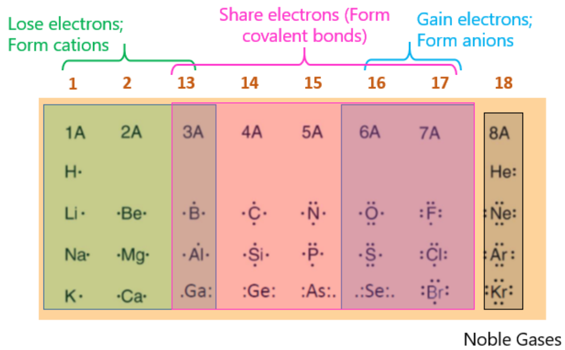
Major Concepts Covered

Concept Video 10-11: Types of bonding and Ionic Bonding

Octet Rule:

Octet Rule: Atoms tend to fill their valence orbital with eight electron (ns^2np^6 except He-like configuration). Atoms lose (form cations), share (covalent bonds), gain (form anions) to achieve noble gas configuration



Ionic Bonding

Lattice Energy: $\boxed{E \propto q_1\, q_2 / r^2}$

Calculating Lattice Energy

Hypothetical steps in the formation of an ionic solid

$Li(s) + ½\, F_2(g) \longrightarrow LiF(s)$

i. Formation of gaseous metal atoms — $Li(s) \longrightarrow Li(g)$

ii. Formation of gaseous metal cations — $Li(g) \longrightarrow Li^+(g)$

iii. Formation of gaseous non-metal atoms — $½\, F_2(g) \longrightarrow F(g)$

iv. Formation of gaseous non-metal anions — $F(g) \longrightarrow F^-(g)$

v. Formation of ionic solid/lattice — $Li^+(g) + F^-(g) \longrightarrow LiF(s)$

Step v releases a lot of heat (-ve enthalpy), compensating for i to iv

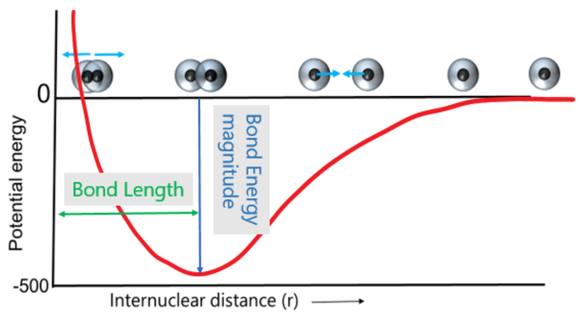
Reverse of step v – gives us the Lattice Energy

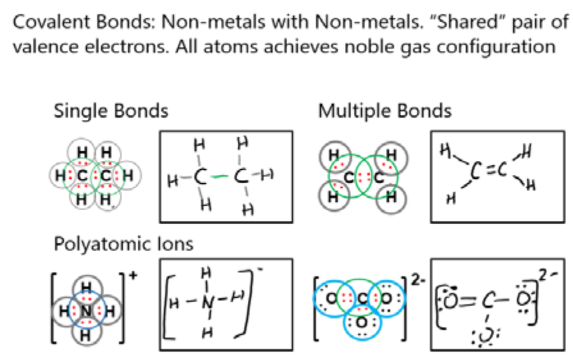
Destruction of ionic lattice (Lattice Energy) — $LiF(s) \longrightarrow Li^+(g) + F^-(g)$

The enthalpy change associated with **lattice destruction** is called lattice energy

