

Making Connections

20. (a) anode: $\text{Pb}_{(s)}$; cathode: $\text{PbO}_{2(s)}$; electrolyte: $\text{H}_2\text{SO}_{4(aq)}$
(b) The large currents are produced by designing electrodes with a large surface area.
(c) The main social impact of this battery is to enable widespread use of motor vehicles for personal transportation.
(d) The lead and acid in used car batteries can have a negative impact on the environment.
21. Plastic batteries are unique in having electrodes made of conducting “doped” polymers rather than metallic materials. In some recent plastic cells, the electrolyte as well is made of a polymer material — resulting in a “leakproof” battery that contains no liquid. Charging involves ion migration to the electrodes, but the electrodes themselves do not charge, making such cells theoretically rechargeable through a very large number of cycles. The cells are very lightweight, may be almost any shape, and have high-energy density and power density characteristics, making them of great interest to designers of satellites. A significant advantage is that such cells operate through a very wide range of temperatures without much change in their electrical properties. Another strong social advantage is that they contain no environmentally harmful materials. Currently, such cells are very expensive and do not store very large quantities of energy, but development continues.

Explore an Issue: Debate: Hydrogen Fuel Cells

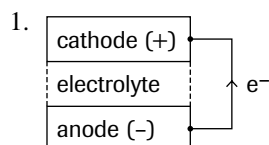
(Page 694)

- (a) (Sample points to consider ...)
- Most current proposals will use hydrogen stripped from methanol or gasoline, although natural gas is another potential hydrogen source.
 - If some fossil fuel is used as a source of hydrogen, carbon dioxide is still produced in the cell and there may be substantial environmental effects of producing the hydrogen-rich fuels, such as methanol and gasoline.
 - The cost of fuel-cell cars will be quite high until mass production lowers the unit cost. The economic effects on communities that depend on the well-established oil and gas industry, and internal-combustion vehicle production for employment may be significant. Political issues such as taxation, environmental regulations, and lobbies from special interest groups need to be considered.
 - Some alternatives include hybrid vehicles; generating hydrogen from renewable, nonpolluting sources such as sunlight and wind; and storing hydrogen in carbon nanotubes or graphite fibres.

SECTION 9.4 QUESTIONS

(Page 694)

Understanding Concepts



2. The chemical changes that occur at the electrodes provide the evidence that an electric cell involves a redox reaction. Reduction always occurs at the cathode (e.g., aqueous metal ions changing to solid metal), and oxidation always occurs at the anode (e.g., solid metal changing to aqueous metal ions).
3. The three types of electric cells used in consumer and commercial operations are primary cells, secondary cells, and fuel cells. Primary cells cannot in practice be recharged. Secondary cells can be recharged repeatedly. Fuel cells produce electricity by the reaction of a fuel that is continuously supplied to keep the cell operating.
4. Two common examples of consumer cells are alkaline dry cells, which are used in flashlights and radios, and Ni–Cad cells, which are used in power tools, shavers, and portable computers.
5. (a) The electrons flow from the zinc to the silver in the external circuit.
(b) Zinc is the anode and silver is the cathode.
(c) $\text{Ag}_2\text{O}_{(s)} + \text{H}_2\text{O}_{(l)} + \text{Zn}_{(s)} \rightarrow 2\text{Ag}_{(s)} + \text{Zn}(\text{OH})_{2(s)}$

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6. If cells and batteries did not exist, we would have to live without many commonplace conveniences, such as portable radios, flashlights, and flash cameras. Portable electronic devices, such as cordless phones, cellular phones, laptop computers, disc players, and digital cameras, would not exist. Starting a vehicle would have to be done the old-fashioned way—with a hand crank!