

Periodic Properties Chemistry Questions with Solutions

Q1: What is the cause of periodicity in the properties of elements?

Answer: As the elements are placed in the increasing order of atomic numbers in the periodic table, the elements with similar electronic configurations lie in the same column. This repetition of properties after some certain period is due to the similarity of electronic configurations of elements.

Q2. Elements A, B, C, D, E and F have the following electron configurations.

A: [He] $2s^2 2p^6$

B: [Ne] $3s^1$

C: [Ne] $3s^2 3p^1$

D: $1s^1$

E: [Ar] $3d^5 4s^1$

F: [Xe] $5d^4 6s^2$

State the group number of each of these elements and mention which of these belong to the same group.

Answer: Element A having 8 valence electrons belong to group 18. The elements B and D have 1 valence electron in s-subshell, hence, B and D belong to group 1. Element C has 3 valence electrons and the valence electron is in the p-subshell; therefore, C belongs to group 13. The elements E and F have 6 valence electrons in d-subshell. Hence, E and F belong to group 6.

Q3. Name the elements in Q2.

Answer: The atomic numbers of A, B, C, D, E and F are 10, 11, 13, 1, 24, and 74. The elements A, B, C, D, E and F are Neon, Sodium, Aluminium, Hydrogen, Chromium, and Tungsten.

Q4. Match the following.

- (i) Lanthanum
- (ii) Ionization Enthalpy
- (iii) Electronegativity
- (iv) Penetration Effect

- (a) $\Delta_i H$, kJ mol^{-1}
- (b) $\propto 1/\text{Ionization Enthalpy}$
- (c) Rare Earth element
- (d) \mathcal{R}

Answer: (i):(c), (ii): (a), (iii): (d), (iv): (b)

Q5. Which of the following properties has no unit?

- (a) Electron Affinity
- (b) Ionization Enthalpy
- (c) Electron potential

(d) Electronegativity

Answer: (d), Electronegativity is a measure of an atom's tendency to attract the shared pair of electrons towards itself. This is why electronegativity is a relative quantity and does not have any unit.

Q6. Why are cations smaller and anions larger than their parent atoms?

Answer: As the cations are formed by the loss of one or more electrons, the effective nuclear charge experienced by the remaining electrons increases. Hence, the size of cations are always smaller than their parent atoms. While, the size of the anions are always larger than the parent atom as the effective nuclear charge decreases due to the gain of 1 or more electrons.

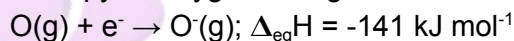
Q7. Compare the electron gain enthalpies of O, F and Cl and give reasons for your answer.

Answer: Both Oxygen and Fluorine lie in the second period. On moving from oxygen to fluorine in the period, the size decreases and the nuclear charge increases. Hence, the electron gain enthalpy (electron affinity) of Fluorine(-328 kJ mol⁻¹) is higher than that of Oxygen(-141 kJ mol⁻¹).

Even though the electron gain enthalpy decreases on going down the group, the electron affinity of Chlorine(-349 kJ mol⁻¹) is higher than Fluorine. This is due to the fact that the compact 2p subshell of Fluorine cannot hold one more electron as the electron-electron repulsion increases. Chlorine having a larger 3p subshell can accommodate one more electron with more ease than Fluorine.

Q8. Why is the second electron gain enthalpy of Oxygen positive?

Answer: The first electron gain enthalpy of Oxygen is negative:



While adding one more electron to O⁻, the electrons of O⁻ repel the incoming electron. Hence, some energy is provided to overcome these repulsions. Therefore, the second electron gain enthalpy of oxygen is positive.



Q9. Give the reason for the increasing order of reactivity in the following:

- (a) Li < Na < K < Rb < Cs (group 1 elements)
- (b) F > Cl > Br > I (group 17 elements)

Answer: Group 1 elements with only 1 valence electron have the tendency to lose it in order to achieve the nearest noble gas configuration. The tendency to lose an electron depends on the Ionization enthalpy of the element; and the Ionization enthalpy decreases on going down the group. Hence, the reactivity of group 1 elements increases on going down in the group.

While group 17 elements have the tendency to gain an electron. The gain of an electron depends upon the electron gain enthalpy and it decreases on going down from Fluorine to Iodine in the group. Hence, among group 17 elements, the reactivity decreases down the group.

Q10. What are the general electronic configurations of s, p, d and f-block elements.

