How to Build a Battery!

Batteries Ancient to Modern

Subject Area(s) Chemistry

Associated Unit

Lesson Title **Batteries (Baghdad to Flexible)**

Grade Level 10 (9-10)

Time Required 4-5 Class Periods or 40 minutes per battery

Summary

Students are introduced to the history and operational parts of various batteries from the most ancient, Baghdad, to present day flexible batteries. Basic knowledge of how a battery works including electron flow dynamics. Understanding an electron flow from cathode to anode must occur for a battery to be of use. Batteries are storage vessels for electrons which may be converted into electrical energy useful to power various instruments. In lab setting students will construct five different batteries (Baghdad, 4 lemon, 20 penny, lead acid, and flexible).

Engineering Connection

Batteries are an important link in the storage and usage of electricity and its many mobile applications. Engineers develop test and manufacture batteries to meet the power needs for most mobile electronic devices. Materials engineers along with chemical engineers assemble the materials necessary to meet design requirements. Depending on design parameters specific materials will be chosen to meet power requirements. Packaging durability along with battery durability are critical to construction of durable long life batteries. The initial class builds the oldest known battery, Baghdad and each succeeding builds an increasingly more complex battery. Students must use their knowledge of acid/base chemistry, electrochemistry, and construction methods to create the five batteries in this series.

Engineering Category = 1

Choose the category that best describes this lesson's amount/depth of engineering content:

1. Relating science and/or math concept(s) to engineering
2. Engineering analysis or partial design
3. Engineering design process

Keywords

electrons, electrical energy, cathode, anode, battery, electrolyte

Educational Standards (List 2-4)

ITEEA 2000, grades 9-12, 16.J

Standard 16. Students will develop an understanding of and be able to select and use energy and power technologies.

J. In order to select, use, and understand energy and power technologies, students should learn that energy cannot be created nor destroyed; however, it can be converted from one form to another.

Texas: Science 2010, grades 9-10, C

Science Concepts. The student recognizes multiple forms of energy and knows the impact of energy transfer and energy conservation in everyday life. The student is expected to demonstrate common forms of potential energy, including gravitational, elastic, and chemical, such as a ball on an inclined plane, springs, and batteries

Pre-Requisite Knowledge

Students should be able to balance chemical equations and use stoichiometry.

Learning Objectives

After this lesson, students should be able to:

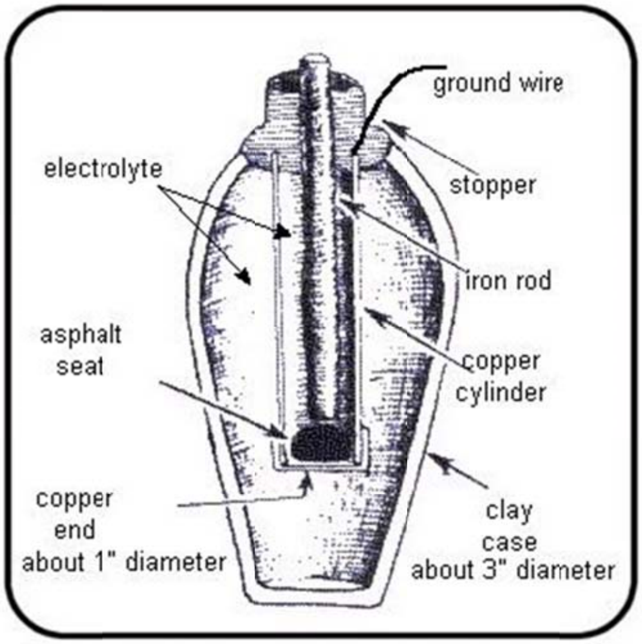
- Draw diagrams of five different basic battery designs
- Know difference between anode and cathode
- Understand the effect of various metals and electrolytes on a batteries performance
- Identify the components needed to build a battery
- Understand the importance of reliable, long lasting batteries necessary for the efficient storage of energy
- Recognize the difference between a strong and weak electrolyte

