Class:- 8

Chemical Bonding

Lattice Enthalpy, Crystal Structures, Fajan's Rules, Polarizing Power

Teaching Task

JEE Main Level Questions

Q1) Ans:- b.

Solution:- When an ionic bond forms, the positive ion (cation) can slightly distort the electron cloud of the negative ion (anion), leading to a small degree of electron sharing, which is considered a covalent characteristic, this phenomenon is called "ion polarization".

Q2) Ans:- a.

Solution:- Lattice energy is defined as the heat of formation for ions of opposite charge in the gas phase to combine into an ionic solid. It is directly proportional to the charge on the ions and inversly proportional to the size of the ions.

Q3) Ans:- C.

Solution:- Lattice Energy, $U = K\left(\frac{1}{r_a + r_c}\right)$

r_a - radius of anion, r_b - radius of cation.

Q4) Ans:- a

Solution:- Cations with 18-electrons shell have greater polarising power than the cations with 8-electron shell.

Q5) Ans:- I

Solution:- The melting point of a compound depends on the strength of the ionic bonds in the crystal lattice. While the crystal radii of Ag^+ and K^+ are similar, the melting points of AgCl (455°C) and KCL (776°C) differ significantly due to bond strength, lattic energy.

Q6) Ans:- C

Solution:- According to Fajan's rules of polarisation, more the size of anion, more easily it will be polarised. Less the size of cation, more will be it's polaring power and hence, compound will be more covalent

Q7) Ans:- B

Solution:- The polarizability of halide ions increases with increase in their size and hence the covalent nature also increases.

$AlF_3 < AlCl_3 < AlBr_3 < AlI_3$.

Q8) Ans:- C.

Solution:- A smaller cation has a greater polarizing power.

LiCl > NaCl > KCl > RbCl > CsCl.

Q9) Ans:- A

Solution:-

Smaller the size and higher the charge on cation will have higher polarizing power and thus can polarize the electron charge density of the nearby anion to a greater extent. For anions will larger size and high charge, polarizability will be high.

Q10) Ans:- 3.

Solution:- Energy is released when the crystal lattice is formed, making this process exothermic.

JEE Advanced Level Questions

Q11) Ans:- A, B, C.

Solution:- The Born-Haber Cycle can applied to determine the lattice energy of an ionic solid; ionization energy, Electron affinity, dissociation energy, sublimation energy, heat of formation, and Hess's Law.

Q12) Ans:- 2, 3

Solution:- Size of the cation increases ionic character, so RbCl is more ionic.

The compound having least ionic character is $BeCl_2$

Q13) Ans:- 1

Solution:- Compounds with a full inert gas configuration tend to be more ionic.

Q14) Ans:- 4

Solution:- The most covalent halide is AlI_3.

Since lesser the electronegativity difference, more covalent is the aluminium halide. Hence the most covalent halide among the given option is aluminium iodide (AlI_3).

Q15) Ans:- 3.

Solution:-

Small size & large charge of cation favourable for high polarization.

$Na = +1$, $Mg = +2$, $Al = +3$

Aluminium has maximum charge.

Q16) Ans:- 4.

Solution:- Covalent character increases, melting point decreases, thus order of melting point is:

$CaF_2 > CaCl_2 > CaBr_2 > CaI_2$

Matrix Matching

Q17) Ans:- a) 2 b) 4 c) 1 d) 3.

Solution:-

a) Ionic nature $\propto$ 2) Size of cation

b) Size of anion increases $\propto$ 4) Polarization increases

c) Greater is the polarization $\propto$ 1) More is covalent character.

d) Magnitude on cation decreases 3) Polarization decreases.

Integer Type

Q18) Ans:- 51.5%.

Solution:- Percentage of ionic character $= \left[1 - e^{-\frac{\Delta X^2}{4}}\right] \times 100$

$\Delta X = 1.7$

Ionic character % $= \left[1 - e^{-\frac{(1.7)^2}{4}}\right] \times 100$

$= [1 - 0.485] \times 100$

$= 0.515 \times 100 = 51.5\%$.

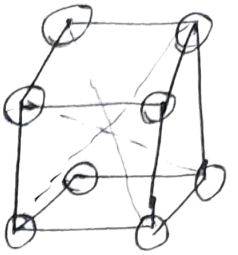
Learners Task.

