

Exercise-1

Marked questions are recommended for Revision.

PART - I : SUBJECTIVE QUESTIONS

Section (A) : Atomic and Ionic radius

- A-1. Explain why cations are smaller and anions larger in radii than their parent atoms ?
- A-2. The atomic radii of palladium and platinum are nearly same. Why ?
- A-3. In the ionic compound KF, the K^+ and F^- ions are found to have practically identical radii, about 1.34 Å each. What can you predict about the relative atomic radii of K & F ?

Section (B) : Ionisation energy

- B-1. Why second ionization enthalpy is always higher than the first ionisation enthalpy for every element ?
- B-2. The first ionization enthalpy of carbon is greater than that of boron, whereas the reverse is true for second ionization enthalpy. Explain.
- B-3. Among the elements B, Al, C and Si, (i) which element has the highest first ionisation enthalpy ?
(ii) which element has the most metallic character ?
Justify your answer in each case.

Section (C) : Electron gain enthalpy

- C-1. Be and Ne have positive values of electron gain enthalpy against the general trend in their period in Modern periodic table. Explain.
- C-2. Nitrogen has positive electron gain enthalpy whereas oxygen has negative. However, oxygen has lower ionisation enthalpy than nitrogen. Explain.

Section (D) : Electronegativity

- D-1. Among alkali metals, which element do you expect to be least electronegative ?
- D-2. Explain the following according to Modern periodic table :
(a) Electronegativity of elements increase on moving from left to right in a period.
(b) Ionisation enthalpy decrease in a group from top to bottom.

PART - II : ONLY ONE OPTION CORRECT TYPE

Section (A) : Atomic and Ionic radius

- A-1. Select correct statement about radius of an atom :
(A) Values of Vander waal's radii is larger than those of covalent radii because the Vander waal's forces are much weaker than the forces operating between atoms in a covalently bonded molecule.
(B) The metallic radii is smaller than the Vander waal's radii, since the bonding forces in the metallic crystal lattice are much stronger than the Vander waal's forces.
(C) Both (A) & (B)
(D) None of these

- A-2. Match the correct atomic radius with the element :

S.No.	Element	Code	Atomic radius (pm)
(i)	Be	(p)	74
(ii)	C	(q)	88
(iii)	O	(r)	111
(iv)	B	(s)	77
(v)	N	(t)	66

- (A) (i) – r, (ii) – q, (iii) – t, (iv) – s, (v) – p
(B) (i) – t, (ii) – s, (iii) – r, (iv) – p, (v) – q
(C) (i) – r, (ii) – s, (iii) – t, (iv) – q, (v) – p
(D) (i) – t, (ii) – p, (iii) – r, (iv) – s, (v) – q

- A-3. Choose the correct order of atomic radii of Fluorine and Neon (in pm) out of the options given below :
(A) 72, 160
(B) 160, 160
(C) 72, 72
(D) 160, 72

A-4. The size of isoelectronic species O^{2-} , F^- and Na^+ is affected by :

- (A) nuclear charge (Z)
- (B) valence principal quantum number (n)
- (C) electron-electron interaction in the outer orbitals
- (D) none of the factors because their size is the same.

A-5. Which of the following order of atomic / ionic radius is not correct ?

- (A) $F < Cl < Br < I$
- (B) $Y^{3+} > Sr^{2+} > Rb^+$
- (C) $Nb \approx Ta$
- (D) $Li > Be > B$

Section (B) : Ionisation energy

B-1. Which one of the following statements is incorrect in relation to ionisation enthalpy ?

- (A) Ionization enthalpy increases for each successive electron.
- (B) The greatest increase in ionization enthalpy is experienced on removal of electron from core of noble gas configuration.
- (C) End of valence electrons is marked by a big jump in ionization enthalpy.
- (D) Removal of electron from orbitals bearing lower n value is easier than from orbitals having higher n value.

B-2. The first ionisation enthalpies (in eV) of N & O are respectively given by :

- (A) 14.6, 13.6
- (B) 13.6, 14.6
- (C) 13.6, 13.6
- (D) 14.6, 14.6

B-3. The first ionisation enthalpies of Na, Mg, Al and Si are in the order :

- (A) $Na < Mg > Al < Si$
- (B) $Na > Mg > Al > Si$
- (C) $Na < Mg < Al < Si$
- (D) $Na > Mg > Al < Si$

B-4. Which represents alkali metals (i.e. 1st group metals) based on $(IE)_1$ and $(IE)_2$ values (in kJ/mol) ?

- | | | $(IE)_1$ | $(IE)_2$ | | $(IE)_1$ | $(IE)_2$ |
|-----|---|----------|----------|-----|----------|----------|
| (A) | X | 500 | 1000 | (B) | Y | 600 |
| (C) | Z | 550 | 7500 | (D) | M | 700 |
| | | | | | | 1400 |

B-5. Which of the following relation is correct with respect to first (I) and second (II) ionization enthalpies of potassium and calcium ?

