Stoichiometry & Heat

Outcome:

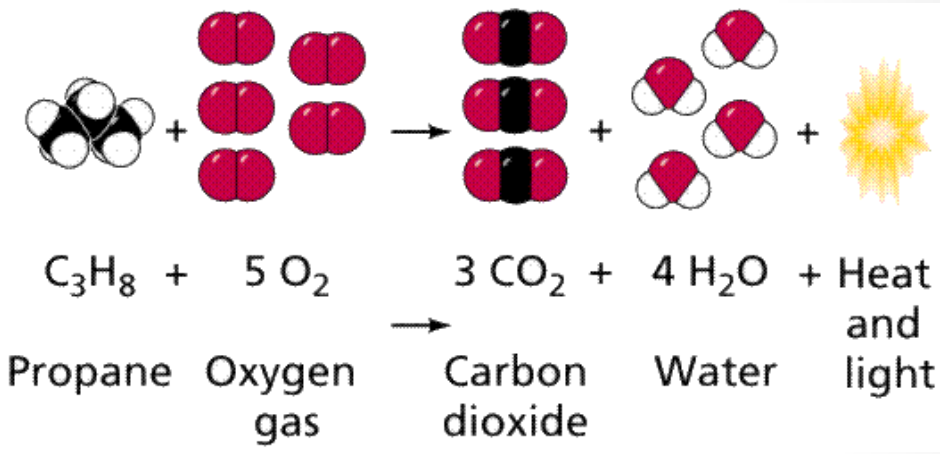
- Solve stoichiometric problems involving: moles, mass, volume, and heat of reaction.

Stoichiometry & Heat

THERMAL ENERGY (**HEAT**) can be **RELEASED** or **ABSORBED** by a chemical reaction…

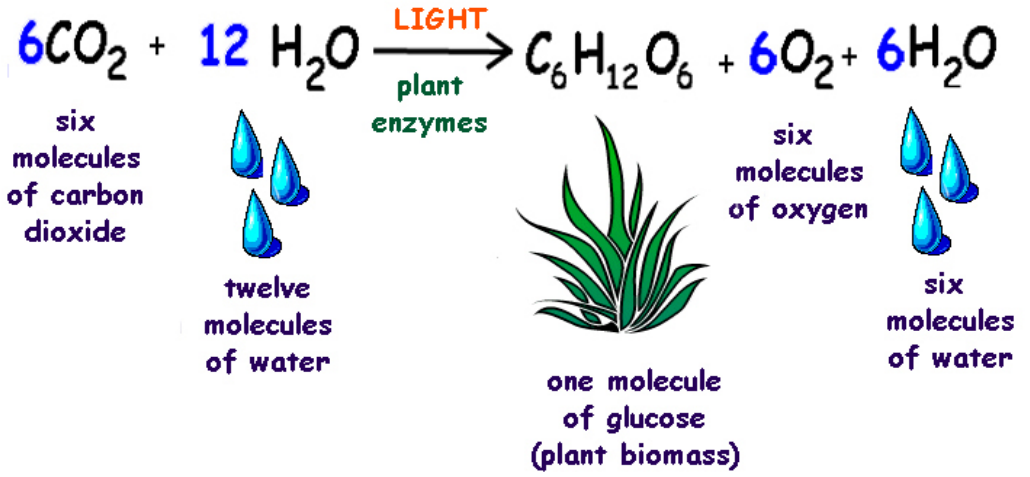
→ *energy can also be called* **ENTHALPY** *(H)*

Energy is RELEASED in the combustion of propane:



https://thecolt84.wordpress.com/2011/03/28/hello-world/

Energy is ABSORBED in photosynthesis:



http://www.bio.miami.edu/dana/226/226F08_10.html

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Exothermic Reactions:

- When energy is **RELEASED** (produced) by a chemical reaction.
- Energy will be a **PRODUCT**, making the system **FEEL WARM**.
- Since energy is released, the **CHANGE IN ENTHALPY (ΔH)** is **NEGATIVE**.

Ex) the complete combustion of 1 mole of propane has a ΔH = -2705kJ

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O + 2705\ kJ$$

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Endothermic Reactions:

- When energy is **ABSORBED** (taken in) by a chemical reaction from the surroundings, making the system **FEEL COLD**
- Energy will be a **REACTANT**.
- Since energy is absorbed, the **CHANGE IN ENTHALPY (ΔH)** is **POSITIVE**.

Video: Veritasium - Misconceptions about Heat

Ie) The decomposition of water has a ΔH = +242kJ/mol

$$2H_2O + 484kJ \rightarrow 2H_2 + O_2$$

Notice that the amount of energy **DOUBLED** in the reaction,

→ to decompose **1 MOLE** of water you need **242kJ**, but the balanced reaction has **2 MOLES** of water decomposing, so **DOUBLE** the amount of **HEAT** is required to keep the equation **BALANCED**.

Stoichiometry & Heat

The energy in a chemical reaction is always interpreted in terms of **MOLES**.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + 890.32\ kJ$$

i.e.) ***one mole of CH_4 reacts with 2 moles O_2 to produce 1 mol CO_2, 2 moles H_2O, and 890.32 kJ of energy.***

If you use **2 MOLES** of CH4, you would make **2X** as much heat

Therefore, the **AMOUNT** of heat **PRODUCED/CONSUMED** in a reaction is **PROPORTIONAL** to the **AMOUNT** of **REACTANTS OR PRODUCTS** you have

→ stoichiometry!!!

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Examples:

1. How many kJ of heat will be produced by the burning of 451g CH_4?

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + 890.32\ kJ$$

$$451g \times \frac{1\ mol}{16.04\ g} = 28.12\ mol\ CH_4 \times \frac{890.32\ kJ}{1\ mol\ CH_4} = 25\,035.8\ kJ$$

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Examples:

2. How many liters of oxygen gas must have been used to produce 2670kJ of energy?

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + 890.32\ kJ$$

$$2670\,kJ \times \frac{2\ mol\ O_2}{890.32\ kJ} = 6.0\ mol\ O_2 \times \frac{22.4\ L}{1\ mol} = 134.35\ L\ O_2$$

Stoichiometry & Heat

Try this one…

What amount of heat is released when 10.0g of C_3H_8 combusts?

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$ $\Delta H = -2705$ kJ/mol

exo

kJ is a product

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O + 2705\,kJ$$

$$10.0\,g\,C_3H_8 \times \frac{1\,mol}{44.08\,g} = 0.227\,mol\,C_3H_8 \times \frac{2705\,kJ}{1\,mol\,C_3H_8} = 613.66\,kJ$$