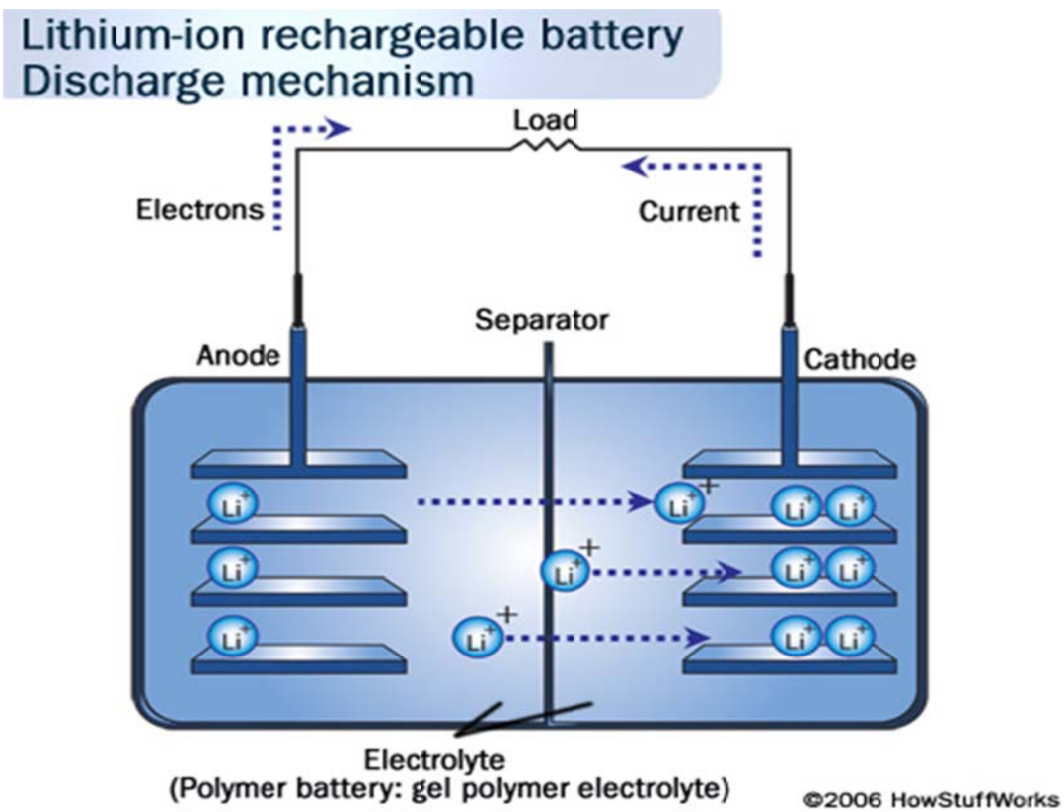
Introduction / Motivation

What makes a battery work? Batteries are our primary storage vehicle and method or transporting electrical energy. What are the components of batteries and where does the electricity come from? Understanding the chemical energy stored the molecules of electrolytes and on the surfaces of the electrodes and how it is transformed into electrical energy is critical to building a successful battery. This series of lessons is designed to give students a basic understanding of what components are necessary to construct a battery and how it works.

Lesson Background & Concepts for Teachers

The students were introduced to acid/bases, electrochemistry and battery fundamentals. Begin the lesson by asking the students to define what makes a battery. They are given a lab kit with basic battery components. Teams of 4 students are instructed to build each of the following batteries: Baghdad, 4 lemon, 20 penny, lead/acid, and a flexible battery (bendable). Batteries are fundamentally electro-chemical reactors which release and collect electrons.

