Born Haber Cycle Chemistry Questions with Solutions

Q1. Which of the following can be calculated from the Born-Haber cycle for Al_2O_3?

a.) The lattice energy of Al_2O_3
b.) Electron affinity of O-atom
c.) The ionization energy of Al
d.) All of these

Correct Answer- (d.) All of these

Q2. The Born Haber cycle below represents the energy changes occurring at 298K when KH is formed from its elements
v : $\Delta H_{atomisation}$ K = 90 kJ/mol
w : $\Delta H_{ionisation}$ K = 418 kJ/mol
x : $\Delta H_{dissociation}$ H = 436 kJ/mol
y : $\Delta H_{electronaffinity}$ H = 78 kJ/mol
z : $\Delta H_{lattice}$ KH = 710 kJ/mol

In terms of the letters v to z the expression for
ΔH_i of K is ΔH_i = w/2.
If true enter 1, else enter 0.

a.) 0
b.) 1
c.) 2
d.) 3

Correct Answer- a.) 0

Q3. The Born Haber cycle below represents the energy changes occurring at 298K when KH is formed from its elements
v : $\Delta H_{atomisation}$ K = 90 kJ/mol
w : $\Delta H_{ionisation}$ K = 418 kJ/mol
x : $\Delta H_{dissociation}$ H = 436 kJ/mol
y : $\Delta H_{electronaffinity}$ H = 78 kJ/mol
z : $\Delta H_{lattice}$ KH = 710 kJ/mol

On complete reaction with water, 0.1g of KH gave a solution requiring 25 cm^3 of 0.1M HCl for neutralization. Calculate the relative atomic mass of potassium from this information.

a.) 39

b.) 40
c.) 41
d.) 42

Correct Answer- a.) 39

Q4. The Born Haber cycle below represents the energy changes occurring at 298K when KH is formed from its elements
v : $\Delta H_{atomisation}$ K = 90 kJ/mol
w : $\Delta H_{ionisation}$ K = 418 kJ/mol
x : $\Delta H_{dissociation}$ H = 436 kJ/mol
y : $\Delta H_{electronaffinity}$ H = 78 kJ/mol
z : $\Delta H_{lattice}$ KH = 710 kJ/mol
Choose the correct value of ΔH.

a.) 124 KJ/mol
b.) -124 KJ/mol
c.) 12 J/mol
d.) None of these

Correct Answer - (b.) -124 KJ/mol

Q5. The Born Haber cycle below represents the energy changes occurring at 298K when KH is formed from its elements
v : $\Delta H_{atomisation}$ K = 90 kJ/mol
w : $\Delta H_{ionisation}$ K = 418 kJ/mol
x : $\Delta H_{dissociation}$ H = 436 kJ/mol
y : $\Delta H_{electronaffinity}$ H = 78 kJ/mol
z : $\Delta H_{lattice}$ KH = 710 kJ/mol
In terms of the letters v to z the expression for $\Delta H_{electronaffinity}$ of H is-

a.) y
b.) y/2
c.) 2y
d.) y/3

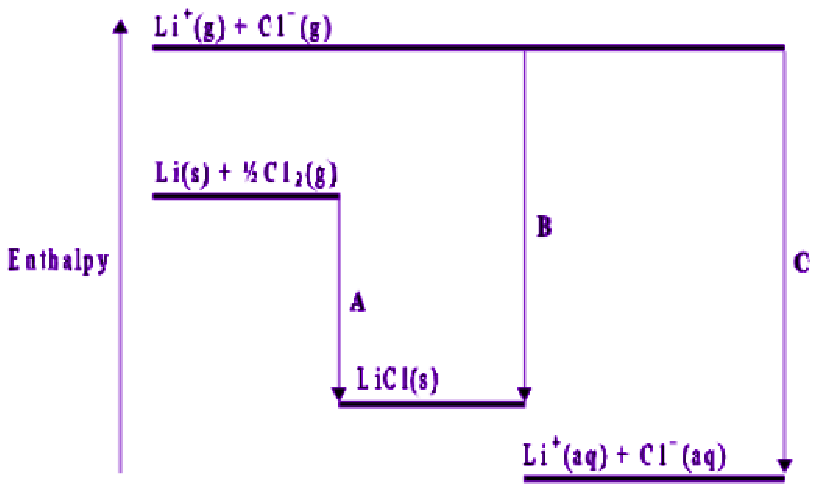
Correct Answer- (a.) y

Q6. Write some examples of the Born Haber Cycle?

