

Preview of Period 8: Chemical Energy

8.1 Atoms, Elements, and Compounds

What are the chemical components of matter?

8.2 The Electromagnetic Force

What holds atoms and molecules together?

8.3 Chemical Reactions and Equations

How do you write a balanced chemical equation?

8.4 Energy and Chemical Reactions

How much energy is released in chemical reactions?

8.5-6 Endothermic and Exothermic Reactions

What are examples of endothermic and exothermic chemical reactions?

Forms of Energy

Mechanical Energy of Motion: The energy exhibited by objects in motion.

Thermal Energy: The unorganized energy of motion of vibrating atoms and molecules.

Sound Energy: The organized energy of motion of vibrating atoms and molecules.

Electrical Energy: The energy resulting from forces between charged particles.

Magnetic Energy: The energy resulting from the forces between magnets.

Radiant Energy: The energy resulting from vibrations of charges, such as radio waves, microwaves, or visible light.

Gravitational Potential Energy: The energy stored in raised objects, which could fall.

Strain Potential Energy: The energy stored in a stretched or compressed spring.

Chemical Energy: The energy available in the chemical bonds binding atoms together.

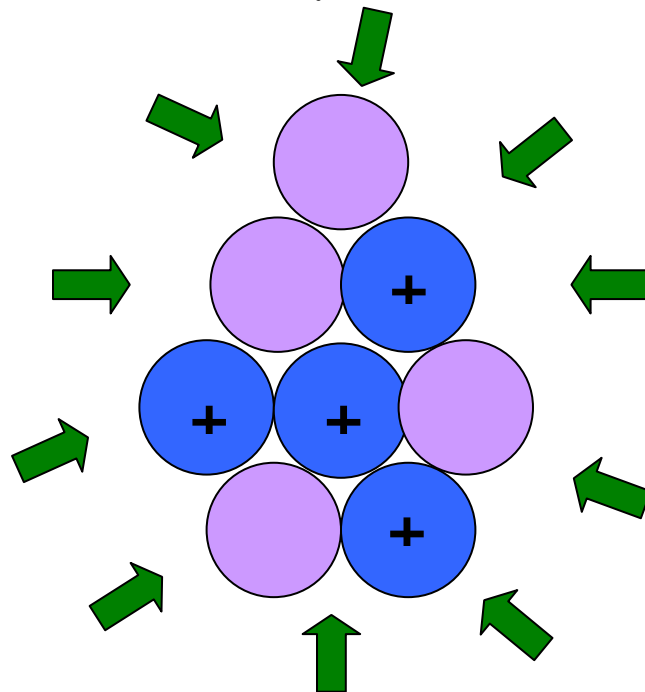
Electrical Potential Energy: The energy stored by static electric charges.

Nuclear Energy: Energy available in the nuclei of radioactive atoms.

The Composition of Matter

- ◆ Atoms consist of a positively charged nucleus surrounded by negatively charged electrons.
- ◆ The nucleus consists of nucleons - positively charged protons and electrically neutral neutrons.
- ◆ What Holds Nucleons together in a Nucleus?

Strong nuclear force - holds nucleons (protons and neutrons) together in atomic nuclei. It is the strongest force, but it acts over only very short distances (10^{-15} m). At even shorter distances, the strong force is repulsive, which keeps the separation between adjacent nucleons nearly the same.



The Composition of Matter, continued

- ◆ An atom is electrically neutral. An **ion** is an atom with a positive or negative charge.
- ◆ Elements consist of atoms. The number of **protons** in the atomic nucleus determines the identity of the element.
- ◆ What holds electrons in orbit around a nucleus?

Electromagnetic force - The electromagnetic attraction between negatively charged electrons and the positively charged nucleus binds the electrons to the nucleus.

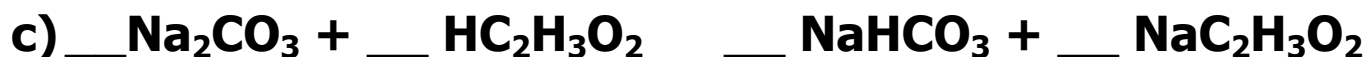
Chemical Reactions

- ◆ Elements consist of atoms. The number of **protons** in the atomic nucleus determines the identity of the element.
- ◆ Elements can combine into molecules or electrically charged ions.
- ◆ A **compound** consists of atoms or molecules all of the same kind
- ◆ Matter consisting of different compounds is a **substance**.

Which atoms make up a molecule of acetic acid?



Are these equations balanced?



Endothermic and Exothermic Reactions

Exothermic reactions give off energy

Chemical energy is converted into another form of energy, such as thermal, radiant, or electrical energy

Examples: combustion, batteries, or fuel cells

Endothermic reactions require energy to be put in to occur.

Some form of energy, such as thermal, radiant, or electrical energy, is converted into chemical energy.

Examples: photosynthesis, recharging batteries, electroplating,

Physical and Chemical Changes

Physical changes involve

- ◆ No change in the chemical composition of the material.
- ◆ Energy may be absorbed or released.
- ◆ Example: a phase change between solid and liquid phases or between liquid and gas phases

Chemical reactions involve

- ◆ Making and breaking chemical bonds between atoms and molecules
- ◆ One or more substances are partially used up
- ◆ One or more new substances are formed
- ◆ Energy is absorbed or released.

Batteries

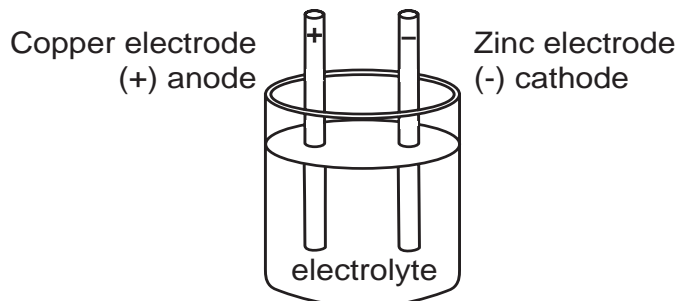
Batteries convert chemical energy into electrical energy using

- 1) Two **electrodes** - two plates made of different materials.

