B.Sc.I Part I Semester I
Chemistry Paper I
Inorganic Chemistry

2.Chemical Bonding and Molecular Structure

A) Ionic Bonding

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Bond – A strong force that joins atoms or ions together in molecules and giant lattices.

Compound ion – An ion made up of a group of atoms, rather than one single atom.

Ionic bond – The electrostatic force of attraction between oppositely charged ions.

Ionic compound – A compound made up of ions.

Ionic lattice – A giant 3D structure of closely packed, oppositely-charged ions.

Negative ion – An atom or group of atoms that has gained electrons and so has a negative charge.

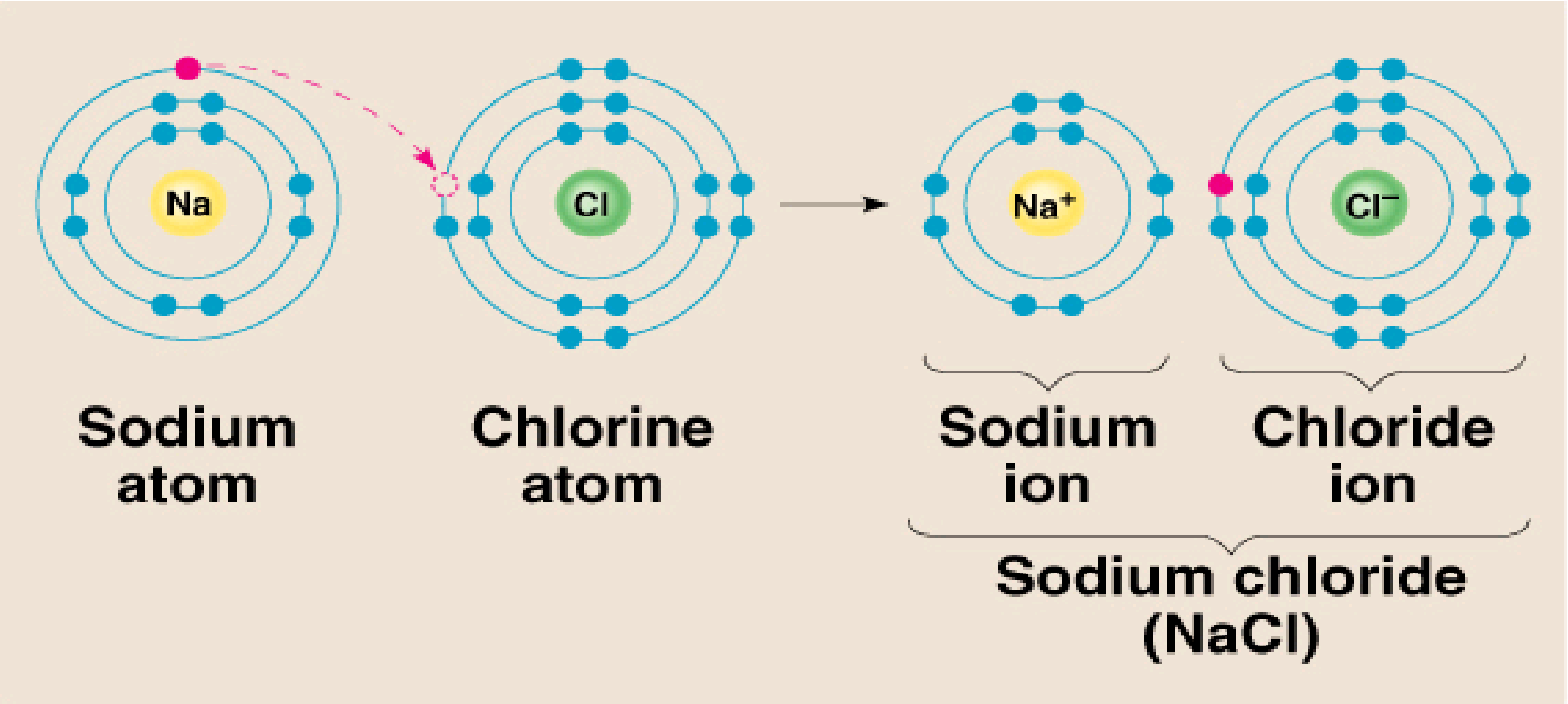
Noble gas – An element that has a full outer electron shell and so is very stable and unreactive.

