PERIODIC CLASSIFICATION OF ELEMENTS

Question 1: *Explain Dobereiner's Triads and its drawback.*

Answer: Dobereiner classified elements into groups of three where the atomic weight of the middle element was approximately the average of the atomic weights of the other two.

Example: A triad of lithium (Atomic weight = 7),

Sodium (Atomic weight = 23),

Potassium (Atomic weight = 39)

$$\text{Mean of Li and K} = \frac{7+39}{2} = \frac{46}{2} = 23$$

This is the atomic weight of the middle element, sodium.

The two drawbacks of Dobereiner's triads are:

1) A large number of elements could not be grouped into triads. For e. g. , iron, manganese, nickel, cobalt, zinc and copper are similar elements but cannot be placed in the triads.

2) It was also observed that dissimilar elements were being grouped into triads.

Question 2: *State Newland's 'Law of Octaves'.*

Answer: When elements are arranged in ascending order of their atomic weights, every eighth element had similar physical and chemical properties and resembled the first element just like the eighth note of an octave of music resembles the first.

Question 3: *State Mendeleev's Periodic Law.*

Answer: Mendeleev's Periodic Law states that the physical and chemical properties of elements are periodic function of their atomic weights.

Question 4: *State the Modern Periodic Law.*

Answer: The Modern Periodic Law states that the physical and chemical properties of elements are a periodic function of their atomic numbers.

Question 5: *What is meant by periodicity? What is the cause of periodicity?*

Answer: The recurrence of characteristic properties of elements, arranged in the periodic table at regular intervals, is called periodicity.

Elements having similar electronic configuration have similar properties. Thus the cause of periodicity is the repetition of similar electronic configuration.

Question 6: *In the periodic table what is*
1) period
2) group?

Answer: 1) The seven horizontal rows of the periodic table are called periods.
2) The vertical columns starting from top to bottom are called groups. There are eighteen such groups in the periodic table.

Question 7: *What are normal elements and noble gases?*

Answer: The elements of group IA, IIA, IIIA, IVA, VA, VIA and VIIA are called the normal elements. These are also called typical or representative elements. Their outer most shells are incompletely filled.

Elements in the zero group are called noble gases. They have their outer most shells completely filled and hence are totally non-reactive due to their stable configuration. Examples of noble gases are helium, neon, argon, xenon, krypton and radon.

Question 8: *What is the major difference between Mendeleev's classification of elements and Moseley's classification?*

Answer: Mendeleev's classification of elements was on the basis of increasing atomic weights while Moseley's classification was on the basis of increasing atomic numbers.

Question 9: *Name three elements which were not known during the preparation of Mendeleev's Periodic Table but were more or less correctly predicted by him.*

Answer: The three elements that were correctly predicted by Mendeleev's Periodic Table are Scandium, Gallium and Germanium.

Question 10: *On what basis is Potassium (z = 19) placed in 4^{th} period and 1^{st} group?*

Answer: The electronic configuration of potassium is 2, 8, 8, 1. It has four shells so it belongs to the 4^{th} period. The 4^{th} period has elements with the 4^{th} shell being filled. K has 1 electron in its valence shell; hence it is placed in group IA. Group IA has elements with 1 electron in the valence shell. K is like other alkali metals of group I with similar properties.

Question 11: *What are valence shell electrons? How can you differentiate between metals and non-metals by the valence shell electrons?*

Answer: Valence shell electrons are the electrons in the outermost shell i. e., those on the valence shell. Metals have 1, 2 or 3 electrons in their valence shell. Non-metals have 4, 5, 6 or 7 electrons in their valence shells. The number of electrons in the valence shells can be used of differentiate between metal and non-metals.

Question 13: *Members of a particular group possess similar properties. Explain.*

Answer: The properties of an element depend on the number of valence electrons. In a particular group, all the members have the same number of valence electrons and hence they have the same properties.

Question 12: *Valency of group IA as well as VIIA with respect to hydrogen is one.Explain.*

Answer: Valency is the combining capacity of an element. Valency of metals is given by the number of electrons in the valence shell. Hence valency of group IA elements is 1. The valency increases from 1 to 4 and then decreases back to 1 along a period.

