

(A) Mendeleev's arranged elements in horizontal rows and vertical columns.

(B) Mendeleev's arranged elements in order of their increasing atomic number.

(C) Mendeleev's system of classifying elements was more elaborate than that of Lother Meyer.

(D) None of the above.

Ans. :

b. Mendeleev's arranged elements in order of their increasing atomic number.

Explanation:

Mendeleev arranged elements in horizontal rows and vertical columns of table in the order of their increasing atomic weights.

39. The order of screening effect of electrons of s, p, d and f orbitals of a given shell of an atom on its outer shell electrons is:

(A) s > p > d > f

(B) f > d > p > s

(C) p < d < s > f

(D) f > p > s > d

Ans. :

a. s > p > d > f

Explanation:

The effective nuclear charge experienced by a valence electron in an atom will be less than the actural charge on the nucleus because of "Shielding" or "Screening" of the valence electron from the nucleus by the intervening core electrons.

For Example: The 2s electron in lithium is shielded from the nucleus by the inner of 1s electrons.

40. Which elements is expected to have lowest ionization enthalpy?

(A) Sr (B) As (C) Xe (D) S

Ans. :

a. Sr

Explanation:

It has largest atomic size.

41. The horizontal rows and the vertical columns in the periodic table are termed as respectively?

(A) Periods, groups. (B) Groups, periods.

(C) Series, periods. (D) Family, periods.

Ans. :

a. Periods, groups.

Explanation:

The horizontal rows (which Mendeleev's called series) are called periods and the vertical columns, groups.

42. Which important property did Mendeleev use to classify the elements in his periodic table?

(A) Atomic weight. (B) Atomic number.

(C) Melting point. (D) None of these.

Ans. :

a. Atomic weight.

Explanation:

Mendeleev's used atomic weight as the basis of classification of elements in the periodic table. He arranged 63 elements known at that time in the periodic table on the basis of the order of their increasing atomic weights and he placed elements with similar nature in same group.

43. In which of the following options order of arrangement does not agree with the variation of property indicated against it?

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

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

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

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

Ans. :

b. B < C < N < O (increasing first ionisation enthalpy)

c. I < Br < Cl < F (increasing electron gain enthalpy)

Explanation:

b. The ionisation enthalpy of N is higher than of O due to greater stability of half-filled electronic configuration.

c. Again in option (c), the electron gain enthalpy of F is lower than that of Cl due to small size of F.

44. Why do elements in the same group have similar physical and chemical properties?

(A) Because of same electronic configuration.

(B) Because of same number of electrons.

(C) Because of same number of protons.

(D) Because of same valence electrons.

Ans. :

d. Because of same valence electrons.

45. The symbol and name according to the IUPAC system for the element with atomic number = 120, respectively are:

(A) Ubn and unbinilium. (B) Ubn and unbiunium.

(C) Ubn and unnilbium. (D) Ubn and unnilium.

Ans. :

a. Ubn and unbinilium.

Explanation:

Atomic number (Z) = 120

IUPAC name = Unbinilium

Symbol = Ubn

46. Consider the isoelectronic species, Na^{+}, Mg^{2+}, F^{-} and O^{2-}. The correct order of increasing length of their radii is ____________.

(A) $F^{-} < O^{2-} < mg^{2+} < Na^{+}$

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

(C) $O^{2-} < F^{-} < Na^{+} < mg^{2+}$

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

Ans. : Consider the isoelectronic species, Na^{+}, Mg^{2+}, F^{-} and O^{2-}. The correct order of increasing length of their radii is $Mg^{2+} < Na^{+} < F^{-} < O^{2-}$

Explanation:

Amongst isoelectronic ions, ionic radii decrease with increase in nuclear charge.

$Mg^{2+}(12) < Na^{+}(11) < F(10) < O^{2-}(8)$

47. Recently (in Aug 2003) two new elements have been discovered with atomic number:

(A) 113, 114 (B) 114, 115 (C) 115, 116 (D) 113, 115

Ans. :

d. 113, 115

Explanation:

Two superheavy elements, elements 113 and 115, were recently synthesized through a collaborative effort between scientists from the Physical and Life Sciences Directorate at the Lawrence Livermore National Laboratory and researchers from the Joint Institute for Nuclear Research at the Flerov Laboratory for Nuclear Reactions in Dubna, Russia.

48. In general second ionisation enthalpy of an atom will be:

(A) Higher than the first ionisation enthalpy.

(B) Equal to the first ionisation enthalpy.

(C) Higher than the third ionisation enthalpy.

(D) Equal to the third ionisation enthalpy.

Ans. :

a. Higher than the first ionisation enthalpy.

49. The pair of amphoteric hydroxides is:

(A) $Al(OH)_3$, LiOH
(B) $Be(OH)_2$, $Mg(OH)_2$
(C) $B(OH)_3$, $Be(OH)_2$
(D) $Be(OH)_2$, $Zn(OH)_2$

Ans. :

d. $Be(OH)_2$, $Zn(OH)_2$

Explanation:

The pair of amphoteric hydroxides is $Be(OH)_2$, $Zn(OH)_2$.

Amphoteric oxides reacts with acids as well as bases.

Beryllium hydroxide is amphoteric in nature due to small size, high electronegativity and high ionisation energy of beryllium.

$Be(OH)_2 + 2HCl \rightarrow BeCl_2 + 2H_2O$

$Be(OH)_2 + 2NaOH \rightarrow Na_2BeO_2 + 2H_2O$

The amphoteric behaviour of zinc hydroxide is as shown.

$Zn(OH)_2 + 2HCl \rightarrow ZnCl_2 + 2H_2O$

$Zn(OH)_2 + 2NaOH \rightarrow Na_2ZnO_2 + H_2O$

50. The elements in which electrons are progressively filled in 4f-orbital are called:

(A) Actinoids.
(B) Transition elements.
(C) Lanthanoids.
(D) Halogens.

Ans. :

c. lanthanoids.

Explanation:

The sixth period (n = 6) contains 32 elements and electrons enter 6s, 4f, 5d and 6p orbitals, in the order of filling up of the 4f orbitals begins with cerium (Z = 58) and ends at lutetium (Z = 71) to give the 4f-inner transition series which is called the lanthanoid series.