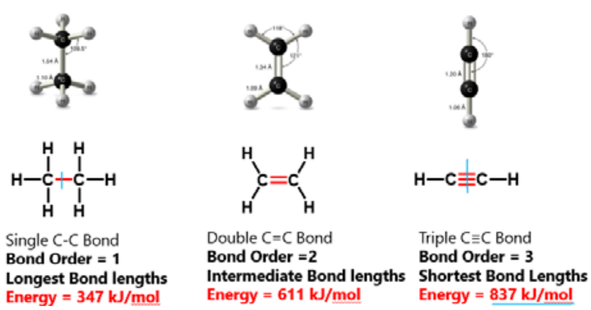
Covalent Bonding

BOND FORMATION BOND ORDER/LENGTH/STRENGTH

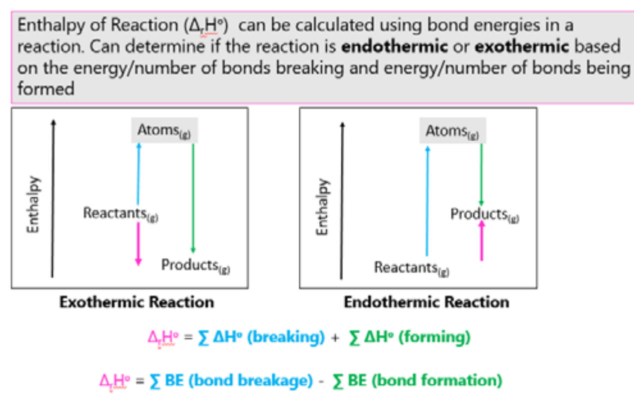




BOND ORDER/LENGTH/STRENGTH



BOND ENERGY CALCULATIONS



Review Questions

Question 1

Using the bond energies provided, calculate ΔH for the reaction:
$CH_4(g) + 4\ Cl_2$ ---- $CCl_4(g) + 4HCl(g)$

Bond energies: C-H = 413 kJ/mol, C-Cl = 339 kJ/mol; H-Cl = 427 kJ/mol, Cl-Cl = 243 kJ/mol

Question 2

The lattice energy of RbCl is the energy change for which process (use a chemical equation to describe the process)?

Calculate the lattice energy of RbCl using the following data:

	$\Delta H°$ (kJ)
$Rb(s) \longrightarrow Rb(g)$	86
$Rb(g) \longrightarrow Rb^+(g) + e^-$	409
$Cl_2(g) \longrightarrow 2Cl(g)$	242
$Cl(g) + e^- \longrightarrow Cl^-(g)$	–355
$Rb(s) + \frac{1}{2} Cl_2(g) \longrightarrow RbCl(s)$	–435

Question 3

Arrange the following bonds, from the highest to lowest bond energy

Si-Br, Si-I, Si-F, Si-Cl

Question 4

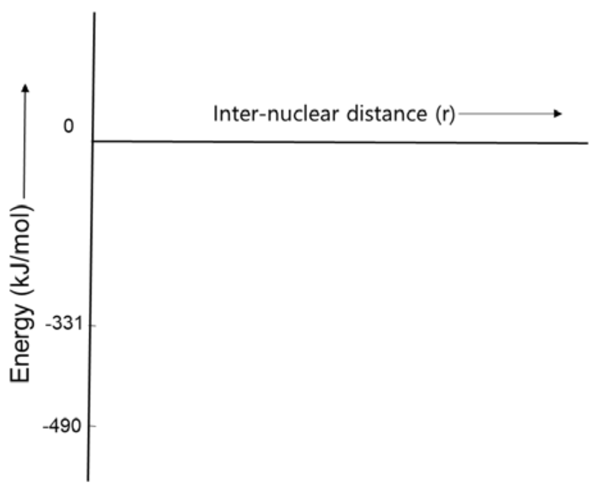
Consider the following 2 bonds: P-F and P-Cl.

The bond dissociation energy for one of the bonds is 331 kJ/mol and the other is 490 kJ/mol. Determine which bond dissociation energy corresponds to P-F and P-Cl.

In the figure given below, **<u>draw</u>** two energy diagrams showing the change in energy (y axis) as function of change in the inter-nuclear distance (x axis) for P-F and P-Cl. Label the diagrams as P-F and P-Cl.

Values corresponding to the bond dissociation energies are shown on y axis.

Using a double headed arrow (⟷) show the distance that corresponds to the bond length for P-F and P-Cl (No numbers needed).



Question 5

a. Using the bond energies provided, calculate the enthalpy (kJ/mol) of the following reaction:

$C_2H_4 + HBr \rightarrow C_2H_5Br$

C=C = (614 kJ/mol)	H–Br = (363 kJ/mol)	C–Br = (276 kJ/mol)
C–H = (413 kJ/mol)	C–C = (347 kJ/mol)	

Question 6

Draw the following molecules showing Lewis dot representation (show valence electrons as dots around the atom) of the atom:

CH_4 (This molecule is methane: central atom is carbon bonded to 4 hydrogens)

CH_3^+ (We will learn about calculating formal charges next week, but I want you to try and show this molecule. C with a positive charge – it is electron deficient – is very crucial for organic chemists – it is known as a carbocation)

CH_3^- (We will learn about calculating formal charges next week, but I want you to try and show this molecule. C with a negative charge – it has an extra lone pair – is also very crucial for organic chemists – it is known as a carbanion)