Valency of non-metals is given by: 8 - number of electrons in the valence shell Valency of group VIIA is thus 8 - 7 = 1. So the combining power of elements of group VIIA is 1 as they have one electron short of completing their octet.

Question 14: *What were the contributions of Mendeleev's table?*

Answer: 1) Mendeleev classified elements with similar properties into groups and thus simplified the study of elements.

2) He helped in correcting the atomic masses of some elements based on their positions in the periodic table. Atomic mass of beryllium was corrected from 13. 5 to 9; atomic mass of In, Au and Pt were also corrected.

3) While arranging elements, in increasing order of atomic mass, Mendeleev left spaces for undiscovered elements and predicted the existence of these elements.

Question 15: *What is meant by a 'diagonal relationship' in the modern periodic table?*

Answer: In the modern periodic table there is a striking resemblance between elements placed across each other in the periodic table i. e., diagonally opposite members. Thus, a diagonal relationship exists between the first element of a group in the second period and the element of the next group of the third period.

For example, Li of 2^{nd} period and I^{st} group resembles Mg of 3^{rd} period and II^{nd} group. Diagonal relationships result from roughly equal size of atoms and the ions e. g., equal sizes of the Li and Mg atoms and of the Li^{+} and Mg^{2+} ions.

Question 16: *Element A has atomic number 15. Find*

1) the period
2) the group it belongs to
3) its valency (valencies)
4) formula of the hydride
5) formula of the oxide

Answer: The electronic configuration of element A is 2, 8, 5

1) Period 3
2) Group VA
3) Valency 3 and 5
4) Hydride formula AH_3
5) Oxide formula A_2O_5

Question 17: *Define ionization potential.*

Answer: The amount of energy required to remove a loosely bound electron from the outermost shell of an isolated gaseous atom of an element is called its ionization potential.

Question 18: *The ionization potential of sodium is much lower than that of chlorine. Explain.*

Answer: The ionization potential of an atom depends on its atomic size and nuclear charge. The atomic size of sodium is greater than that of chlorine. The nuclear attraction exerted on the valence electrons of sodium is lesser and so its valence electrons can be lost easily. The nuclear charge also increases from Na to Cl, making the valence electrons to be firmly bound in Cl, hence the ionization potential values increases from Na to Cl.

Question 19: *Why does the atomic size decrease from sodium to chlorine in the 3rd period?*

Answer: The atomic size depends on the number of shells and the nuclear charge on the atom. Along a period i. e., from sodium to chlorine, the number of shells does not change. But the nuclear charge increases along a period. The increase in nuclear charge causes the electrons in the valence shell to be attracted more strongly by the nucleus. This causes a decrease in the atomic size from sodium to chlorine in the 3rd period.

Question 20: *Why does the size of the atom increase downward in a group?*

Answer: The size of the atom depends on the number of shells and the nuclear charge on the atom. On moving down a group, the number of shells increases causing an increase in size of the atom. The nuclear charge also increases down a group simultaneously, causing an increased attraction on the outer shell electrons. This should decrease the size of the atom.

However, the increase in size due to increasing number of shells outweighs the decreasing size due to increased nuclear charge. Thus the distance of the outermost shell from the nucleus increases and the atomic size increases. The net effect is that size increases down a group.

Question 21: *Define electron affinity.*

Answer: The amount of energy released when an atom of an element in the gaseous state accepts an electron to form an anion, is called its electron affinity.

Question 22: *Why does the element with the lowest atomic number have the greatest atomic radius in each period?*

Answer: Lower the atomic number of the element, lower is the nuclear charge. The attraction by the nucleus on the outer shell electrons is therefore less. As a result the atomic radius is the greatest of the element with lowest nuclear charge in each period.

Question 23: *Define electronegativity.*

Answer: The tendency of an element to attract the electrons more to itself when combined in a compound is called the electronegativity of that element.

Question 24: *Sodium is more reactive than lithium. Explain.*

Answer: Reactivity in alkali metals is related to the tendency to lose electrons from the valence shell. The ionization potential of sodium is lower than that of lithium as sodium is a larger atom compared to lithium. Hence electrons are more easily lost from sodium, making it more reactive than lithium.

Question 25: *Arrange the following elements:*

1) In order of increasing atomic size: Li, N, F.

2) In order of decreasing reactivity: Br, Cl, I.