51. Write the electronic configuration of the Ca^{2+} in absence of Aufbau Principle.

(A) $1s^2, 2s^2p^6, 3s^23p^6$
(B) $1s^2, 2s^22p^6, 3s^23p^34d^3$
(C) $1s^2, 2s^22p^6, 3s^23p^54d^1$
(D) None of these

Ans. :

a. $1s^2, 2s^2p^6, 3s^23p^6$

Explanation:

The Aufbau rule states that in the ground state of an atom, an electron enters the orbital with the lowest energy first and subsequent electrons are fed in the order of increasing energies.

The word 'Aufbau' in German means 'building up'. Here, it refers to the filling up of orbitals with electrons.

So the correct configuration is $1s^2, 2s^2p^6, 3s^23p^6$

52. The decreasing order of the second ionization potential of K, Ca and Ba is:

(A) K>Ca>Ba
(B) Ca>Ba>K
(C) Ba>K>Ca
(D) K>Ba>Ca

Ans. :

a. K>Ca>Ba

Explanation:

As we move down the group size increases and the electrons experience less effective nuclear charge. Due to this reason, ionization potential decreases down the group. Thus, the second ionization potential of Ca is greater than that of Ba.

The second ionization potential of K is greater than that of Ca as K acquires stable noble gas configuration after losing one electron.

53. Which of the following types of elements show variable valency?

(A) Transition elements. (B) s-block elements.

(C) f-block elements. (D) Both (a) and (c).

Ans. :

d. Both (a) and (c).

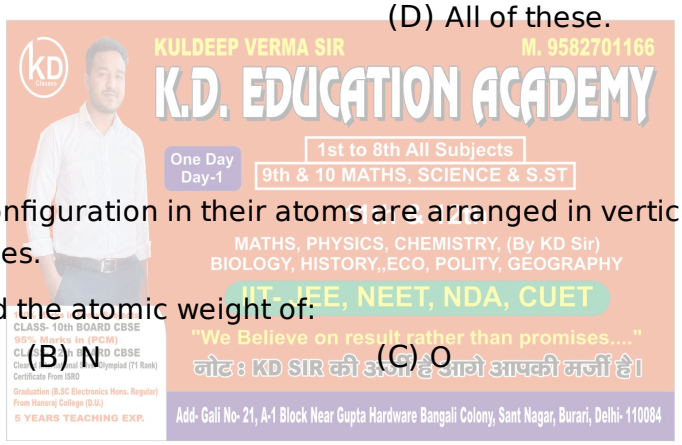
Explanation:

Variable valency is exhibited by transition elements and f-block elements.

54. Elements having similar outer shell electronic configuration in their atoms are arranged in:

(A) Groups. (B) Vertical columns.

(C) Families. (D) All of these.



Ans. :

d. All of these.

Explanation:

Similar outer configuration in their atoms are arranged in vertical columns called groups or families.

55. Mendeleev corrected the atomic weight of:

(A) Be (B) N (C) O (D) Cl

Ans. :

a. Be

Explanation:

Mendeleev's periodic table helped in correcting the atomic masses of some of the elements, based on their positions in the periodic table.

For example, the atomic mass of beryllium was corrected from 13.5 to 9.0. Atomic masses of indium, gold and platinum were also corrected.

56. Which of the following have no unit?

(A) Electronegativity. (B) Electron gain enthalpy.

(C) Lonisation enthalpy. (D) Metallic character.

Ans. :

a. Electronegativity.

d. Metallic character.

Explanation:

A qualitative measure of the ability of an atom in a chemical compound to attract shared electrons to itself is called electronegativity. Unlike ionization enthalpy and electron gain enthalpy, it is not a measureable quantity.

57. Which of the following will have the most negative and least negative electron gain enthalpy respectively, P, S, Cl and F?

(A) P and Cl. (B) S and Cl. (C) Cl and F. (D) Cl and P.

Ans. :

d. Cl and P.

58. The ionization energies from Ga to Tl do not decrease due to:

(A) Shielding effect (B) Improper shielding effect.

(C) Increase in the atomic size. (D) Decrease in the nuclear charge.

Ans. :

b. Improper shielding effect.

Explanation:

Due to poor shielding effect of d and f orbitals, which balances the effect of increase in nuclear charge down the group, resulting in unevenness in the trend.

59. The element with configuration $1s^2$, $2s^2$, $2p^6$, $3s^2$ would be:

(A) A metal (B) A non-metal

(C) A inert gas (D) A metalloid

Ans. :

c. A metal

Explanation:

Since, it has two valence electrons, it is a part of alkaline earth metals, therefore, it is a metal.

60. A neutral atom of an element has a nucleus with nuclear charge 11 times and mass 23 times that of hydrogen. Write the electronic configuration of the element?

(A) 2, 1 (B) 2, 8, 1 (C) 2, 8 (D) 2, 8, 8, 3

Ans. :

b. 2, 8, 1

Explanation:

Since the charge of the nucleus is 11 times that of the hydrogen atom, the number of electrons is 11 and electronic configuration is 2, 8, 1.

61. Which of the following elements can show covalency greater than 4?

(A) Be (B) P (C) S (D) B

Ans. :

b. P

c. S

Explanation:

P and S have d-orbitals in their valence shell and therefore, can accommodate more than 8. electrons in their respective valence shells. Hence they show covalency more than 4.

62. The most reactive metal is:

(A) Sodium (B) Magnesium

(C) Potassium (D) Calcium

Ans. : C. Potassium

Explanation: Sodium Na and Potassium K are present in the group I that is alkali metal elements. While Magnesium Mg and Calcium Ca are group II alkaline earth metals. As we move from left to right in the periodic table the ionization energy increases as new electrons enter the same shell so, effective nuclear charge increases. So, Na and K are more reactive than Mg and Ca respectively. And as we go down the group number of shells increases so atomic size increases so, ionization energy decreases. As ionization energy decreases the reactivity of metal increases. So, Potassium is the most reactive metal.

63. 3d-transition series of elements starts with scandium which has the electronic configuration:

(A) $3d^1\ 4s^2$ (B) $3d^1\ 4s^1$ (C) $3d^2\ 4s^2$ (D) $3d^3\ 4s^2$

Ans. :

a. $3d^1\ 4s^2$

Explanation:

Before the 4p-orbital is filled, filling up of 3d-orbitals becomes energetically favourable and we come across the so called 3d transition series of elements. This starts from scandium (Z = 21) which has electronic configuration $[Ar]3d^1\ 4s^2$.

64. Which of the following is not a noble gas?

(A) Helium (B) Xenon (C) Radium (D) Radon

Ans. :

c. Radium

Explanation:

Helium, xenon and radon are inert gases. Radium is an alkaline earth metal.

