

Combustion reaction equation examples

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A combustion reaction is a major class of chemical reactions, commonly referred to as "burning." In the most general sense, combustion involves a reaction between any combustible material and an oxidizer to form an oxidized product. It usually occurs when a hydrocarbon reacts with oxygen to produce carbon dioxide and water. Good signs that you're dealing with a combustion reaction include the presence of oxygen as a reactant and carbon dioxide, water, and heat as products. Inorganic combustion reactions might not form all of those products but remain recognizable by the reaction of oxygen. Combustion is an exothermic reaction, meaning it releases heat, but sometimes the reaction proceeds so slowly that the change in temperature is not noticeable. Combustion doesn't always result in fire, but when it does, a flame is a characteristic indicator of the reaction. While the activation energy must be overcome to initiate combustion (i.e., using a lit match to light a fire), the heat from a flame may provide enough energy to make the reaction self-sustaining. hydrocarbon + oxygen → carbon dioxide + water It's important to remember that combustion reactions are easy to recognize because the products always contain carbon dioxide and water. Here are several examples of balanced equations for combustion reactions. Note that while oxygen gas is always present as a reactant, in the trickier examples, the oxygen comes from another reactant. Combustion of methaneCH4(g) + 2 O2(g) → CO2(g) + 2 H2O(g)Burning of naphthaleneC10H8 + 12 O2 → 10 CO2 + 4 H2OCombustion of ethane2 C2H6 + 7 O2 → 4 CO2 + 6 H2OCombustion of butane (commonly found in lighters)2C4H10(g) + 13O2(g) → 8CO2(g) + 10H2O(g)Combustion of methanol (also known as wood alcohol)2CH3OH(g) + 3O2(g) → 2CO2(g) + 4H2O(g)Combustion of propane (used in gas grills, fireplaces, and some cookstoves)2C3H8(g) + 7O2(g) → 6CO2(g) + 8H2O(g) Combustion, like all chemical reactions, does not always proceed with 100% efficiency. It's prone to limiting reactants the same as other processes. As a result, there are two types of combustion you're likely to encounter: Complete Combustion: Also called "clean combustion," complete combustion is the oxidation of a hydrocarbon that produces only carbon dioxide and water. An example of clean combustion would be burning a wax candle: The heat from the flaming wick vaporizes the wax (a hydrocarbon), which in turn, reacts with oxygen in the air to release carbon dioxide and water. Ideally, all the wax burns so nothing remains once the candle is consumed, while the water vapor and carbon dioxide dissipate into the air.Incomplete Combustion: Also called "dirty combustion," incomplete combustion is hydrocarbon oxidation that produces carbon monoxide and/or carbon (soot) in addition to carbon dioxide. An example of incomplete combustion would be burning coal (a fossil fuel), during which quantities of soot and carbon monoxide are released. In fact, many fossil fuels—including coal—burn incompletely, releasing waste products into the environment. A combustion reaction is a reaction between a fuel and oxidizer to form an oxidized product. Usually, a hydrocarbon reacts with oxygen to form carbon dioxide and water.The fire triangle illustrates the necessary ingredients for combustion. (image: GustavB, CC3.0)A combustion reaction is an exothermic chemical reaction between a fuel and an oxidizer that forms an oxidized product. In general chemistry, it is one of the main types of chemical reactions. Combustion is a reaction between a hydrocarbon fuel (e.g., coal, propane, wood, methane) and molecular oxygen (O2), producing carbon dioxide (CO2), water (H2O), and heat. Heat provides the activation energy to start the chemical reaction. The combination of oxygen, fuel, and heat forms the fire triangle, which is one way to represent the requirements for combustion.General Form of Combustion Reaction EquationThe general form of a combustion reaction is:hydrocarbon + oxygen → carbon dioxide + water + heatCxHy + O2 → CO2 + H2OExamples of Combustion ReactionsCombustion is also called burning. So, any example of burning you can think of is a combustion reaction, including burning matches, candles, campfires, and gas burners. Here are examples of balanced equations for combustion reactions:Combustion of methaneCH4(g) + 2 O2(g) → CO2(g) + 2 H2O(g)Burning of naphthaleneC10H8 + 12 O2 → 10 CO2 + 4 H2OCombustion of ethane2 C2H6 + 7 O2 → 4 CO2 + 6 H2OCombustion of butane (commonly found in lighters)2C4H10(g) + 13O2(g) → 8CO2(g) + 10H2O(g)Combustion of methanol (also known as wood alcohol)2CH3OH(g) + 3O2(g) → 2CO2(g) + 4H2O(g)Combustion of propane (used in gas grills, fireplaces, and some cookstoves)2C3H8(g) + 7O2(g) → 6CO2(g) + 8H2O(g)How to Recognize a Combustion ReactionYou'll know you have a combustion reaction when you see a hydrocarbon (molecule containing carbon and hydrogen) and oxygen gas (O2) on the reactant side (left side) of the reaction arrow and carbon dioxide (CO2) and water (H2O) on the product side (right side) of the reaction arrow. Also, combustion using oxygen always produces heat. The reaction still requires activation energy to start, but more heat is released by combustion than is absorbed starting it.Many combustion reaction produce flames. If you see fire, it indicates a combustion reaction. However, combustion often occurs without fire. For example, smoldering is combustion without flames.Sometimes it's harder to recognize a combustion reaction because the reactant contains its own oxidizer (oxygen) or because combustion is incomplete, forming other products besides carbon dioxide and water. For example, some rockets rely on the reaction between Aerozine 50 (C2H12N4) and nitrogen tetroxide (N2O4). If you're clever, you'll see Aerozine 50 contains the necessary chemical bonds to act as a fuel (carbon-hydrogen and carbon-nitrogen) and nitrogen tetroxide supplies oxygen for combustion. Then, there are forms of combustion that don't even involve oxygen.Combustion Without OxygenTechnically, oxidation doesn't always require oxygen, so combustion can occur without oxygen, too.An oxidizer accepts electrons, usually by supplying oxygen to a chemical reaction. Other oxidizers include the halogens (fluorine, chlorine, etc.). Metallic fuels burn using fluoropolymers (e.g., Teflon, Viton), without the need for any oxygen at all.Complete Versus Incomplete CombustionLike other chemical reactions, combustion is subject to a limiting reactant and doesn't always proceed to completion.Complete combustion or "clean combustion" occurs when the oxidation of a hydrocarbon only produces carbon dioxide and water. Burning candle wax is a good example of complete combustion. Heat from the burning wick vaporizes wax (a hydrocarbon). Wax reacts with oxygen, releasing carbon dioxide and water. The wax burns away and the carbon dioxide and water dissipate into the air.Incomplete combustion or "dirty combustion" is incomplete hydrocarbon oxidation, producing carbon monoxide (CO), carbon (soot), and other products, in addition to carbon dioxide and water. Wood and most fossil fuels undergo incomplete combustion, releasing these additional waste products.ReferencesLackner, Maximilian; Winter, Franz; Agarwal, Avinash K., eds. (2010). Handbook of Combustion. Wiley-VCH. ISBN 978-3-527-32449-1.Law, C.K. (2006). Combustion Physics. Cambridge University Press. ISBN 9780521154215.Schmidt-Rohr, K (2015). "Why Combustions Are Always Exothermic, Yielding About 418 kJ per Mole of O2". J. Chem. Educ. 92 (12): 2094–2099. doi:10.1021/acs.jchemed.5b00333Related Posts Figure