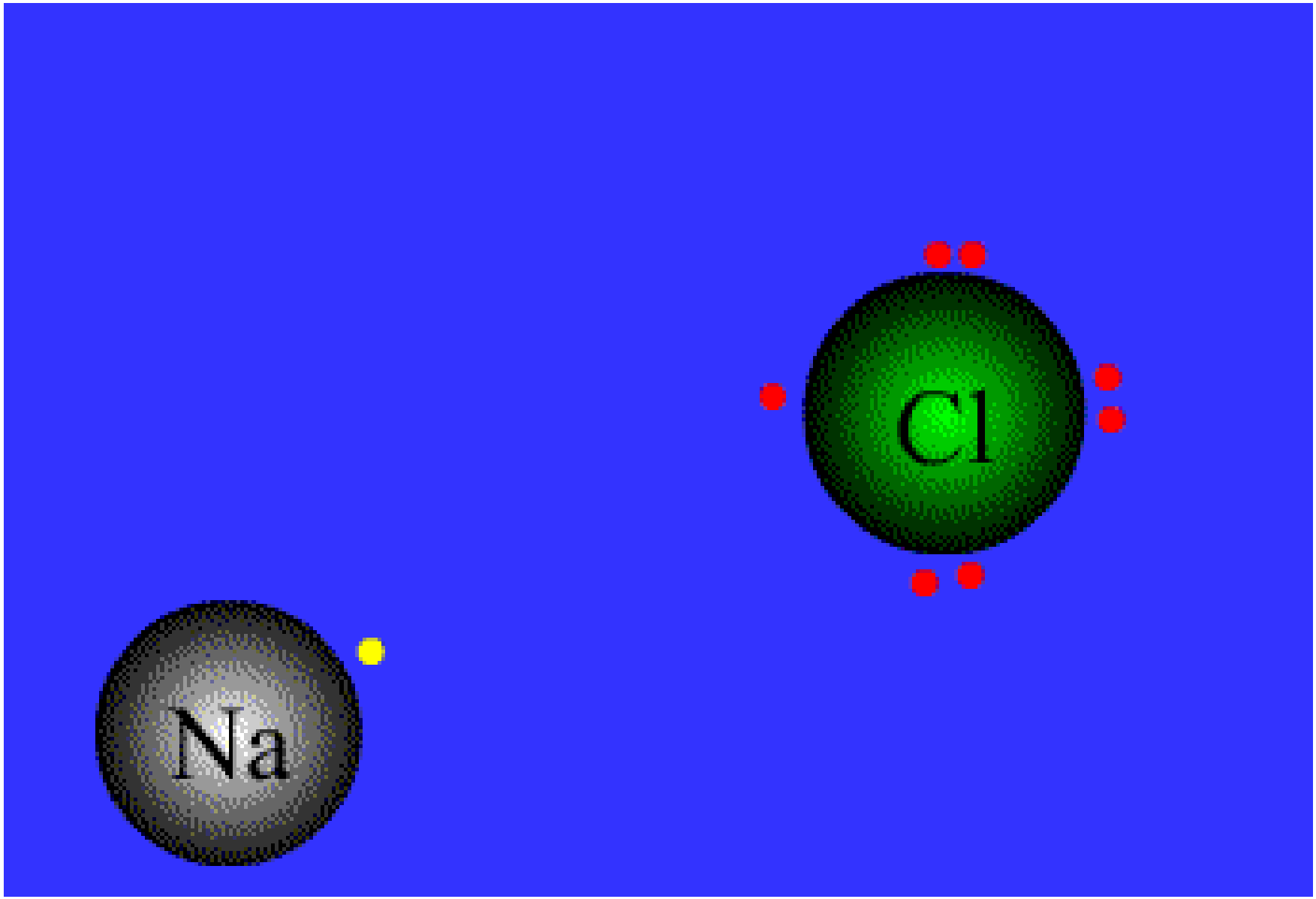
Positive ion – An atom or group of atoms that has lost electrons and so has a positive charge.

Three types of chemical bonds

1. Ionic bond (electrovalent bond)

Electrostatic attraction between positively charged particles and negatively charged particles