65. Outer electronic configuration of f-block elements is:

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

(C) $(n - 2)f^{1-14}(n - 1)d^{0-1}ns^2$ (D) None of the above.

Ans. :

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

66. From Be to Ra, ionization energies:

(A) Increases (B) Decreases

(C) Remain same (D) None of these

Ans. :

b. Decreases

Explanation:

Be to Ra,

As we go down the group in Periodic table, atomic size increase, Nuclear hold on electron decrease for an outer electron.

Thus, Ionization energy decreases down the group.

67.

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

(A) Both are found together in nature.

(B) Both have nearly the same size.

(C) Both have similar electronic configurations.

(D) The ratio of their charge to size is nearly the same.

Ans. :

d. The ratio of their charge to size is nearly the same.

Explanation:

A Diagonal Relationship is said to exist between certain pairs of diagonally adjacent elements in the second and third periods of the periodic table. These pairs (Li & Mg, Be & Al, B & Si etc.) exhibit similar properties; for example, Boron and Silicon are both semiconductors, form halides that are hydrolyzed in water and have acidic oxides.

Such a relationship occurs because crossing and descending the periodic table have opposing effects. On crossing a period of the periodic table, the size of the atoms decreases, and on descending a group the size of the atoms increases. Similarly, on moving along the period the elements become progressively more covalent, less reducing and more electronegative, whereas on descending the group the elements become more ionic, more basic and less electronegative.

Thus, on both descending a group and crossing by one element the changes cancel each other out, and elements with similar properties which have similar chemistry are often found - the atomic size, electronegativity, properties of compounds (and so forth) of the diagonal members are similar.

The chemistry of lithium is very similar to that of magnesium even though they are placed in different groups. Its reason is that the ratio of their charge to size is nearly the same.

68. As we go down in the electro-chemical series of metals, the reactivity _____ .

(A) Decreases and then increases

(B) Increases and then decreases

(C) Decreases

(D) Increases

Ans. :

3. Decreases

Explanation: The higher the metal in the series, the more reactive it is and the more vigorously it reacts with water, oxygen and acid. A metal in the activity series can displace any metal below it in the series from its compound. The elements potassium, sodium, lithium and calcium are very reactive and they react with cold water to produce hydroxides and hydrogen gas. The metals above hydrogen are more reactive than hydrogen. These metals can displace hydrogen from acids or water and liberate hydrogen gas. The metals copper, silver gold and platinum are less reactive than hydrogen and they do not replace hydrogen from water or acid.

69. The period number in the long form of the periodic table is equal to:

(A) Magnetic quantum number of any element of the period.

(B) Atomic number of any element of the period.

(C) Maximum principal quantum number of any element of the period.

(D) Maximum azimuthal quantum number of any element of the period.

Ans. :

c. Maximum principal quantum number of any element of the period.

Explanation:

Period number = maximum n of any element (where, n = principal quantum number).

70. A pair of atomic numbers which belong to s-block are:

(A) 7, 15 (B) 6, 12 (C) 9, 17 (D) 3, 12

Ans. :

d. 3, 12

Explanation:

Atomic number 3 is lithium and it belongs to the 1st group.

Atomic number 12 is magnesium which belongs to the 2nd group.

Both 1 and 2 groups belong to the s-block.

71. The ionisation energy of nitrogen is more than oxygen because of:

(A) More attraction of electrons by the nucleus.

(B) The extra stability of half-filled p-orbitals.

(C) The ionic radius of nitrogen atom is smaller.

(D) All of the above are correct.

Ans. :

b. The extra stability of half-filled p-orbitals.

Explanation:

Ionisation energy of nitrogen is more than oxygen due to half-filled p-orbitals, which gives it extra stability.

72. The atomic number of Uut is:

(A) 113 (B) 114 (C) 108 (D) 115

Ans. :

a. 113

Explanation:

Un − 1; Tri − 3. The symbols for these are U,T, respectively.

Hence for Uut it becomes 113.

The symbols above mentioned are capital only if they are the first letter otherwise symbols would be small alphabets.

73. Which of the following has maximum difference in 1^{st} and 2^{nd} ionisation enthalpy.

(A) $1s^2, 2s^2, 2p^6, 3s^1$ (B) $1s^2, 2s^2, 2p^6, 3s^1$

(C) $1s^2, 2s^2, 2p^1$ (D) $1s^2, 2s^2, 2p^6$

Ans. :

a. $1s^2, 2s^2, 2p^6, 3s^1$

Explantion:

After losing one electron, it acquires stable electronic configuration, that is why second ionisation enthalpy is very high.

74. The first ionisation potential is maximum for:

(A) Lithium (B) Uranium (C) Iron (D) Hydrogen

Ans. :

d. Hydrogen

Explanation:

Hydrogen experiences the maximum effective nuclear charge. After removal of a electron there will be no electron in the species. Just a nucleus with positive charge will be left which is very unstable. Therefore, ionization potential is maximum for hydrogen.

*** a statement of Assertion (A) is followed by a statement of Reason (R). [2]**

Choose the correct option.

75. **Note:** In the following questions a statement of Assertion (A) followed by a statement of reason (R) is given. Choose the correct option out of the choices given below each question.

Assertion (A): Boron has a smaller first ionisation enthalpy than beryllium.

Reason (R): The penetration of a 2s electron to the nucleus is more than the 2p electron hence 2p electron is more shielded by the inner core of electrons than the 2s electrons.

i. Assertion and reason both are correct statements but reason is not correct explanation for assertion.
ii. Assertion is correct statement but reason is wrong statement.
iii. Assertion and reason both are correct statements and reason is correct explanation for assertion.
iv. Assertion and reason both are wrong statements.

Ans. :

iii. Assertion and reason both are correct statements and reason is correct explanation for assertion.

Explanation:

Boron ($1s^2\ 2s^2\ 2p^1$) has less first ionisation enthalpy than beryllium ($1s^2\ 2s^2$) because beryllium has fully filled. s-sub shell. 2s-electrons are nearer to the nucleus as compared to 2s-electrons.

76. **Note:** In the following questions a statement of Assertion (A) followed by a statement of reason (R) is given. Choose the correct option out of the choices given below each question.

Assertion (A): Generally, ionisation enthalpy increases from left to right in a period.