- (A) $I_{Ca} > I_K$
- (B) $I_K > I_{Ca}$
- (C) $II_{Ca} > II_K$
- (D) $II_K > II_{Ca}$

Section (C) : Electron gain enthalpy

C-1. Among halogens, the correct order of amount of energy released in electron gain (electron gain enthalpy) is:

- (A) $F > Cl > Br > I$
- (B) $F < Cl < Br < I$
- (C) $F < Cl > Br > I$
- (D) $Cl > Br > F > I$

C-2. Which of the following will have the most negative electron gain enthalpy and which the least negative ? F, P, S, Cl.

- (A) P, Cl
- (B) Cl, F
- (C) Cl, S
- (D) Cl, P

C-3. The order of electron gain enthalpy (magnitude) of O, S and Se is :

- (A) $O > S > Se$
- (B) $S > Se > O$
- (C) $Se > S > O$
- (D) $S > O > Se$

C-4. Electronic configurations of four elements A, B, C and D are given below :

- (i) $1s^2 2s^2 2p^6$
- (ii) $1s^2 2s^2 2p^4$
- (iii) $1s^2 2s^2 2p^6 3s^1$
- (iv) $1s^2 2s^2 2p^5$

Which of the following is the correct order of increasing tendency to gain electron :

- (A) (i) < (iii) < (ii) < (iv)
- (B) (i) < (ii) < (iii) < (iv)
- (C) (iv) < (ii) < (iii) < (i)
- (D) (iv) < (i) < (ii) < (iii)

C-5. Which of the following statement is correct ?

- (A) Electron gain enthalpy may be positive for some elements.
- (B) Second electron gain enthalpy always remains positive for all the elements.
- (C) $\Delta_{eg}H(K^+) = -IE(K)$
- (D) All of these

Section (D) : Electronegativity

- D-1.** Which of the following is affected by the stable electron configuration of an atom ?
 (a) Electronegativity (b) Ionisation enthalpy (c) Electron gain enthalpy
 Correct answer is :
 (A) only electronegativity (B) only ionisation enthalpy
 (C) both electron gain enthalpy and ionisation enthalpy (D) all of the above
- D-2.** The electronegativity values of C, N, O and F on Pauling scale :
 (A) decrease from carbon to fluorine.
 (B) increase from carbon to fluorine.
 (C) increase upto oxygen and then decrease upto fluorine.
 (D) decrease from carbon to nitrogen and then increase continuously.
- D-3.** Correct order of electronegativity of N, P, C and Si on Pauling scale is :
 (A) $N > P > C > Si$ (B) $C > Si > N > P$ (C) $N < P < C < Si$ (D) $N > C > P > Si$
- D-4.** The correct order of electronegativity on Pauling scale is :
 (A) $F > Cl > O > S$ (B) $Li > Na > K > Rb > Cs$
 (C) $Be < B < N < C$ (D) Both (A) and (B)
- D-5.** Which of the following is most electronegative element.
 (A) Li (B) Mg (C) H (D) Na

PART - III : MATCH THE COLUMNS

1. Match the column.

	Column-I		Column-II
(A)	$O(g) + e^- \longrightarrow O^-(g)$	(p)	Positive Electron gain enthalpy
(B)	$O^-(g) + e^- \longrightarrow O^{2-}(g)$	(q)	Negative Electron gain enthalpy
(C)	$Na^-(g) \longrightarrow Na(g) + e^-$	(r)	Exothermic
(D)	$Mg^+(g) + e^- \longrightarrow Mg(g)$	(s)	Endothermic

Exercise-2

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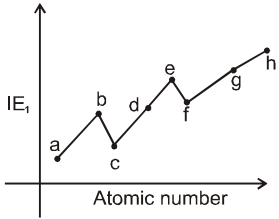
PART - I : ONLY ONE OPTION CORRECT TYPE

- 1.** When the following five anions are arranged in order of decreasing ionic radius, the correct sequence is:
 (A) $Se^{2-}, I^-, Br^-, O^{2-}, F^-$ (B) $I^-, Se^{2-}, Br^-, F^-, O^{2-}$
 (C) $Se^{2-}, I^-, Br^-, F^-, O^{2-}$ (D) $I^-, Se^{2-}, Br^-, O^{2-}, F^-$
- 2.** In which of the following compounds, manganese shows maximum radius ?
 (A) MnO_2 (B) $KMnO_4$ (C) MnO (D) $K_3[Mn(CN)_6]$
- 3.** Which of the following is the correct order of ionisation enthalpy ?
 (1) $Be^+ > Be$ (2) $Be > Be^+$ (3) $C > Be$ (4) $B > Be$
 (A) 2, 3 (B) 3, 4 (C) 1, 3 (D) 1, 4
- 4.** Considering the elements B, Al, Mg, and K, the correct order of their metallic character is :
 (A) $B > Al > Mg > K$ (B) $Al > Mg > B > K$ (C) $Mg > Al > K > B$ (D) $K > Mg > Al > B$
- 5.** Fluorine has the highest electronegativity among the ns^2np^5 group on the Pauling scale, but the electron affinity of fluorine is less than that of chlorine because :
 (A) the atomic number of fluorine is less than that of chlorine.
 (B) fluorine being the first member of the family behaves in an unusual manner.
 (C) chlorine can accommodate an electron better than fluorine by utilising its vacant 3d-orbital.
 (D) small size, high electron density and an increased electron repulsion makes addition of an electron to fluorine less favourable than that in the case of chlorine in isolated stage.