Answer. Born-Haber Cycle Examples
- A solid magnesium atom sublimes to a gaseous atom by absorbing heat energy (H_{sub}).

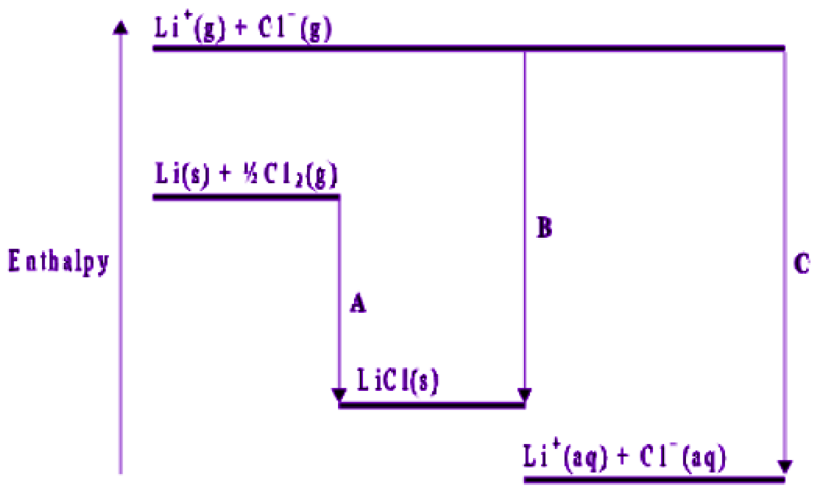
- Magnesium atoms in gaseous form emit two electrons with matching ionization energies in two stages.

Q7. The following data relate to lithium chloride. The standard molar enthalpy change of solution is -37.0 kJ mol^{-1}. Lattice enthalpy is -846 kJ mol^{-1}. Give the name of each of the changes A and B.



Answer. A is (enthalpy change) of formation and B is lattice enthalpy

Q8. Calculate the value of the enthalpy change represented by C and suggest the name(s) of the enthalpy change(s).