Reason (R): When successive electrons are added to the orbitals in the same principal quantum level, the shielding effect of inner core of electrons does not increase very much to compensate for the increased attraction of the electron to the nucleus.

i. Assertion is correct statement and reason is wrong statement.
ii. Assertion and reason both are correct statements and reason is correct explanation of assertion.
iii. Assertion and reason both are wrong statements.
iv. Assertion is wrong statement and reason is correct statement.

Ans. :

ii. Assertion and reason both are correct statements and reason is correct explanation of assertion.

Explanation:

Ionisation enthalpy increases from left to right across the period due to decrease in atomic size. The electron present within the subshell has almost same effective nuclear charge.

*** Answer The Following Questions In One Sentence.[1 Marks Each] [17]**

77. Anything that influences the valence electrons will affect the chemistry of the element. Which one of the following factors does not affect the valence shell?

a. Valence principal quantum number (n)
b. Nuclear charge (Z)
c. Nuclear mass
d. Number of core electrons.

Ans. :

c. Nuclear mass.

Nuclear mass does not affect the valence electrons.

78. Which element do you think would have been named by:
Lawrence Berkeley Laboratory.

Ans. : Lawrencium (Lr) with atomic number (z) = 103

79. What is the total number of sigma and pi bonds in the following molecules?
C_2H_4

Ans. :

; No. of σ bonds = 5,

No. of π bonds = 1

80. Electronegativity of F on Pauling scale is 4.0. What is the value on Mulliken's scale.

Ans. : Value on Mulliken's scale = 2.8 × 4 = 11.2.

81. The electronic configuration of Re^{3+} is $[Xe]4f^{14}5d^4$. Calculate the number of unpaired electrons in this ion.

Ans. : Four.

82. What is covalency of Al in $[AlCl_4]^-$?

Ans. : It is equal to 4 because it is forming four covalent bonds.

83. State modern periodic law.

Ans. : The properties of elements are periodic functions of their atomic numbers i.e. properties of elements depend upon atomic number.

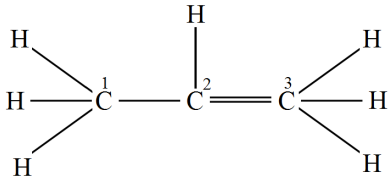
84. Which is the smallest among Na^+, Mg^{2+}, Al^{3+} and why?

Ans. : Al^{3+} is smallest because it has the highest number of protons (13) among Na^+, Mg^{2+} and Al^{3+} ions, due to which effective nuclear charge is maximum.

85. An element belongs to 5th period and 3rd group, identify the element.

Ans. : Y(39): $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ \underline{5s^2}\ \underline{4d^1}$. The element is Ytterium(39).
It belongs to 5th period and 3rd group due to 3 valence electrons.

86. Which hybrid orbitals are used by carbon atoms in the following molecules?
CH_3 –CH=CH_2;



Ans. :
C_1 is sp^3 hybridized, while C_2 and C_3 are sp^2 hybridized.

87. How do the basic character and solubility in water vary from $Be(OH)_2$ to $Ba(OH)_2$?

Ans. : Basic character and solubility increases from $Be(OH)_2$ to $Ba(OH)_2$ because hydration energy increases more than lattice energy.

88. An element X belongs to the third period of p-block. It has 4 electrons in the outermost shell. Name the element.

Ans. : The outer configuration of the element is $3s^2\ 3p^2$ (as it has 4 elements in outermost shell). Thus, the complete configuration is $1s^2, 2s^2\ 2p^6, 3s^2, 3p^2$. So the atomic number is 2 + 8 + 4 = 14. Hence, the element is silicon.

89. Considering the elements B, C, N, F, and Si, the correct order of their non-metallic character is :
    a. B > C > Si > N > F
    b. Si > C > B > N > F
    c. F > N > C > B > Si
    d. F > N > C > Si > B

Ans. :
c. F > N > C > B > Si

Explanation:

In a period, the non-metallic character increases from left to right. Thus, among B, C, N and F, non-metallic character decreases in the order: F > N > C > B. However, within a group, non-metallic character decreases from top to bottom.

Thus, C is more non-metallic than Si. Therefore, the correct sequence of decreasing non-metallic character is: F > N > C > B > Si,

90. Explain why chlorine can be converted into chloride ion more easily as compared to fluoride ion from fluorine.

Ans. : Electron gain enthalpy of Cl is more negative than that of F.

91. To which series do man-made elements belong?

Ans. : Actinoid series (f-block elements).

92. Write the IUPAC name and symbol for the element with atomic number 109.

Ans. : Ununennium, Uue.

93. Arrange the following species in increasing order of their size:

Mg^{2+}, Al^{3+}, Na^{+}, O^{2-}, F^{-}.

Ans. : $O^{2-} > F^{-} > Na^{+} > Mg^{2+} > Al^{3+}$

*** Given Section consists of questions of 2 marks each.** **[24]**

94. Magnesium and Lithium both form nitride, why? Write the equation for formation of their nitride.

Ans. : Li and Mg resemble with each other due to diagonal relationship i.e. due to same charge/ radius ratio that is why both form nitride.

$3Mg + N_2 \rightarrow Mg_3N_2$ (Magnesium nitride)

$6Li + N_2 \rightarrow 2Li_3N$ (Lithium nitride)

95. How does ionisation energy vary (i) down the group, (ii) along the period from left to right?

Ans. :

i. Ionisation enthalpy decreases down in the group because atomic size increases and effective nuclear charge decreases, less energy is needed to remove electrons.

ii. Ionisation enthalpy increases along the period from left to right due to increase in effective nuclear charge.

96. Give the name and atomic number of the inert gas tom in which total number of d-electrons is equal to difference in number of total 'p' and s-electrons.

Ans. : Kr(36) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6$

Number of d-electrons = 10

Number of p-electrons = 18

Number of s-electrons = 8

Difference in 'p' and 's' electrons = 18 - 8 = 10

97. Among the elements of the third period Na to Ar, pick out the element:

i. With highest first ionisation enthalpy.

ii. With largest atomic radius.

iii. Which is most reactive non-metal.

iv. Which is most reactive metal.

Ans. :

i. Ar has highest first ionisation enthalpy, because it is noble gas.

ii. Na has largest atomic radius (covalent radius), it has less nuclear charge.

iii. Cl is most reactive non-metal in third period, it can gain electron easily.

iv. Na is most reactive metal in third period, it can lose electron easily.

98. Arrange the following elements in the increasing order of non-metallic character. Give reason.

B, C, O, N, F

Ans. : B < C < N < O < F

Its is because atomic size decreases from 'B' to 'F', effective nuclear charge increases, tendency to gain electron increases, that is why non-metallic character increases.