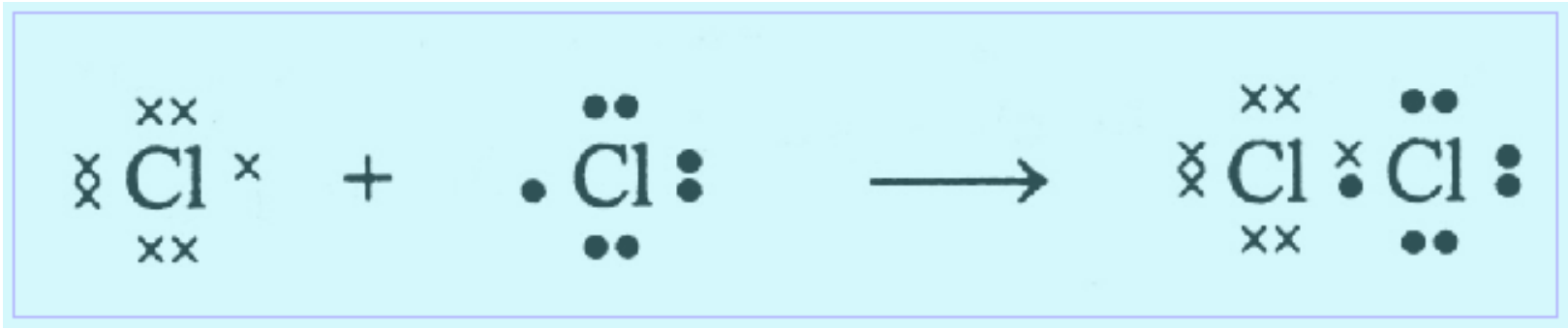


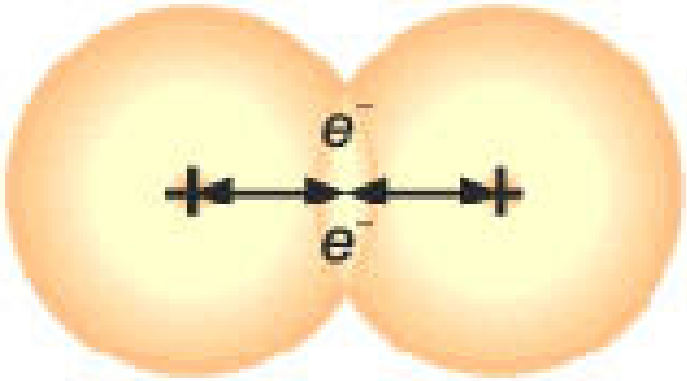

Cl
Na

2. Covalent bond

Formed by sharing of electrons

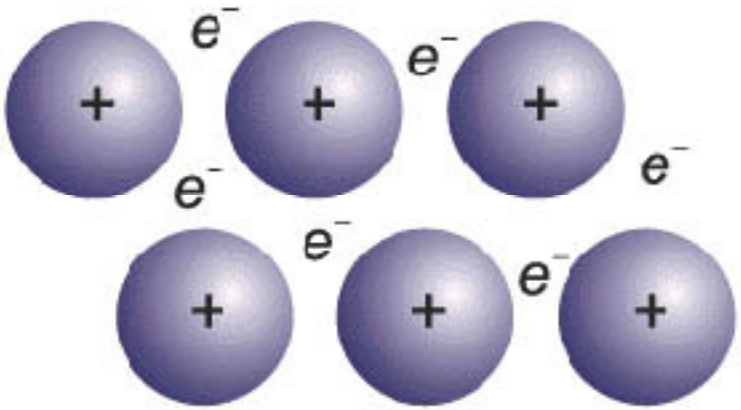
Electrostatic attraction between nuclei and shared electrons





3. Metallic bond

Electrostatic attraction between metallic cations and delocalized electrons (electrons that have no fixed positions)



Energy for Bond formation

1. Ionization enthalpy

The enthalpy change when one mole of electrons are removed from one mole of atoms or positive ions in gaseous state.

$$X(g) \rightarrow X^{+}(g) + e^{-} \qquad \Delta H_{1^{st}\ I.E.}$$

$$X^{+}(g) \rightarrow X^{2+}(g) + e^{-} \qquad \Delta H_{2^{nd}\ I.E.}$$

Ionization enthalpies are always positive.

2. Electron affinity

The enthalpy change when one mole of electrons are added to one mole of atoms or negative ions in gaseous state.

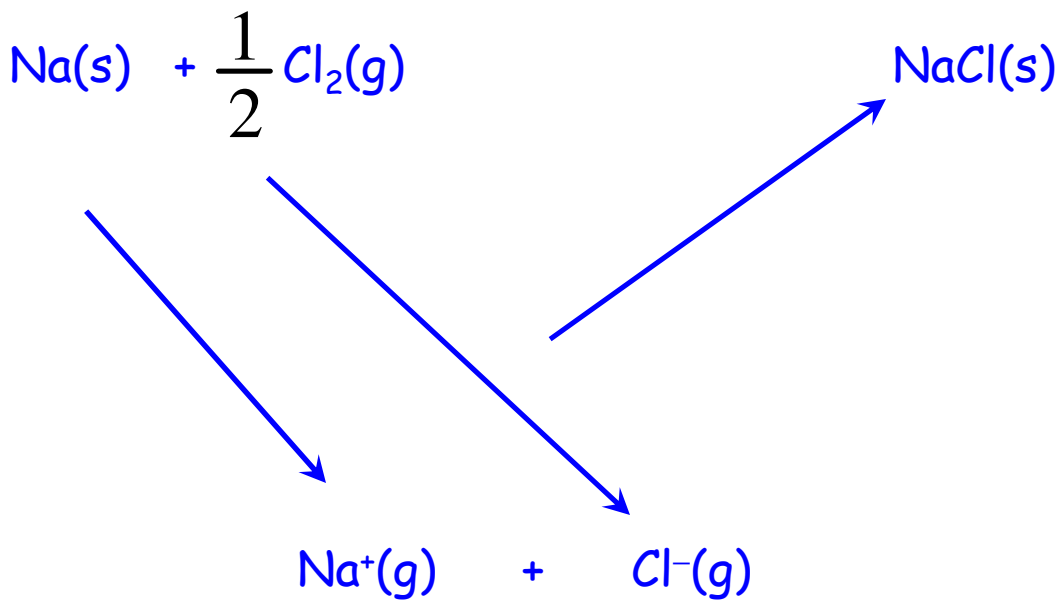
$$X(g) + e^- \rightarrow X^-(g) \qquad \Delta H_{1^{st}\ E.A.}$$

