

Board – CBSE

Class – 10

Topic – Periodic Classification of Elements

1. The elements of the second period of the Periodic Table are given below:

Li Be B C N O F

(a) Give reason to explain why atomic radii decrease from Li to F.

(b) Identify the most

(i) metallic and

(ii) non-metallic element.

Answer:

(a) It is because nuclear charge increases due to increase in atomic number, therefore, force of attraction between nucleus and valence electrons increases, i.e. effective nuclear charge increases, hence atomic radii decrease from Li to F.

(b) (i) Most metallic element is 'Li' as it can lose electrons easily due to larger atomic size.

(ii) Most non-metallic element is 'F' because it can gain electrons easily due to smallest atomic size.

2. What physical and chemical properties of elements were used by Mendeleev in creating his periodic table? List two observations which posed a challenge to Mendeleev's Periodic Law.

Answer:

Atomic mass as a physical property and nature and formulae of oxide and hydride formed, and chemical property was used by Mendeleev.

Following are the two observations which posed a challenge to Mendeleev's Periodic Law.

(i) Increasing order of atomic weights could not be maintained while matching chemical properties. Chemical properties do not depend upon atomic mass.

(ii) Isotopes have different atomic mass but same chemical properties.

3. (a) Why do we classify elements?
(b) What were the two criteria used by Mendeleev in creating his Periodic Table?
(c) Why did Mendeleev leave some gaps in his Periodic Table?
(d) In Mendeleev's Periodic Table, why was there no mention of Noble gases like Helium, Neon and Argon?

(e) Would you place the two isotopes 'of chlorine, Cl-35 and Cl-37 in different slots because of their different atomic masses or in the same slot because their chemical properties are the same? Justify your answer.

Answer:

- (a) It is done so as to study the properties of elements conveniently.
 - (b) Increasing order of atomic mass and similarities in chemical properties (especially nature and formulae of oxide and hydride formed).
 - (c) These gaps were left for undiscovered elements.
 - (d) Noble gases were not invented at that time.
 - (e) They will be kept at same slot as they have same chemical properties.
4. Lithium, sodium and potassium form a Dobereiner's triad. The atomic masses of lithium and potassium are 7 and 39 respectively. Predict the atomic mass of sodium.

Answer:

$$\text{Atomic mass of Na} = \frac{7 + 39}{2} = \frac{46}{2} = 23$$

5. Why the system of classification of elements into triads was not found suitable?

Answer:

It is because all the elements discovered at that time could not be classified into triads.

6. State Mendeleev's periodic law. Write two achievements of Mendeleev's periodic table

Answer:

Mendeleev's Periodic Law: 'Properties of elements are the periodic function of their atomic masses.

Achievements:

- a. It could classify all the elements discovered at that time.
 - b. It helped in discovery of new elements.
 - c. It helped in correction of atomic mass of some of the elements.
7. (a) What is meant by periodicity in properties of elements with reference to the periodic table?
- (b) Why do all the elements of the same group have similar properties?
 - (c) How will the tendency to gain electrons change as we go from left to right across a period? Why?

Answer:

(a) The repetition of same properties after definite interval is called periodicity in properties.

(b) It is because they have same valence electrons therefore, have similar properties.

(c) Tendency to gain electrons increases from left to right in a period because atomic size goes on decreasing and effective nuclear charge increases.

8. (a) What are 'groups' and 'periods' in the 'periodic table'?

(b) Two elements M and N belong to group I and II respectively and are in the same period of the periodic table. How do the following properties of M and N vary?

Sizes of their atoms

Their metallic characters

Their valencies in forming oxides

Molecular formulae of their chlorides

Answer:

(a) The vertical columns in the periodic table are called 'groups'. The horizontal rows in the periodic table are called 'periods'.

(b)

- 'M' and 'N' belong to same period but group I and II. Therefore, 'N' will be smaller than 'M' as atomic size goes on decreasing from left to right.
- 'M' is more metallic than 'N'. Metallic character goes on decreasing from left to right as tendency to lose electrons decreases due to decrease in atomic size.
- Their valencies are 1 and 2 respectively in forming oxides. Valency goes on increasing first and then decreases.
- MCl , NCl_2 are molecular formulae of their chlorides.

9. How can the valency of an element be determined if its electronic configuration is known? What will be 'the valency of an element of atomic number 9 (nine)?

Answer:

If the element has 1, 2, 3, 4 valence electrons, its valency will be 1, 2, 3, 4 respectively.

If the element has 5, 6, 7, 8 valence electrons, its valency will be 3, 2, 1, 0. Element with atomic number 9 has electronic configuration 2, 7. So, its valency will be 1.

10. How does the electronic configuration of an atom of an element relate to its position in the modern periodic table? Explain with one example.

Answer:

- The position of element depends upon number of valence electrons which depend upon electronic configuration. Those elements which have same valence electrons, occupy same group.

- Those elements which have one valence electron belong to group 1.
Elements with two valence electrons belong to group 2.
 - Period number is equal to number of shells.
 - If valence electrons are equal to 1, it belongs to group 1. If it has 2 shells, it belongs to second period, e.g. if element 'X' has atomic number 11, its electronic configuration is 2, 8,1. It has one valence electron, it belongs to group 1 and it has three shells therefore, it is in third period.
11. The atomic numbers of three elements, X, Y and Z are 9,11 and 17 respectively. Which two of these elements will show similar chemical properties? Why?