99. i. Name the most metallic element in second period and most non-metallic element.

ii. Name the element with (a) largest atomic radius, (b) smallest atomic radius in third period.

iii. Name the element having general electronic configuration $ns^2\ np^4$ in fourth period.

Ans. :

i. Most metallic element is Li and most non-metallic element is F.

ii.

a. Na has largest atomic radius.

b. Cl has smallest atomic radius.

iii. Se(34): $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^4$ is element in fourth period with general electronic configuration $ns^2\ np^4$.

100. What would be IUPAC names and symbols for elements with atomic numbers 122, 127, 135, 149 and 150?

Ans. : The roots 2, 7, 5, 9 and 0 are referred as bi, sept, pent, enn and nil respectively. Therefore, their names and symbol are:

Z (Atomic number)	Name	Symbol
122	Unbibium	Ubb
127	Unbiserptium	Ubs
135	Untripentium	Utp
149	Unquadennium	Uqe
150	Unpentnilium	Upn

101. i. How do the electronic configurations of the elements with Z = 107 to 109 differ from one another?

ii. Rn (Z = 86) is the last noble gas discovered. Predict what will be the atomic number of the next noble gas to be discovered. Write its symbol.

Ans. :

i. Element with Z = 107 has five, Z = 108 has six electrons while Z = 109 has seven 6d-electrons. Thus, these elements differ in the number of electrons in the 6d-subshell.

ii. 118, Uuo.

102. Element 'Al' belongs to group 13 forms ionic compounds. Write,

a. Formula of its oxide.

b. Arrange the following in decreasing order of electropositive character Li, Na, K, Cs Give reason.

Ans. :

a. Al_2O_3 is formula of its oxide.

b. Cs > K > Na > Li because tendency to lose electron decreases due to decrease in atomic size and increase in effective nuclear charge.

103. Eka-aluminium and eka-silicon were the names given by Mandeleev for the then unknown elements gallium and germanium respectively. A recently discovered element was first named as eka-mercury. What is its atomic number? Write its group number, electronic configuration, IUPAC and official names.

Ans. : The element which comes after mercury in the periodic table is called eka-mercury.

Its various parameters are Z = 80 + 32 = 112

IUPAC name: Uub

Official name: Cn (copernicium)

Electronic configuration = [Rn] $5f^{14}$ $6d^{10}$ $7s^2$

104. i. How does basic character of oxides and hydroxides down the group in alkali metals change? Why?
ii. How does reducing power of elements vary in Group I?

Ans. :

i. It goes on increasing down the group due to decrease in ionisation energy and increase in metallic character.
ii. Reducing power of 'Li' is highest, Na is lowest, then it goes on increasing:

Li > Cs > Rb > K > Na.

105. Name the species that will be isoelectronic with the following atoms or ions:

i. Na
ii. Cl^-
iii. Ca^{2+}
iv. Rb^+

Ans. : Isoelectronic species are those which have same number of electrons.

i. Na has 10 electrons. Therefore, the species N^{3-}, O^{2-}, F^-, Mg^{2+}, Al^{3+} etc., each of which has also 10 electrons and hence, isoelectronic with it.
ii. Cl^- has 18 electrons. Therefore, the species P^{3-}, S^{2-}, Ar, K^+ and Ca^{2+}, each one of which contains 18 electrons and hence, isoelectronic with it.
iii. Ca^{2+} has 18 electrons. Therefore, the species P^{3-}, S^{2-}, Ar and K^+, each of which also contains 18 electrons and hence, isoelectronic with it.
iv. Rb^+ has 36 electrons. Therefore, the species Br^-, Kr or Sr^{2+} each of which also has 36 electrons and hence, isoelectronic with it.

* **Given Section consists of questions of 3 marks each.** **[15]**

106. How would you react to the statement that the electronegativity of N on Pauling scale is 3.0 in all the nitrogen compounds?

Ans. : On Pauling scale, the electronegativity of nitrogen, (3.0) indicates that it is sufficiently electronegative. But it is not correct to say that the electronegativity of nitrogen in all the compounds is 3. It depends upon its state of hybridization in a particular compound, greater the percentage of s-character, more will be the electronegativity of the element. Thus, the electronegativity of nitrogen increases in moving from SP^3 hybridized orbital's to SP hybridized orbital's i.e., as $SP^3 < SP^3 < SP$.

107. Give reason for the following:

i. Halogens act as good oxidising agent.
ii. Electron gain enthalpy of noble gas is almost zero.
iii. Na and Mg^+ have same number of electrons but removal of electron from Mg^+ requires more energy.

Ans. :

i. Due to highly negative electron gain enthalpy they act as good oxidising agent as they can gain electrons easily.
ii. Electronic configuration of noble gases is such that all sub-shells are completely filled. Hence their electron gain enthalpy is almost zero.

iii. Sodium has eleven electrons and eleven protons but number of protons in Mg^+ are twelve, though it has eleven electrons. Due to higher effective nuclear charge in case of Mg^+, removal of electron from it requires more energy.

108. Consider the element N, P, O and S and arrange them in order of:

i. Increasing first ionisation enthalpy.
ii. Increasing negative electron gain enthalpy.
iii. Increasing non-metallic character.

Ans. :

i. S < P < O < N is increasing order of first ionisation energy.
ii. N < P < O < S is increasing order of negative electron gain enthalpy.
iii. P < S < N < O is increasing order of non-metallic character.

109.
a. Name the group of the elements in which electrons are progressively filled in 4f-orbital and 5f orbitals.
b. Which of the following is the correct order of size of the given species: I, I^+, I^-?
c. Which of the following elements can show covalency greater than 4?

Be, P, S, B

Ans. :

a. In lanthanoids, 4f orbital is progressively filled.
b. $I^- > I > I^+$, cations are smaller and anions are bigger than neutral atom. Cations have greater effective nuclear charge as protons are more than electrons anions have less effective nuclear charge as electrons are more than protons.
c. 'P' and 'S' show co-valency greater than 4 due to presence of d-orbitals, in which electrons can be exited e.g. PCl_5, SF_6.

110. Among the elements B, Al, C and Si:

i. Which element has the highest first ionisation enthalpy?
ii. Which element has the most metallic character? Justify your answer in each case.

Ans. : Arranging the elements into different groups and periods:

Group	13	14
Period 2	B	C
Period 3	Al	Si

- Ionization enthalpy increases along a period and decreases down a group. Therefore, C has the highest first ionization enthalpy.
- Metallic character decreases along a period and increases down a group. Therefore, Al has the most metallic character.