Q1) Ans:- 12

Solution:- Each constituent particle in a fcc lattice is surrounded by 4 particles in the plane, 4 particles above it & 4 particles below it. The coordination number of an atom in a fcc lattice lattice is 12.

Q2) Ans:- 1

Solution:- Cs is in centre (due to its large size) and Cl are at corners of the cube (i.e, 8 Cl as 8 corners).



Q3) Ans:- 4.

Solution:- Down the periodic table, generally the size of atom increases.

Carbon will be smaller size compared to Aluminium. So carbon has more polarizing power.

CCl_4 will have maximum covalent character.

Q4) Ans:- 4.

Solution:- Be has the smallest size, $BeCl_2$ will have maximum covalent character.

Q5) Ans:- 2

Solution:- Beryllium (Be) has a tendency to form covalent compounds.

Q6) Ans:- 3.

Solution:- Polarization introduces covalent character in a molecule.

Q7) Ans:- B.

Solution:- A higher positive charge increases the cation's polarizing power increases.

Q8) Ans:- B.

Solution:- Smaller is the size of a cation, the more better it can hold the proton in its nucleus.

Al^{3+} has more polarizing power.

Q9) Ans:- D.

Solution:- Aluminium Iodide (AlI_3) has more covalent nature because it has more anion size.

Q10) Ans:- C

Solution:- According to fajan's rules, a covalent bond is favored by a small cation and large anion.

JEE Main Level Questions

Q1) Ans:- D

Solution:- Polarisability $\propto$ size of the anion.

$F^- < Cl^- < Br^- < I^-$

Q2) Ans:- A

Solution:- Polarising power of Cation $\propto \frac{\text{Charge}}{\text{radius}}$

Size of cation decreases polarizing power increases.

Q3) Ans:- I

Solution:- Greater the size of anion, greater is its polarizability. Higher is the covalent nature, lower is the melting point.

Q4) Ans:- 4.

Solution:- Size of cation $\propto$ Ionic nature

$\rightarrow$ Ionic nature $\propto \frac{1}{\text{size of anion.}}$

$\rightarrow$ Ionic nature $\propto \frac{1}{\text{charge on cation.}}$

Q5) Ans:- 1.

Solution:- The number of oppositely charged ions surrounding an ion at the nearest possible distances in an ionic crystal is called the Coordination Number

JEE Advanced level Questions

Q6) Ans:- 1, 2, 3, 4

Solution:- The Born-Haber cycle is a series of steps used to calculate the lattice energy of an ionic compound. The cycle involves

1) Sublimation Energy 2) Ionization Energy

3) Electron affinity 4) Lattice Energy.

Q7) Ans:- 1, 2, 3.

Solution:- A larger cation & a smaller anion leads to greater polarisation, which in turn increases the covalent character of the bond, and a higher charge on the cation also increases its polarizing power.

Q8) Ans:- 1

Solution:- A cation with a pseudo inert gas configuration tends to form more covalent bonds due to greater polarization of the anion compared to a cation with a true inert gas configuration.

Q9) Ans:- 4

Solution:- The overall change in energy is determined by breaking the process into steps and adding changes in each step. The Born-Haber cycle is based on Hess's law and its application of ionic solid.

Q10) Ans:- -124 KJ/mole

Solution:- Born Haber cycle as a special case of Hess's law which state that the overall energy change in a chemical process can be calculated by breaking down the process into several steps and adding the energy change from each step.

$$\Delta H_r = 2\times 90 + 2\times 418 + 436 - (2\times 78) - (2\times 740)$$

$$= -124 \text{ KJ/mole}$$

Matrix Matching

Q11) Ans:- a) 3 b) 4 c) 2 d) 1.

Solution:-

a) Co-ordination Number in NaCl → 3) 6

b) Co-ordination Number in CsCl → 4) 8

c) Lattice Arrangement → 2) Unit cell.

d) Coordination Number → 1) Radius ratio of the ionic crystal.

Integer Type

Q12) Ans:- 1.7

Solution:- For a Covalent compound, the electronegativity difference is generally considered to be less than 1.7

Q13) Ans:- Zero.

Solution:- When applying Hess's law to the formation of a solid ionic compound, the total energy or summation in the cycle is Zero.