Answer: The general electronic configurations for the respective elements are given below:

- (a) s-block elements: ns^{1-2} , $n= 2-7$
- (b) p-block elements: $ns^2 np^{1-6}$, $n= 2-7$
- (c) d-block elements: $(n-1)d^{1-10} ns^{0-2}$, $n= 4-7$
- (d) f-block elements: $(n-2)f^{0-14} (n-1)d^{0-2} ns^2$, $n= 6-7$

Q11. Tick the correct answer for the following:

In the modern periodic table, what does a group represent?

- (a) Principal Quantum number
- (b) Atomic number
- (c) Atomic mass
- (d) The set of subshells which are under the process of filling of electrons.

Answer: (d); The elements are distributed in the groups based on their valence electrons. For example: the valence electron of s- block elements lies in s-subshell.

Q12. Which of the following factors affect the size of the isoelectronic species?

- (a) Nuclear charge (Z)
- (b) Electronegativity (\mathcal{A})
- (c) Principal quantum number(n)
- (d) None of the above

Answer: (a); More the nuclear charge (force of attraction exerted by the nucleus), the more the electrons will be pulled towards the nucleus and smaller will be the size of the ion.

Q13. The correct order of metallic character is:

- (a) $B > Al > Mg > K$
- (b) $B > Mg > K > Al$
- (c) $K > Mg > Al > B$
- (d) $K > Al > Mg > B$

Answer: (c); On moving from left to right in a period, the metallic character decreases. Hence, the order of metallic character of K, Al and Mg is: $K > Mg > Al$. On the other hand, on going down the group, the metallic character increases. Hence, the order of metallic character becomes: $K > Mg > Al > B$

Q14. The correct order of electron gain enthalpy (electron affinity) is:

- (a) $F > Cl > Br > I$
- (b) $F > Cl < Br > I$
- (c) $F < Cl < Br < I$
- (d) $F < Cl > Br > I$

Answer: (d), The tendency to gain an electron increases on ascending the group 17 elements. This trend gets reversed in between chlorine and fluorine, in that, the negative electron gain enthalpy of chlorine is greater than that of fluorine.

Q15. The correct order of size is:

- (a) $Cl^- < Br < Br < Br^+$
- (b) $Cl^- < Br^+ < Br < Br$
- (c) $Cl^- < Br^+ < Br < Br$
- (d) $Cl^- > Br^+ < Br < Br$

Answer: (c), The size of elements increases down the group, hence, chlorine ion is the smallest. However, the size of a cation is always smaller and the size of the anion is always larger than the parent atom.

Practise Questions on Periodic Properties

Q1. What are the isoelectronic species? Arrange the following ions in the increasing order of ionic radii.

- | | |
|----------------|----------------|
| (i) Mg^{2+} | (iv) Na^{2+} |
| (ii) N^{3-} | (v) Al^{3+} |
| (iii) O^{2-} | (vi) F^- |

Answer: The species having exactly the same number of electrons are called Isoelectronic species. In the given ions, the total number of electrons is 10. The ionic radii of the isoelectronic species decreases in the increasing order of atomic numbers of elements. Hence, the increasing order of ionic radii is: $Al^{3+} < Mg^{2+} < Na^+ < F^- < O^{2-} < N^{3-}$

Q2. Must the Ionization Enthalpies of two isotopes of an element be the same or different?

Answer: Ionization enthalpy depends upon the electronic configuration and the number of protons present in an element. Since, the number of protons and electronic configuration are same in the case of isotopes, their ionization enthalpies must be the same.

Q3. Which of the following elements can show a covalency of greater than 4?

- (a) Cl
- (b) Mg
- (c) B
- (d) C

Answer: (a), because Chlorine has 7 valence electrons.

Q4. Give the reason for the following: All transition elements are d-block elements; but the converse is not true.

Answer: By definition of d-block elements, the valence electron of all the d-block elements must occupy the d-subshell of the penultimate shell. However, in some elements such as Zn, Hg and Cd, the last electron enters the s-subshell of the ultimate shell. But, since the properties of transition elements resemble the properties of d-block elements; all transition elements are d-block elements.

Q5. Choose the correct order of the vander waal radii of oxygen, fluorine, neon, and chlorine respectively.

- (a) 152, 147, 160, 175
- (b) 175, 160, 147, 152
- (c) 175, 160, 147, 152
- (d) 147, 152, 160, 175

Answer: (a), On moving down the group, the atomic radius increases; hence, the radius of chlorine is the largest among all i.e. 175. On moving left to right in a period, the atomic radius decreases except for group 18 elements. Group 18 contains noble gases which possess the largest atomic radius within a period. Hence, the order of O, F and Ne is: 152, 147, 160.