Periodic Table & Periodicity

6. Which one of the following arrangements represents the correct order of electron gain enthalpy (with negative sign) of the given atomic species ?
 (A) $\text{Cl} < \text{F} < \text{S} < \text{O}$ (B) $\text{O} < \text{S} < \text{F} < \text{Cl}$ (C) $\text{S} < \text{O} < \text{Cl} < \text{F}$ (D) $\text{F} < \text{Cl} < \text{O} < \text{S}$
7. Which of the following statement is INCORRECT ?
 (A) The tendency to attract bonded pair of electron in case of hybrid orbitals follow the order : $sp > sp^2 > sp^3$
 (B) Alkali metals generally have negative value of electron gain enthalpy.
 (C) $\text{Cs}^+(\text{g})$ releases more energy upon gain of an electron than $\text{Cl}(\text{g})$.
 (D) The electronegativity values for 2p-series elements is less than that for 3p-series elements on account of small size and high inter electronic repulsions.

PART - II : SINGLE AND DOUBLE VALUE INTEGER TYPE

1. If internuclear distance between A atoms in A_2 is 10\AA and between B atoms in B_2 is 6\AA , then calculate internuclear distance between A and B in \AA . [Electronegativity difference between A and B has negligible value].
2. Report atomic number of the element having largest size among the following :
 Ni, Cu, Zn
3. How many of following atoms have maximum ionization energy than boron.
 (i) Be (ii) N (iii) P (iv) Ga (v) S (vi) Mg
4. Where a, b, c, d, e, f, g, h are 3rd period elements. If difference between atomic number of elements b and e is x and difference between atomic number of elements c and f is y. What is the value of $x - y$.
- 
5. Values of IE_1 , IE_2 , IE_3 of an element are 9.3, 18.2 and 553.8 eV. Predict group number in Modern Periodic Table.
6. $\text{A}^-(\text{g}) \rightarrow \text{A}^{2+}(\text{g}) \quad \Delta H = 1100 \text{ KJ/mol}$
 $\text{A}(\text{g}) \rightarrow \text{A}^{2+}(\text{g}) \quad \Delta H = 1200 \text{ KJ/mol}$
 Electron gain enthalpy of A is $P \times 10^2 \text{ KJ/mol}$. What is the value of P ?
7. The electron gain enthalpy of a hypothetical element 'A' is -3 eV per atom. How much energy in kCal is released when 10 g of 'A' are completely converted to A^- ions in gaseous state ?
 (Take : $1 \text{ eV per atom} = 23 \text{ kCal mol}^{-1}$, Molar mass of A = 30 g)
8. What is atomic number of element which have maximum electron affinity in Modern Periodic table.
9. How many of the following elements are more electronegative than Boron.
 (i) H (ii) Li (iii) Be (iv) C (v) N
 (vi) O (vii) F

PART - III : ONE OR MORE THAN ONE OPTIONS CORRECT TYPE

1. Which is/are the correct order/s of atomic radius ?
 (A) $\text{Li} < \text{B} < \text{Be}$ (B) $\text{Be} < \text{B} < \text{Li}$ (C) $\text{Li} > \text{Be} > \text{B}$ (D) $\text{N} > \text{O} > \text{F}$
2. Which is/are the correct order/s of atomic radius ?
 (A) $\text{Mn} > \text{Fe} > \text{Co}$ (B) $\text{Mn} \approx \text{Fe} \approx \text{Co}$ (C) $\text{Sc} > \text{Ti} > \text{V}$ (D) $\text{Zn} < \text{Cu} < \text{Ni}$
3. Which of the following orders is(are) correct for size :
 (A) $\text{Al} \approx \text{Ga}$ (B) $\text{Te}^{2-} > \text{I}^- > \text{Cs}^+ > \text{Ba}^{2+}$
 (C) $\text{Cr}^{3+} < \text{Cr}^{6+}$ (D) $\text{Pd} \approx \text{Pt}$

