Chapter 3. Classification of Elements and Periodicity in Properties

Question-1

Why is electro negativity a relative property?

Solution:

The tendency of an atom to attract pair of electrons in a bond is called electro negativity. It cannot be determined by experiment. It can be calculated. It has no unit. Arbitrarily electro negativity values for F, C, and H are given as 4,2.5 and 2.1 respectively.

Question-2

Which element has the highest electro negativity value?

Solution:

Chlorine has highest electron affinity value. Fluorine has lesser electron affinity value than chlorine due to its high electron density (electron density $= \frac{\text{Ch arg e}}{\text{radius}}$) Radius of F is lesser than Cl.

Question-3

The first ionization of carbon atom is greater than that of boron atom where as the reverse is true for second ionization energy.

Solution:

Carbon atom has $1s^2 2s^2 2p^2$ configuration. After first ionization it has $1s^2 2p^2 2s^1$ configuration. Single electron can be easily removed from 2p orbital. Hence second ionisation of carbon is lesser than first ionization. Boron has $1s^2 2s^2 2p^1$ configuration. One electron in the 2p orbital can be easily removed. Hence first ionisation for B is less: After losing first it has $1s^2 2s^2$ configuration from which removed of an electron is difficult. Hence second ionization for B is greater than first ionisation.

Question-4

Electron affinity of noble gases are zero and those of N and P are very low Give reason.

Solution:

Noble gases have stable electronic configuration – s^2p^6. All electron are in paired condition. Hence, addition of an electron is difficult and it may require supply of energy. Hence electron affinity may be zero or negative values.

N and P have stable half filled 'p' orbitals. Hence addition of an electron is not required, to make it stable. Hence they have very low values.

Question-5

Arrange ions in the increasing order of its size O^{2-}, F^-, Na^+, N^{3-}.

Solution:

	Proton numbers	Electrons numbers
O^{2-}	8	10
F^-	9	10
Na^+	10	10
N^{3-}	7	10

All ions have same number of electrons but different proton numbers. Greater the number of protons greater will be the nuclear force and small will be the size.

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

Question-6

How will you explain the correct order of size Ne>B>C>F?

Solution:

The decrease in size along a period is due to the effect of successive increasing nuclear charge without addition of a new shall. Nuclear charge increases for +5 in B to +9 in F. But electrons are added only to the same second shell, for all above elements.

For inert gases like Ne, their atomic radii are only the Vander Wall's radii. Vander wall's radii are naturally higher than the covalent radii of older elements.

Question-7

Arrange Fe, Fe^{3+}, Fe^{2+} in the increasing order of size.

Solution:

$Fe^{3+} < Fe^{2+} < Fe$

24 25 26

Fe^{3+} has lesser number of electrons than Fe^{2+} Hence nuclear force of attraction will be more for Fe^{3+}. Hence it has the least size.

Question-8

Which are metalloids among the following? Li, Be, Si, Ge, As, sb, Te.

Solution:

Si, Ge, As, Sb, and Te are metalloids which have properties of both metals and non-metals.

Question-9

What would the expected outmost electronic configuration, the groups and period, and block for elements with 114, 116 and 118?

Solution:

Their electronic configuration is $7S^2$,$7P^2$,$7S^2$,$7P^4$, & $7s^2$ $7p^6$ respecting. 114, 116, 118 all belongs to p block elements. Since 114 has s^2p^2 to belongs to 14 the group,116 has s^2p^4 it belong to 16 the group. 118 has s^2p^6, it belongs to 18^{th} group. The three elements have 7S & 7P; Hence they belong to 7^{th} period.

Question-10

Xenon form compounds with fluorine and oxygen. But neon does not . Why?

Solution:

In a group as we move from He to Xe, size increases and ionisation enthalpy decreases. Hence, Xe, (n = 5) has lower ionisation enthalpy than Ne (n = 2).

More over Xe has ($5s^2 5p^6 5d^0$) empty 5d orbitals, with which it can accept pairs electrons from other elements and thus can form compounds. Neon has no 'd' orbital in its electronic configuration ($1s^2 2s^2 2p^6$).

CBSE Class 11 Chemistry

Important Questions

Chapter 3

Classification of Elements and Periodicity in Properties

1 Marks Questions

1.How many elements are known at present?

Ans. There are about 114 elements known at present.

2.Who was the first scientist to classify elements according to their properties?

Ans. The German Chemist, Johann Dobereiner in early 1829 was the first to consider the idea of trends among properties of element.

