Analysis

(b) $q_{water} = mc\Delta T$

$= 100.0\ g \times 4.18\ J/g{\bullet}°C \times (25.0 - 20.0)°C$

$q_{water} = 2.09\ kJ$

$q_{aluminum} = c\Delta T$

$= 50.0\ g \times 0.91\ J/g{\bullet}°C \times (25.0 - 20.0)°C$

$q_{aluminum} = 0.23\ kJ$

$q_{total} = q_{water} + q_{aluminum}$

$q_{water} + q_{aluminum} = 2.32\ kJ$

$n\Delta H_c = q_{total}$

$m_{acetone} = 0.092\ g$

$M_{acetone} = 58.0\ g$

$n_{acetone} = 0.092\ g \times \dfrac{1\ mol}{58.0\ g}$

$n_{acetone} = 0.0016\ mol$

$\Delta H_c = \dfrac{q_{total}}{n}$

$= \dfrac{2.32\ kJ}{0.0016\ mol}$

$\Delta H_c = 1.5\ MJ/mol\ acetone$

Because the reaction is exothermic, the molar enthalpy of combustion of acetone, ΔH_c, is –1.5 MJ/mol.

Evaluation

(c) Percentage error $= \dfrac{|(1.5 - 1.79)|}{1.79} \times 100\%$

$= 16\%$

(d) The percentage error suggests that heat has been lost to the surroundings as part of experimental error.

(e) If heat is lost to the surroundings, then the observed temperature change in the water and calorimeter, the calculated q values, and the experimental ΔH all will be smaller than predicted.

5.6 THE ENERGY DEBATE

PRACTICE

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Understanding Concepts

1. (a) hydroelectric power, nuclear power, burning fossil fuels
   (b) All produce power by driving turbines: nuclear and fossil fuels heat water to drive steam turbines, whereas hydroelectric power uses falling water. Hydroelectric and nuclear energy have higher capital costs. Hydroelectric is relatively environmentally benign, fossil fuel burning produces the greatest amount of pollution, and nuclear energy poses the greatest safety risk.

Making Connections

2. (Sample answer) The CANDU system uses a heavy water moderator and ordinary uranium fuel, whereas some other systems use ordinary water as a moderator and enriched uranium fuel.

Explore an Issue: Take a Stand: Energy Options

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(Answers will vary.)

Advantages	Disadvantages
hydroelectric power; no air pollution	impact on watersheds of major development such as James Bay; high capital cost
fossil fuel power; low capital cost	pollution, including acid rain and greenhouse effect; ready access to fuel gases
nontraditional fuels; no air pollution	limited application due to geography; high capital cost per unit of power produced
soft energy paths; no air pollution	resistance of people unwilling to change lifestyle
no consumption of natural resources	

PRACTICE

(Page 346)

Understanding Concepts

3. (a) $\Delta H = n\Delta H_{\text{fission}}$

$= 4.26 \text{ mol} \times 1.9 \times 10^{10} \text{ kJ/mol}$

$\Delta H = 8.1 \times 10^{10} \text{ kJ}$

(b) $n_{\text{He}} = 1000 \text{ g} \times \dfrac{1 \text{ mol}}{4.00 \text{ g}}$

$n_{\text{He}} = 250 \text{ mol}$

$\Delta H = n\Delta H_{\text{fusion}}$

$= 250 \text{ mol} \times 1.7 \times 10^{9} \text{ kJ/mol}$

$\Delta H = 4.3 \times 10^{11} \text{ kJ}$

(c) Helium has a much lower molar mass, so 1 kg represents many more moles.

4. (a) Answers will vary, but fusion reactions require temperatures and concentrations of isotopes that are technologically challenging. No safe and efficient nuclear fusion reactors have been developed as of 2002.

SECTION 5.6 QUESTIONS

(Page 346)

Understanding Concepts

1. Fission of uranium produces about 2×10^{10} kJ/mol and fusion of hydrogen produces about 2×10^{9} kJ/mol. Thus, uranium produces about 10 times as much energy, per mole, as hydrogen. However, there are many more moles of hydrogen per kilogram, so the energy production per kilogram would be greater from hydrogen fusion than from uranium fission.

Making Connections

2. Answers will vary, but will include: descriptions of the Pickering and Bruce nuclear power stations; recent information on power output; and mention of the "pollution-free" nature of atomic energy balanced against the problems of disposal and large capital cost of facilities.

3. (Answers will vary.) Choices of alternative fossil fuels include natural gas (largely methane), propane, and other petroleum fractions.

Generating Power from Propane

Advantages	Disadvantages
Propane generators are portable.	Their portability makes them easy targets for thieves.
Power can be made available in an emergency.	Generators are very noisy.
Propane is readily available.	Propane is a relatively expensive form of fuel.

4. (Answers will vary.) Geothermal energy is very useful in areas that are geographically suitable, but few such areas exist in Canada. Solar energy is highly useful for small-scale energy production and many homes already use this source for home and water heating. Canada does not get sufficient intense sunshine for large-scale production.
5. (Answers will vary.) Hydrogen fuel has potential in combustion engines, but probably more in fuel cell application as suggested at the Ballard web site provided.
6. (Answers will vary.) The Chernobyl disaster was a significant example of human error leading to catastrophic short- and long-term effects.

CHAPTER 5 LAB ACTIVITIES

INVESTIGATION 5.1.1 MEDICAL COLD PACKS

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Experimental Design

(a) Add a measured mass of the unknown salt to a measured mass of water and stir to dissolve the solid. Measure the temperature change that occurs in the water, and use calorimetric calculations to determine an experimental enthalpy of solution which may be compared to accepted values.

(b) mass of water $= m_1$

mass of solid $= m_2$

initial temperature of water $= T_1$

final temperature of water $= T_2$

$q = mc\Delta T$

$q = m_1(4.18)(T_1 - T_2)$

enthalpy of solution $= \dfrac{q}{m_2}$

Procedure

(c) 1. Measure 100 g of water into a Styrofoam cup.
2. Measure its initial temperature.
3. Add a measured mass of the unknown salt to the water.
4. Stir to dissolve the solid, and measure the minimum final temperature of the solution.

Analysis

(d) See above. A mass of 10 g of ammonium chloride would absorb about 2800 J of heat, causing a temperature change in 100 g of water of about 6.7ºC.

Evaluation

(e) % difference $= \dfrac{|\text{accepted value} - \text{experimental value}|}{\text{accepted value}} \times 100\%$

(f) We are not completely confident: Errors could occur in measurements of mass or temperatures, or as a consequence of heat loss to the air.

(g) Since the temperature change in the water would be too small, the calculated heat of solution would be too low.

(h) Since the temperature change in the water would be too small, the calculated heat of solution would be too low.