Chem101: General Chemistry
Chapter 6 - States of Matter

IV. ANSWERS AND SOLUTIONS TO ODD-NUMBERED PROBLEMS:

Observed Properties of Matter (Section 6.1)

6.1 Calculate the volume of 25.0 g of the following liquids:
a) acetone (d = 0.792 g/mL) b) olive oil (d = 0.918 g/mL) c) chloroform (d = 1.49 g/mL)

SOLUTION:

a) $V = \frac{m}{d} = \frac{25.0\text{ g}}{0.792\text{ g/mL}} = 31.6\text{ mL}$

b) $V = \frac{m}{d} = \frac{25.0\text{ g}}{0.918\text{ g/mL}} = 27.2\text{ mL}$

c) $V = \frac{m}{d} = \frac{25.0\text{ g}}{1.49\text{ g/mL}} = 16.8\text{ mL}$

6.3 Copper metal has a density of 8.92 g/cm^3 at 20.0 °C and 8.83 g/cm^3 at 100.0 °C. Calculate the change in volume that occurs when a 10.0 cm^3 piece of copper is heated from 20.0 °C to 100.0 °C.

SOLUTION:

Assuming the 10.0 cm^3 piece of copper was measured at 20.0 °C the mass is:

$m = d \times V = 8.92\text{ g/cm}^3 \times 10.0\text{ cm}^3 = 89.2\text{ g}$

At 100.0 °C, the volume of the copper would be

$V = \frac{m}{d} = \frac{89.2\text{ g}}{8.83\text{ g/cm}^3} = 10.1\text{ cm}^3$

The volume changed from 10.0 cm^3 to 10.1 cm^3. The change was 0.1 cm^3.

6.5 Gallium metal melts at 29.8 °C. At the melting point, the density of the solid is 5.90 g/mL, and that of the liquid is 6.10 g/mL.
a) Does solid gallium expand or contract when it is melted?
b) What is the change in volume when 5.00 mL (cm^3) of solid gallium is melted?

SOLUTION:
a) Since the density = mass/volume, the density is inversely proportional to the volume. The lower density has a higher volume. The solid has the lower density, so it has the higher volume. The solid contracts when it melts.
b) The mass of the solid gallium is m = d x V = 5.90 g/~~mL~~ x 5.00 ~~mL~~ = 29.5 g

$$\text{The volume of the liquid is } V = \frac{m}{d} = \frac{29.5\text{ g}}{6.10\text{ g/mL}} = 4.84\text{ mL}$$

The change in volume = 5.00 mL - 4.84 mL = 0.16 mL

The Kinetic Molecular Theory of Matter (Section 6.2)

6.7 Describe the changes in form of energy (kinetic changes to potential, etc.) that occur for the energy of a rock dropped to the ground from a cliff. What form or forms do you suppose the energy takes when the rock hits the ground?

SOLUTION:
At the top of the cliff before being dropped, the rock has no kinetic energy (it is not moving) and high potential energy. As the rock falls, the kinetic energy increases and the potential energy decreases. As the rock hits the ground, the kinetic energy is changed to sound, heat, and to breaking the rock apart.

6.9 Suppose a 180 lb (81.8 kg) halfback running at a speed of 8.0 m/s collides head-on with a 260 lb (118.2 kg) tackle running at 3.0 m/s. Which one will be pushed back? That is, which one has more kinetic energy? If you are not familiar with football, check with someone who is for definition of terms.

SOLUTION:
The one with the smaller kinetic energy will be moved back by the one who has the higher kinetic energy.
halfback's kinetic energy = $\frac{1}{2}mv^2 = \frac{1}{2}(81.8\text{ kg})(8.0\text{ m/s})^2 = 2.62 \times 10^3$ or about 2620 kg m^2/s^2
tackle's kinetic energy = $\frac{1}{2}(118.2\text{ kg})(3.0\text{ m/s})^2 = 532$ kg m^2/s^2
The tackle is pushed back.