Answer:

1) Order of increasing atomic size: F > N > Li

2) Order of decreasing reactivity: Cl > Br > I

Question 26: *Explain why ionization potential increases across a period.*

Answer: Ionization potential depends on atomic size and nuclear charge of the atom. Along a period atomic size decreases, thereby increasing the nuclear attraction on the outer shell electrons and holding them more strongly. Also, along a period the nuclear charge increases causing an increasing nuclear attraction for valence shell electrons. Thus the ionization potential value increases and electrons are lost less easily.

Question 27: *Arrange in order of:*

1) Increasing electron affinity: P, Na, Ar

2) Decreasing electronegativity: S, Cl, Mg

3) Increasing ionization potential: K, Cs, Li.

Answer:

1) Order of increasing electron affinity: Ar > P > Ar

2) Order of decreasing electronegativity: Cl > S > Mg

3) Order of increasing ionization potential: Cs > K > Li

Question 28: *Explain why the electron affinity of fluorine is less than that of chlorine though fluorine precedes chlorine in group VIIA.*

Answer: Fluorine is a smaller atom compared to chlorine. The 7 valence electrons in fluorine are accommodated in a smaller volume compared to chlorine. On accepting an electron, there are 8 electrons in the valence shell. This leads to increased electron repulsion in fluorine compared to the bigger atom chlorine. Hence tendency to accept electrons i. e., electron affinity is lesser in fluorine than in chlorine.

Question 29: *Explain why metallic character increases down a group?*

Answer: Metallic character depends on atomic size and ionization potential. The atomic size increases while the ionization potential decreases down a group. The more easily an element loses electrons, the more metallic is its nature, and hence the metallic character increases down a group.

Question 30: *1) Electron Affinities of two elements 'A' and 'B' are given below: A = 3. 79 eV, B = 3. 56 eV Which of them will ionize more easily and why?*

2) Why inert gases have zero electron affinity.

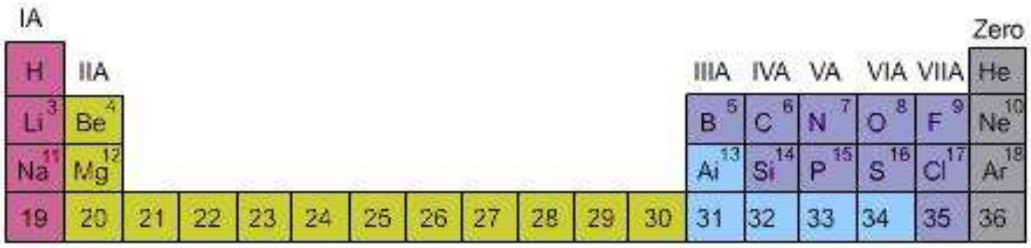
Answer: 1) Element 'A' will ionize more easily than element 'B'. The electron affinity of 'A' being higher means it will accept electrons more easily than 'B'. Thus element 'A' will form negatively charged ions more easily than element 'B'.

2) Inert gases have completely filled outmost shells (valence shells). They have a stable configuration and need not accept any electrons. Thus they have zero electron affinity.

Question 31: *Of the elements in the 3rd period, why is chlorine the most non-metallic?*

Answer: In the 3rd period, chlorine has the highest ionization potential and the smallest size (except for Argon). When the atom size is small and ionization potential is high, the non-metallic character is pronounced. Thus chlorine is the most non-metallic element.

Question 32:



1) Write the formula of the sulphate of the element with atomic number 13.

2) What type of bonding will be present in the oxide of the element with atomic number 12?

3) Which feature of the atomic structure accounts for the similarities in the chemical properties of the elements in group VIIA of the periodic table?

4) Name the element with the highest ionization potential in 2nd period.

5) How many electrons are present in the valence shell of the element with atomic number 18?

6)) What is the electronic configuration of the element in the 3rd period, which gains one electron to change into an anion?

Answer:

1) Al has configuration 2, 8, 3. Hence the valency of aluminium is +3 and that of the sulphate ion is $-2\,(SO_4^{2-})$. Thus the formula of the sulphate is $Al_2(SO_4)_3$.

2) The element with atomic number 12, has a configuration of 2, 8, 2. Thus it has a valency of +2 and is a metal. So its oxide has an electrovalent bonding.