* Case study based questions [8]

111. The s-Block Elements The elements of Group 1 (alkali metals) and Group 2 (alkaline earth metals) which have ns1and ns2 outermost electronic configuration belong to the s-Block Elements. They are all reactive metals with low ionization enthalpies. They lose the outermost electron(s) readily to form 1+ ion (in the case of alkali metals) or 2+ ion (in the case of alkaline earth metals). The metallic character and the reactivity increase as we go down the group. Because of high reactivity they are never found pure in nature. The compounds of the s-block elements, with the exception of those of lithium and beryllium are predominantly ionic. The p-Block Elements comprise those belonging to Group 13 to 18 and these together with the s-Block Elements are called the

Representative Elements or Main Group Elements. The outermost electronic configuration varies from ns2np1 to ns2np6 in each period. At the end of each period is a noble gas element with a closed valence shell ns2np6 configuration. All the orbitals in the valence shell of the noble gases are completely filled by electrons and it is very difficult to alter this stable arrangement by the addition or removal of electrons. The noble gases thus exhibit very low chemical reactivity. Preceding the noble gas family are two chemically important groups of non-metals. They are the halogens (Group 17) and the chalcogens (Group 16).The non-metallic character increases as we move from left to right across a period and metallic character increases as we go down the group. These are the elements of Group 3 to 12 in the centre of the Periodic Table. These are characterised by the filling of inner d orbitals by electrons and are therefore referred to as d-Block Elements. These elements have the general outer electronic configuration (n-1)d1-10ns0-2 . They are all metals. They mostly form coloured ions, exhibit variable valence (oxidation states), paramagnetism and oftenly used as catalysts. However, Zn, Cd and Hg which have the electronic configuration, (n-1) d10ns2 do not show most of the properties of transition elements. In a way, transition metals form a bridge between the chemically active metals of s-block elements and the less active elements of Groups 13 and 14 and thus take their familiar name “Transition Elements”.The two rows of elements at the bottom of the Periodic Table, called the Lanthanoids, Ce(Z = 58) – Lu(Z = 71) and Actinoids, Th(Z = 90) – Lr (Z = 103) are characterised by the outer electronic configuration (n-2)f 1-14 (n-1)d 0–1ns2 . The last electron added to each element is filled in f- orbital. These two series of elements are hence called the Inner- Transition Elements (f-Block Elements). They are all metals. Within each series, the properties of the elements are quite similar. The chemistry of the early actinoids is more complicated than the corresponding lanthanoids, due to the large number of oxidation states possible for these actinoid elements. Actinoid elements are radioactive. Many of the actinoid elements have been made only in nanogram quantities or even less by nuclear reactions and their chemistry is not fully studied. The elements after uranium are called Transuranium Elements. The elements can be divided into Metals and Non-Metals. In contrast, non-metals are located at the top right hand side of the Periodic Table. The elements become more metallic as we go down a group; the non- metallic character increases as one goes from left to right across the Periodic Table. Periodic Table show properties that are characteristic of both metals and non- metals. These elements are called Semi-metals or Metalloids.

i. Alkali metal and alkaline earth metal belongs to ..
   a. S – block
   b. P – block
   c. D – block
   d. F – block

ii. The metallic character and the reactivity … as we go down the group.
   a. Decreases
   b. Increases
   c. Remains Constant
   d. None of Above

iii. Group … Elements known as chalcogens.
   a. 12
   b. 14
   c. 16
   d. 18

iv. Elements Ce(Z = 58) to Lu(Z = 71) are known as:
   a. Halogens
   b. Chalcogens

c. Actinoids
d. Lanthenoids

v. The elements after uranium are called ... Elements.
a. Halogens
b. Chalcogens
c. Actinoids
d. Transuranium

Ans. :

i. (a) S – block
ii. (b) Increases
iii. (c) 16
iv. (d) Lanthenoids
iv. (d) Transuranium

112. We must bear in mind that when Mendeleev developed his Periodic Table, chemists knew nothing about the internal structure of atom. However, the beginning of the 20th century witnessed profound developments in theories about sub-atomic particles. In 1913, the English physicist, Henry Moseley observed regularities in the characteristic X-ray spectra of the elements. A plot of ν (whereν is frequency of X-rays emitted) against atomic number (Z) gave a straight line and not the plot of ν vs atomic mass. He thereby showed that the atomic number is a more fundamental property of an element than its atomic mass. Mendeleev's Periodic Law was, therefore, accordingly modified. This is known as the Modern Periodic Law and can be stated as : The physical and chemical properties of the elements are periodic functions of their atomic numbers.Numerous forms of Periodic Table have been devised from time to time. Some forms emphasise chemical reactions and valence, whereas others stress the electronic configuration of elements. A modern version, the so-called "long form" of the Periodic Table of the elements , is the most convenient and widely used. The horizontal rows (which Mendeleev called series) are called periods and the vertical columns, groups. Elements having similar outer electronic configurations in their atoms are arranged in vertical columns, referred to as groups or families. According to the recommendation of International Union of Pure and Applied Chemistry (IUPAC), the groups are numbered from 1 to 18 replacing the older notation of groups IA ... VIIA, VIII, IB ... VIIB and 0. There are altogether seven periods. The period number corresponds to the highest principal quantum number (n) of the elements in the period. The first period contains 2 elements. The subsequent periods consists of 8, 8, 18, 18 and 32 elements, respectively. The seventh period is incomplete and like the sixth period would have a theoretical maximum (on the basis of quantum numbers) of 32 elements. In this form of the Periodic Table, 14 elements of both sixth and seventh periods (lanthanoids and actinoids, respectively) are placed in separate panels at the bottom. the IUPAC has made recommendation that until a new element's discovery is proved, and its name is officially recognised, a systematic nomenclature be derived directly from the atomic number of the element using the numerical roots for 0 and numbers 1-9. The roots are put together in order of digits which make up the atomic number and "ium" is added at the end.Groupwise Electronic Configurations Elements in the same vertical column or group have similar valence shell electronic configurations, the same number of electrons in the outer orbitals, and similar properties. theoretical foundation for the periodic classification. The elements in a vertical column of the Periodic Table constitute a group or family and exhibit similar chemical behaviour. This similarity arises because these elements have the same number and same distribution of electrons in their outermost orbitals. We can classify the elements into four blocks viz., s-block, p-block, d-block and f-block depending on the type of atomic orbitals that are

being filled with electrons. Two exceptions to this categorisation. Strictly, helium belongs to the s-block but its positioning in the p-block along with other group 18 elements is justified because it has a completely filled valence shell (1s) and as a result, exhibits properties characteristic of other noble gases. The other exception is hydrogen. It has only one s-electron and hence can be placed in group 1 (alkali metals). It can also gain an electron to achieve a noble gas arrangement and hence it can behave similar to a group 17 (halogen family) elements. Because it is a special case, we shall place hydrogen separately at the top of the Periodic Table.