6.11 Which has the greater kinetic energy, hydrogen molecules traveling with a velocity of 2 v, or helium molecules traveling with a velocity of v? Express molecular masses in u.

SOLUTION:
H_2 kinetic energy = $\frac{1}{2}(2.0\text{ u})(2\text{ v})^2 = 4\text{ v}^2\text{u}$
He kinetic energy = $\frac{1}{2}(4.0\text{ u})(\text{v})^2 = 2\text{ v}^2\text{u}$
The H_2 molecules have the greater kinetic energy. They must have a higher temperature.

The Solid, Liquid, and Gaseous States (Section 6.3 - 6.5)

6.13 Explain each of the following observations using the kinetic molecular theory of matter:
a) A liquid takes the shape, but not necessarily the volume, of its container.
b) Solids and liquids are practically incompressible.
c) A gas always exerts uniform pressure on all walls of its container.

SOLUTION:
a) The liquid molecules are touching but randomly arranged, hence, the molecules can flow to conform to the shape of the container.

b) In both solids and liquids, there is very little empty space between the molecules, hence, they cannot be forced much closer together.
c) The gas molecules move in a totally random direction, hence, there will be the same number of molecules travelling in any direction, exerting the same pressure on all of the walls.

6.15 The following statements are best associated with the solid, liquid, gaseous states of matter. Match the statements to the appropriate state of matter.
a) This state is characterized by the lowest density of the three.
b) This state is characterized by an indefinite shape and a high density.
c) In this state, disruptive forces prevail over cohesive forces.
d) In this state, cohesive forces are most dominant.

SOLUTION:
a) Gases have much lower density than solids or liquids.
b) Liquids have indefinite shapes and a high density compared with gases.
c) Gases have much stronger disruptive forces than cohesive forces.
d) In solids, the cohesive forces are most dominant.

The Gas Laws (Section 6.6)

6.17 What is a gas law?

SOLUTION:
Gas laws are simple, quantitative relationships between volume, temperature, pressure, and other properties.

6.19 The pressure of a gas sample is recorded as 615 torr. Calculate this pressure in the following units:

a) atm b) in. Hg c) psi d) bars

SOLUTION:

a) $615\ \cancel{\text{torr}} \times \frac{1\ \text{atm}}{760\ \cancel{\text{torr}}} = 0.809\ \text{atm}$

b) $615\ \cancel{\text{torr}} \times \frac{1\ \cancel{\text{atm}}}{760\ \cancel{\text{torr}}} \times \frac{29.9\ \text{in. Hg}}{1\ \cancel{\text{atm}}} = 24.2\ \text{in. Hg}$

c) $615\ \cancel{\text{torr}} \times \frac{1\ \cancel{\text{atm}}}{760\ \cancel{\text{torr}}} \times \frac{14.7\ \text{psi}}{1\ \cancel{\text{atm}}} = 11.9\ \text{psi}$

d) $615\ \cancel{\text{torr}} \times \frac{1\ \cancel{\text{atm}}}{760\ \cancel{\text{torr}}} \times \frac{1.01\ \text{bars}}{1\ \cancel{\text{atm}}} = 0.817\ \text{bars}$

6.21 A chemist reads a pressure from a manometer attached to an experiment as 17.6 cm Hg. Calculate this pressure in the following units:
a) atm b) mm Hg c) torr d) psi