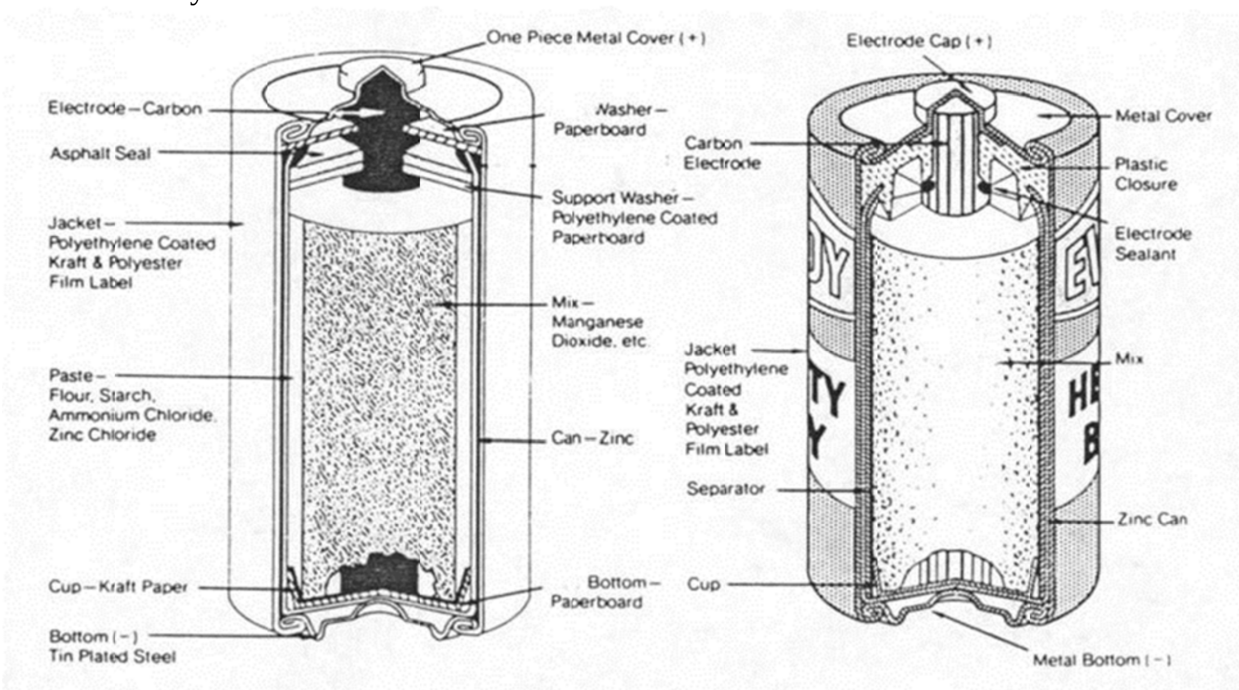


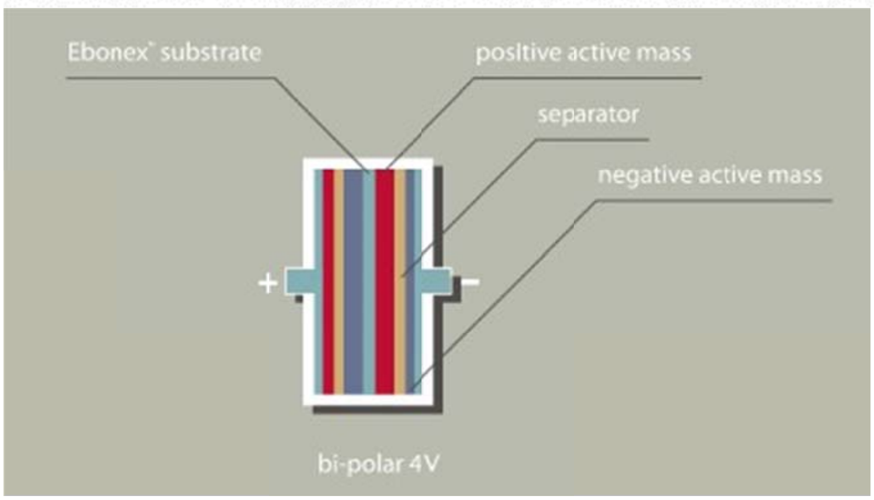


In order to engineer any battery to generate electricity one must have an anode and cathode composed of two different metals separated from each other bathed in an effective electrolyte. Include stripping of electrons, electrode collection of e-, role of metals, role of separator, role of electrolyte, what makes a good electrolyte, diagram of battery function with e- flow direction

