Bond Breaking and Bond Forming

Filed Under: Energy Changes In Chemical Reactions, O Level

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Bond breaking and bond forming occurs during a chemical reaction.

- The energy changes in chemical reactions are caused by bond breaking and bond forming.

Breaking a bond is endothermic. Energy is taken in to break a chemical bond.

- E.g. $H-H(g) \rightarrow H(g)+H(g)$, whereby $\Delta H=+436$ kJ mol−1
- 436 kJ of energy is required to break one mole of covalent bonds in the hydrogen molecules.

Forming a bond is exothermic. Energy is released when a chemical bond is formed.

- E.g. $H(g)+H(g) \rightarrow H-H(g)$, whereby $\Delta H=-436$ kJ mol−1
- 436 kJ of energy is released to form one mole of covalent bonds in the hydrogen molecules.

The energy absorbed in breaking one mole of covalent bonds is called the **bond energy**. It is the same as the energy given out in making the same amount of covalent bonds.

Bond energy measures the **strength of a covalent bond**. The stronger the bond to be broken, the more energy is required to be taken in.

- A triple bond requires the most energy to break whereas a single bond is

easiest to break.
    - You can refer to the table below to see this.
    - From the table, 347 kJ is released when 1 mole of carbon-carbon single bonds, C–C, are formed.
    - 612 kJ is released when 1 mole of carbon-carbon double bonds, C=C, are formed.
    - 838 kJ is released when 1 mole of carbon-carbon triple bonds, C≡C, are formed.
- Similarly, the stronger the bond formed, the more energy is released.

Some examples of bond energies are shown in the table below.

Covalent Bond	**Bond energy (kJ mol−1)**
H–H	436
F–F	158
Cl–Cl	244
Br–Br	224
I–I	214
H–F	568
H–Cl	432
H–Br	366
H–N	388
O=O	496
C=C	612
C=O	743
N≡N	945
C≡C	838

The heat taken in or given out in a reaction comes from the chemical bonds

being made or broken in the reaction.

Heat of reaction = Total heat energy absorbed when old bonds are broken in the reactants − Total heat energy released when new bonds are formed in the products

During a chemical reaction,

- If the total energy required to break bonds in the reactants is **more than** the total energy released when new bonds are formed in the products, it is an **endothermic reaction**.
- If the total energy required to break bonds in the reactants is **less than** the total energy released when new bonds are formed in the products, it is an **exothermic reaction**.

Alternatively, you can denote:

Er = Total energy required to break bonds in the reactants

Ep = Total energy released when new bonds are formed in the products

If Er>Ep, it is an endothermic reaction.

If Er<Ep, it is an exothermic reaction.

Examples

Calculate the heat of reaction of the formation of hydrogen fluoride from its elements.

Calculate the heat of reaction of the decomposition of ammonia.

Determine whether the formation of hydrogen chloride from hydrogen gas and chlorine gas is endothermic or exothermic.

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