Electron affinities can be positive or negative.

3. Lattice Energy

The amount of energy released when appropriate number of oppositely charged ions in their gases isolated state are brought together to form one mole of ionic solid is known as Lattice energy.

Formation of NaCl



1. **Standard enthalpy change of atomization of Na(s)**

   $Na(s) \rightarrow Na(g)$ **Sublimation Energy (S)**

2. **First ionization enthalpy of Na(g)**

   $Na(g) \rightarrow Na^{+}(g) + e^{-}$ **Ionization Energy (I)**

3. **Standard enthalpy change of atomization of $Cl_2(g)$**

   $1/2Cl_2(g) \rightarrow Cl(g)$ **Dissociation Energy (D)**

4. **First electron affinity of Cl(g)**

   $Cl(g) + e^{-} \rightarrow Cl^{-}(g)$ **Electron Affinity (E)**

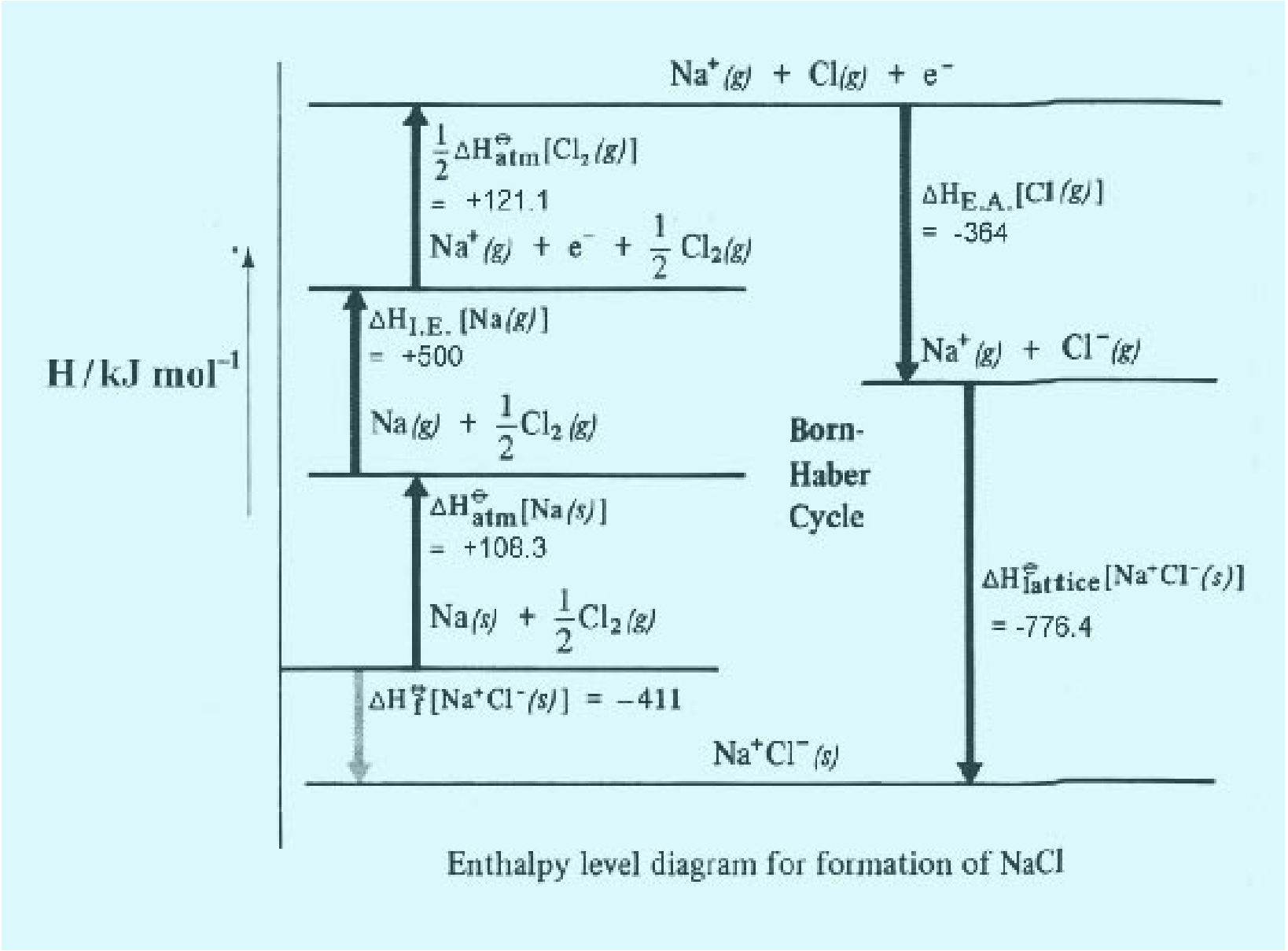
lattice enthalpy of NaCl.