SOLUTION:

a) $17.6\ \cancel{\text{cm Hg}} \times \frac{10\ \cancel{\text{mm Hg}}}{1\ \cancel{\text{cm Hg}}} \times \frac{1\ \text{atm}}{760\ \cancel{\text{mm Hg}}} = 0.232\ \text{atm}$

b) $17.6\ \cancel{cm\ Hg} \times \frac{10\ mm\ Hg}{1\ \cancel{cm\ Hg}} = 176\ mm\ Hg$

c) $17.6\ \cancel{cm\ Hg} \times \frac{10\ \cancel{mm\ Hg}}{1\ \cancel{cm\ Hg}} \times \frac{1\ torr}{1\ \cancel{mm\ Hg}} = 176\ torr$

a) $17.6\ \cancel{cm\ Hg} \times \frac{10\ \cancel{mm\ Hg}}{1\ \cancel{cm\ Hg}} \times \frac{1\ \cancel{atm}}{760\ \cancel{mm\ Hg}} \times \frac{14.7\ psi}{1\ \cancel{atm}} = 3.40\ psi$

6.23 Convert each of the following temperatures from the unit given to the unit indicated.
a) the melting point of gold, 1337.4 K, to Celsius
b) the melting point of tungsten, 3410 °C, to kelvins
c) the melting point of tin, 505 K, to Celsius

SOLUTION:

K = °C + 273 °C = K - 273
a) 1337.4 K - 273 = 1064 °C
b) 3410 °C + 273 = 3683 K
c) 505 K - 273 = 232 °C

Pressure, Temperature, and Volume Relationships (Section 6.7)

6.25 A 200 mL sample of oxygen gas is collected at 26.0 °C and a pressure of 690 torr. What volume will the gas occupy at STP (0 °C and 760 torr)?

SOLUTION:

Convert both temperatures to K: 26.0 °C + 273 = 299 K; 0 °C + 273 = 273 K

P_i = 690 torr; V_i = 200 mL; T_i = 299 K; P_f = 760 torr; T_f = 273 K; V_f = ?

$$V_f = V_i \times \frac{P_i}{P_f} \times \frac{T_f}{T_i} = 200\ mL \times \frac{690\ \cancel{torr}}{760\ \cancel{torr}} \times \frac{273\ \cancel{K}}{299\ \cancel{K}} = 166\ mL$$

6.27 A 3.00 L sample of helium at 0.00 °C and 1.00 atm is compressed into a 0.50 L cylinder. What pressure will the gas exert in the cylinder at 50 °C?

SOLUTION:

Convert both temperatures to K: T_i = 273 K; T_f = 50 °C + 273 = 323 K; P_i = 1.00 atm; P_f = ?

$$P_f = P_i \times \frac{V_i}{V_f} \times \frac{T_f}{T_i} = 1.00\ atm \times \frac{3.00\ \cancel{L}}{0.50\ \cancel{L}} \times \frac{323\ \cancel{K}}{273\ \cancel{K}} = 7.1\ atm$$

6.29 What volume (in liters) of air measured at 1.00 atm would have to be put into a bicycle tire with a 1.00 L volume if the pressure in the bike tire is to be 65.0 psi? Assume the temperature of the gas remains constant.

SOLUTION:

V_i = ?; V_f = 1.00 L; P_i = 1.00 atm; P_f = 65.0 psi; $T_i = T_f$

change P_i to psi units = $1.00\ \cancel{atm} \times \frac{14.7\ psi}{1\ \cancel{atm}} = 14.7\ psi$

$$V_i = V_f \times \frac{P_f}{P_i} = 1.00\ L \times \frac{65.0\ \cancel{psi}}{14.7\ \cancel{psi}} = 4.42\ L$$

6.31 A sample of gas has a volume of 500 mL at a pressure of 640 torr. What volume will the gas occupy at the same temperature but at the standard atmospheric pressure, 760 torr?

SOLUTION:

V_i = 500 mL; V_f = ?; P_i = 640 torr; P_f = 760 torr; $T_i = T_f$

$$V_f = V_i \times \frac{P_i}{P_f} = 500 \text{ mL} \times \frac{640 \text{ \sout{torr}}}{760 \text{ \sout{torr}}} = 421 \text{ mL}$$

6.33 A 3.0 L sample of gas at 1.0 atm and 0.0 °C is heated to 85 °C. Calculate the gas volume at the higher temperature if the pressure remains at 1.0 atm.

