NCERT CBSE Solutions for Class 10 Science Chapter 5

Periodic Classification of Elements

Back of Chapter Questions

1. Which of the following statements is not a correct statement about the trends when going from left to right across the periods of periodic Table.

   (A) The elements become less metallic in nature.

   (B) The number of valence electrons increases.

   (C) The atoms lose their electrons more easily.

   (D) The oxides become more acidic.

   Solution: (C)

   (A) Metals lose their e^- easily. Going from left to right, the tendency to lose e^- decreases. Hence, the non-metallic character increases.

   (B) Going from Left to right, the number of valence electron increases.

   (C) The atoms lose their electrons more easily is incorrect because tendency to lose electrons decreases and hence, it gets more difficult to lose electrons when moving from left to right in a period.

   (D) Metal oxides are basic and non-metal oxides are acidic or neutral in nature. Going from left to right, the non-metallic character increases. Hence acidic nature of oxides increases.

2. Element X forms a chloride with the formula XCl_2, which is a solid with a high melting point. X would most likely be in the same group of the Periodic Table as

   (A) Na

   (B) Mg

   (C) AI

   (D) Si

   Solution: (B)

   Valence electron in Cl is 7. Thus a Cl atom needs to accept 1 electron in the ionic bond with X. As there are two Cl atoms, it implies that X will supply two electrons. Thus, X should have 2 electrons in its outermost shell.

   Na has 1 electron in valance shell.

   Mg has 2 electrons in valance shell

   Al has 3 electrons in valance shell

Si has 4 electrons in valance shell

X would most likely be in the same group of the periodic table as magnesium (Mg) and the formula will be $XCl_2 = MgCl_2$.

3. Which element has:

(i) Two shells, both of which are completely filled with electrons?
(ii) The electronic configuration 2, 8, 2?
(iii) A total of three shells, with four electrons in its valence shell?
(iv) A total of two shells, with three electrons in its valence shell?
(v) Twice as many electrons in its second shell as in its first shell?

Solution:

(i) Neon ($_{10}Ne$) has two shells, both of which are completely filled with electrons (2 electrons in K shell and 8 electrons in L shell)

(ii) Magnesium ($_{12}Mg$) has the electronic configuration of 2, 8, 2.

(iii) Silicon ($_{14}Si$) has a total of three shells, with four electrons in its valence shell (2 electrons in K shell, 8 electrons in L shell and 4 electrons in M shell).

(iv) Boron ($_{5}B$) has a total of two shells, with three electrons in its valence shell (2 electrons in K shell and 3 electrons in L shell).

(v) Carbon ($_{6}C$) has twice as many electrons in its second shell as in its first shell (2 electrons in K shell and 4 electrons in L shell).

4. (i) What property do all elements in the same column of the Periodic Table as boron have in common?

(ii) What property do all elements in the same column of the Periodic Table as fluorine have in common?

Solution:

(i) All the elements in the same column as boron have the same number of valence electrons (3).

$B = 2,3$

$Al = 2, 8, 3$

$Ga = 2, 8, 18, 3$

$In = 2, 8, 18, 18, 3$

$Tl = 2, 8, 18, 32, 18, 3$

Hence, they all have valency equal to 3.

(ii) All the elements in the same column as fluorine have the same number of valence electrons (7).

$F = 2, 7$

$Cl = 2, 8, 7$

$Br = 2, 8, 18, 7$

$I = 2, 8, 18, 18, 7$

$At = 2, 8, 18, 32, 18, 7$

Hence, they all have valency equal to 1.

5. An atom has electronic configuration $2, 8, 7$.

(i) What is the atomic number of this element?

(ii) To which of the following elements would it be chemically similar?

(Atomic numbers are given in parentheses.)

N(7) F(9) P(15) Ar(18)

Solution:

(i) Atomic number is equal to the number of protons, which is equal to number of electrons in a neutral atom. Since, total number of electrons will be 17 $(2 + 8 + 7)$, the atomic number of this element will be 17.

(ii) It would be chemically similar to F(9) with configuration as 2,7 as both of these have 7 valence electrons.

6. The position of three elements A, B and C in the Periodic Table are shown below:

Group 16	Group 17
–	–
–	A
–	–
B	C

(i) State whether A is a metal or non-metal.
(ii) State whether C is more reactive or less reactive than A.
(iii) Will C be larger or smaller in size than B?
(iv) Which type of ion, cation or anion, will be formed by element A?

Solution:

(i) group 16 and 17 elements are non-metal.

Group 16	Group 17
O	F

S	Cl (A)
Se	Br
Te (B)	I (C)

So, A is a non-metal.

(ii) C is less reactive than A, as reactivity decreases down the group in halogens.

(iii) C will be smaller in size than B as moving across a period, the nuclear charge increases and therefore, electrons are pulled closer to the nucleus.

(iv) A will form an anion as it has 7 electrons in its valence shell and thus, needs 1 more to complete its octet.

$A + e^- \rightarrow \underset{\text{Anion}}{A^-}$

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

Solution:

Element	K L M
Nitrogen	2, 5
Phosphorus	2, 8, 5

Nitrogen is more electronegative than phosphorus. On moving down a group, the number of shell increases. Therefore, the valence electrons move away from the nucleus and the effective nuclear charge decreases. This causes a decrease in the tendency to pull an electron in its outermost shell and hence, electronegativity decreases.

8. How does the electronic configuration of an atom relate to its position in the Modern Periodic Table?

Solution:

In the modern periodic table, atoms with similar electronic configurations are placed in the same column and atoms with the same number of shells are placed in the same period. If an element has electronic configuration of, say, 2, 8, 2, it will be placed in the 2^{nd} group and in the 3^{rd} period as it 2 valence electrons and a total of 3 shells.

