Module 8: Thermochemistry
Topic 3 Content: Thermostoichiometry Presentation Notes

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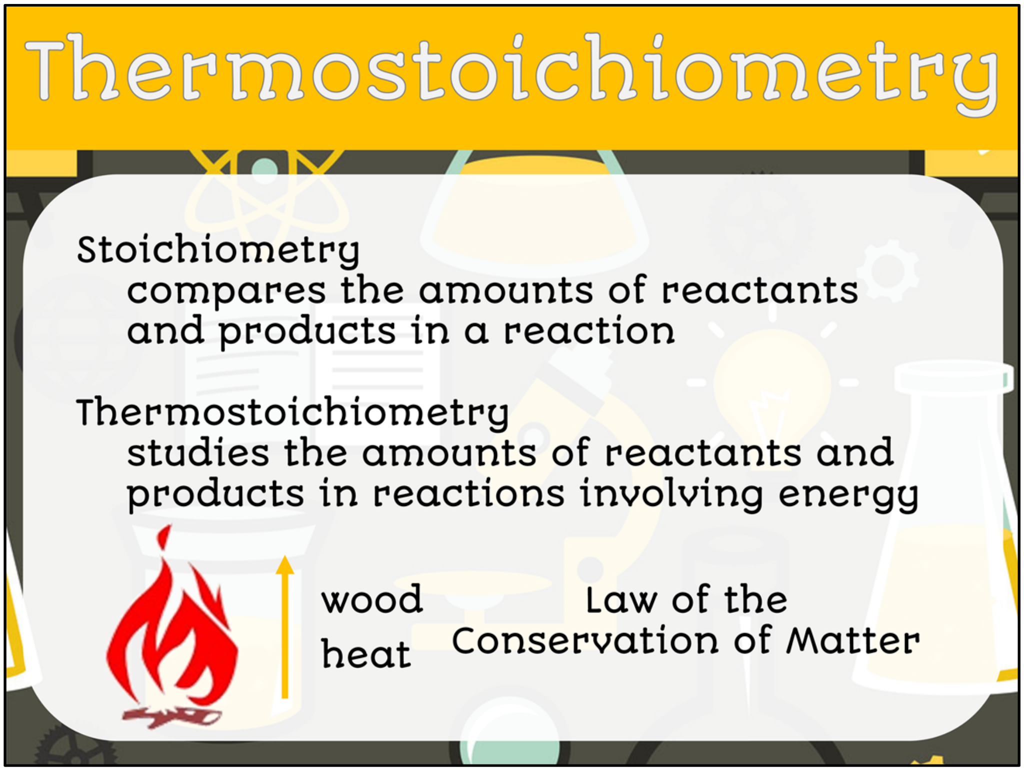
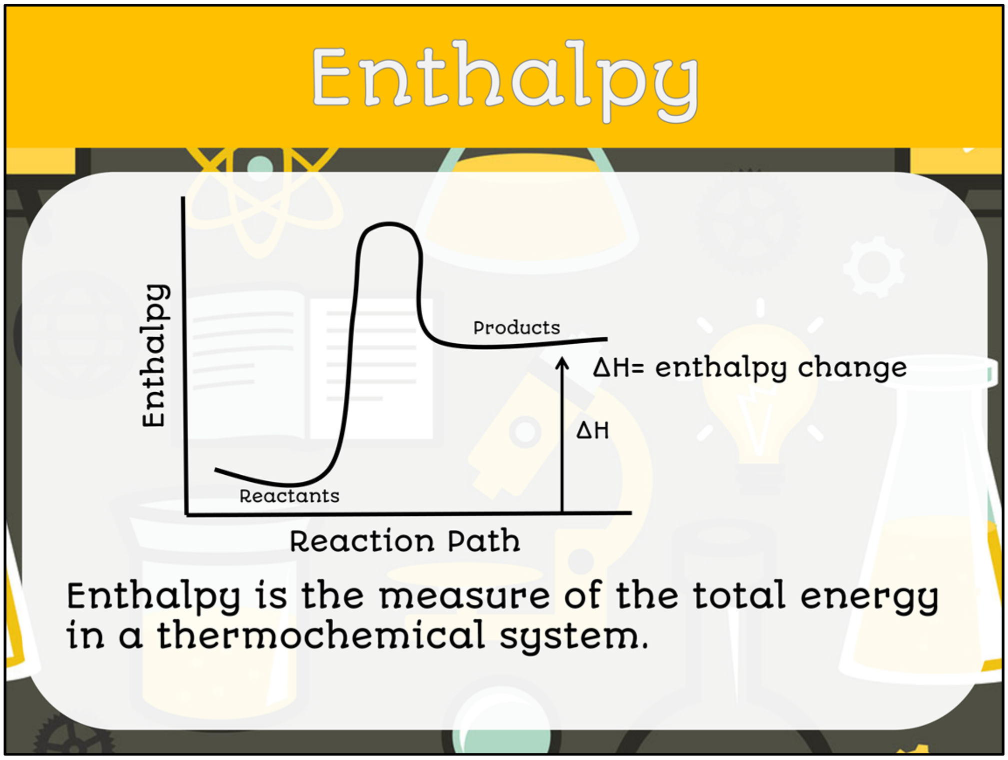
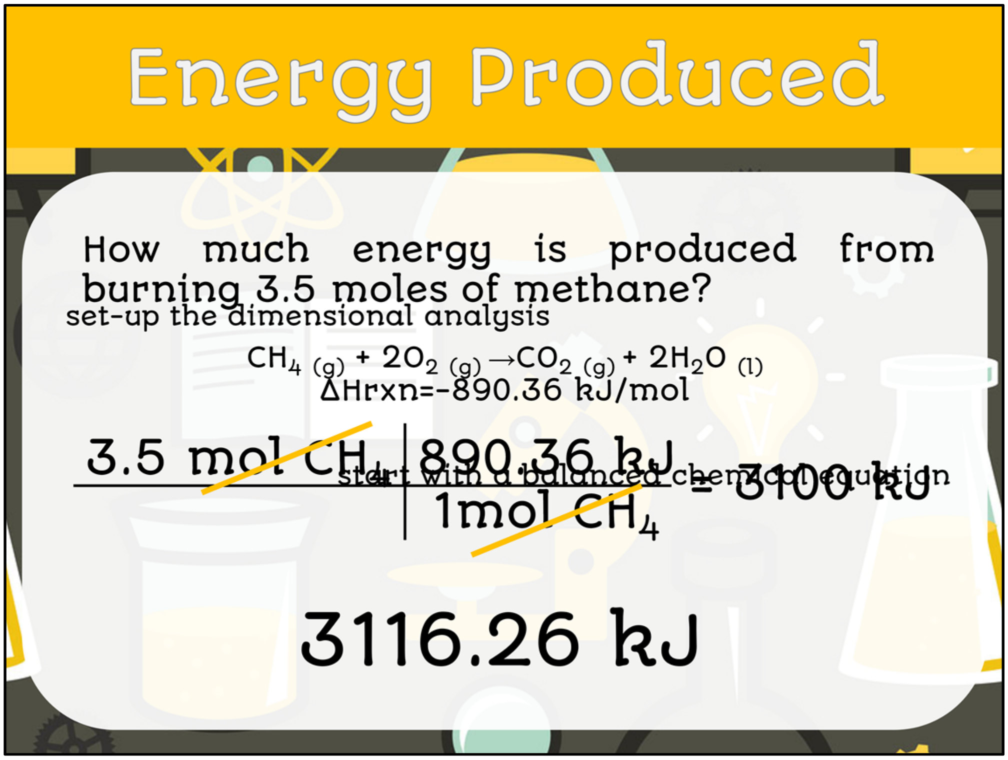


Stoichiometry is the study of the amount of reactants in a reaction compared to the amount of products. This makes thermostoichiometry a study of the heat associated with chemical reactions and physical transformations. In thermostoichiometry, you will still study the amount of reactants and products. You will do this for reactions that have a change in energy or heat.