i. In 1913, the English physicist, ….observed regularities in the characteristic X-ray spectra of the elements.
   a. Johann Dobereiner
   b. John Alexander Newlands
   c. Demitri Mendeleev
   d. Henry Moseley

ii. Horizontal row in periodic table called:
   a. Group
   b. Period
   c. Triad
   d. Octave

iii. Vertical Column in periodic table called:
   a. Group
   b. Period
   c. Triad
   d. Octave

iv. According to Modern Periodic Law the physical and chemical properties of the elements are periodic functions of their ….
   a. Atomic mass
   b. Atomic numbers
   c. Atomic structure
   d. Atomic size

v. What is IUPAC name of element having atomic number 107.
   a. Unnilpentium
   b. Unnilhexium
   c. Unnilseptium
   d. Unniloctium

Ans. :

i. (d) Henry Moseley
ii. (b) Period
iii. (a) Group
iv. (b) Atomic numbers
v. (c) Unnilseptium

*** Given Section consists of questions of 5 marks each. [60]**

113. What is the significance of the terms — ‘isolated gaseous atom’ and ‘ground state’ while defining the ionization enthalpy and electron gain enthalpy?
Hint : Requirements for comparison purposes.

Ans. : Significance of term ‘isolated gaseous atom’. The atoms in the gaseous state are far separated in the sense that they do not have any mutual attractive and repulsive interactions. These are therefore regarded as isolated atoms. In this state the value of ionization enthalpy and electron gain enthalpy are not influenced by the presence of the

other atoms. It is not possible to express these when the atoms are in the ; liquid or solid state due to the presence of inter atomic forces.

Significance of ground state. Ground state of the atom represents the normal – energy state of an atom. It means electrons in a particular atom are in the lowest energy state and they neither lose nor gain electron. Both ionisation enthalpy and I electron gain enthalpy are generally expressed with respect to the ground state ofan atom only.

114. Consider the following species:

N^{3-}, O^{2-}, F^{-}, Na^{+}, Mg^{2+} and Al^{3+}

a. What is common in them?

b. Arrange them in the order of increasing ionic radii.

Ans. :

a. Each of the given species (ions) has the same number of electrons (10 electrons). Hence, the given species are isoelectronic.

b. The ionic radii of isoelectronic species increases with a decrease in the magnitudes of nuclear charge.

The arrangement of the given species in order of their increasing nuclear charge is as follows:

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

Nuclear charge = +7 +8 +9 +11 +12 +13

Therefore, the arrangement of the given species in order of their increasing ionic radii is as follows:

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

115. The first ionization enthalpy values (in kJ mol^{-1}) of group 13 elements are:

B	Al	Ga	In	Tl
801	577	579	558	589

How would you explain this deviation from the general trend?

Ans. : On moving down a group, ionization enthalpy generally decreases due to an increase in the atomic size and shielding. Thus, on moving down group 13, ionization enthalpy decreases from B to Al. But, Ga has higher ionization enthalpy than Al. Al follows immediately after s–block elements, whereas Ga follows after d–block elements. The shielding provided by d-electrons is not very effective. These electrons do not shield the valence electrons very effectively. As a result, the valence electrons of Ga experience a greater effective nuclear charge than those of Al. Further, moving from Ga to In, the ionization enthalpy decreases due to an increase in the atomic size and shielding. But, on moving from In to Tl, the ionization enthalpy again increases. In the periodic table, Tl follows after 4f and 5d electrons. The shielding provided by the electrons in both these orbitals is not very effective. Therefore, the valence electron is held quite strongly by the nucleus. Hence, the ionization energy of Tl is on the higher side.

116. Distinguish between a sigma and a pi bond.

Ans. :

Sr. No.	Pi bond	Sigma bond

1	Pi bond is formed by lateral overlapping of orbitals.	Sigma bond is formed by end to end overlapping of orbitals.
2	It is comparatively weak bond.	It is comparatively strong bond.
3	There is only one overlapping orbital is p-p.	The overlapping orbitals are s-s, s-p, p-p.
4	Rotation around pi-bond is restricted.	Rotation is possible around sigma bond.
5	Electron cloud is not symmetrical about the line joining 2 nuclei.	Electron cloud is symmetrical about the line joining 2 nuclei.
6	It is having 2 electron clouds one above the plane of atomic nuclei and one below the plane of atomic nuclei.	It is having 1 electron cloud and that is symmetrical about the inter-nuclear axis.

117. Among the second period elements the actual ionization enthalpies are in the order Li < B < Be < C < O < N < F < Ne.Explain why,

i. Be has higher $\Delta_t H$ than B

ii. O has lower $\Delta_t H$ than N and F?

Ans. :

i. During ionization process, the electron that can be expelled from Be (beryllium) – atom is 2s – electron, but the electron that can be expelled from boron is 2p – electron.The attractive force between a 2s – electron and nucleus is higher than between a 2s – electron and nucleus.Thus, the energy required to expel 2s – electron is higher than the energy required to expel 2p –electron.Thus, $\Delta_i H$ for Be is higher than $\Delta_i H$ than B

ii. In nitrogen, there are three 2p-electrons and all of these 3 occupy 3 distinct atomic orbital. While in oxygen 2 out of 4, 2p – electrons occupy same 2p-orbital, so the repulsion between the electrons in the oxygen atom increases.Thus, the energy required to expel 2^{nd} 2p –electron in oxygen atom is higher than the energy required to expel 4^{th} 2p –electron in nitrogen atom.Thus, $\Delta_i H$ for O is lower than $\Delta_i H$ of N.

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119. On the basis of quantum numbers, justify that the sixth period of the periodictable should have 32 elements.

Ans. : In the periodic table of the elements, a period indicates the value of the principal quantum number (n) for the outermost shells. Each period begins with the filling of principal quantum number (n). The value of n for the sixth period is 6. For n = 6, azimuthal quantum number (l) can have values of 0, 1, 2, 3, 4.

