24. a. Graph B represents $\frac{1}{x}$, an inverse relationship

Graph C represents x^n ($n > 1$), an exponential relationship

b. Graph A represents a direct relationship between variables.

25. a. $c_{\text{mean}} = \dfrac{0.54 \text{ mol/L} + 0.491 \text{ mol/L} + 0.51 \text{ mol/L}}{3}$

$= 0.51366 \text{ mol/L}$
$= 0.51 \text{ mol/L}$

b. $m = nM$

Find n:

$n = cV$

$= 0.51366 \dfrac{\text{mol}}{\cancel{\text{L}}} \times 25 \cancel{\text{mL}} \times \dfrac{1 \cancel{\text{L}}}{1000 \cancel{\text{mL}}}$

$= 0.01284 \text{ mol}$

Use n to find m.

$m = nM$

$= 0.01284 \cancel{\text{mol}} \times 45.6 \dfrac{\text{g}}{\cancel{\text{mol}}}$

$= 0.58558 \text{ g}$
$= 0.59 \text{ g}$

26. a. $y = 3$

b. $x = 2$

27. a. 0.583 L

b. 4.7×10^3 cm/s

Chapter 5 Energy Changes

Answers to Learning Check Questions

(Student textbook page 283)

1. *Sample answer*: The heating element on an electric stove transfers heat to a metal pot, which transfers heat to the water inside; hot water in a wash basin transfers heat to your hands; a person exercising transfers body heat to the surrounding air.

2. A closed system can exchange energy with its surroundings in forms such as thermal energy, mechanical energy, and chemical energy. For example, a hot object in a closed, metal container can transfer thermal energy to the metal container and then to the surroundings because the hot object, metal container, and surroundings are in thermal contact.

3. Under conditions of constant pressure and volume, the enthalpy change of a system is equal to the heat exchanged between the system and the surroundings.

4. The burning of fuel in an automobile occurs in an open system. It is not possible to isolate the combustion reaction that occurs in an automobile engine. Thermal energy is continually released to the surroundings and dispersed. Under laboratory conditions, the combustion of a fuel could be studied in a controlled manner with all released thermal energy accounted for. The second law of thermodynamics would be shown to be valid. This tells us that when studying chemical reactions, the immediate surroundings must be isolated from the system for the results to be accurate.

5. An endothermic process is one in which the enthalpy or heat content of the system increases. Thermal energy is absorbed by the system. An exothermic process is one in which the enthalpy or heat content of the system decreases. Thermal energy is given off by the system.

6. a. The products have greater potential energy.

b. The enthalpy of the system is increasing: the reaction is endothermic; the enthalpy change is positive.

(Student textbook page 295)

7. The enthalpy term is a product in a thermochemical equation. The negative value for the enthalpy change means that energy is released.

8. Energy is released by the system, so the products have a lower potential energy than the reactants. The reactants, therefore, have more potential energy.

9. $C_2H_6(g) + \frac{7}{2} O_2(g) \rightarrow 2CO_2(g) + 3H_2O(\ell) + 1560.7 \text{ kJ}$

10. The diagram should indicate that the vertical scale measures potential energy in kilojoules per mole. The reactants, $C_3H_6(\ell) + \frac{9}{2} O_2(g)$, are at a higher energy level than the products, $3CO_2(g) + 3H_2O(\ell)$, with an energy difference of 2091.3 kJ.

11. $C_7H_6O_2(s) + \frac{15}{2} O_2(g) \rightarrow 7CO_2(g) + 3H_2O(\ell) + 3228.2 \text{ kJ}$

$\Delta H^\circ_{\text{comb}} = -3228.2 \text{ kJ/mol of } C_7H_6O_2(s)$

12. The equation for complete combustion of methyl methanoate is as written:

$C_2H_4O_2(\ell) + 2O_2(g) \rightarrow 2CO_2(g) + 2H_2O(\ell) + 972.6 \text{ kJ}$

The equation for complete combustion of methyl ethanoate is as shown below (divide the given equation by 2):

$C_3H_6O_2(\ell) + \frac{7}{2} O_2(g) \rightarrow 3CO_2(g) + 3H_2O(\ell) + 1592.2 \text{ kJ}$

More heat is given off for $C_3H_6O_2(\ell)$ than for $C_2H_4O_2(\ell)$. The standard molar enthalpy of combustion for $C_3H_6O_2(\ell)$ is -1592.2 kJ/mol.