Think of thermostoichiometry like a campfire. If you add more wood, you expect to generate more heat. This simple concept is true for chemical reactions, as well. The amount of energy released or absorbed by a chemical process depends on how much of the reactants are used. The amount of reactants used determines how much product is formed. This simple concept is described by the Law of Conservation of Matter.



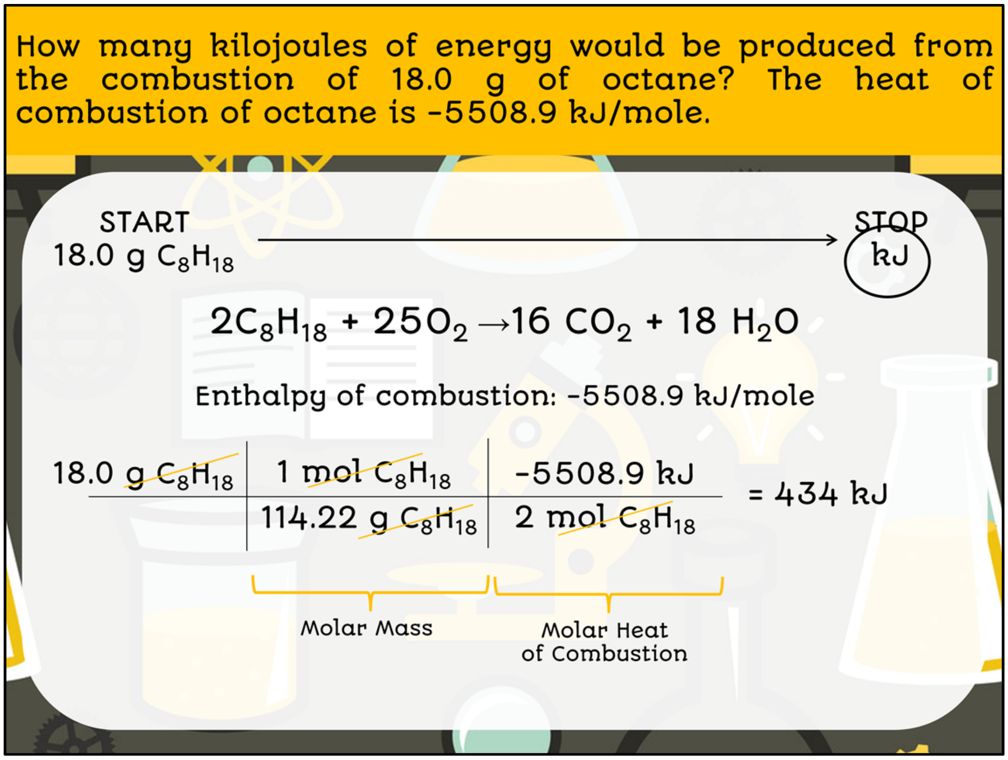
Enthalpy is the measure of the total energy in a thermochemical system. Enthalpies are typically provided in molar quantities. This means that you know how much energy is absorbed or released per mole. The symbol for enthalpy is ΔH.



Stoichiometry problems and thermostoichiometry problems are completed in a similar fashion. You already know that the enthalpy of a reaction is provided in molar quantities. All that you need to do when completing thermostoichiometry problems is set-up the dimensional analysis. Remember, you must always start with a balanced chemical equation. If you know the balanced equation for a reaction and the enthalpy change for a reaction, then you can calculate stoichiometry problems involving energy. Take a look at an example problem that asks for how much energy is produced by a reaction. The combustion of methane produces heat as seen in the reaction shown here.

How much energy is produced from burning 3.5 moles of methane?