4. The ionic radii depends upon in the following factors :
 (A) Charge on cation
 (B) Charge on anion
 (C) Shell number of valence shell electron(s) of the ion.
 (D) Effective nuclear charge
5. Which of the following statements is/are correct ?
 (A) The second ionization enthalpy of oxygen element is greater than that of fluorine element.
 (B) The third ionization enthalpy of phosphorus is greater than that of aluminium.
 (C) The first ionization enthalpy of aluminium is slightly greater than that of gallium.
 (D) The second ionization enthalpy of copper is greater than that of zinc.
6. Which of the following elements will gain one electron more readily in comparison to other elements of their group ?
 (A) S(g) (B) N(g) (C) O(g) (D) Cl (g)
7. Which of the following is/are correct order/s of electron affinity.
 (A) $N < C < O < F$ (B) $P < Si < S < Cl$ (C) $Si < P < S < Cl$ (D) $C < N < O < F$
8. Which of the following is correct order of electronegativity :
 (A) $Cs > Rb > Na$ (B) $Li < Be < B$ (C) $C < N < O$ (D) $Cl > F > Br$
9. Choose the correct statement(s) :
 (A) In general more the ionisation energy more will be electronegativity.
 (B) Electronegativity increase means metallic character increases.
 (C) In general lower will be the ionisation energy, easier will be to remove electron.
 (D) Electron affinity of S is less than that of Cl.

PART - IV : COMPREHENSION

Read the following passage carefully and answer the questions.

Comprehension # 1

It is not possible to measure the atomic radius precisely since the electron cloud surrounding the atom does not have a sharp boundary. One practical approach to estimate the size of an atom of a non-metallic element is to measure the distance between two atoms when they are bound together by a single bond in a covalent molecule and then dividing by two. For metals we define the term "metallic radius" which is taken as half the internuclear distance separating the metal cores in the metallic crystal. The van der waal's radius represents the over all size of the atoms which includes its valence shell in a non bonded situation. It is the half of the distance between two similar atoms in separate molecules in a solid. The atomic radius decreases across a period and increases down the group. Same trends are observed in case of ionic radius. Ionic radius of the species having same number of electrons depends on the number of protons in their nuclei. Sometimes, atomic and ionic radii give unexpected trends due to poor shielding of nuclear charge by d- and f-orbital electrons.

Now answer the following three questions :

1. Which of the following relations is correct, if considered for the same element :
 (A) $r_{\text{Vanderwaal}} > r_{\text{Covalent}} > r_{\text{Metallic}}$ (B) $r_{\text{Covalent}} > r_{\text{Metallic}} > r_{\text{Vanderwaal}}$
 (C) $r_{\text{Vanderwaal}} > r_{\text{Metallic}} > r_{\text{Covalent}}$ (D) $r_{\text{Metallic}} > r_{\text{Covalent}} > r_{\text{Vanderwaal}}$
2. K^+ , Cl^- , Ca^{2+} , S^{2-} ions are isoelectronic. The decreasing order of their size is :
 (A) $Ca^{2+} > K^+ > Cl^- > S^{2-}$ (B) $S^{2-} > Cl^- > K^+ > Ca^{2+}$
 (C) $K^+ > Cl^- > Ca^{2+} > S^{2-}$ (D) $S^{2-} > Cl^- > Ca^{2+} > K^+$
3. Select the INCORRECT option regarding atomic/ionic sizes :
 (A) $Zn > Cu$ (B) $Pb^{2+} > Pb^{4+}$ (C) $Zr \approx Hf$ (D) $N^{3-} < Al^{3+}$

Comprehension # 2

The periodicity is related to the electronic configuration. That is, all chemical and physical properties are a manifestation of the electronic configuration of the elements.

The atomic and ionic radii generally decrease in a period from left to right. As a consequence, the ionization enthalpies generally increase and electron gain enthalpies become more negative across a period. In other words, the ionization enthalpy of the extreme left element in a period is the least and the electron gain enthalpy of the element on the extreme right is the highest negative. This results into high chemical reactivity at the two extremes and the lowest in the centre. Similarly down the group, the increase in atomic and ionic radii result in gradual decrease in ionization enthalpies and a regular decrease (with exception in some third period elements) in electron gain enthalpies in the case of main group elements.

The loss and gain of electrons can be co-related with the reducing and oxidising behaviour, and also with metallic and non-metallic character respectively, of the elements.

4. The correct order of the metallic character is :
(A) $\text{Al} > \text{Mg} > \text{Na} > \text{Si}$ (B) $\text{Na} > \text{Mg} < \text{Al} > \text{Si}$ (C) $\text{Na} > \text{Mg} > \text{Al} > \text{Si}$ (D) $\text{Al} > \text{Mg} > \text{Si} > \text{Na}$
5. Considering the elements B, C, N, F, and Si, the correct order of their non-metallic character is :
(A) $\text{B} > \text{C} > \text{Si} > \text{N} > \text{F}$ (B) $\text{Si} > \text{C} > \text{B} > \text{N} > \text{F}$
(C) $\text{F} > \text{N} > \text{C} > \text{B} > \text{Si}$ (D) $\text{F} > \text{N} > \text{C} > \text{Si} > \text{B}$
6. Which of the following statement is correct ?
(A) Ionisation enthalpies of elements decrease along a period and increase along a group in Modern periodic table.
(B) In the 3rd period of Modern periodic table, the two most reactive elements are sodium and fluorine.
(C) Fluorine has the least negative electron gain enthalpy among all halogens.
(D) Ionisation enthalpy of Pb is greater than that of Sn.