SOLUTION:

V_i = 3.00 L; V_f = ?; $P_i = P_f$; T_i = 0.0 °C + 273 = 273 K; T_f = 85 °C + 273 = 358 K

$$V_f = V_i \times \frac{T_f}{T_i} = 3.00 \text{ L} \times \frac{358 \text{ \sout{K}}}{273 \text{ \sout{K}}} = 3.93 \text{ L}$$

6.35 A sample of gas has a volume of 350 mL at 27 °C. The gas is heated at a constant pressure until the volume is 500 mL. What is the new temperature of the gas in degrees Celsius?

SOLUTION:

V_i = 350 mL; V_f = 500 mL; $P_i = P_f$; T_i = 27 °C + 273 = 300 K; T_f = ?

$$T_f = T_i \times \frac{V_f}{V_i} = 300 \text{ K} \times \frac{500 \text{ \sout{mL}}}{350 \text{ \sout{mL}}} = 429 \text{ K}$$

Convert K to °C: °C = 429 K − 273 = 156 °C

6.37 A 5.00 L gas sample is collected at a temperature and pressure of 27.0 °C and 1.20 atm. The gas is transferred to a 3.00 L container at a pressure of 1.00 atm. What must the Celsius temperature of the gas in the 3.00 L container be?

SOLUTION:

V_i = 5.00 L; V_f = 3.00 L; P_i = 1.20 atm; P_f = 1.00 atm; T_i = 27 °C + 273 = 300 K; T_f = ?

$$T_f = T_i \times \frac{P_f}{P_i} \times \frac{V_f}{V_i} = 300 \text{ K} \times \frac{1.00 \text{ \sout{atm}}}{1.20 \text{ \sout{atm}}} \times \frac{3.00 \text{ \sout{L}}}{5.00 \text{ \sout{L}}} = 150 \text{ K}$$

Convert K to °C: °C = 150 K − 273 = −123 °C

6.39 A steel tank with a volume of 6.25 L is full of gas at a pressure of 2.30 atm. What volume would the gas occupy at a pressure of 0.250 atm if its temperature did not change?

SOLUTION:

V_i = 6.25 L; V_f = ?; P_i = 2.30 atm; P_f = 0.250 atm; $T_i = T_f$

$$V_f = V_i \times \frac{P_i}{P_f} = 6.25 \text{ L} \times \frac{2.30 \text{ \sout{atm}}}{0.250 \text{ \sout{atm}}} = 57.5 \text{ L}$$

6.41 You have a 1.50 L balloon full of air at 30 °C. To what Celsius temperature would you have to heat the balloon to double its volume if the pressure remained unchanged?

SOLUTION:

V_i = 1.50 L; V_f = 2 x V_i = 3.00 L; $P_i = P_f$; T_i = 30 °C + 273 = 303 K; T_f = ?

$$T_f = T_i \times \frac{V_f}{V_i} = 303 \text{ K} \times \frac{3.00 \text{ \sout{L}}}{1.50 \text{ \sout{L}}} = 606 \text{ K}$$

Convert K to °C: °C = 606 K − 273 = 333 °C

Note: While Problem 6.41 can be solved in concept, it does not represent a real situation. If the balloon were "full of air" originally, the elastomer forming the balloon is limiting the volume. Increasing the temperature will attempt to make the balloon larger, but the elastomer resists the stretching. Thus, the final pressure must be higher than the initial pressure. Furthermore, if the balloon was "full" initially, the elastomer probably would break before doubling its volume.

6.43 What minimum pressure would a 250 mL aerosol can have to withstand if it were to contain 2.00 L of gas measured at 700 torr? Assume constant temperature.

