

Period 7 Activity Solutions: Chemical Energy

7.1 What are Chemical Reactions?

1) **Chemical Compounds** Your instructor will discuss chemical substances and compounds.

- a) The formula for acetic acid, which is found in vinegar, is $\text{HC}_2\text{H}_3\text{O}_2$. Which elements make up acetic acid? How many atoms of each element are contained in one molecule?

A molecule of $\text{HC}_2\text{H}_3\text{O}_2$ contains 4 hydrogen atoms, two carbon atoms and two oxygen atoms.

2) Chemical Equations

A balanced equation has the same number of atoms of each element on either side of the arrow. Are the equations given below balanced? If not, write numbers in the blanks before the substances to indicate the number of molecules of each substance needed to balance the equation.

- a) $\underline{2}\text{H}_2 + \underline{1}\text{O}_2 \rightarrow \underline{2}\text{H}_2\text{O}$
- b) $\underline{6}\text{CO}_2 + \underline{6}\text{H}_2\text{O} \rightarrow \underline{1}\text{C}_6\text{H}_{12}\text{O}_6 + \underline{6}\text{O}_2$
- c) $\underline{1}\text{Na}_2\text{CO}_3 + \underline{1}\text{HC}_2\text{H}_3\text{O}_2 \rightarrow \underline{1}\text{NaHCO}_3 + \underline{1}\text{NaC}_2\text{H}_3\text{O}_2$
- d) $\underline{1}\text{NaHCO}_3 + \underline{1}\text{HC}_2\text{H}_3\text{O}_2 \rightarrow \underline{1}\text{H}_2\text{O} + \underline{1}\text{CO}_2 + \underline{1}\text{NaC}_2\text{H}_3\text{O}_2$

3) Endothermic and Exothermic Reactions

Your instructor will show you how to mix acetic acid and sodium carbonate in a plastic bag.

- a) What do you feel when you touch the outside of the plastic bag? **Heat**
- b) Is this reaction endothermic or exothermic? How do you know?

The reaction is exothermic because energy (heat) is given off by the reactants.

Next your instructor will show you how to mix acetic acid with sodium bicarbonate in another plastic bag.

- c) What do you feel when you touch the outside of this plastic bag? **Cold**
- d) Is this reaction endothermic or exothermic? How do you know?

This reaction is endothermic because energy (heat) is taken in by the reactants. The bag feels cold because heat is transferred from your hand to the chemicals in the bag.

4) Chemical and Physical Changes

- a) What is the difference between a chemical reaction and a physical change?

In a chemical reaction, one or more compounds are partially used up and one or more new compounds are formed.

A physical change involves no change in chemical composition. Energy may be absorbed and released in chemical reactions and physical changes.

- b) Activate a commercial hot pack. Does a chemical reaction or a physical process take place? How do you know?

This is a physical change. The hot pack can be reused if energy is added by placing it in boiling water. Because the hot pack can be recharged, the chemical substances in the pack have not been used up.

- c) Activate a commercial cold pack. Does a chemical reaction or a physical process take place? How do you know?

This is a chemical change of ammonium nitrate reacting with water. The cold pack cannot be reused because the chemical composition of its substances have been used up.

5) Activation Energy

- a) What is activation energy?

Activation energy is the energy required to cause two or more substances to begin to react chemically.

- b) Is activation energy required in endothermic reactions? **Yes**

- c) Is activation energy required in exothermic reactions? **Yes**

- d) In the presence of oxygen and water, iron at room temperature rusts into iron oxide. Is activation energy required in this reaction?

Activation energy is required in all reactions. In this example, the thermal energy of the iron molecules at room temperature is enough energy to begin the reaction.

6) Catalysts

- a) What is the purpose of a catalyst?

A catalyst reduces the activation energy required for a reaction to take place. In many cases, reducing the required activation energy increases the rate of the reaction. In other cases, reducing the activation energy allows a reaction to occur at a lower temperature. A lower temperature reaction may proceed more slowly.

- b) Your instructor will demonstrate hydrogen peroxide mixed with water.

- 1) What is the purpose of adding a piece of platinum to the beaker?

The platinum acts as a catalyst and increases the speed of the reaction.

- 2) Is the platinum used up in the reaction? **_No_**

- 3) Does the platinum change the outcome of the reaction? **_No_**

7) Batteries

Your instructor will show you how to make a battery.

- a) Hook your battery to a voltmeter. How much voltage does your battery produce? _____

- b) What causes a voltage difference between the anode and the cathode of the battery?

Negative charge moves toward the cathode, and positive charge moves toward the anode. When the cathode and anode are connected to an external circuit, the voltage from the accumulated separated charge causes a current to flow.

8) Electroplating

Your instructor will show you electroplating with carbon and copper rods.

- a) What happens to the carbon rod?

In time the carbon rod becomes coated with copper.

- b) Why must the copper and carbon rods be connected to batteries?

The reaction is endothermic. Electrical energy is used to remove positive copper ions from the copper strip. These ions move to the negatively charged carbon rod.

9) Electrolysis of Water

Your instructor will demonstrate the electrolysis of water.

- a) Is this an endothermic or exothermic reaction? How do you know?

This is an endothermic reaction because electrical energy must be continuously added to the reactant (water).

- b) Is a catalyst used in this reaction?

Yes, sodium hydroxide is added to the water.

- c) What are the reaction products?

Water molecules are dissociated into hydrogen and oxygen gas.

10) Fuel Cells

- a) The fuel cell demonstrated is the opposite of electrolysis of water. Is this reaction endothermic or exothermic?

The fuel cell is an exothermic reaction that produces electrical energy.

- b) How is a fuel cell different from a battery?

Fuel cells are similar to batteries in that they both convert chemical energy directly into electrical energy. A battery is a closed system to which no reactants or products are added or lost. In a fuel cell, the reactants (hydrogen and oxygen gas) must be added and the product (water) is given off.

- c) Group Discussion Question: What are some of the advantages and disadvantages to using fuel cells to power automobiles?