It is the enthalpy change for the formation of 1 mole of NaCl(s) from its constituent ions *in the gaseous state.*

$$Na^+(g) + Cl^-(g) \rightarrow NaCl(s)$$

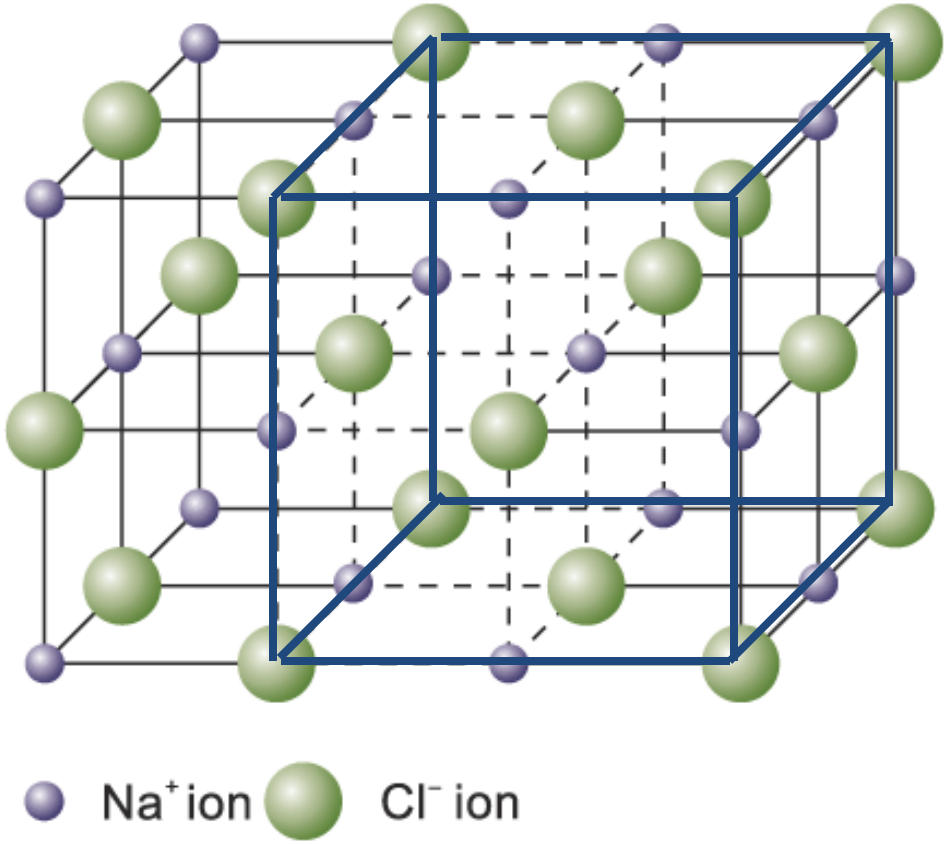
U = H-S-I-1/2D-E

Born –Haber Cycle for sodium chloride

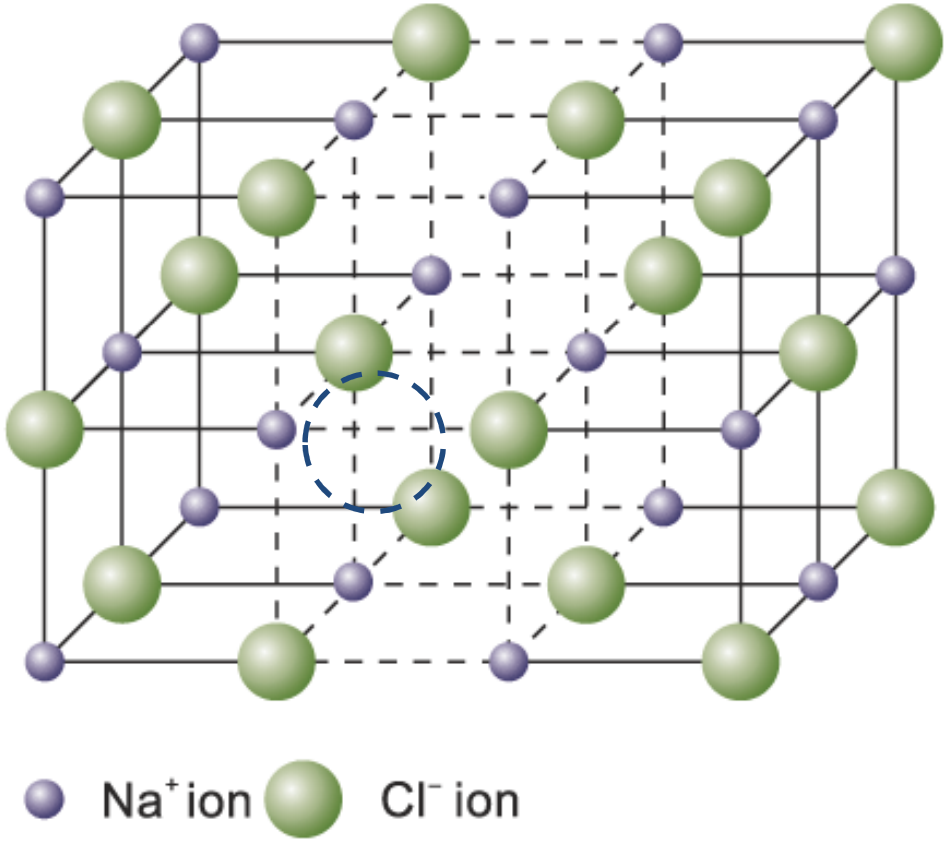


Enthalpy level diagram for formation of NaCl

The unit cell of a crystal lattice is the simplest 3-D arrangement of particles which, when repeated 3-dimensionally in space, will generate the whole crystal lattice.



The coordination number (C.N.) of a given particle in a crystal lattice is the number of nearest neighbours of the particle.