3. What is the basis of triad formation of elements?

Ans. The middle element of each of the triads had an atomic weight about half way between the atomic weights of the other two. Also the properties of the middle element were in between those of the other two members. Dobereiner's relationship is known as the law of triads**.**

4. Stale the modern 'Periodic law'?

Ans. The physical and chemical properties of the elements are periodic functions of their atomic numbers.

5.Define and state Mendeleev's periodic law.

Ans. Mendeleev's Periodic law states that

'The properties of the elements are periodic function of their atomic weights'.

6.Give the general characteristics of the long form of Modern periodic table?

Ans. General characteristics of the long form of Periodic table :-

(i) There are in all 18 vertical columns i.e. 18 groups in the long form periodic table.

(ii) There are groups numbered from 1 to 18 from the left.

(iii) There are seven horizontal rows called periods.

(iv) The elements of groups 1, 2 and 13 to 17 are called main group elements.

(v) The elements of group 3 to 12 are called transition elements.

7.In short give the features of the seven periods.

Ans.First period contains 2 elements, $_{1}$H and $_{2}$ He and it is the shortest period.

Second and third periods contain 8 elements each namely $_{3}$ Li to $_{10}$Ne and $_{10}$ Na to $_{18}$Ar and is a short period.

Fourth and fifth period contains 18 elements each namely $_{19}$K to $_{36}$Kr and $_{37}$Rb to $_{54}$Xe and is a long period.

Sixth period contains 32 elements namely $_{55}$Cs to $_{86}$Rn and is the longest period.

Seventh period is incomplete. It has all other elements starting with $_{87}$Fr onwards. Elements from 93 onwards are purely synthetic and are called trans–uranium elements and is incomplete period.

8.Define electronic configuration.

Ans. The distribution of electrons into orbitals of an atom is electronic configuration.

9.What is the electronic configuration when elements are classified group wise?

Ans. 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.

10.Predict the position of the element in the periodic table satisfying the electronic configuration (n-1) d^1 ns^2 for n=4,

Ans. (n-1) d^1 ns^2 = (4-1) d^1 $4s^2$

= $3d^1$ $4s^2$

It lies in fourth period and III B group.

11.How does atomic size change in a group?

Ans.it increases from top bottom in a group.

12.Why Li and Mg show resemblance in chemical behaivour?

Ans. Due to diagonal relationship, since their atomic size, electro negativity and ionisation potential are almost the same.

13.The atomic radius of elements decreases along the period but Neon has highest size among III period element? Why

Ans. Ne is the only element in III period element which has Van der walls radius whereas the rest has covalent radius. And it is known fact that Van der walls radius is always greater than covalent radius.

14.Define valency.

Ans. The combining capacity of an element is known as valency.

15.How does valency vary in a group and period in the periodic table?

Ans. In a group, the valency of an element remains constant while in a period it increases from left to right.

16.What is the valency of noble gases?

Ans. Noble gases on the extreme right are zero valent.

17.How do metals react in a period?

Ans. The tendency of an element to lose electrons decreases in going from left to right in a period. Thus the reactivity of metals goes on decreasing in a period from left right.

18.How do metals react in a group?

Ans. the tendency to lose electrons increases as we go down a group so the reactivity of metals increases down the group.

19.What is an amphoteric oxide?

Ans. Oxides which behave as acids with bases and as a base with an acid are called amphoteric oxide.

20.Define a neutral oxide

Ans. Neutral oxides have no acidic or basic properties.

21.What is the general outer electronic configuration of f – block elements?

Ans. The general outer electronic configuration of f – block element is

$(n-2)\ f^{1-14}\ (n-1)\ d^{0-11}\ ns^2$

22.Why do Na and K have similar properties?

Ans. Na and K have similar physical and chemical properties because they have same number of valence electrons.

23.Arrange the following elements in the increasing order of metallic character: Si, Be, Mg, Na, P.

Ans. P < Si < Be < Mg < Na

CBSE Class 12 Chemistry
Important Questions
Chapter 3
Classification of Elements and Periodicity in Properties

2 Marks Questions

1.How did Mendeleev arrange the elements?

Ans. Mendeleev arranged elements in horizontal rows and vertical columns of a table in order of their increasing atomic weights in such a way that the elements with similar properties occupied the same vertical column or group.

2.Name the two elements whose existence and properties were predicted by Mendeleev though they did not exist then.