Comprehension # 3

Answer Q.7, Q.8 and Q.9 by appropriately matching the information given in the three columns of the following table.

Column-1		Column-2		Column-3	
(I)	Graphite	(i)	d-block elements	(P)	Liquid
(II)	Transition elements	(ii)	Group-16	(Q)	$6s^2 6p^4$
(III)	Amalgam	(iii)	Allotropy	(R)	Lubricant
(IV)	Polonium	(iv)	Mercury	(S)	Variable oxidation number.

7. For given content is column-1, the correct combination is :
(A) (I), (iii), R (B) (II), (iv), R (C) (II), (iii), S (D) (IV), (iv), Q
8. For iron the correct combination is :
(A) (III), (iv), Q (B) (II), (i), S (C) (IV), (i), Q (D) (I), (ii), P
9. The incorrect combination is :
(A) (III), (iv), P (B) (III), (i), S (C) (II), (ii), S (D) (IV), (ii), Q

Exercise-3

* Marked Questions may have more than one correct option.

PART - I : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

1. The incorrect statement among the following is : [JEE-1997(Cancelled), 2/200]
(A) the first ionization energy of Al is less than first ionization energy of Mg.
(B) the second ionization energy of Mg is greater than second ionization energy of Na.
(C) the first ionization energy of Na is less than first ionization energy of Mg.
(D) the third ionization energy of Mg is greater than third ionization energy of Al.
2. Arrange the following ions in order of their increasing size : Li^+ , Mg^{2+} , K^+ , Al^{3+} . [JEE-1997, 1/100]

3. **Assertion** : F atom has a less negative electron affinity than Cl atom. [JEE-1998, 2/200]
Reason : Additional electrons are repelled more effectively by 3p electrons in Cl atom than by 2p electrons in F atom.
 (A) Both Assertion and Reason are true, and Reason is the correct explanation of Assertion.
 (B) Both Assertion and Reason are true, but Reason is not correct explanation of Assertion.
 (C) Assertion is true but Reason is false.
 (D) Assertion is false but Reason is true.
4. The correct order of radii is : [JEE-2000, 1/35]
 (A) $N < Be < B$ (B) $F^- < O^{2-} < N^{3-}$ (C) $Na < Li < K$ (D) $Fe^{3+} < Fe^{2+} < Fe^{+4}$
5. **Assertion** : The first ionization energy of Be is greater than that of B. [JEE-2000, 1/35]
Reason : 2p orbital is lower in energy than 2s.
 (A) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
 (B) Both Assertion and Reason are true but Reason is not correct explanation of Assertion.
 (C) Assertion is true but Reason is false.
 (D) Assertion is false but Reason is true.
6. The set representing the correct order of first ionization potential is : [JEE-2001, 1/35]
 (A) $K > Na > Li$ (B) $Be > Mg > Ca$ (C) $B > C > N$ (D) $Ge > Si > C$
7. Identify the least stable ion amongst the following : [JEE-2002, 3/90]
 (A) Li^- (B) Be^- (C) B^- (D) C^-
8. Among the following, the number of elements showing only one non-zero oxidation state is : [JEE 2010, 3/163]
 O, Cl, F, N, P, Sn, Tl, Na, Ti

PART - II : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

JEE(MAIN) OFFLINE PROBLEMS

1. Which one of the following ions has the highest value of ionic radius ? [AIEEE-2004, 3/225]
 (1) Li^+ (2) B^{3+} (3) O^{2-} (4) F^-
2. The formation of the oxide ion $O^{2-}_{(g)}$ requires first an exothermic and then an endothermic step as shown below :
 $O_{(g)} + e^- = O^-_{(g)} ; \Delta H^\circ = -142 \text{ kJmol}^{-1}$
 $O^-_{(g)} + e^- = O^{2-}_{(g)} ; \Delta H^\circ = 844 \text{ kJmol}^{-1}$
 This is because : [AIEEE-2004, 3/225]
 (1) oxygen is more electronegative.
 (2) oxygen has high electron affinity.
 (3) O^- ion will tend to resist the addition of another electron.
 (4) O^- ion has comparatively larger size than oxygen atom.
3. In which of the following arrangements the order is NOT according to the property indicated against it ? [AIEEE-2005, 3/225]
 (1) $Al^{3+} < Mg^{2+} < Na^+ < F^-$ – increasing ionic size
 (2) $B < C < N < O$ – increasing first ionisation enthalpy
 (3) $I < Br < F < Cl$ – increasing electron gain enthalpy (with negative sign)
 (4) $Li < Na < K < Rb$ – increasing metallic radius
4. Which of the following factors may be regarded as the main cause of lanthanide contraction ? [AIEEE 2005, 4½ / 225]
 (1) Greater shielding of 5d electrons by 4f electrons.
 (2) Poorer shielding of 5d electron by 4f electrons.
 (3) Effective shielding of one of 4f electrons by another in the sub-shell.
 (4) Poor shielding of one of 4f electron by another in the sub-shell.