SOLUTION:

$V_i = 2.00 \text{ L} \times \frac{1000 \text{ mL}}{\text{L}} = 2000 \text{ mL}; V_f = 250 \text{ mL}; P_i = 700 \text{ torr}; P_f = ?; T_i = T_f$

$P_f = 700 \text{ torr} \times \frac{2000 \text{ mL}}{250 \text{ mL}} = 5.60 \times 10^3 \text{ torr}$

Convert to atm: $5.60 \times 10^3 \text{ torr} \times \frac{1 \text{ atm}}{760 \text{ torr}} = 7.37 \text{ atm}$

The Ideal Gas Law (Section 6.8)

6.45 Use the ideal gas law and calculate the following:

a) the pressure exerted by 2.00 mol of oxygen confined to a volume of 500 mL at 20.0 °C

b) the volume of hydrogen gas in a steel cylinder if 0.525 mol of the gas exerts a pressure of 3.00 atm at a temperature of 10.0 °C

c) the temperature (in degrees Celsius) of a nitrogen gas sample that has a volume of 2.50 L, a pressure of 300 torr, and contains 0.100 mol

SOLUTION:

PV = nRT where R = 0.0821 L atm/mol K

a) convert to K: 20.0 °C + 273 = 293 K convert to L: $500 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} = 0.500 \text{ L}$

$$P = \frac{nRT}{V} = \frac{(2.00 \text{ mol})(0.0821 \text{ L atm/mol K})(293 \text{ K})}{0.500 \text{ L}} = 96.2 \text{ atm}$$

b) convert to K: 10.0 °C + 273 = 283 K

$$V = \frac{nRT}{P} = \frac{(0.525 \text{ mol})(0.0821 \text{ L atm/mol K})(283 \text{ K})}{3.00 \text{ atm}} = 4.07 \text{ L}$$

c) convert to atm: $300 \text{ torr} \times \frac{1 \text{ atm}}{760 \text{ torr}} = 0.395 \text{ atm}$

$$T = \frac{PV}{nR} = \frac{(0.395 \text{ atm})(2.50 \text{ L})}{(0.100 \text{ mol})(0.0821 \text{ L atm/mol K})} = 120 \text{ K}$$

convert to Celsius: °C = 120 K − 273 = −153 °C

6.47 Suppose 0.156 mol of SO_2 gas is compressed into a 0.750 L steel cylinder at a temperature of 27 °C. What pressure in atmospheres would be exerted by the gas?

SOLUTION:

convert to K: 27 °C + 273 = 300 K

$$P = \frac{nRT}{V} = \frac{(0.156 \text{ mol})(0.0821 \text{ L atm/mol K})(300 \text{ K})}{0.750 \text{ L}} = 5.12 \text{ atm}$$

6.49 Calculate the volume occupied by 8.75 g of oxygen gas (O_2) at a pressure of 0.890 atm and a temperature of 35.0 °C.

SOLUTION:

convert to K: 35.0 °C + 273 = 308 K

convert to mol O_2: $8.75\ \text{g}\ O_2 \times \dfrac{1\ \text{mol}\ O_2}{32.0\ \text{g}\ O_2} = 0.273\ \text{mol}\ O_2$

$$V = \frac{nRT}{P} = \frac{(0.273\ \text{mol})(0.0821\ \text{L atm/mol K})(308\ \text{K})}{0.890\ \text{atm}} = 7.76\ \text{L}$$

6.51 Suppose 10.0 g of dry ice (solid CO_2) were placed in an empty 400 mL steel cylinder. What pressure would develop if all the solid sublimed at a temperature of 35.0 °C?