Ans. Mendeleev predicted not only the existence of gallium and germanium, but also described some of their general physical properties.

3.Give the main features of s-block elements.

Ans.S – block elements :- The elements in which the last electron enters the s – orbital of their outer most energy level are called s – block elements. It has elements of groups 1 and 2. The general electronic configuration of s – block elements is ns^{1-2}.

4.Give the main features of p-block elements.

Ans.p – block elements : The elements in which the last electron enters the p – orbital of their outermost energy level are called p – block elements. It contains elements of group 13,14, 15, 16, 17 and 18 of the periodic table. General electronic configuration of p – block elements is $ns^2\ np^{1-6}$.

5.Give the main features of d-block elements.

Ans. d – block elements :- The elements in which the last electron enters the d – orbitals of their last but one energy level constitute d – block elements. There block consists of the elements lying between s and p block starting from 4^{th} period and onwards. They constitute groups 3 to 12 in the periodic table. General electronic configuration is (n – 1) d^{1-10} ns^{1-2}.

6.Give the main features of f-block elements.

Ans. f – block elements : The elements in which the last electron enters the f – orbital of their atoms are called f – block elements. In these elements the last electron is added to the third to the outermost energy level. These consist of two series of elements placed at the bottom of the periodic table known as Lanthanoid and actinoid series. General electronic configuration is $(n-2)f^{1-14}$ $(n-1)d^{0-1}$ ns^2.

7.Explain why cations are smaller and anions are larger in radii than their parent atom?

Ans. The radius of cation is smaller than the parent atom. Cation is formed by the loss of one or more electron from the gaseous atom, but the nuclear charge remains the same. As a result, the nuclear hold on the remaining electrons increases because of the increases in the effective nuclear change per electron resulting in decrease in size.

Whereas anion is formed by the gain of one or more electrons by the gaseous atom but the nuclear charge is same though the number of electrons has increased. The effective nuclear charge per electron decrease in the anion and the cloud is held less tightly by the nucleus. This causes increase in size.

8.Define ionization enthalpy and electron gain enthalpy?

Ans. Ionization enthalpy – It represents the energy required to remove an electron from an isolated gaseous atom (x) in ground state resulting in the formation of a positive ion.

$x(g) + Energy \rightarrow x^+(g) + e^-$

Electron gain enthalpy – When an electron is added to a neutral gaseous atom (x) to convert

it into a negative ion, the enthalpy change accompanying the process is defined as the electron gain enthalpy.

$x(g) + e^- \rightarrow x^-(g)$

9.How does metalic charecter change in a group?

Ans. It increases from top to bottom in a group

10.The size of an atom can be expressed by three radii. Name them. Which of these given the highest, and the lowest value of the atomic radius of an element?

Ans. The atomic size are generally expressed in terms of the following radii covalent radius, metallic radius and Van der waal's radius.

Van der waal's radius > Metallic radius > covalent radius.

11.Among the elements B, Al, C and Si

(a) Which has the highest first ionization enthalpy?

(b) Which has the largest atomic radius?

Ans.

(a) Carbon has the highest first ionization enthalpy.

(b) Aluminum has the largest atomic radius.

12.Na^+ has higher value of ionization enthalpy than Ne, though both have same electronic configuration.

Ans. Na^+ and Ne both has 10 electrons but Na^+ having, 11 protons in its nucleus (Ne has 10 protons) exert higher effective nuclear charge and thus removal of electron from Na^+ requires more energy.

13.How does the reactivity of non–metals changes in a period and group?

Ans. The reactivity of non – metals is measured in terms of its tendency to gain electrons to form an ion. The reactivity of non – metals increases from left to right in a period whereas reactivity decreases in a group as we go down the group because the tendency to accept electrons decreases down the group.

14.Give the properties of the oxides in a particular period.

Ans. Elements on two extremes of a period easily combines with oxygen to form oxides. The normal oxide formed by the element on extreme left is the most basic (eg. Na_2O) whereas that formed by the element on extreme right is the most acidic (eg. $cl_2\ O_7$). Oxides at the centre are however amphoteric (eg. $Al_2\ O_3$) or neutral (eg. CO).

15.Why does lithium form covalent bond unlike other alkali which forms ionic bond?

Ans. Lithium forms covalent bond which is different from its group members because of its anomalous behaviour Li is small in size, large charge / radius ratio and has high electro negativity value. Also it has only $1s^2\ 2s^1$ orbital for bonding.