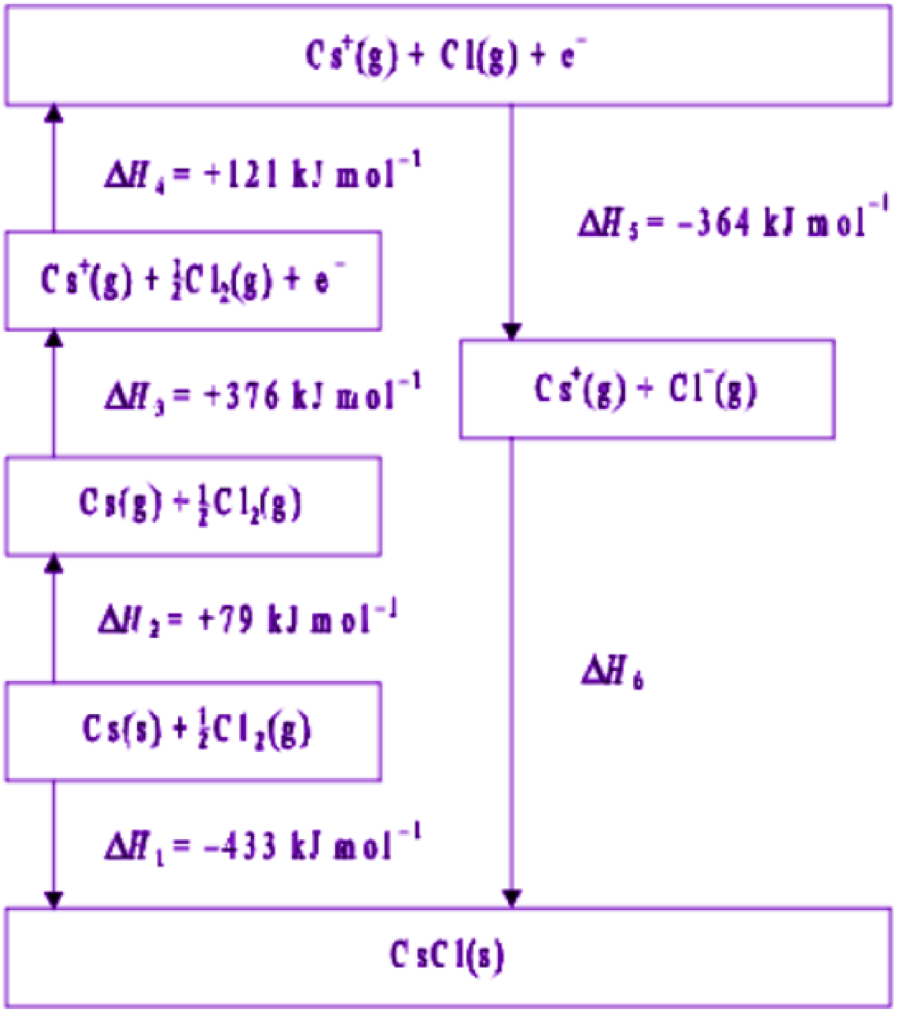


Answer. – 846+ – 37 = – 883 kJ mol^{-1}
Hydration/Solvation enthalpies of Li^+ and Cl^-.

Q9. What distinguishes Hess law from the Born Haber cycle?**

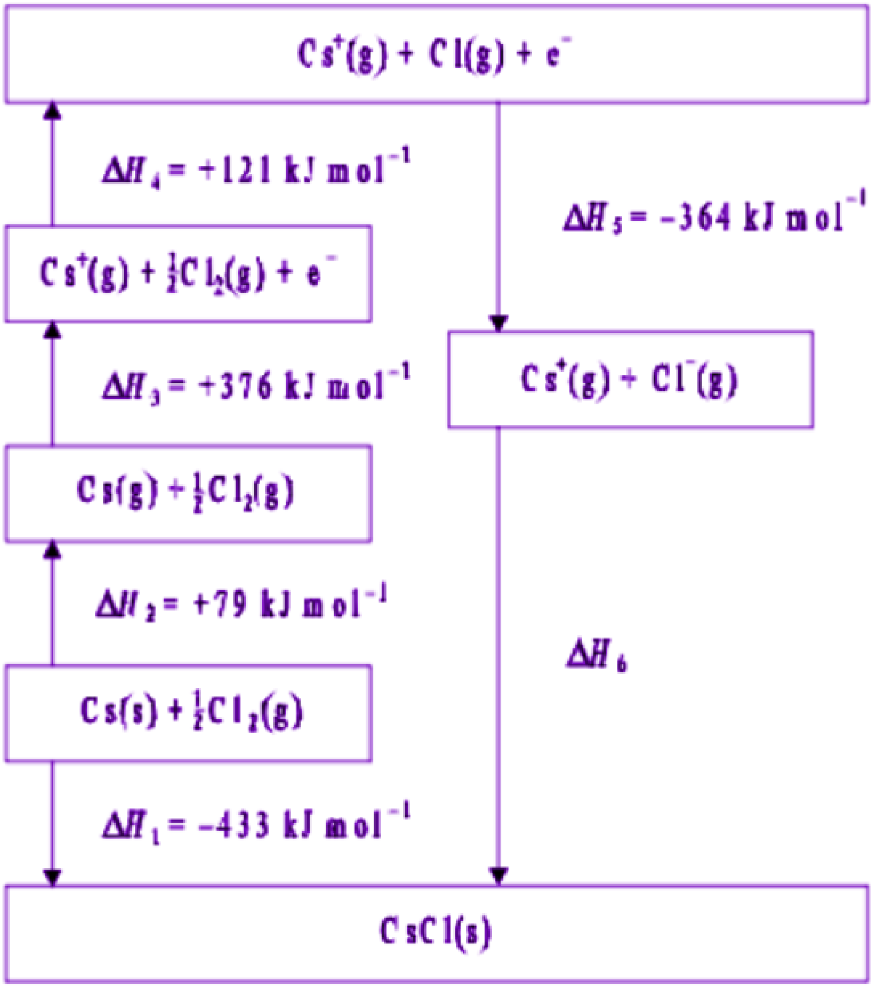
Answer. Hess's Law states that the overall change in energy of a process can be calculated by breaking it down into parts and then adding the energy changes of each phase. In the Born-Haber Cycle, Hess' Law is effectively applied to an ionic solid. The Born Haber cycle is employed to calculate electron affinity, crystal energy, and lattice energy.