{\displaystyle {}1}

 (Credit: Nina Hale; Source: RoastingMarshmallow.jpg(opens in new window); License: CC BY 2.0(opens in new window)) Roasting marshmallows over an open fire is a favorite past-time for campers, outdoor cook-outs, and just gathering around a fire in the back yard. The trick is to get the marshmallow a nice golden brown without catching it on fire. Too often we are not successful and we see the marshmallow burning on the stick – a combustion reaction taking place right in front of us. A combustion reaction is a reaction in which a substance reacts with oxygen gas, releasing energy in the form of light and heat. Combustion reactions must involve

{\ce{O2}}

 as one reactant. The combustion of hydrogen gas produces water vapor:

{\ce{2H2}}

{\left(g \right)}

 +

{\ce{O2}}

{\left(g \right)}

{\rightarrow 2H2O}

{\left(g \right)}

{\text{onumber}}

 \ Notice that this reaction also qualifies as a combination reaction. Figure

{\displaystyle {}2}

: Explosion of the Hindenberg. (Credit: Courtesy of Gus Pasquerella/US Navy; Source: Hindenburg burning.jpg(opens in new window); License: Public Domain) The Hindenberg was a hydrogen-filled airship that suffered an accident upon its attempted landing in New Jersey in 1937. The hydrogen immediately combusted in a huge fireball, destroying the airship and killing 36 people. The chemical reaction was a simple one: hydrogen combining with oxygen to produce water. Many combustion reactions occur with a hydrocarbon, a compound made up solely of carbon and hydrogen. The products of the combustion of hydrocarbons are carbon dioxide and water. Many hydrocarbons are used as fuel because their combustion releases very large amounts of heat energy. Propane

{\left(\ce{C3H8} \right)}

 is a gaseous hydrocarbon that is commonly used as the fuel source in gas grills.

{\ce{C3H8}}

{\left(g \right)}

 +

5

{\ce{O2}}

{\left(g \right)}

{\rightarrow 3CO2}

{\left(g \right)}

 +

4

{\ce{H2O}}

{\left(g \right)}

{\text{onumber}}

 \ Ethanol can be used as a fuel source in an alcohol lamp. The formula for ethanol is

{\ce{C2H5OH}}

. Write the balanced equation for the combustion of ethanol. Step 1: Plan the problem. Ethanol and oxygen are the reactants. As with a hydrocarbon, the products of the combustion of an alcohol are carbon dioxide and water. Step 2: Solve. Write the skeleton equation:

{\ce{C2H5OH}}

{\left(1 \right)}

 +

{\ce{O2}}

{\left(g \right)}

{\rightarrow 2CO2}

{\left(g \right)}

 +

{\ce{H2O}}

{\left(g \right)}

{\text{onumber}}

 \ Balance the equation.

{\ce{C2H5OH}}

{\left(1 \right)}

 +

3

{\ce{O2}}

{\left(g \right)}

{\rightarrow 2CO2}

{\left(g \right)}

 +

3

{\ce{H2O}}

{\left(g \right)}

{\text{onumber}}

 \ Combustion reactions must have oxygen as a reactant. Note that the water produced is in the gas state, rather than the liquid state, because of the high temperatures that accompany a combustion reaction. Summary Combustion reaction is defined and examples are given. Review What is needed for a combustion reaction to take place? What is formed in any combustion reaction? Mercury reacts with oxygen to form mercuric oxide. Is this a combustion reaction? What are the products of any combustion reaction involving a hydrocarbon? LICENSED UNDER

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