Periodic Table & Periodicity

5. The lanthanide contraction is responsible for the fact that : [AIEEE-2005, 3/225]
(1) Zr and Y have about the same radius (2) Zr and Nb have similar oxidation state
(3) Zr and Hf have about the same radius (4) Zr and Zn have same oxidation state.
6. The increasing order of the first ionization enthalpies of the elements B, P, S and F (lowest first) is : [AIEEE-2006, 4/220]
(1) $F < S < P < B$ (2) $P < S < B < F$ (3) $B < P < S < F$ (4) $B < S < P < F$
7. Lanthanoid contraction is caused due to : [AIEEE-2006, 4/220]
(1) the appreciable shielding on outer electrons by 4f electrons from the nuclear charge
(2) the appreciable shielding on outer electrons by 5f electrons from the nuclear charge
(3) the same effective nuclear charge from Ce to Lu
(4) the imperfect shielding on outer electrons by 4f electrons from the nuclear charge
8. The set representing the correct order of ionic radius is : [AIEEE-2009, 4/144]
(1) $Na^+ > Li^+ > Mg^{2+} > Be^{2+}$ (2) $Li^+ > Na^+ > Mg^{2+} > Be^{2+}$
(3) $Mg^{2+} > Be^{2+} > Li^+ > Na^+$ (4) $Li^+ > Be^{2+} > Na^+ > Mg^{2+}$
9. The correct sequence which shows decreasing order of the ionic radii of the elements is : [AIEEE-2010, 4/144]
(1) $Al^{3+} > Mg^{2+} > Na^+ > F^- > O^{2-}$ (2) $Na^+ > Mg^{2+} > Al^{3+} > O^{2-} > F^-$
(3) $Na^+ > F^- > Mg^{2+} > O^{2-} > Al^{3+}$ (4) $O^{2-} > F^- > Na^+ > Mg^{2+} > Al^{3+}$
10. The correct order of electron gain enthalpy with negative sign of F, Cl, Br and I, having atomic number 9, 17, 35 and 53 respectively, is:
(1) $F > Cl > Br > I$ (2) $Cl > F > Br > I$ (3) $Br > Cl > I > F$ (4) $I > Br > Cl > F$
11. The increasing order of the ionic radii of the given isoelectronic species is : [AIEEE-2012, 4/144]
(1) $Cl^-, Ca^{2+}, K^+, S^{2-}$ (2) $S^{2-}, Cl^-, Ca^{2+}, K^+$
(3) $Ca^{2+}, K^+, Cl^-, S^{2-}$ (4) $K^+, S^{2-}, Ca^{2+}, Cl^-$
12. Which of the following represents the correct order of increasing first ionization enthalpy for Ca, Ba, S, Se and Ar ?
(1) $Ca < S < Ba < Se < Ar$ (2) $S < Se < Ca < Ba < Ar$ [JEE(Main)-2013, 4/120]
(3) $Ba < Ca < Se < S < Ar$ (4) $Ca < Ba < S < Se < Ar$
13. The first ionisation potential of Na is 5.1 eV. The value of electron gain enthalpy of Na^+ will be : [JEE(Main)-2013, 4/120]
(1) -2.55 eV (2) -5.1 eV (3) -10.2 eV (4) +2.55 eV
14. The ionic radii (in Å) of N^{3-} , O^{2-} and F^- are respectively : [JEE(Main)-2015, 4/120]
(1) 1.36, 1.40 and 1.71 (2) 1.36, 1.71 and 1.40
(3) 1.71, 1.40 and 1.36 (4) 1.71, 1.36 and 1.40
15. Which of the following atoms has the highest first ionization energy? [JEE(Main)-2016, 4/120]
(1) Na (2) K (3) Sc (4) Rb
16. The group having isoelectronic species is : [JEE(Main)-2017, 4/120]
(1) O^-, F^-, Na, Mg^+ (2) O^{2-}, F^-, Na, Mg^{2+} (3) O^-, F^-, Na^+, Mg^{2+} (4) $O^{2-}, F^-, Na^+, Mg^{2+}$