Answer:

Electronic configuration of X, Y and Z will be:

X(9) : 2, 7

Y(11) : 2, 8, 1

Z(17) : 2, 8, 7

X and Z will show similar chemical properties due to same number of valence electrons.

12. On the basis of electronic configuration, how will you identify the first and the last element of a period?

Answer:

First element has 1 valence electron and last element has 8 valence electrons. Number of shells remains the same in the same period.

13. In the modern periodic table, the element Calcium (atomic number = 20) is surrounded by elements with atomic numbers 12, 19, 21 and 38. Which of these elements has physical and chemical properties resembling those of Calcium and why?

Answer:

Elements with atomic number 12, 38 resemble calcium in physical and chemical properties because they have same number of valence electrons and belong to same group 2.

Mg(12) : 2, 8, 2

Ca(20) : 2, 8, 8, 2

Sr(38) : 2, 8, 18, 8, 2

14. How does the metallic character of elements change along a period of the periodic table from the left to the right and why?

Answer: The metallic character goes on decreasing along a period from left to right because atomic size goes on decreasing therefore, tendency to lose electrons decreases.

15. How does the valency of elements vary
- (a) in going down a group, and
 - (b) in going from left to right in a period of the periodic table?

Answer:

- (a) Valency remains the same in a group.
- (b) Valency first goes on increasing from left to right in a period till middle of period, then decreases.

16. "Hydrogen occupies a unique position in the Modern Periodic Table". Justify the statement.

Answer:

Hydrogen resembles with both group 1 (Alkali metals) as well as group 17 (Halogens), therefore, it occupies a unique position in the Modern Periodic Table.

17. Write the formula of chlorides of Eka-silicon and Eka-aluminium, the elements predicted by Mendeleev.

Answer:

Germanium is Eka-silicon. The formula is GeCl_4 .

Gallium is Eka-aluminium. The formula is GaCl_3 .

18. Arrange the following elements in the increasing order of their metallic character: Mg, Ca, K, Ge, Ga.

Answer:

$\text{Ge} < \text{Ga} < \text{Mg} < \text{Ca} < \text{K}$ is increasing order of metallic character. It is because 'K' can lose electron more easily due to larger size whereas, 'Ge' is smallest and cannot lose electrons.

19. Atomic number of a few elements are given below.

10, 20, 7, 14

- (a) Identify the elements.
- (b) Identify the Group number of these elements in the Periodic Table.
- (c) Identify the Periods of these elements in the Periodic Table.
- (d) What would be the electronic configuration for each of these elements?
- (e) Determine the valency of these elements.

Answer:

Atomic number	Element (a)	Group no. (b)	Period (c)	Electronic configuration (d)	Valency (e)
10	Neon	18	2nd Period	2, 8	Zero
20	Calcium	2	4th Period	2, 8, 8, 2	2
7	Nitrogen	15	2nd Period	2, 5	3
14	Silicon	14	3rd Period	2, 8, 4	4

20. Three elements A, B and C have 3, 4 and 2 electrons respectively in their outermost shell. Give the group number to which they belong in the Modern Periodic Table. Also, give their valencies

Answer:

Element	Valence electrons	Group number	Valency
A	3	13	3
B	4	14	4
C	2	2	2

21. Compare the radii of two species X and Y. Give reasons for your answer.

- (a) X has 12 protons and 12 electrons
 (b) Y has 12 protons and 10 electrons

Answer:

'X' has 12 protons and 12 electrons. It has bigger atomic size as compared to 'Y' which has 12 protons and 10 electrons because effective nuclear charge is less in X than Y. Secondly, number of shells are more in 'X' than 'Y'.

Therefore,

- (a) 'X' has bigger atomic size.
 (b) Y has smaller size as compared to 'X'.

22. Arrange the following elements in increasing order of their atomic radii,

- (a) Li, Be, F, N
 (b) Cl, At, Br, I

Answer:

- (a) $F < N < Be < Li$ is increasing order of atomic size because atomic size decreases along a period from left to right.
 (b) $Cl < Br < I < At$ is increasing order of atomic size because atomic size increases down the group due to increase in number of shells.

23. Identify and name the metals out of the following elements whose electronic configurations are given below.

- (a) 2, 8, 2
- (b) 2, 8, 1
- (c) 2, 8, 7
- (d) 2, 1

Answer:

(a) Magnesium (b) Sodium (c) Chlorine (d) Lithium

Metals are (a) Magnesium, (b) Sodium and (d) Lithium as they have 1 to 3 valence electrons. Whereas, (c) chlorine is a non-metal.

24. What were the limitations of Newland's Law of Octaves?

Answer:

- Newlands' law was applicable only till calcium, after Ca, every eighth element did not possess properties similar to first.
- New elements discovered did not fit into the law.
- Wrong order of arrangement of elements was done, e.g. Co and Ni do not

25. Nitrogen (atomic number 7) and phosphorous (atomic number 15) belong to group 15 of the Periodic Table. Write the electronic configuration of the two elements. Which of the will be more electronegative? Why?

Answer:

Nitrogen atomic number 7 \rightarrow 2, 5

Phosphorus atomic number 15 \rightarrow 2, 8, 5

Nitrogen with two shells will be more electronegative because it can easily gain electron due to its smaller size of atom, the nuclear charge attracts the electron easily to become negative ion.