SOLUTION:

convert to K: 35.0 °C + 273 = 308 K

convert to mol CO_2: $10.0\ \text{g}\ CO_2 \times \dfrac{1\ \text{mol}\ CO_2}{44.0\ \text{g}\ CO_2} = 0.227\ \text{mol}\ CO_2$

convert to L: $400\ \text{mL} \times \dfrac{1\ \text{L}}{1000\ \text{mL}} = 0.400\ \text{L}$

$$P = \frac{nRT}{V} = \frac{(0.227\ \text{mol})(0.0821\ \text{L atm/mol K})(308\ \text{K})}{0.400\ \text{L}} = 14.4\ \text{atm}$$

6.53 How many molecules of nitrogen (N_2) are present in sample that fills a 10.0 L tank at STP?

SOLUTION:

$$10.0\ \text{L}\ N_2 \times \frac{1\ \text{mol}\ N_2}{22.4\ \text{L}\ N_2} \times \frac{6.02 \times 10^{23}\ \text{molecules}\ N_2}{1\ \text{mol}\ N_2} = 2.69 \times 10^{23}\ \text{molecules}\ N_2$$

6.55 A sample of a gaseous nitrogen oxide is found to weigh 0.525 g. The sample has a volume of 300 mL at a pressure of 708 torr and a temperature of 25.7 °C. Is the gas NO or NO_2?

SOLUTION:

convert to K: 25.7 °C + 273 = 299 K

convert to atm: $708\ \text{torr} \times \dfrac{1\ \text{atm}}{760\ \text{torr}} = 0.932\ \text{atm}$

convert to L: $300\ \text{mL} \times \dfrac{1\ \text{L}}{1000\ \text{mL}} = 0.300\ \text{L}$

$$MW = \frac{mRT}{PV} = \frac{(0.525\ \text{g})(0.0821\ \text{L atm/mol K})(299\ \text{K})}{(0.932\ \text{atm})(0.300\ \text{L})} = 46.1\ \text{g/mol}$$

The gas must be NO_2.

6.57 A 2.00 g sample of gas has a volume of 1.12 L at STP. Calculate its molecular weight and identify it as He, Ne, or Ar.

SOLUTION:

The MW can be obtained by dividing the mass by the number of moles.

$$1.12\ \text{L} \times \frac{1\ \text{mol}}{22.4\ \text{L}} = 0.0500\ \text{mol}$$

$$MW = \frac{2.00\ \text{g}}{0.0500\ \text{mol}} = 40.0\ \text{g/mol}$$

The gas is Ne.

Dalton's Law (Section 6.9)

6.59 A 250 mL sample of oxygen gas is collected by water displacement. As a result, the oxygen is saturated with water vapor. The partial pressure of water vapor at the prevailing temperature is 22 torr. Calculate the partial pressure of the oxygen if the total pressure of the sample is 720 torr.

SOLUTION:

$P_{Tot} = P_{Oxygen} + P_{Water}$

$P_{Oxygen} = 720 \text{ torr} - 22 \text{ torr} = 698 \text{ torr}$

Graham's Law (Section 6.10)

6.61 The mass of a bromine molecule is 160 u, and the mass of an argon molecule is 40 u. Compare the rates at which these gases will diffuse.

SOLUTION:

$$\frac{\text{Rate}_{Ar}}{\text{Rate}_{Br2}} = \sqrt{\frac{m_{Br2}}{m_{Ar}}} = \sqrt{\frac{160 \text{ u}}{40 \text{ u}}} = \frac{2}{1}$$

The Argon would diffuse twice as fast as Br_2.

6.63 Assume the balloon in Exercise 6.62 that went flat first showed signs of "flatness" 12 hours after it was filled. How long would it take for the other balloon to begin to show signs of going flat?

SOLUTION:

$$\frac{\text{Rate}_{He}}{\text{Rate}_{N2}} = \sqrt{\frac{m_{N2}}{m_{He}}} = \sqrt{\frac{28.0}{4.0}} = \frac{2.65}{1}$$

It will take the N_2 balloon 2.65 times as long to deflate = 12 hrs x 2.65 = 32 hrs

Changes in State (Section 6.11)

6.65 Classify each of the following processes as *endothermic* or *exothermic*.

a) condensation b) liquefaction c) boiling

SOLUTION:

a) exothermic b) exothermic c) endothermic

Evaporation and Vapor Pressure (Section 6.12)

6.67 The following are all nonpolar, liquid-hydrocarbon compounds derived from petroleum: butane (C_4H_{10}), pentane (C_5H_{12}), hexane (C_6H_{14}), and heptane (C_7H_{16}). Arrange these compounds in order of increasing vapor pressure (lowest first, highest last) and explain how you arrived at your answer.

