**Bond Energies**

**https://chem.libretexts.org/Textbook\_Maps/Physical\_and\_Theoretical\_Chemistry\_Textbook\_Maps/Supplemental\_Modules\_(Physical\_and\_Theoretical\_Chemistry)/Chemical\_Bonding/Fundamentals\_of\_Chemical\_Bonding/Bond\_Energies**

**Atoms bond together** to form compounds because in doing **so they attain lower energies** than they possess as individual atoms.

A quantity of energy, equal to the difference between the energies of the bonded atoms and the energies of the separated atoms, is released, usually as **heat energy**.

That is, the bonded atoms have a lower energy than the individual atoms do.

When atoms combine to make a compound, energy is always given off, and the compound has a lower overall energy.

When a **chemical reaction** occurs, molecular bonds are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and

other bonds are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to make **different** molecules.

When a chemical reaction occurs, the atoms in the reactants \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

their chemical bonds to make products.

**All reactions require the addition of energy to start.**

What determines whether the reaction is overall endothermic or overall exothermic is the

difference between \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The new arrangement of bonds does not have the same total energy as the bonds in the reactants.

Therefore, when chemical reactions occur*,*there will always be an accompanying energy change*.*

e.g. The bonds of hydrogen and oxygen are broken to form the bonds of the water molecules.

**2 H2(g) + O2(g) → 2 H2O(ℓ)**

Energy is **always required** to **break** a bond, which is known as bond energy. Energy is

necessary to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Energy is **released** when a bond is **formed**. Energy is released as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

When a bond is strong, there is a higher bond energy because it takes more energy to break a strong bond.

The shorter the bond length means a greater the Bond Energy because of increased electric attraction.

**Recall Coulomb's Law:**

In general, **the shorter the bond length, the greater the bond energy.**

Double bonds are higher energy bonds in comparison to a single bond (but not necessarily 2-fold higher).

Triple bonds are even higher energy bonds than double and single bonds (but not necessarily 3-fold higher).

**Exothermic and Endothermic Reactions**

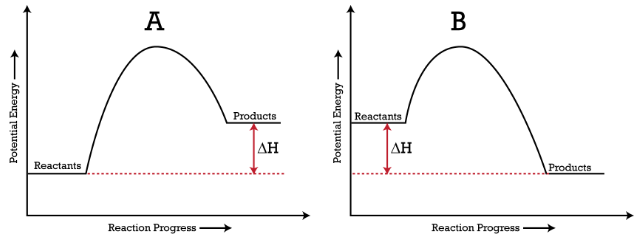
**Endothermic** reactions require energy, so **energy** is a **reactant**.

**N2(g) + O2(g) + 72 kJ → 2 NO(g)**

**Exothermic** reactions releases energy, so **energy** is a **product**.

**2 H2(g) + O2(g) → 2 H2O(ℓ) + 572 kJ**

**Graphically:**



**∆H**

**Enthalpy H**

* is the total energy content of a system
* is the sum of the kinetic and potential energies of a system
* cannot be measured but the change in enthalpy **∆H** can
* measured in kJ/mole

**∆H** can be calculated in many ways--using **Bond Energies** is one way.

**Using Bond Energies to Calculate ∆H**

Combustion reactions are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ i.e. they release more energy

when the product bonds form than the energy absorbed when the reactant bonds are broken.

**1. Write the BCE for the combustion reaction of BBQ propane:**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**2. Draw the Lewis Dot Diagrams of the Particles in a VERY organized fashion in columns:**

|  |  |
| --- | --- |
| **REACTANTS** | **PRODUCTS** |
|  |  |

**3. Do the Math in a VERY organized fashion immediately under the moles of particles:**

**4. Subtract the Sum of the Bond Energies of the Products from the Sum of the Bond Energies of the Reactants:**

**"BER minus BEP"**

**5. The molar enthalpy (ΔH) for the combustion of ethane is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.**