To figure out the amount of energy released in this reaction, you multiply the moles of methane by the enthalpy change of the reaction. Once this step is completed, you will find that 3116.26 kJ of energy is released by burning 3.5 moles of methane. Remembering significant figures, the answer is 3100 kJ.



Thermostoichiometry problems may include molar mass conversions and mole to particle conversions, in addition to the energy conversions. Remember, always read the problem carefully and determine the set-up in dimensional analysis. Take a look at an example problem that asks for how much energy is produced by a reaction.

How many kilojoules of energy would be produced from the combustion of 18.0 g of octane? The equation for the combustion of octane is shown here. The heat of combustion of octane is -5508.9 kJ/mole.

You should first determine the start and stop of the problem. In other words, what information are you given? Where are you trying to go? In this problem, you are given grams of octane. You are asked to calculate kilojoules of energy. The balanced equation and the enthalpy of combustion are used to determine the energy.

The problem can be solved with two steps. First, convert the mass to moles. Then, convert the moles to energy. The molar mass is calculated using 8 moles of carbon and 18 moles of hydrogen. The molar heat of combustion is provided in this problem. If the heat of reaction, which is combustion in this case, was not provided, it can be calculated from the Standard Enthalpies of Formation Table. After the conversion is completed, you will find kJ of energy are produced by a combustion containing 18.0 grams of octane.

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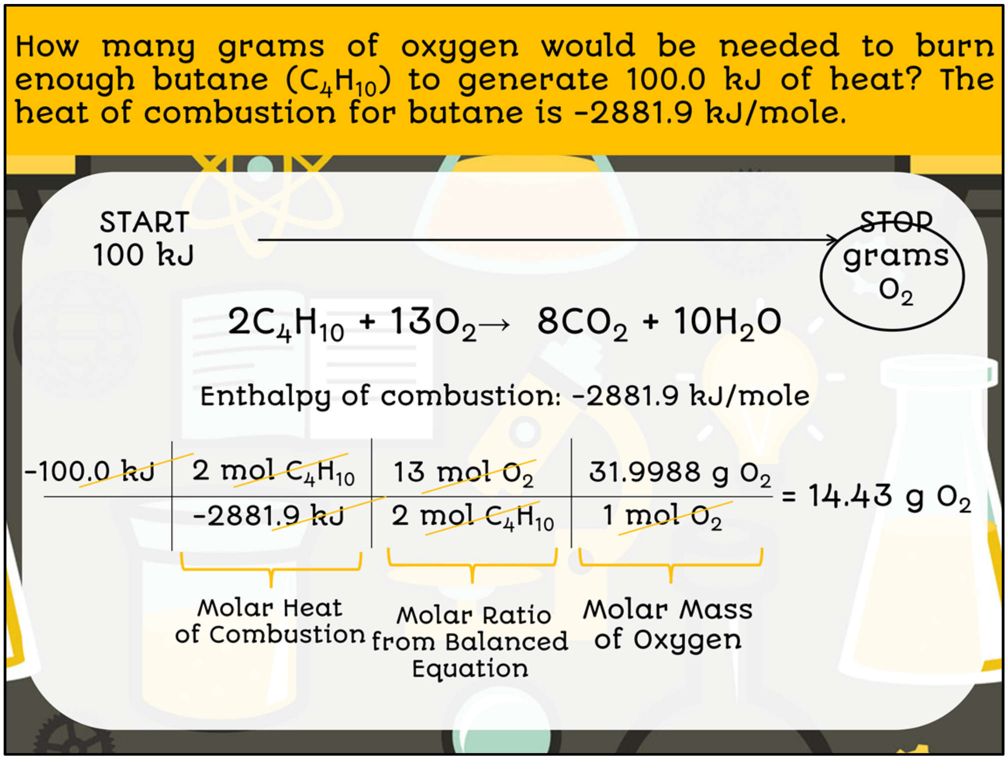