JEE(MAIN) ONLINE PROBLEMS

1. Which of the following arrangements represents the increasing order (smallest to largest) of ionic radii of the given species O^{2-} , S^{2-} , N^{3-} , P^{3-} ? [JEE(Main) 2014 Online (15-04-14), 4/120]
(1) $O^{2-} < N^{3-} < S^{2-} < P^{3-}$ (2) $O^{2-} < P^{3-} < N^{3-} < S^{2-}$
(3) $N^{3-} < O^{2-} < P^{3-} < S^{2-}$ (4) $N^{3-} < S^{2-} < O^{2-} < P^{3-}$
2. Which one of the following has largest ionic radius ? [JEE(Main) 2014 Online (19-04-14), 4/120]
(1) Li^+ (2) O_2^{2-} (3) B^{3+} (4) F^-
3. In the long form of the periodic table, the valence shell electronic configuration of $5s^2 5p^4$ corresponds to the element present in : [JEE(Main) 2015 Online (10-04-15), 4/120]
(1) Group 17 and period 6 (2) Group 17 and period 5
(3) Group 16 and period 6 (4) Group 16 and period 5

4. The following statements concern elements in the periodic table. Which of the following is true?
[JEE(Main) 2016 Online (10-04-16), 4/120]
- The Group 13 elements are all metals.
 - All the elements in Group 17 are gases.
 - Elements of Group 16 have lower ionization enthalpy values compared to those of Group 15 in the corresponding periods.
 - For Group 15 elements, the stability of +5 oxidation state increases down the group.
5. Consider the following ionization enthalpies of two elements 'A' and 'B'
- | Element | Ionization enthalpy (kJ/mol) | | |
|---------|------------------------------|-----------------|-----------------|
| | 1 st | 2 nd | 3 rd |
| A | 899 | 1757 | 14847 |
| B | 737 | 1450 | 7731 |
- Which of the following statements is correct ? [JEE(Main) 2017 Online (08-04-17), 4/120]
- Both 'A' and 'B' belong to group-1 where 'B' comes below 'A'.
 - Both 'A' and 'B' belong to group-2 where 'A' comes below 'B'.
 - Both 'A' and 'B' belong to group-2 where 'B' comes below 'A'.
 - Both 'A' and 'B' belong to group-1 where 'A' comes below 'B'.
6. The electronic configuration with the highest ionization enthalpy is :
[JEE(Main) 2017 Online (09-04-17), 4/120]
- [Ne] 3s² 3p¹
 - [Ne] 3s² 3p²
 - [Ne] 3s² 3p³
 - [Ar] 3d¹⁰ 4s² 4p³
7. For Na⁺, Mg²⁺, F⁻ and O²⁻ ; the correct order of increasing ionic radii is :
[JEE(Main) 2019 Online (15-04-18), 4/120]
- O²⁻ < F⁻ < Na⁺ < Mg²⁺
 - Na⁺ < Mg²⁺ < F⁻ < O²⁻
 - Mg²⁺ < Na⁺ < F⁻ < O²⁻
 - Mg²⁺ < O²⁻ < Na⁺ < F⁻
8. In general, the properties that decrease and increase down a group in the periodic table, respectively, are :
[JEE(Main) 2019 Online (09-01-19), 4/120]
- atomic radius and electronegativity
 - electronegativity and atomic radius
 - electron gain enthalpy and electronegativity
 - electronegativity and electron gain enthalpy
9. The effect of lanthanoid contraction in the lanthanoid series of elements by an and large means :
[JEE(Main) 2019 Online (10-01-19), 4/120]
- increase in atomic radii and decrease in ionic radii
 - decrease in both atomic and ionic radii
 - increase in both atomic and ionic radii
 - decrease in atomic radii and increase in ionic radii
10. The electronegativity of aluminium is similar to :
[JEE(Main) 2019 Online (10-01-19), 4/120]
- Lithium
 - Carbon
 - Boron
 - Beryllium
11. The correct order of the atomic radii of C, Cs, Al, and S is:
[JEE(Main) 2019 Online (11-01-19), 4/120]
- C < S < Al < Cs
 - S < C < Al < Cs
 - S < C < Cs < Al
 - C < S < Cs < Al
12. The correct option with respect to the Pauling, electronegativity values of the elements is :
[JEE(Main) 2019 Online (11-01-19), 4/120]
- Te > Se
 - Ga < Ge
 - Si < Al
 - P > S
13. The element with Z = 120 (not yet discovered) will be an/a :
[JEE(Main) 2019 Online (12-01-19), 4/120]
- transition metal
 - alkali metal
 - alkaline earth metal
 - inner-transition metal

