

## 9.4 Technology of Cells and Batteries

- Before 1800 the only electricity was static electricity. It could be stored but it could only be discharged as a spark that was of limited practical use.
- Alessandro Volta invented the electric cell in 1800. He determined from an experiment done by Luigi Galvani that an electric current could be generated by conductors and electrolytes.

### Cells and Batteries

- Electric Cell: a device that continuously converts chemical energy into electrical energy.
- Battery: a group of two or more electric cells connected in series.
- Volta's first battery was a series of copper and zinc rods alternately connected in bowls of brine. This idea was refined to use metal plates and wet cardboard. See figures 1 and 2 on page 685. Figure 2 also effectively illustrates the difference between a cell and a battery.

### Basic Cell Design and Properties

- Electrode: a solid electrical conductor.
- Electrolyte: an aqueous electrical conductor
- Electric Potential Difference (Voltage): the potential energy difference per unit charge.
- Volt (V): the SI unit for electric potential difference;  $1\text{ V} = 1\text{ J/C}$
- Electric Current: the rate of flow of charge past a point.
- Ampere (A): the SI unit for electric current;  $1\text{ A} = 1\text{ C/s}$
- Coulomb (C): the SI unit for electric charge.
- In an electric cell or battery, the cathode is the positive electrode and the anode is the negative electrode.
- Electricity flows from the anode through an external conductor (wire) to the cathode.
- Size of the battery is irrelevant when it comes to voltage. The voltage of a cell depends mainly on the chemical composition of the reactants in the cell. (larger batteries just last longer)

### Technological Problem Solving

- Cells and batteries were discovered about 100 years before the discovery of the electron. Sometimes it is the technology that leads to scientific understanding.

### Consumer, Commercial, and Industrial Cells

- Primary Cell: an electric cell that cannot be recharged.
- Secondary Cell: an electric cell that can be recharged.
- Fuel Cell: an electric cell that produces electricity by a continually supplied fuel.

### Primary Cells

- The basic primary cell is the zinc chloride dry cell. Which has been improved upon by the development of the alkaline dry cell and the mercury cell.
- See page 689 for the half reactions that generate the electricity for the cells.

### Secondary Cells

- The rechargeable cells are dominated by the nickel-cadmium cell and the lead-acid battery (car battery).
- See page 689 for the half reactions that generate the electricity for the cells.

### Fuel Cells

- Fuel cells are dominated by the hydrogen-oxygen cell and the aluminum-air cell.
- See page 689 for the half reactions that generate the electricity for the cells.
- This is an exciting area of research. The idea of a fuel cell has been around since 1839 but it is only recently that it has been made efficient (NASA has a fuel cell that is 70% efficient but is very expensive). Cheap and efficient fuel cells are still in development.

### The Ballard Fuel Cell

- The Ballard Fuel cell is the most promising technology for a cheap and efficient fuel cell. Instead of using a damaging electrolyte like the one NASA uses, Ballard Power of Vancouver has developed a proton exchange membrane.
- All the major car companies have contracts with Ballard for fuel cells and the development of zero emission vehicles.
- The primary concern for this technology is the fuel. Hydrogen is very explosive and transporting large volumes in a vehicle has many risks. A containment vessel is also being developed to eliminate this problem.

**Aluminum-Air Cell**

- Unlike the Ballard Fuel cell, the aluminum-air cell has been getting very little media attention.
- It uses solid aluminum as its fuel. After it is consumed the aluminum would need to be replaced. Currently that is about 2500 km in an electric car. The waste aluminum oxide can be recycled back to aluminum. On a side note, aluminum is the third most abundant element on Earth.