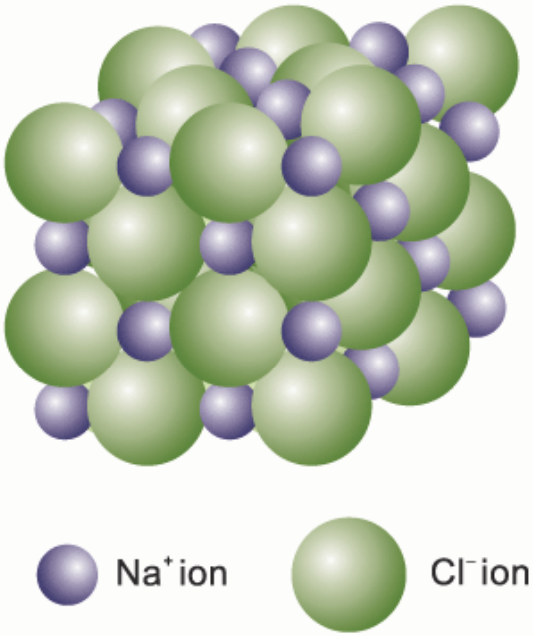


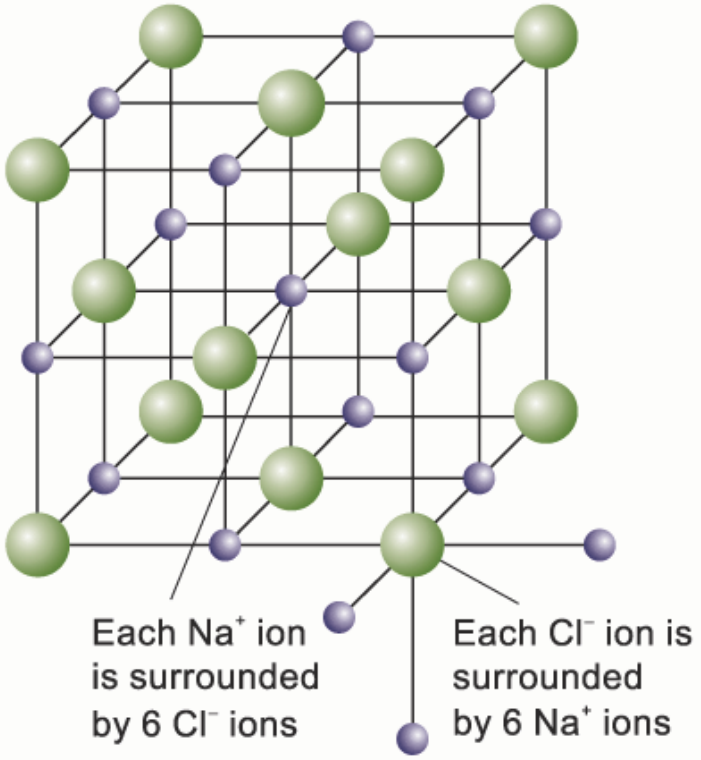
C.N. of Na^+ = 6

Crystal Lattice

Structure of Sodium Chloride

Unit cell of NaCl





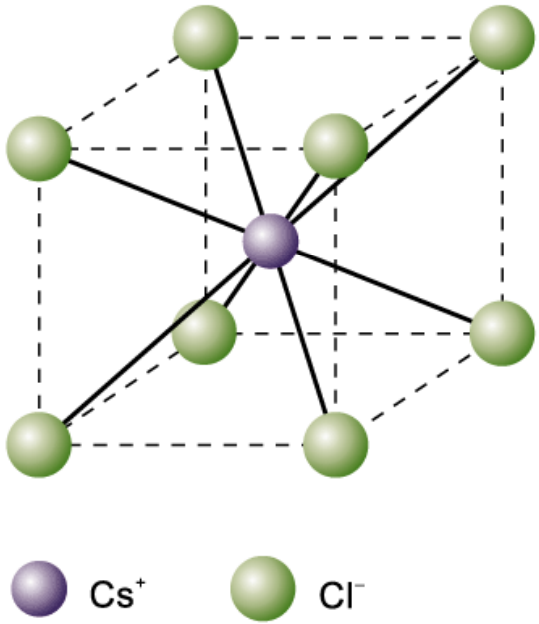
Co-ordination number of Na^+ = 6