Q10. The energy level diagram (Born-Haber cycle) for caesium chloride is shown below. Give the names of the enthalpy changes represented by ∆H1, ∆H2, and ∆H5.



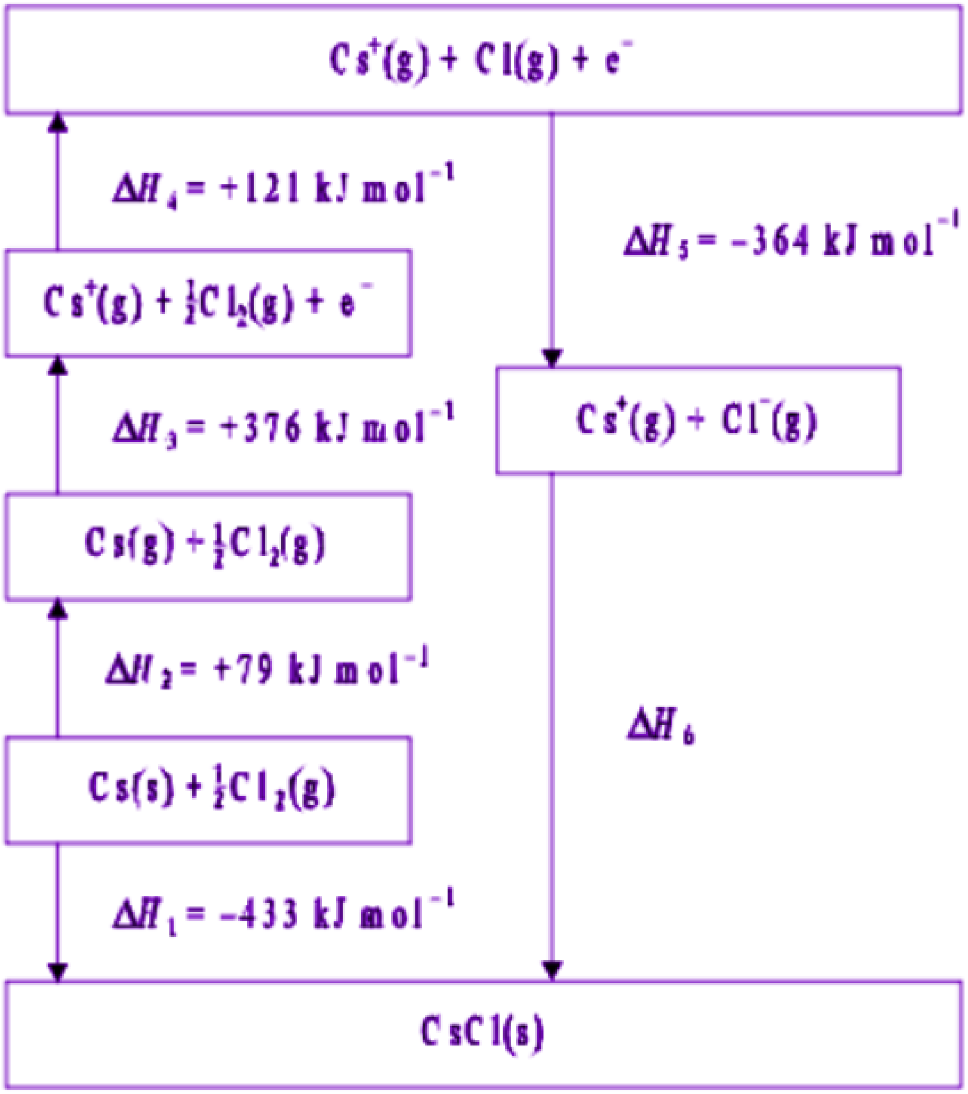
Answer. ∆H1 - formation
∆H2 - atomization/sublimation of Cs
∆H5 - electron affinity of Cl