16.The atomic number of an element is 16. Determine its position in accordance to its electronic configuration.

Ans. The atomic number of the element is 16.

The electronic configuration of the element is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$

Thus the element belongs to 'p-block' and is placed in third period and 16^{th} group of the periodic table.

17. Why are elements at the extreme left and extreme right the most reactive?

Ans. The maximum chemical reactivity at the extreme left (among alkali metals) is exhibited due to the loss of an electron leading to the formation of a cation due to low ionization

enthalpy and at the extreme right (among halogens) shown by the gain of an electron forming an anion. Due to high electron affinity.

18. Why does the ionization enthalpy gradually decreases in a group?

Ans. In a group, the increase in atomic and ionic radii with increase in atomic number generally results in a gradual decrease in ionization enthalpies.

19. Why does electronegativity value increases across a period and decreases down period?

Ans. The attraction between the outer electrons and the nucleus increases as the atomic radius decreases in a period. The electeonegativity also increases. On the same account electronegativity value decreases with the increase in atomic radii down a group.

20.How does electronegativity and non – metallic character related to each other?

Ans. Electronegativity is directly related to the non – metallic character of elements. Electronegativity is inversely related to the metallic properties of elements. Thus the increase in electronegativities across a period is accompanied by an increase in non – metallic properties of elements. Similarly, the decrease in electronegativity down a group is accompanies by a decrease in non – metallic properties of elements.

21.Describe the main features of Mendeleev's periodic table?

Ans.(i) In Mendeleev table, the elements were arranged in vertical columns, and horizontal rows. The vertical columns were called groups and the horizontal rows were called periods.

(ii) There were in all eight groups. Group I to VIII. The group numbers were indicated by Roman numerals. Group VIII occupy three triads of the elements each i.e. in all nine elements.

(iii) There were seven periods to accommodate more elements the period 4, 5, 6 and 7 were divided into two halves. The first half of the elements were placed in the upper left corner and the second half in the lower right corner of each box.

Classification Of Elements & Periodicity In Properties

Short Answer Type Questions

1. Explain why the electron gain enthalpy of fluorine is less negative than that of chlorine.
2. All transition elements are d-block elements, but all d-block elements are not transition elements. Explain.
3. Identify the group and valency of the element having atomic number 119. Also predict the outermost electronic configuration and write the general formula of its oxide.
4. Ionisation enthalpies of elements of second period are given below :
   Ionisation enthalpy/ k cal mol^{-1} : 520, 899, 801, 1086, 1402, 1314, 1681, 2080.
   Match the correct enthalpy with the elements and complete the graph given in Fig. 3.1.
   Also write symbols of elements with their atomic number.

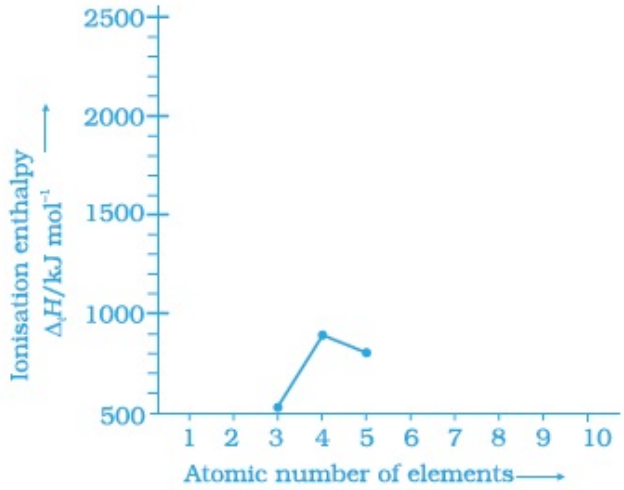

Fig. 3.1

5. 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.
6. Write four characteristic properties of p-block elements.

7. Choose the correct order of atomic radii of fluorine and neon (in pm) out of the options given below and justify your answer.
    - (i) 72, 160
    - (ii) 160, 160
    - (iii) 72, 72
    - (iv) 160, 72

8. Illustrate by taking examples of transition elements and non-transition elements that oxidation states of elements are largely based on electronic configuration.
9. Nitrogen has positive electron gain enthalpy whereas oxygen has negative. However, oxygen has lower ionisation enthalpy than nitrogen. Explain.
10. First member of each group of representative elements (i.e., s and p-block elements) shows anomalous behaviour. Illustrate with two examples.
11. 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.
12. How would you explain the fact that first ionisation enthalpy of sodium is lower than that of magnesium but its second ionisation enthalpy is higher than that of magnesium?
13. What do you understand by exothermic reaction and endothermic reaction?
    Give one example of each type.
14. Arrange the elements N, P, O and S in the order of-
    (i) increasing first ionisation enthalpy.
    (ii) increasing non metallic character.
    Give reason for the arrangement assigned.
15. Explain the deviation in ionisation enthalpy of some elements from the general trend by using Fig. 3.2.