Answers

EXERCISE - 1

PART - I

- A-1.** The ionic radius of a cation is always smaller than the parent atom because the **loss of one or more electrons increases the effective nuclear charge (Z_{eff})**. As a result, the **force of attraction of nucleus for the remaining electrons increases and hence the electron cloud contracts** and ionic radii decreases.
- In contrast, the ionic radius of an anion is always larger than its parent atom because the **addition of one or more electrons decreases the effective nuclear charge (Z_{eff})**. As a result, the **force of attraction of the nucleus for the remaining electrons decreases and hence electron cloud expands** and the ionic radii increases.
- A-2.** Due to lanthanide contraction (poor shielding of nuclear charge by 4f-electrons), atomic radii of 4d and 5d elements are nearly same.
- A-3.** Atomic radius of K is larger than F because the size of cation is smaller than its parent atom while size of anion is bigger than its parent atom. Thus, atomic radii of K will be greater than 1.34 \AA while atomic radii of F will be less than 1.34 \AA .
- B-1.** Electron is more tightly bound by the nucleus in an cation (i.e. M^+) as the number of proton remains the same as in neutral atom whereas number of electron is one less than the proton. This increases the attraction between the valence shell electrons and the nucleus (Z_{eff} increases). So, second ionization enthalpy is always higher than the first ionisation enthalpy for every element.
- B-2.** Carbon has higher IE_1 because of smaller atomic size and greater Z_{eff} . Removal of second electron from stable $1s^2 2s^2$ configuration in case of B^+ requires greater energy. So, B has greater IE_2 .
- B-3.** (i) C (ii) Al
- C-1.** In Be, the extra electron is to be added in 2p orbital because 2s orbital is completely filled and in Ne, it is to be added to a noble gas configuration. Since full-filled orbitals and noble gas configuration are more stable, reluctance in accepting the electron is found. So, they have positive values of electron gain enthalpy.
- C-2.** Nitrogen has stable half filled configuration $2s^2 2p^3$. So removal of one electron will require more energy than oxygen. Similarly, in nitrogen, addition of one electron will require energy (endothermic) while in oxygen, addition of one electron will release energy (exothermic).
- D-1.** Caesium (Cs).
- D-2.** (a) On moving left to right in a period, tendency of an atom to attract the shared electron pair towards itself increases due to increasing Z_{eff} . So, electronegativity of elements increase on moving from left to right in a period.
(b) On moving top to bottom in a group, size increases due to addition of extra shells. So, attraction of nucleus outermost electron decreases. So, ionisation enthalpy decrease in a group from top to bottom.

PART - II

- | | | | | |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| A-1. (C) | A-2. (C) | A-3. (A) | A-4. (A) | A-5. (B) |
| B-1. (D) | B-2. (A) | B-3. (A) | B-4. (C) | B-5. (D) |
| C-1. (C) | C-2. (D) | C-3. (B) | C-4. (A) | C-5. (D) |
| D-1. (C) | D-2. (B) | D-3. (D) | D-4. (B) | D-5. (C) |

PART - III

1. (A - q,r) ; (B - p,s) ; (C - s) ; (D - q,r)

EXERCISE - 2

PART - I

- | | | | | |
|--------|--------|--------|--------|--------|
| 1. (D) | 2. (C) | 3. (C) | 4. (D) | 5. (D) |
| 6. (B) | 7. (D) | | | |

PART - II

- | | | | | |
|------|-------|--------------|-----------------------|------|
| 1. 8 | 2. 30 | 3. 2 (i, ii) | 4. 0 | 5. 2 |
| 6. 1 | 7. 23 | 8. 17 | 9. 5 (except ii, iii) | |

PART - III

- | | | | | |
|---------|---------|----------|-----------|----------|
| 1. (CD) | 2. (BC) | 3. (ABD) | 4. (ABCD) | 5. (ABD) |
| 6. (AD) | 7. (AB) | 8. (BC) | 9. (ACD) | |

PART - IV

- | | | | | |
|--------|--------|--------|--------|--------|
| 1. (C) | 2. (B) | 3. (D) | 4. (C) | 5. (C) |
| 6. (D) | 7. (A) | 8. (B) | 9. (C) | |

EXERCISE - 3

PART - I

- | | | | |
|--------|---|--------|--------|
| 1. (B) | 2. $\text{Al}^{3+} < \text{Mg}^{2+} < \text{Li}^+ < \text{K}^+$ | 3. (C) | 4. (B) |
| 5. (C) | 6. (B) | 7. (B) | 8. 2 |

PART - II

JEE(MAIN) OFFLINE PROBLEMS

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|---------|---------|---------|---------|---------|
| 1. (3) | 2. (3) | 3. (2) | 4. (4) | 5. (3) |
| 6. (4) | 7. (4) | 8. (1) | 9. (4) | 10. (2) |
| 11. (3) | 12. (3) | 13. (2) | 14. (3) | 15. (3) |
| 16. (4) | | | | |

JEE(MAIN) ONLINE PROBLEMS

- | | | | | |
|---------|---------|---------|--------|---------|
| 1. (1) | 2. (2) | 3. (4) | 4. (3) | 5. (3) |
| 6. (3) | 7. (3) | 8. (2) | 9. (2) | 10. (4) |
| 11. (1) | 12. (2) | 13. (3) | | |