Q11. The energy level diagram (Born-Haber cycle) for caesium chloride is shown below. Calculate the value of the lattice energy ∆H6.



Answer. -433 = 79 + 376 + 121 - 364 + ∆H6
∆H6 = -645 (kJ mol^{-1})

Q12. The energy level diagram (Born-Haber cycle) for caesium chloride is shown below. Explain why the enthalpy change represented by ∆H3 has a lower magnitude for caesium than for sodium.



Answer. Cs has larger radius / larger atom (not ion) / more shells / more orbitals / more sub-shells. So more shielding

So, less powerful attraction (of the nucleus) for (outer) e^- in Cs

Q13. Figure 1 shows the energy level diagram (Born-Haber cycle) for forming rubidium iodide from its elements. Complete the diagram giving the identities of the missing species.

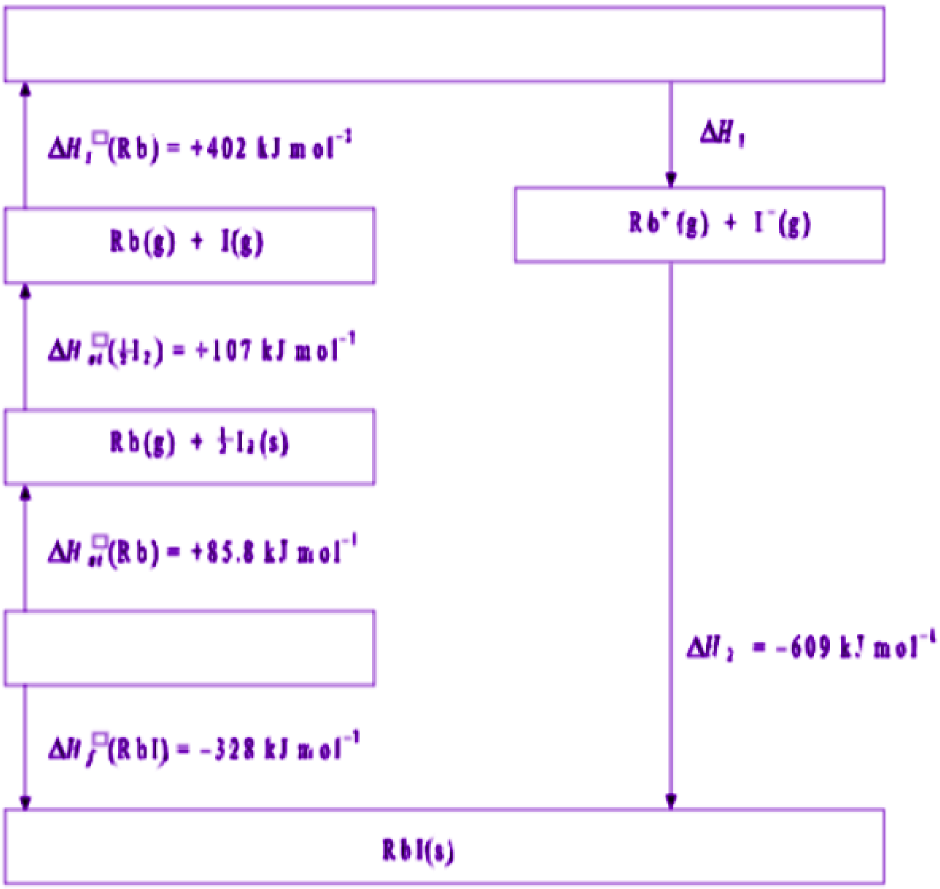


Figure 1

Answer.