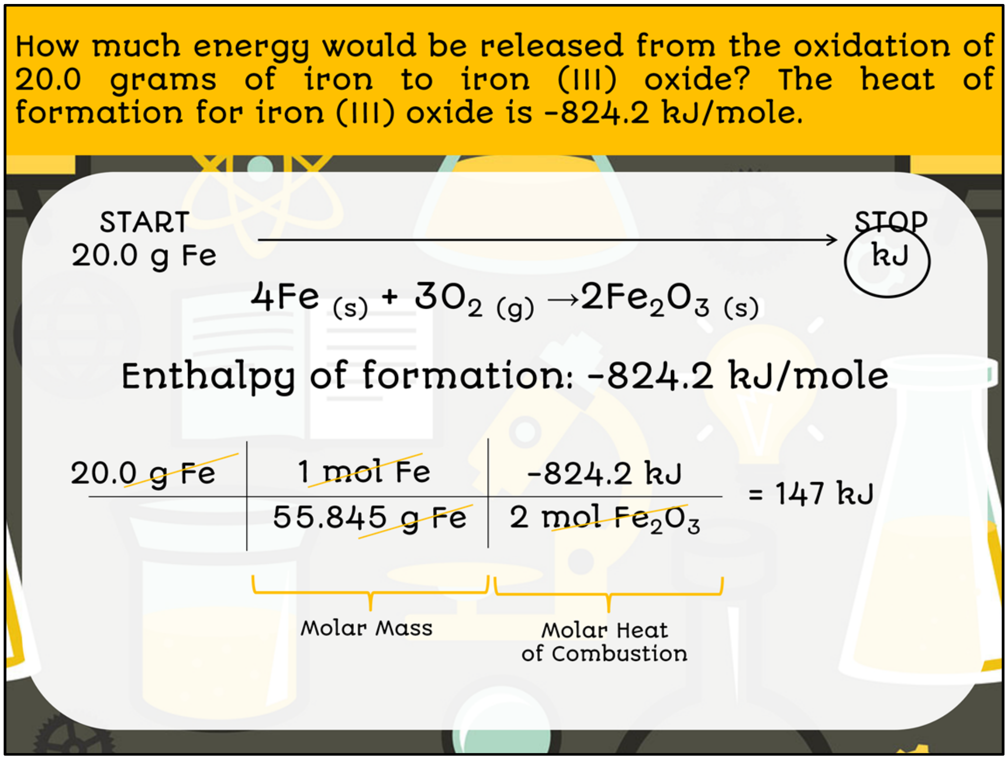
Now try a problem where you need to figure out how much of a substance is needed in a reaction. Remember, you need to establish the start and stop for the problem. Also, determine the molar mass using the periodic table and the molar heat of combustion using the Standard Enthalpies of Formation Table.

Here is an example problem that asks for how many grams of oxygen are needed to generate a specific amount of heat.

How many grams of oxygen would be needed to burn enough butane to generate 100.0 kJ of heat?

The equation is shown here, and the heat of combustion for butane is -2881.9 kJ/mole.

In this case you are given the energy amount. You must convert the energy amount to moles of fuel using the molar heat of combustion. Then, since it asks how many grams of oxygen, not butane, you must convert using the balanced equation to moles of oxygen. Since it takes thirteen moles of oxygen to burn two moles of butane, the ratio used is thirteen to two. Once you have converted to moles, now you must convert to grams using the periodic table. After the conversion is completed, you will find grams of oxygen are needed to produce 100.0 kJ of energy.



Now, examine a problem where energy is released. This indicates that the answer will be a negative quantity. Take a look at an example problem that asks for the amount of energy released in a reaction.

Iron oxidizes to make iron (III) oxide. The reaction occurs as shown here. The heat of formation for iron (III) oxide is -824.2 kJ/mole.

How much energy would be released from the oxidation of 20.0 grams of iron to iron (III) oxide?

Once you have completed the conversion, you will find that kJ of energy are released from the oxidation of iron to iron (III) oxide.