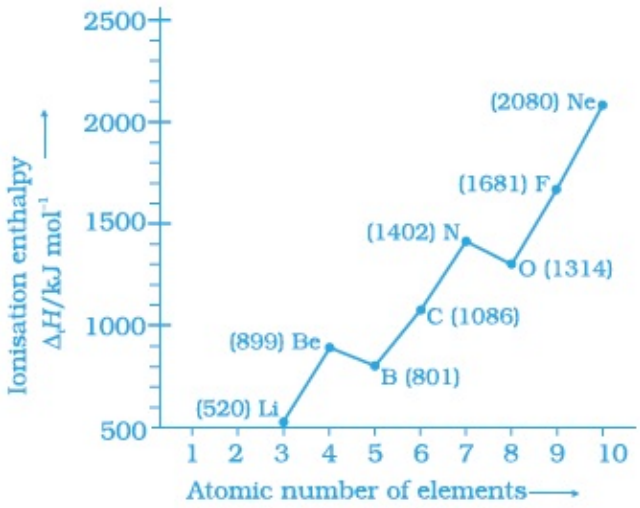

Fig. 3.2

16. Explain the following:
    - (a) Electronegativity of elements increase on moving from left to right in the periodic table.
    - (b) Ionisation enthalpy decrease in a group from top to bottom?

17. How does the metallic and non metallic character vary on moving from left to right in a period?
18. The radius of Na+ cation is less than that of Na atom. Give reason.
19. Among alkali metals which element do you expect to be least electronegative and why?

Matching Type Questions

1. Match the correct atomic radius with the element.

Element	Atomic radius (pm)
Be	74
C	88
O	111
B	77
N	66

2. Match the correct ionisation enthalpies and electron gain enthalpies of the following elements.

	Elements		ΔH_1	ΔH_2	$\Delta_{eg} H$
(i)	Most reactive non metal	A.	419	3051	– 48
(ii)	Most reactive metal	B.	1681	3374	– 328
(iii)	Least reactive element	C.	738	1451	– 40
(iv)	Metal forming binary halide	D.	2372	5251	+ 48

3. Electronic configuration of some elements is given in Column I and their electron gain enthalpies are given in Column II. Match the electronic configuration with electron gain enthalpy.

Column (I)		Column (II)	
Electronic configuration		**Electron gain enthalpy/kJ mol^{-1}**	
(i)	$1s^2\ 2s^2\ sp^6$	(A)	– 53
(ii)	$1s^2\ 2s^2\ 2p^6\ 3s^1$	(B)	– 328
(iii)	$1s^2\ 2s^2\ 2p^5$	(C)	– 141
(iv)	$1s^2\ 2s^2\ 2p^4$	(D)	+ 48

Assertion and Reason Type Questions

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.

1. 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.

2. 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.

3. Assertion (A) : Electron gain enthalpy becomes less negative as we go down a group.
   Reason (R) : Size of the atom increases on going down the group and the added electron would be farther from the nucleus.
   - (i) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
   - (ii) Assertion and reason both are correct statements and reason is correct explanation for assertion.
   - (iii) Assertion and reason both are wrong statements.

- (iv) Assertion is wrong statement but reason is correct statement.

Long Answer Type Questions

1. Discuss the factors affecting electron gain enthalpy and the trend in its variation in the periodic table.
2. Define ionisation enthalpy. Discuss the factors affecting ionisation enthalpy of the elements and its trends in the periodic table.
3. Justify the given statement with suitable examples— "the Properties of the elements are a periodic function of their atomic numbers".
4. Write down the outermost electronic configuration of alkali metals. How will you justify their placement in group 1 of the periodic table?
5. Write the drawbacks in Mendeleev's periodic table that led to its modification.
6. In what manner is the long form of periodic table better than Mendeleev's periodic table? Explain with examples.
7. Discuss and compare the trend in ionisation enthalpy of the elements of group 1 with those of group 17 elements.