PERIODIC CLASSIFICATION OF ELEMENTS

Gist of the Lesson:

Classification of Elements: The arrangement of element in such manner that element with similar properties are grouped together while elements with dissimilar properties are separated.

Early attempt to classify elements:

Dobereiner's Triads:

He arranged the elements with similar properties in a group of three known as triad in such a manner that the atomic mass of the middle element was approximately the average of the atomic masses of the other two elements

Limitations:

Only three triads were identified from the element known at that time hence this classification was as not useful.

Newland's Law of Octaves:

He arranged the element in the order of increasing atomic masses starting with hydrogen (least atomic mass) and ended with thorium having atomic mass 56. According to him, the properties of every eighth element are similar to the first element. It was compared to music notation sa,re ,ga,ma, pa ,da ,ni ,sa,and thus the name Newlands law of octaves(notes of music).

Limitations:

1. It was applicable only for lighter element having atomic mass up to 40 amu, i.e. up to calcium.
2. He believed that only 56 elements existed in nature but later on more element were discovered whose properties did not fit into Newland law of octaves.
3. Some elements having different properties were grouped together like cobalt and nickel have been placed with halogens. Due to above limitations, Newland law of octave was rejected

Mendeleev's Periodic Table:

He arranged the elements in order of increasing atomic masses, similarity in physical and chemical properties of element. Properties of hydrides and oxides of different element were studied and elements with similar properties were grouped together. He classified the elements in table consisted of vertical columns called groups and horizontal rows called periods , there were 7 groups in

table and group is subdivided into subgroups A and B except group 7 which has three sets of elements in 4th , 5th , 6th period.

Limitations of Mendeleev, Periodic Table:

1. Position of hydrogen was not assigned correctly.
2. No separate position has been given to isotopes of an element.
3. Some element having higher atomic mass are placed before the elements with lower atomic mass.

Modern Periodic Table:

Mosely modified the Mendeleev's periodic table by taking atomic number as the fundamental property instead of atomic mass. Modern periodic table consists of 18 vertical columns known as group, and 7 horizontal rows known as periods .

Groups:

Elements in group one are called Alkali Metals.

Elements in group 2 are called Alkaline Earth Metals.

Elements in group 17 are called Halogens.

Group 18 elements are called inert gases or noble gases. Significance of group in the periodic table is that an element in a group has same number of valence electron, valency and thus identical chemical properties.

Periods

1st PERIOD - 2 elements and is called Very Short Period.

2nd PERIOD - 8 elements and are called Short Period.

3rd PERIOD - 8 elements and are called Short Period.

4th PERIOD - 18 elements and are called Long Period.

5th PERIOD - 18 elements and are called Long Period.

6th PERIOD - 32 elements and are called Very Long Period.

7th PERIOD - Incomplete Period.

The number of shells present in the element indicates the period to which it belongs.

Valency:

It is defined as the combing capacity of an atom of an element to acquire noble gas configuration. It is equal to the number of electron lost, gained or shared during the formation of chemical compound

Atomic Size / Atomic Radii:

It is defined as the distance from the centre of the nucleus to the outer most cell of atom. It is generally expressed in pico meter (pm).

On moving down the group the atomic radii increases. Because on moving down the group a new energy shell is added which increases the distance between the outermost electron and the nucleus. All though the nucleus charge also increases, but it is compensated by the additional shell being added thus, increasing the size of the atom.

Across the period the atomic radii decrease. Due to the increase nuclear charge, the pull on the electron increases and hence, they are pulled closer to the nucleus thus, decreasing the atomic size. Oxides and its nature. Metal reacts with oxygen to form oxides by loss of electrons. These oxides on dissolution in water from bases.

Reactivity of Elements.

Down the group reactivity of metal increases as the tendency to lose electron increases due to the increased atomic size. Reactivity of non metals decreases down the group because of the increased atomic size and the tendency to gain electron decreases. On moving across the period the reactivity first increases due to the decreased in the metallic character and increase in nonmetallic character.

One Mark Questions (One word or one sentence)

1. How many shells are present in the elements of the second period?

A. 2 (Two)

2. State periodic law on which the Modern Periodic Table is based?

A. Physical and chemical properties of elements are periodic function of their atom: number.

3. Write the number of vertical columns in the modern periodic table. What are these columns called?

A.
- 18
- Groups

Two Marks Questions (30 words)

1. Three elements 'X', 'Y' and 'Z' having atomic numbers 11, 7 and 6 respectively react with oxygen to form their oxides.

(a) Arrange these oxides in increasing order of their basic nature. (b) Give reason for your answer.

A. $_{11}X$ = 2, 8, 1

$_{7}Y$ = 2, 5

$_{6}Z$ = 2, 4

(a) Y < Z < X

(b) X is metallic in nature hence, its oxide is basic in nature. While Y, and Z are n -metals and their oxides are acidic in nature. (In a period acidic character and basic character decreases.)

2. Calcium is an element with atomic number 20.

(i) Will it be a metal/non-metal?

(ii) What will be its valency?

(iii) What would be the formula of its chloride?

(iv) Will it be larger/smaller than K?

A. (i) Metal, (ii) Two (2), (iii) CaC12, (iv) Smaller.

3. "Elements in Periodic Table show periodicity of properties." List any four such properties?

A. (i) Atomic size. (ii) Valency or combining capacity.
(iii) Metallic property. (iv) Non-metallic property.

4. The position of three elements X, Y and Z in the Periodic Table are shown alongside.

(i) Which type of ion - cation or anion, will be formed by element X?

(ii) Which element - Y -or Z, has the atom of [04-2850 comparatively larger size? Give reason in each case.