According to Aufbau's principle, electrons are added to different orbitals in order of their increasing energies. The energy of the 6d subshell is even higher than that of the 7s subshell.

In the 6^{th} period, electrons can be filled in only 6s, 4f, 5d, and 6 p subshells. Now, 6s has one orbital, 4f has seven orbitals, 5d has five orbitals, and 6p has three orbitals. Therefore, there are a total of sixteen (1 + 7 + 5 + 3 = 16) orbitals available. According to Pauli's exclusion principle, each orbital can accommodate a maximum of 2 electrons. Thus, 16 orbitals can accommodate a maximum of 32 electrons.

Hence, the sixth period of the periodic table should have 32 elements.

120. p-Block elements form acidic, basic and amphoteric oxides. Explain each property by giving two examples and also write the reactions of these oxides with water.

Ans. :

In p-block, when we move from left to right in a period, the acidic character of the oxides increases due to increase in electronegativity. For example,

In 2^{nd} period $B_2O_3 < CO_2 < N_2O_3$ (acidic nature increases).

In 3^{rd} period $A1_2O_3 < SiO_2 < P_4O_{10} < SO_3 < C1_2O_7$ (acidic character increases).

On moving down the group, acidic character decreases and basic character increases, e.g.,

(a) Nature of oxides of 13 group elements

B_2O_3 (Weakly acidic) — Al_2O_3, Ga_2O_3 (Amphoteric) — In_2O_3 (Basic) — Tl_2O (Strongly basic)

b. Nature of oxides of 15 group elements.

N_2O_5	P_4O_{10}	As_4O_{10}	Sb_4O_{10}	Bl_2O_3
Strongly acidic	Moderately acidic	Amphoteric	Amphoteric	Basic

Among the oxides of same element, higher the oxidation state of the element, stronger is the acid. For example, SO_3 is a stronger acid than SO_2.

B_2O_3 is weakly acidic and on dissolution in water, it forms orthoboric acid. Orthoboric acid does not act as a protonic acid (it does not ionise) but acts as a weak Lewis acid.

$$\underset{\text{Boron trioxide}}{B_2O_3} + 3H_2O \rightleftharpoons \underset{\text{Orthoboric acid}}{2H_3BO_3}$$

$$B(OH)_3 + H-OH \longrightarrow \left[B(OH)_4\right]^- + H^+$$

Al_2O_3 is amphoteric in nature. It is insoluble in water but dissolves in alkalies and reacts with acids.

$$\underset{\text{Aluminium trioxide}}{Al_2O_3} + 2NaOH \xrightarrow{\Delta} \underset{\text{Sodium meta chloride}}{2NaAlO_2} + H_2O$$

$$Al_2O_3 + 6HCl \xrightarrow{\Delta} \underset{\text{Aluminium chloride}}{2AlCl_3} + 3H_2O$$

Tl_2O is as basic as NaOH due to its lower oxidation state (+1).

$$Tl_2O + 2HCl \longrightarrow 2TlCl + H_2O$$

121. Write the drawbacks in Mendeleev's periodic table that led to its modification.

Ans. : Drawbacks of Mendeleev's table:

1. **Position of hydrogen:** Hydrogen is placed in group I-A of the periodic table. However, it resembles the elements of both group I A (alkali metals) and group VII A (halogens). Therefore, the position of hydrogen in the periodic table is not clear.
2. **Anomalous pairs of elements:** In some cases, elements of higher atomic masses are placed before those having lower atomic masses.

   Examples:

   - $\underset{39.95}{Ar}$ and $\underset{39.1}{K}$
   - $\underset{58.93}{CO}$ and $\underset{58.71}{Ni}$ $\underset{127.6}{Te}$ and $\underset{126.9}{I}$
3. **Metals and non-metals:** No attempt has been made to place metals and non-metals separately in it.
4. **Lanthanoides and Actinodes:** Fifteen elements are placed in one position. Group (III) B
   - **6th period:** La + 14 lathanoide elements. ($_{58}$Ce to $_{71}$Lu).
   - **7th period:** Ac + 14 actinoide elements. ($_{90}$Th to $_{103}$Lr)

   Thus, lanthanoids and actinoides have not been provided separate and proper places in the Mendeleev's periodic table.
5. **Position of isotopes:** Isotopes of elements are placed in the same position in the table though according to their atomic masses they should have been placed in different positions.

6. **Similar elements separated in the table:** Certain elements such as copper and mercury or gold and platinum which possess similar chemical properties are placed in different groups.
7. **Dissimilar elements placed together in the same group:** Alkali metals such as Li, Na, K etc. (group IA) are grouped together with coinage metals such as Cu, Ag and Au (group IB) though their properties are quite different.

Number of elements in the periods. The presence of only 2 elements in the first period, 8 in the second and third etc. cannot be explained.

122. Explain why cation are smaller and anions larger in radii than their parent atoms?

Ans. : Cations are formed by expelling an electron from outermost orbit of an atom, thus cation has less electrons compared to parent atom which results in increased effective nuclear charge but the total nuclear charge remains same which results in increased attraction of electrons towards nucleus than that of parent atom. Thus, cations are having smaller radii then that of their parent atom.

Anions are formed by gaining an electron in the outermost orbit of an atom, thus anion has more electrons compared to parent atom which results in decreased effective nuclear charge but the total nuclear charge remains same which results in increased distance the nucleus and the valence electrons as the attraction of electrons towards nucleus decreases than that of parent atom. Thus, anions are having larger radii then that of their parent atom.

123. Consider the following species:

N^{3-}, O^{2-}, F^{-}, Na^{+}, Mg^{2+} and Al^{3+}

a. What is common in them?
b. Arrange them in the order of increasing ionic radii.

Ans. :

a. Each of the given species (ions) has the same number of electrons (10 electrons). Hence, the given species are isoelectronic.
b. The ionic radii of isoelectronic species increases with a decrease in the magnitudes of nuclear charge.

The arrangement of the given species in order of their increasing nuclear charge is as follows:

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

Nuclear charge = +7 +8 +9 +11 +12 +13

Therefore, the arrangement of the given species in order of their increasing ionic radii is as follows:

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

124. What is the basic difference in approach between the Mendeleev's Periodic Lawand the Modern Periodic Law?

Ans. : According to Mendeleev's periodic law, the physical and chemical properties of the elements are periodic functions of their atomic masses, but according to modern periodic law, the physical and chemical properties of the elements are periodic functions of their atomic numbers.

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