We will use zinc and copper strips.

- 2) An **electrolyte** solution - an acid, base or salt often dissolved in water to form positively and negatively charged ions.

We will use weak acetic acid (vinegar).



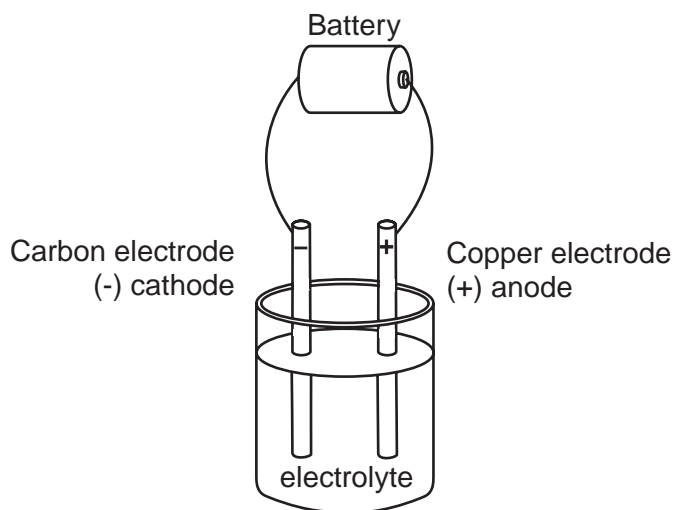
Battery

- ◆ Negative ions migrate to the cathode, which becomes negatively charged.
- ◆ Positive ions migrate to the anode, which becomes positively charged.
- ◆ When the cathode and anode are connected to an external circuit, the separated charge causes a current to flow.

Electroplating

Electroplating coats a material with a thin layer of metal.

- ◆ To copper plate a carbon rod, use the carbon rod as the negative cathode
- ◆ A strip of copper is the positive anode.
- ◆ A solution of copper sulfate is the electrolyte.
- ◆ Connect the positive terminal of a battery to the anode and the negative terminal to the cathode.
- ◆ Positive copper ions are attracted to the negative cathode where they cover (or plate) the carbon rod.



Electroplating

Chemical Reactions and Physical Changes

- ◆ In a chemical reaction, some compounds are partially used up and new compounds are formed.
- ◆ In a physical change, there is no change in chemical composition.

Activation energy is the minimum energy needed to start a chemical reaction.

- ◆ All reactions require activation energy.
- ◆ In some cases the thermal energy of the reactants is sufficient.
- ◆ In other cases, energy must be added.

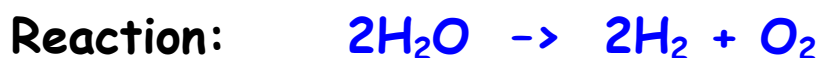
Catalysts change the rates of chemical reactions by reducing the amount of activation energy required.

Thus, reactions can occur at lower temperatures.

- ◆ Catalysts do not change the outcome of the reaction.
- ◆ The catalyst is not used up in the reaction

Electrolysis of water

In electrolysis, water molecules are separated into H₂ and O₂ gas molecules.



- ◆ A source of energy (an electric current) is required. Thus, the reaction is endothermic.
- ◆ A catalyst is added to speed the reaction

Fuel Cells

In some fuel cells, H₂ and O₂ gases are combined to form H₂O.

The reaction is the reverse of hydrolysis:



The reaction is exothermic. Thus, fuel cells are an energy source.

Period 8 Summary

- 8.1** Atomic nuclei consist of **nucleons** - positively charged protons and neutral neutrons.

The nucleus is surrounded by a cloud of negatively charged electrons.

Elements consist of **atoms**. Elements can combine into molecules or electrically charged ions.

A **compound** consists of atoms or molecules all of the same kind. Matter consisting of different compounds is a **substance**.

- 8.2** Balanced chemical reactions have the same number of atoms of each element on both sides of the arrow.

- 8.3 Chemical reaction:** One or more substances are partially used up and one or more new substances are formed

Physical change: No change in chemical composition occurs.

- 8.5 Exothermic reactions** give off energy (often thermal energy) Examples: combustion, batteries, or fuel cells

Endothermic reactions require energy put in to occur. Examples: recharging batteries, electroplating, photosynthesis

8.5 Activation energy is the minimum energy needed to start a chemical reaction.

All reactions require activation energy. In some cases the thermal energy of the reactants is sufficient. In other cases, energy must be added.

Catalysts change the rates of chemical reactions, but they do not change the outcome of the reaction.

8.6 Electrolysis of water: Water molecules are separated into H₂ and O₂ gas molecules.



A source of energy (an electric current) is required. A catalyst is added to speed the reaction

Fuel Cells: H₂ and O₂ gases are combined to form H₂O. The reaction is the reverse of hydrolysis:



The reaction is exothermic. Thus, fuel cells are an energy source.

Period 8 Review Questions

- R.1** What is an exothermic reaction? Give examples of exothermic reactions.
- R.2** What is an endothermic reaction? Give examples of endothermic reactions. How can endothermic reactions occur in nature?
- R.3** What is a catalyst? Give examples of chemical processes that require catalysts.
- R.4** In class we made a battery using tap water as the electrolyte. Why was it possible to use tap water as the electrolyte?
- R.5** What is a fuel cell? Could a fuel cell be used to power a car? What are some of the advantages of fuel cells? Are there any disadvantages for using fuel cells to power a car?