3) All the elements in group VIIA have the same number of valence electrons, which give rise to similar chemical properties. This feature accounts for the similarities in the chemical properties of these elements.

4) The element with the highest ionization potential in 2nd period is neon.

5) The element with atomic number 18 has an electronic configuration of 2, 8, 8. So number of electrons present in its valence shell is 8.

6) The element in the 3rd period, which gains one electron to change into an anion is chlorine. Its electronic configuration is 2, 8,7.

Question 33: *What are*
1) alkali metals
2) halogens?

Answer: 1) Alkali metals are elements of group IA of the periodic table. They have one electron in their valence shell and posses low ionisation energies. This makes them lose their electrons and become highly metallic. They are called alkalis because their hydroxides are strong alkalis. Examples: Li, Na, K, Rb, Cs and Fr are alkali metals.

2) Halogens are 'salt producers'. They are elements of group VIIA and have seven electrons in their valence shell. They are typical non-metals. Examples: F, Cl, Br and I are halogens.

Question 34: *Why are alkali metals not found in the free state?*

Answer: Alkali metals are very reactive in nature. As they have one electron in their valence shell, they react very vigorously with air, oxygen, water and other substances in order to complete their octet. Hence they are found only in the combined state in nature.

Question 35: *In the third period, which is the most metallic and non-metallic element.*

Answer:

1) The most metallic element is - Na (Sodium)
2) The most non-metallic is - Cl (Chlorine).

Question 36: *How does the number of valence shell change on moving*
1) Down a group?
2) Down a period?

Answer: 1) Down a group - the number of valence shell increases.
2) Down a period - the number of valence shells remains the same.

Question 37: *Valency of the extreme right group is zero. Explain.*

Answer: Valency is the combining power of an element. Elements tend to complete their octet or duplet by combining with other elements. The extreme right elements have 8 electrons in their valence shell (except Helium which has 2, a duplet).

Their valence shell being completely filled, their octet is satisfied and they do not take part in chemical reactions. Hence their valency or combining power is zero.

Question 38: *Why are halogens not found in free state in nature?*

Answer: Halogens have one electron short of an octet. They need to complete their outer valence shell and hence are very reactive and unstable. In order to complete their octet, they take part in chemical reactions. Thus they are always found in the combined state in nature and not free.

Question 39: *Element 'Y' has electronic configuration 2, 8, 18, 32, 18, 8, 1. To which period and group does 'Y' belong?*

Answer: 'Y' belongs to group 1A since it has 1 electron in its valence shell, and 7^{th} period as it has 7 shells.

Question 40: *Why was it not possible to find a meaningful relationship between atomic mass and properties of elements?*

Answer: Properties of elements depend on the number of electrons in the valence shell. Atomic number gives the number of protons or electrons in an atom, which determine the physical and chemical properties of elements and not atomic mass. Atomic mass is the number of protons and neutrons together, which have no relationship with the properties of elements.

Question 41: *In the group of elements C, Si, Ge, Sn, Pb. Which is the most metallic and most non-metallic element?*

Answer:
1) The most metallic is - Lead (Pb)
2) The most non-metallic is - Carbon (C).

Question 42: *Give the oxides of all the 3rd period elements.*

Answer: The oxides of all the 3rd period elements are: Na_2O, MgO, Al_2O_3, SiO_2, P_2O_5, SO_3 and Cl_2O_7.

Question 43: *An element has configuration 2, 8, 6. Write the*

1) The period to which it belongs
2) The group to which it belongs
3) The formula of oxide
4) The formula of hydride

Answer:
1) The element belongs to the 3rd period
2) It belongs to group VIA
3) The formula of the oxide of the element is SO_3
4) The formula of its hydride is H_2S

Question 44: *Out of Na^+ and Na which has a smaller size and why?*

Answer: Na^+ ion has one electron less than Na atom. As a result the nuclear force of attraction overcomes the inter-electronic repulsion and pulls the electron cloud closer towards itself. Therefore Na^+ has a smaller size than Na atom.

Question 45: *Assign reasons for the following: Mg^{+2} ion is smaller than O^{2-} although both have the same electronic configuration.*

Answer: In Mg^{+2} ion nuclear force of attraction is greater than the inter-electronic repulsion whereas in O^{2-} the inter-electronic repulsion is greater than the force of attraction.