9. In the Modern Periodic Table, calcium (atomic number 20) is surrounded by elements with atomic numbers 12, 19, 21 and 38. Which of these have physical and chemical properties resembling calcium?

Solution:

The element with atomic number 12 (Mg (2,8,2)) and element with atomic number 20 (calcium (2,8,8,2) have the same number of valence electrons (2). Hence, both will have similar chemical properties.

10. Compare and contrast the arrangement of elements in Mendeleev's Periodic Table and the Modern Periodic Table.

Solution:

	Mendeleev's Periodic Table		Modern Periodic Table
1.	Elements are arranged in the increasing order of their atomic masses.	1.	Elements are arranged in the increasing order of their atomic numbers.
2.	There are a total of 7 groups (columns) and 6 periods (rows).	2.	There are a total of 18 groups (columns) and 7 periods (rows).
3.	Elements having similar properties were placed directly under one another.	3.	Elements having the same number of shells are present in the same period while elements having the same number of valence electrons are present in the same group
4.	The position of hydrogen could not be explained	4.	Hydrogen is placed above alkali metals.
5.	No distinguished positions for metals and non-metals	5.	Metals are present at the left-hand side of the periodic table whereas non-metals are present at the right-hand side.

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In-Text Questions

1. Did Döbereiner's triads also exist in the columns of Newlands' Octaves? Compare and find out.

Solution:

Yes, Döbereiner's triads (ex. Li, Na and K) existed in the Newland's octaves.

If we consider lithium as the first element, the 8^{th} element from it will be sodium. Again, considering sodium as the 1st element, the 8^{th} element from it is potassium. This means that according to the Newland's law of octaves, lithium, sodium and potassium should have similar properties.

According to the law of triads, the properties of sodium is in between lithium and potassium. Thus, lithium, sodium and potassium form a Döbereiner's triad having similar chemical properties. This shows that Döbereiner's triads also exist in the columns of Newlands' octaves.

2. What were the limitations of Döbereiner's classification?

Solution:

The Döbereiner's classification had a big limitation. All the known elements couldn't be grouped into sets of 3 elements with similar properties. In fact, only 3 triads were formed, and the rest of the elements couldn't be put.

3. What were the limitations of Newlands' Law of Octaves?

Solution:

Limitations of Newlands' Law of Octaves were:

- The new elements which were discovered later did not fit into the Law of Octaves.
- Newland's law was applicable only till calcium. After Ca, every eighth element did not possess properties similar to first.
- Wrong order of arrangement of elements was done, e.g., Co and Ni do not resemble with halogens but were found together in the same slot. Fe was similar to Co and Ni but was separated and kept in a different slot.

4. Use Mendeleev's Periodic Table to predict the formulae for the oxides of the following elements:

K, C, Al, Si, and Ba.

Solution:

Element	Group No.	Formula
K	1	K_2O
C	4	CO_2
Al	3	Al_2O_3
Si	4	SiO_2
Ba	2	BaO

5. Besides gallium, which other elements have since been discovered that were left by Mendeleev in his Periodic Table? (any two)

Solution:

Besides gallium, germanium and scandium have been discovered that were left by Mendeleev.

6. What were the criteria used by Mendeleev in creating his Periodic Table?

Solution:

The criteria used by Mendeleev in creating his Periodic Table are:

(i) Elements were arranged in increasing order of their atomic masses.

(ii) All elements in a group should have similar properties.

7. Why do you think the noble gases are placed in a separate group?

Solution:

Noble gases are inert. They do not resemble other elements as they are highly unreactive and rarely get involved in chemical reactions. Since, all of the noble gases show the same properties, they are grouped separately.

8. How could the Modern Periodic Table remove various anomalies of Mendeleev's Periodic Table?

Solution:

Modern Periodic Table is based on the atomic number of elements, therefore

(i) Problem of isotopes was solved because isotopes have the same atomic number.

(ii) Wrong order of Ar, K, Co, Ni was removed in the Modern Periodic Table.

9. Name two elements you would expect to show chemical reactions similar to magnesium. What is the basis for your choice?

Solution:

Calcium and barium are two elements that will show chemical reactions similar to magnesium.

The reason being, that both of them belong to same group as magnesium. Ba and Ca have the same number of valence electrons as Mg and hence, will show same chemical properties as magnesium.

10. Name:

(i) Three elements that have a single electron in their outermost shells.
(ii) Two elements that have two electrons in their outermost shells.
(iii) Three elements with filled outermost shells.

Solution:

(i) Li (2,1), Na (2,8,1) and K (2,8,8,1)

(ii) Be (2,2) and Mg (2,8,2)

(iii) He (2), Ne (2,8) and Ar (2,8,8)

11. (i) Lithium, sodium and potassium are all metals that react with water to liberate hydrogen gas. Is there any similarity in the atoms of these elements?

(ii) Helium is an unreactive gas and neon is a gas of extremely low reactivity. What, if anything, do their atoms have in common?

Solution:

(i) All the given metals are highly reactive. So, these metals react with water to liberate hydrogen gas. They have the same number of valence electrons i.e., 1 and can readily loose electrons to become positive ions.

(ii) Helium and neon have completely filled outermost shell which makes them exceptionally unreactive and thus, stable. They are part of the noble gases.

12. In the Modern Periodic Table, which are the metals among the first ten elements?

Solution:

Among the first ten elements, Lithium and beryllium are metals.

13. By considering their position in the Periodic Table, which one of the following elements would you expect to have maximum metallic characteristic?

Ga $\longrightarrow$ Ge $\longrightarrow$ As $\longrightarrow$ Se $\longrightarrow$ Be

Solution:

We know that metallic character decreases from left to right in a period and increases down a group. Be belongs to the extreme left of periodic table. Therefore, Be is most metallic among the given elements.

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