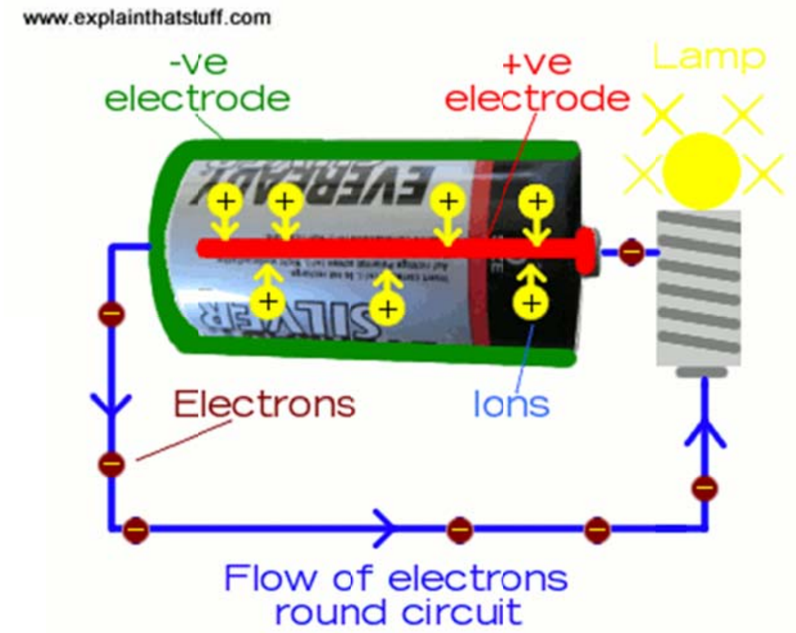
Battery Design Basics .

Modern Battery

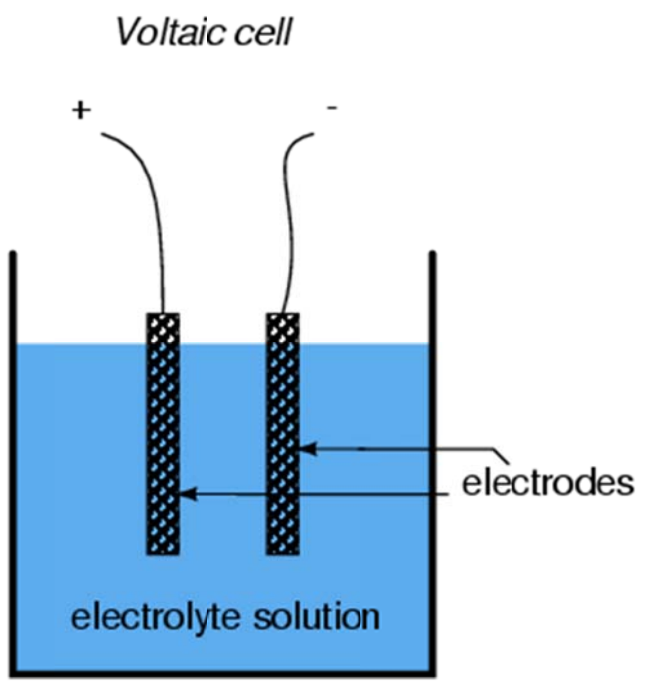




To apply these principles to a battery, we must identify the two electrode metals . Based on Newton's second law of motion, we know that F=ma (force is equal to the mass of an object multiplied by its acceleration). Thus, the weight of any object is equal to its mass multiplied by the gravitational acceleration constant of 9.81 m/s^2. In order to lift the rocket off the ground, there must be another force acting upward on the rocket and has a larger magnitude than the weight. This is the thrust force.



electrochemical (oxidation/reduction) reaction: FROM ALL ABOUT CIRCUITS.COM



The two electrodes are made of different materials, both of which chemically react with the electrolyte in some form of ionic bonding.

