Unit 3 Energy Changes and Rates of Reaction

ARE YOU READY?

(Page 294)

Knowledge and Understanding

1. (a) balloon: chemical potential energy
   (b) dragster: chemical potential energy
   (c) solar panel: solar or light energy
   (d) nuclear power station: nuclear potential energy
2. Chemical energy is energy stored in molecules.
3. (a) An exothermic process, such as the burning of wood, releases energy to the surroundings. An endothermic process, such as the melting of ice, absorbs energy from the surroundings. The difference is in the direction of heat transfer.
   (b) (i) and (iii) are exothermic; (ii) and (iv) are endothermic.
4. (a) Heat the acid, use more concentrated acid, grind the chalk into finer particles, or add a catalyst.
5. (a) q is heat transferred, m is mass of water, c is the specific heat capacity, and ΔT is temperature change.
   (b) Units are joules or calories for q, grams or kilograms for m, joules per gram•°C for c, and °C for ΔT.
   (c) $q = mc\Delta T$

   $= (200.0\text{ g})(4.18\text{ J/g•°C})(45 - 30\text{°C})$

   $q = 12\,540\text{ J or }12\text{ kJ}$

Inquiry and Communication

6. $CH_{4(g)} + 2\,O_{2(g)} \rightarrow CO_{2(g)} + 2\,H_2O_{(g)} + 890\text{ kJ}$

   $2\,C_2H_{6(g)} + 7\,O_{2(g)} \rightarrow 4\,CO_{2(g)} + 6\,H_2O_{(g)} + 3120\text{ kJ}$

   $C_3H_{8(g)} + 5\,O_{2(g)} \rightarrow 3\,CO_{2(g)} + 4\,H_2O_{(g)} + 2220\text{ kJ}$

   $2\,C_4H_{10(g)} + 13\,O_{2(g)} \rightarrow 8\,CO_{2(g)} + 10\,H_2O_{(g)} + 5716\text{ kJ}$

   (Note that the heats of combustion are expressed as absolute values, and that the heat of reaction is doubled if 2 mol of fuel are burned.)

7. $CH_{4(g)} + 2\,O_{2(g)} \rightarrow CO_{2(g)} + 2\,H_2O_{(g)} + 890\text{ kJ}$

   $C_2H_{6(g)} + 7/2\,O_{2(g)} \rightarrow 2\,CO_{2(g)} + 3\,H_2O_{(g)} + 1560\text{ kJ}$

   $C_3H_{8(g)} + 5\,O_{2(g)} \rightarrow 3\,CO_{2(g)} + 4\,H_2O_{(g)} + 2220\text{ kJ}$

   $C_4H_{10(g)} + 13/2\,O_{2(g)} \rightarrow 4\,CO_{2(g)} + 5\,H_2O_{(g)} + 2858\text{ kJ}$

Mathematical Skills

8. (a) $2\,NaHCO_{3(s)} + H_2SO_{4(aq)} \rightarrow Na_2SO_{4(aq)} + 2\,H_2O_{(l)} + 2\,CO_{2(g)}$
   (b) rate, $r = \dfrac{\Delta n_{NaHCO_3}}{\Delta T}$

   $= 10\text{ mol}/4\text{ min}$

   $r = 2.5\text{ mol }NaHCO_3/\text{min}$
   (c) 10 mol
   (d) rate $= 2.5\text{ mol }CO_2/\text{min}$

Technical Skills and Safety

9. Possible answers include the following:
   - Know the location of the fire extinguisher, fire blanket, and emergency gas shut-off valve.
   - Tie back long hair.
   - Remove or secure loose clothing.
   - Know about the “drop and roll” technique if clothing catches fire.

Making Connections

10. Use smaller pieces of wood; shield the fire from wind to keep the temperature high at the beginning; blow on the fire to increase concentration of oxygen; use dry wood or bark that burns more easily.