A. (i) The valency of X is one. It has tendency to lose one electron. Therefore, X will form cation.

(ii) Y; because atomic radius decreases across a period due to increase in the electrostatic force between electrons and nucleus.

Group 1	Group 2
–	–
X	–
–	–
Y	Z

Three Marks Questions (50 words)

1. Describe the basic character of the oxide of third period elements across the period?

A. (3rd period)

Element: $_{11}Na\ _{12}Mg\ _{13}Al\ _{14}Si\ _{15}P\ _{16}S\ _{17}Cl\ _{18}Ar$

Oxide: $Na_2O\ MgO\ Al_2O_3\ SiO_2\ P_4O_{10}\ SO_2\ Cl_2O$

Basic character decreases across a period when we move left to right because:

1. Metallic character decreases across a period.
2. Electropositive character decreases across a period.

2. List the anomalies of Mendeleev's periodic table which were renamed by modern periodic law?

A. Anomalies of Mendeleev's periodic table

- Correct position of hydrogen was not assigned.
- Position of isotopes was not defined.
- Placement of heavier element before lighter element.

3. Halogens are placed in a separate group in the Modern Periodic Table.

(a) State their group number.

(b) How many valence electrons does each have?

(c) What is the type of ions formed by them /

(d) Name any two halogens.

A. (a) Group number 17

(b) Seven (7)

(c) Anion (X^- = Halide ion)

(d) Fluorine (F), Chlorine (Cl)

4. The atomic number of Na and Mg is 11 and 12 respectively and they belong to the same period.

(a) What one would have smaller atomic size?

(b) Which one would be more electropositive?

(c) To which group would each one belong?

A. (a) Magnesium (Mg) has smaller atomic size.

(b) Na would be more electropositive.

(c) Na belongs to group 1

Mg belongs to group 2

Five Marks Questions (70 words)

1. Give reason for the need of classification of elements?

A. Classification of the elements was required because:

(i) It is difficult to study each and every element individually.

(ii) When elements are classified on the basis of similar properties, we know about their uses and chemical behaviour.

(iii) It saves lot of time.

(iv) It helps in making study easier.

(v) Variation in properties of elements can be understood easily.

2. What are the important characteristics of a period in periodic table?

A. **(i) Valence Electrons:** On moving from left to right in a period, the number of valence electrons increases from one to eight (except first period where the increase is from one to two only.

(ii) Valency: The valency of elements increases from one to four, then decreases to one and becomes zero in the case of inert gases.

For example, in compounds LiCl, $BeCl_2$, BCl_3 and CCl_4, the valency of Li, Be, B and C are 1, 2, 3 and 4 respectively, whereas in compounds. NH_3, H_2O, HF, the valency of N, O, F are 3, 2 and 1 respectively.

(iii) Zero Groups: At the end of each period is the zero group element, the inert gas.

(iv) Size of Atoms: Atomic radii of the elements decrease gradually from left to right in a period because the nuclear charge increases but no extra shell is added.

(v) Metallic Character: Metallic character decreases from left to right across a period and non-metallic character increases.

(vi) Ionisation Energy: Ionisation energy increases across a period from left to right. Ionisation energy is the energy required to remove the most loosely bound electron from a neutral gaseous atom.

(vii) Chemical Reactivity: On moving from left to right in a period, the chemical reactivity of elements first 'decreases and then increases.

For example, in third period, Na is very reactive, Mg, Al are less reactive, Si is least reactive and the reactivity increases from P, S to Cl.

(viii) Oxides: The basic character of the oxides of the elements decreases and the acidic nature of oxides of the elements increases. For example, in the 3rd period starting with sodium oxide, it is highly basic in nature, the next magnesium oxide is less basic. Then comes aluminium and silicon which give amphoteric oxides. Then are the oxides of phosphorus and sulphur which are acidic. And the last chlorine oxide is highly acidic.

(ix) Electro negativity: Electro negativity increases on moving across a period from left to right. It is measure of the tendency of the element to attract electrons towards it.

3. What is a group in periodic table? What are the characteristics of a group?

A. The vertical column in the periodic table is called a group.

Characteristics of a Group:

(i) Valency: In a group all the elements have the same valency. For example, group I elements: Li, Na, K etc. all have a valency of +1. Elements of group 17: Cl, Br, I etc. all have valency of —1.

(ii) Size of Atoms: Atomic radii or the size of atoms of the element increase on going down a group. This is due to the addition of new electronic shells.

(iii) Metallic Character: On descending a group the metallic character increases. For example, groups 14 and 15 begin with carbon and nitrogen which are non-metals. These groups end with lead and bismuth respectively which are metals. The oxides of the elements become increasingly basic.

(iv) Melting and Boiling Points: The melting and boiling points of metals decrease on going down in a group. For example, the m. pts. and b. pts. of alkali metals of group 1 decrease gradually on going down the group. Li (m. pt. 180.5°C, b. pt. 1347°C), K (m. pt. 63.4°C, b. pt. 774°C). The melting points and boiling points of non-metals increase on going down in a group. For example, the melting points of the group 17 increase gradually on going down in the group. F (m. pt. —219.6°C), 12 (m. pt. 113.6°C).

(v) Ionisation Energy: Ionisation energy decreases on moving down a group with the increase in atomic number. This is because the size of the atom increases and the valency electrons are farther removed from the attractive effect of the nucleus.

(vi) Chemical Reactivity: The chemical reactivity of metals increases on going down a group. For example, in group 1 of alkali metals, the chemical reactivity increases from lithium to francium. On the other hand, the chemical reactivity of non-metals decreases on going down in a group. For example, in group 17 of halogen elements (non-metals), fluorine is most reactive and iodine is least reactive.

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