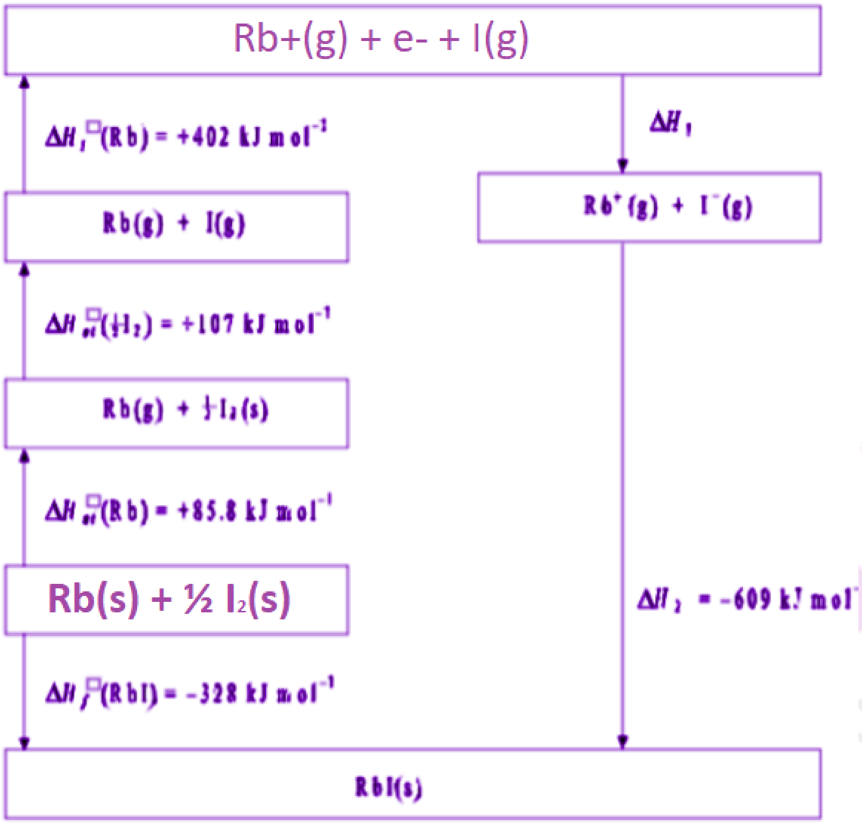


Figure 1

Q14. Give the names of the enthalpy changes represented by △H1 and △H2.