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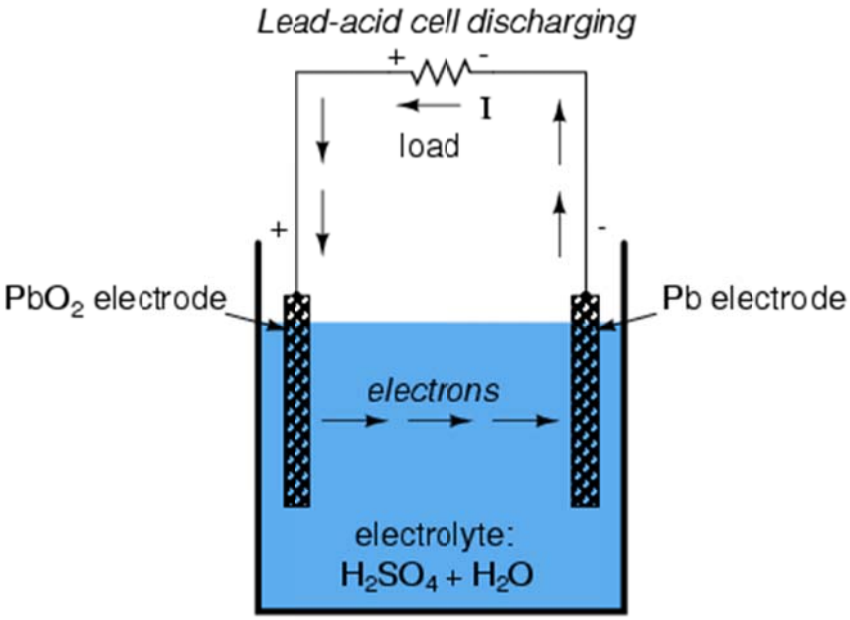

At (+) electrode: $Pb(IV)O_2 + 3H^+ + HSO_4^- + 2e^- \rightarrow Pb(II)SO_4 + 2H_2O$

At (-) electrode: $Pb + HSO_4^- \rightarrow Pb(II)SO_4 + H^+ + 2e^-$

Overall cell: $PbO_2 + Pb + 2H_2SO_4 \rightarrow 2PbSO_4 + 2H_2O$

Vocabulary / Definitions

Word	Definition
Battery	The branch of mechanics that is concerned with the analysis of loads on physical systems in static equilibrium, that is, in a state where the relative positions of subsystems do not vary over time, or where components and structures are at a constant velocity
Electricity	The flow of electrons in a circuit
Electrodes	Usually a metal used to collect electrons An **electrode** is an electrical conductor used to make contact with a nonmetallic part of a circuit (e.g. a semiconductor, an electrolyte.

Associated Activities

Voltage is generated

Lesson Closure

Assessment

Pre-Lesson Assessment

- What materials are necessary to build a battery?
- What where the most critical aspects of the battery construction?
- Why are batteries so important in the storage of energy?

Post-Introduction Assessment

- For a battery to generate electron flow, what must happen chemically within the battery cell?
- What are the key components required for a battery?
- What are the key design features of a battery?

Lesson Summary Assessment

- Where do the electrons come from in a battery?
- What makes the electrons flow?

Lesson Extension Activities

As a demonstration, you can create your own combustion reaction using a flame as a heat source, air for oxygen, and any powder (sugar, creamer, etc.) as fuel. Prior to the demonstration, ask the class what would happen if you were to put a fairly large amount of powder over the flame. The answer: the flame should go out because there is not oxygen for the combustion reaction to occur. What would happen is the powder is sprinkled over the flame instead? Using a Bunsen burner or a candle, lightly sprinkle any powder over the flame. You should see a sort of combustion reaction. How would the particle size of the powder affect combustion? Finer powder particles can allow for a more homogenous mixture of oxygen and fuel, thus creating a larger combustion. To tie this into a real scenario, factories dealing with food processing or anything where an accumulation of dust is possible are at risk for exploding. This has happened to several factories in the past, where silos or canisters are not cleaned properly and dust accumulates and spreads throughout the air. A single spark or an overheated piece of equipment could cause the entire plant to explode. The success of demonstration described above is dependent on the room environment and state of the powder. High humidity days or a large moisture content trapped in the powder, used as fuel, could cause a failed demonstration. As an extension, you could discuss spectrums and how different molecules burn different colors. Additives can be used in the fuel to make green or blue flames rather red or orange.

Additional Multimedia Support

none

References

Allaboutcircuits.com

Attachments

Rockets.pptx XXXXXXX

Other

Redirect URL

Contributors

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Classroom Testing Information
This lesson was used in a 10th grade chemistry class at the Village School in Houston, TX during the month of March 2015. This lesson was given three times, three times to the honors chemistry students (64 students total). Each class holds 20-22 students.