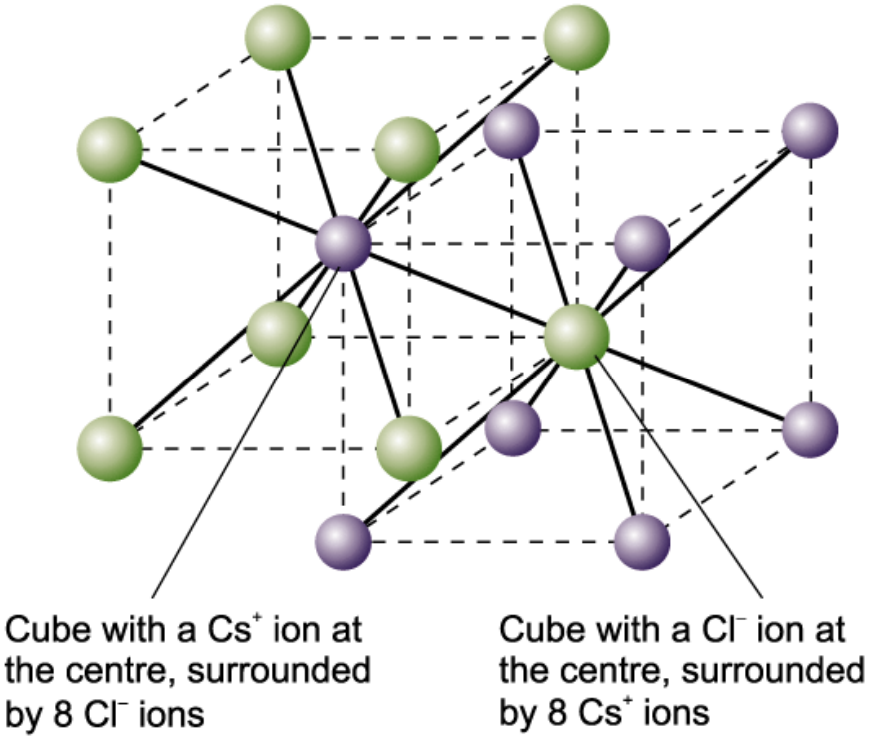
Co-ordination number of Cl^- = 6

} 6 : 6 co-ordination

Structure of Caesium Chloride

Simple cubic lattice



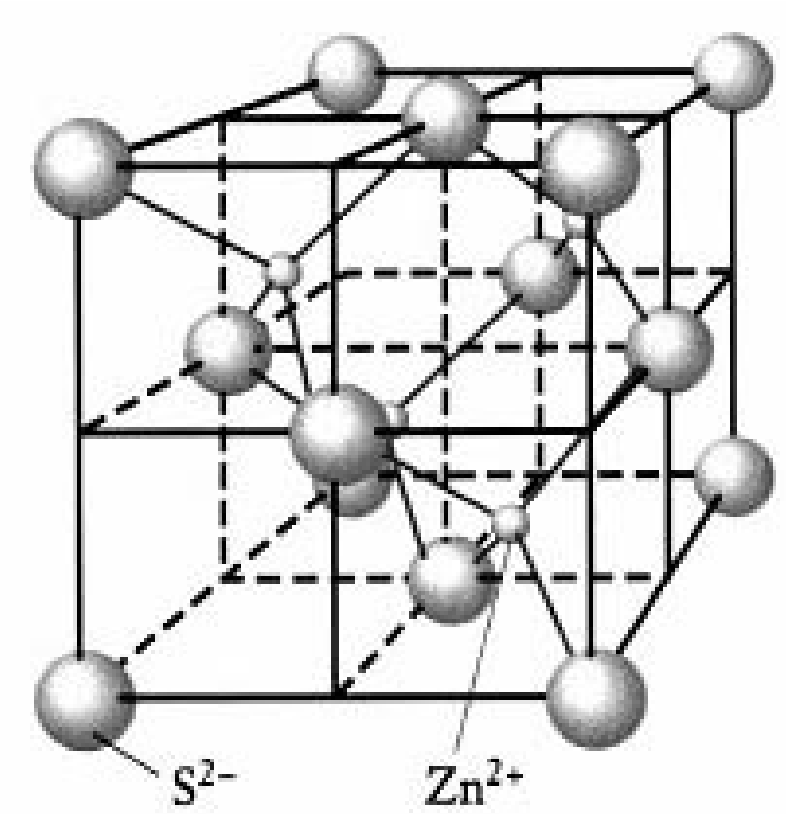


Co-ordination number of Cs^+ = 8

Co-ordination number of Cl^- = 8

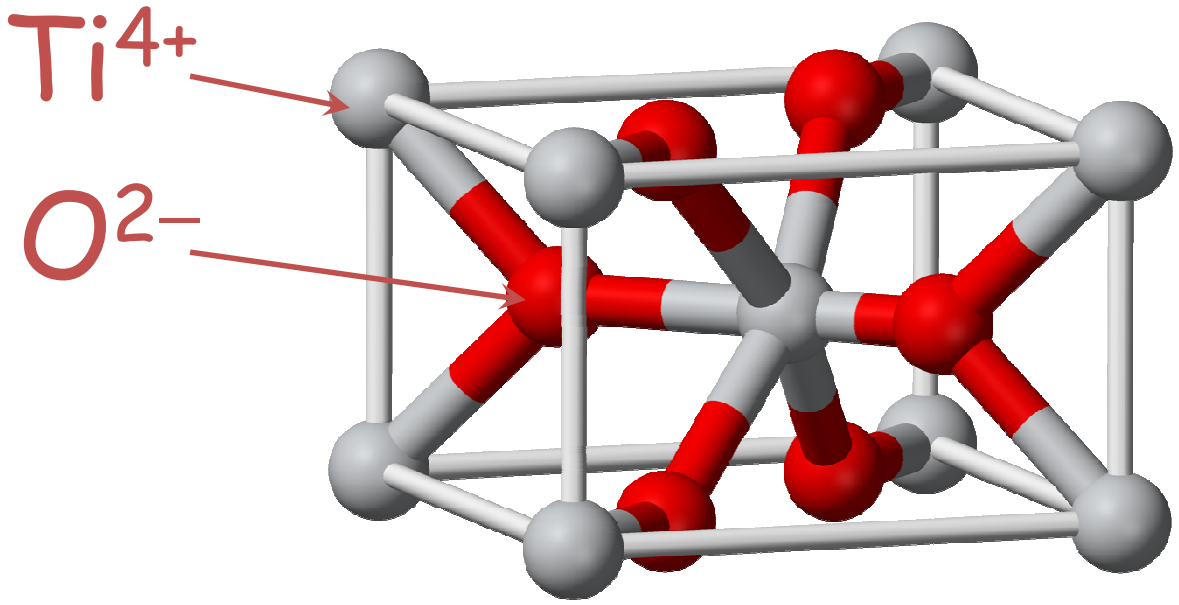
} 8 : 8 co-ordination

Structure of ZnS



Number of Zn^{2+} = 4

Number of S^{2-} = $8\times\frac{1}{8}+6\times\frac{1}{2}=4$



Structure of TiO_2

Number of Ti^{4+} = $1+8\times\frac{1}{8}=2$

Number of O^{2-} = $2+4\times\frac{1}{2}=4$

Thank you