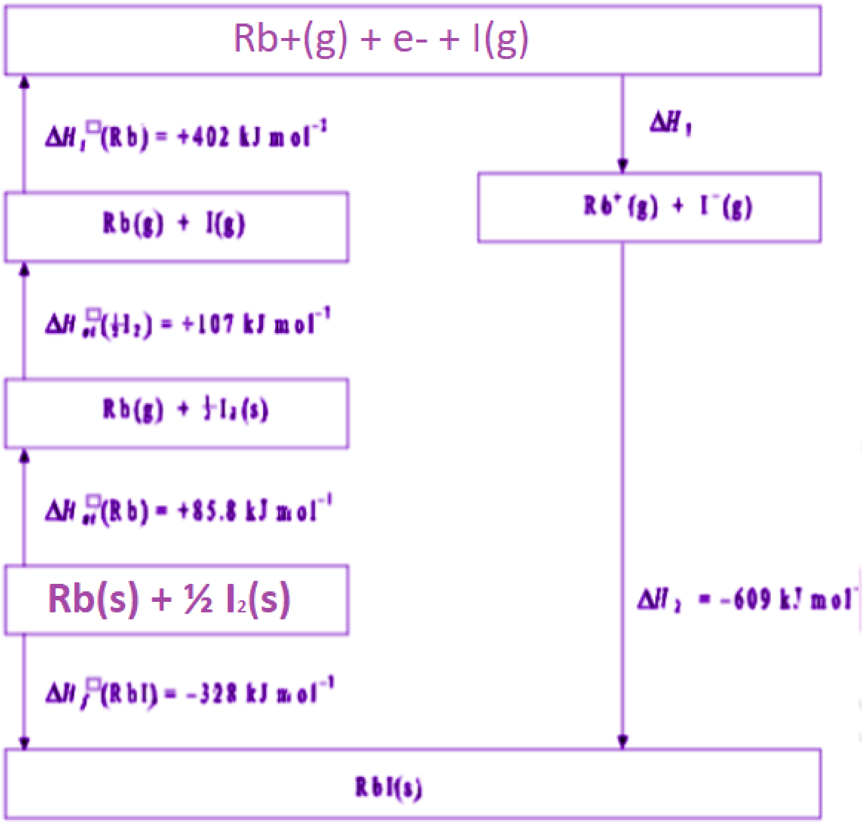


Figure 1

Answer. ∆H1 - electron affinity of iodine
∆H2 - lattice enthalpy of RbI

Q15. Calculate the value of the enthalpy change represented by ∆H1.

Answer. ∆H1 = -(+402) - (+107) - (+85.8) + (-328) - (-609)
= -314 (kJ mol^{-1})

Practise Questions on Born Haber Cycle

Q1. Born Haber Cycle is used to determine-

a.) Lattice energy
b.) electron affinity
c.) ionization energy
d.) either of them

Correct Answer- (d.) either of them

Q2. What type of enthalpy cycle is used to find out the solution for lattice energy?

a.) Hess's Law
b.) Born-Haber cycle
c.) Haber process
d.) Contact process

Correct Answer- (b.) Born-Haber cycle

Q3. How does the Born-Haber cycle explain the stability of ionic compounds?

Answer. This stability cannot be explained solely by the enthalpies of ionic molecule formation. These molecules are more stable because of the solid structure's lattice energy. We can understand and calculate the lattice energies of ionic solids using the Born-Haber cycle.

Q4. What is the limitation of the Born-Haber cycle?

Answer. The Born Haber cycle is used to calculate lattice energy, electron affinity, and crystal energy. Only elements with relatively low ionization energies, on the other hand, can contribute as cations to ionic materials because elements with excessively high ionization energies cannot be recovered from the resulting lattice energy.

Q5. How to Apply the Born-Haber Cycle

Answer. The Born Haber Cycle steps are as follows:
Step 1: Determine the energy levels of metals and nonmetals (elemental forms). Subtract the heat of formation of the ionic solid formed by combining these elements in the appropriate ratio. This gives us the ionic solid's energy.
Step 2: The Born Haber Cycle requires the reaction's elements to be in their gaseous state. Add the enthalpy changes required to convert one element to its gaseous state, and then repeat for the other element.
Step 3: Because metals exist in nature as single atoms, they do not require dissociation energy. Many nonmetals, such as chlorine, do exist as polyatomic species. To the value obtained in Step 2, add the energy required to convert Cl2 into 2Cl atoms.
Step 4: The metal and nonmetal are now transformed into their ionic forms in order to exist in the ionic solid. This is accomplished by adding the metal's ionization energy to the value obtained in Step 3. The electron affinity of a nonmetal is subtracted from the previous value because adding an electron releases energy.
Step 5: The metal and nonmetal will now be mixed together to form an ionic solid. This will result in the release of lattice energy. The value for the lattice energy can be calculated as the difference between the values obtained in Steps 1 and 4.