SOLUTION:

The interparticle attraction between nonpolar molecules is greatest for the largest and least for the smallest molecule. The vapor pressure is greater for liquids with weaker, interparticle forces. Thus the order of increasing vapor pressure is the reverse of the order of increasing molecular weight.

C_7H_{16} (MW = 100 u), C_6H_{14} (MW = 86 u), C_5H_{12} (MW = 72 u), C_4H_{10} (MW = 58 u)

6.69 Suppose a drop of methyl ether (C_2H_6O) was put on the back of one of your hands and a drop of ethyl ether ($C_4H_{10}O$) was put on your other hand. Propose a way you could tell which compound was which without smelling them.

SOLUTION:
The liquid with the smaller molecular weight (methyl ether) will evaporate faster, cooling the skin more. The one that feels cooler is the methyl ether.

Boiling and the Boiling Point (Section 6.13)

6.71 Suppose a liquid in an open container was heated to a temperature just 1 or 2 degrees below its boiling point, then insulated so it stayed at that temperature. Describe how the liquid would behave (what you would see happen) if the hot sample was suspended beneath a helium balloon and taken rapidly to higher altitudes.

SOLUTION:
As the balloon rises the container is exposed to a decreasing air pressure. The hot liquid would begin boiling when the reduced air pressure equals the vapor pressure of the hot liquid.

Energy and the States of Matter (Section 6.15)

6.73 Using the specific heat data of Table 6.8, calculate the amount of heat (in calories) needed to increase the temperature of the following:

a) 50 g of aluminum from 25 °C to 55 °C
b) 2500 g of ethylene glycol from 80 °C to 85 °C
c) 500 g of steam from 110 °C to 120 °C

SOLUTION:
a) heat = (50 g)(0.24 cal/g °C)(55 − 25) °C = 3.6×10^2 cal
b) heat = (2500 g)(0.57 cal/g °C)(85 − 80) °C = 7×10^3 cal
c) heat = (500 g)(0.48 cal/g °C)(120 − 110) °C = 2.4×10^3 cal

6.75 For solar energy to be effective, collected heat must be stored for use during periods of decreased sunshine. One proposal suggests that heat can be stored by melting solids that, upon solidification, would release heat. Calculate the heat that could be stored by melting 1000 kg of each of the following solids.

Note: The water in each formula is included in the molecular weight.

a) calcium chloride ($CaCl_2 \cdot 6H_2O$): melting point = 30.2 °C heat of fusion = 40.7 cal/g
b) lithium nitrate ($LiNO_3 \cdot 3H_2O$): melting point = 29.9 °C heat of fusion = 70.1 cal/g
c) sodium sulfate ($Na_2SO_4 \cdot 10\,H_2O$): melting point = 32.4 °C heat of fusion = 57.1 cal/g

SOLUTION:
a) heat = (1000 kg x 1000 g/kg)(40.7 cal/g) = 4.07×10^7 cal
b) heat = (1000 kg x 1000 g/kg)(70.7 cal/g) = 7.07×10^7 cal
c) heat = (1000 kg x 1000 g/kg)(57.1 cal/g) = 5.71×10^7 cal

6.77 Liquid freon (CCl_2F_2) is used as a refrigerant. It is circulated inside the cooling coils of a refrigerator or freezer. As it vaporizes, it absorbs heat. How much heat can be removed by 2.00 kg of freon as it vaporizes inside the coils of a refrigerator? The heat of vaporization of freon is 38.6 cal/g.

SOLUTION:
a) heat = (2.00 kg x 1000 g/kg)(38.6 cal/g) = 7.72×10^4 cal