7.8: Solutions (Exercises)

These are homework exercises to accompany Chapter 7 of the University of Kentucky's LibreText for CHE 103 - Chemistry for Allied Health. Answers are available below the solutions.

Questions

7.1: States of Matter

(click here for solutions)

Q7.1.1

In which state(s) of matter are atoms

a. closest together?
b. farthest apart?
c. filling the container?
d. fixed in position relative to one another?
e. moving past one another?
f. taking on the shape of the container?

Q7.1.2

Which of the following statements are true? Correct any false statements.

a. All substances exist as a liquid at room temperature and pressure.
b. Water changes from liquid to solid at 32°C.
c. All substances can exist as solids, liquids, or gases.

Q7.1.3

Which state of matter is most compressible?

Q7.1.4

Use online resources to find the boiling point of ethanol and dimethyl ether. Which one is higher? Why?

Q7.1.5

Describe the relationship between boiling point and altitude.

Q7.1.6

Where is the boiling point of ethanol the highest? The lowest?

a. Lexington, KY
b. New Orleans, LA
c. Salt Lake City, UT
d. Same at all locations.

7.2: Heat and Changes of State

(click here for solutions)

7.2.1

What phase change is described by each term? Is the process endothermic or exothermic?

a. sublimation
b. vaporization
c. fusion
d. deposition

Q7.2.2

List two phase changes that consume energy.

Q7.2.3

List two phase changes that release energy.

Refer to Table 7.2.1 for enthalpy values.

Q7.2.4

What is the enthalpy of fusion, vaporization, freezing, and condensation for each substance?

a. oxygen, O_2
b. ethane, C_2H_6
c. carbon tetrachloride, CCl_4
d. lead, Pb

Q7.2.5

How much energy is needed to vaporize 1.4 moles of ammonia (NH_3)?

Q7.2.6

How much energy is needed to melt 3.0 moles of ice (H_2O)?

Q7.2.7

What is the change in energy when 2.0 moles of ethanol is condensed?

Q7.2.8

What is the change in energy when 2.2 moles of oxygen is condensed?

Q7.2.9

Using the molar mass of water, convert the molar heats of fusion and vaporization for water from units of kJ/mol to kJ/g.

Q7.2.10

Calculate the quantity of heat that is absorbed or released during each process.

a. 655 g of water vapor condenses at 100°C
b. 8.20 kg of water is frozen
c. 40.0 mL of ethanol is vaporized. The density of ethanol is 0.789 g/mL.
d. 25.0 mL of ethanol condenses. The density of ethanol is 0.789 g/mL.

Q7.2.11

Various systems are each supplied with 9.25 kJ of heat. Calculate the mass of each substance that will undergo the indicated process with this input of heat.

a. melt ice at 0°C
b. vaporize water at 100°C
c. vaporize ethanol at 351 K

Q7.2.12

15.5 kJ of energy is released from each change. What mass of substance is involved?

a. condensation of NH_3
b. freezing water
c. condensation of ethanol

Q7.2.13

What is ΔH_{vap} for benzene (C_6H_6) if 7.88 kJ of energy is needed to vaporize 20.0 g of benzene?

7.3: Kinetic-Molecular Theory

(click here for solutions)

7.3.1

How are gases different from liquids and solids in terms of the distance between the particles?

Q7.3.2

Under what conditions do gases exhibit the most ideal behavior?

Q7.3.3

Which of the following are behaviors of a gas that can be explained by the kinetic-molecular theory?

a. Gases are compressible.
b. Gases exert pressure.
c. All particles of a gas sample move at the same speed.
d. Gas particles can exchange kinetic energy when they collide.
e. Gas particles move in a curved-line path.

Q7.3.4

What is an elastic collision?

Q7.3.5

Perform the indicated conversions for the following pressure measurements.

a. 1.721 atm to mmHg
b. 559 torr to kPa
c. 91.1 kPa to atm
d. 2320 mmHg to atm

Q7.3.6

a. A typical barometric pressure in Redding, California, is about 755 mmHg. Calculate this pressure in atm and kPa.
b. A typical barometric pressure in Denver, Colorado, is 615 mmHg. What is this pressure in atmospheres and kilopascals?

Q7.3.7

How does the average kinetic energy of an air sample near a campfire compare to the average kinetic energy of a sample of air that is far away from it?

7.4: The Ideal Gas Equation

(click here for solutions)

7.4.1

Complete the missing temperature values in the table.

ºC	ºF	K
25		
	99	
32		
		0
		300
	65	

Q7.4.2

What units must temperature be in for gas law calculations?

Q7.4.3

Based on R = 0.08206 $\frac{L\dot{a}tm}{mol\dot{K}}$, what units should be used in ideal gas law calculations?

Q7.4.4

A 1.00 mol sample of gas is at 300 K and 4.11 atm. What is the volume of the gas under these conditions?

Q7.4.5

What is the pressure in a 2.5 L container with 2.5 moles of gas at 293 K?

Q7.4.6

How many moles of carbon monoxide, CO, are in an 11.2-L sample at 744 torr at 55 °C?

Q7.4.7

A weather balloon contains 8.80 moles of helium at a pressure of 0.992 atm and a temperature of 25 °C at ground level. What is the volume of the balloon under these conditions?

Q7.4.8

A balloon inflated with three breaths of air has a volume of 1.7 L. At the same temperature and pressure, what is the volume of the balloon if five more same-sized breaths are added to the balloon?

Q7.4.9

The volume of an automobile air bag was 66.8 L when inflated at 25 °C with 77.8 g of nitrogen (N_2) gas. What was the pressure in the bag in kPa?

Q7.4.10

How many moles of gaseous boron trifluoride, BF_3, are contained in a 4.3410-L bulb at 788.0 K if the pressure is 1.220 atm? How many grams of BF_3?

Q7.4.11

How is the combined gas law is simplified for each set of conditions?

a. constant V and n
b. constant n
c. constant P and V
d. constant T and n
e. constant V and T
f. constant P and n
g. constant T

Q7.4.12

A nitrogen sample has a pressure of 0.56 atm with a volume of 2.0 L. What is the final pressure if the volume is compressed to a volume of 0.75 L? Assume constant moles and temperature.

Q7.4.13

A 2.50-L volume of hydrogen measured at –196 °C is warmed to 100 °C. Calculate the volume of the gas at the higher temperature, assuming no change in pressure.

Q7.4.14

A high altitude balloon is filled with 1.41×10^4 L of hydrogen at a temperature of 21 °C and a pressure of 745 torr. What is the volume of the balloon at a height of 20 km, where the temperature is –48 °C and the pressure is 63.1 torr?

Q7.4.15

A cylinder of medical oxygen has a volume of 35.4 L, and contains O_2 at a pressure of 151 atm and a temperature of 25 °C. What volume of O_2 does this correspond to at normal body conditions, that is, 1 atm and 37 °C?

Q7.4.16

A 0.50 L container of helium expands to 1.50 L. By what factor does the pressure change? Assume constant moles and temperature.

Q7.4.17

A sample of oxygen gas has an initial pressure and volume of 1.0 L and 1.0 atm. What is the final pressure if the volume is compressed to 0.50 L? Assume constant moles and temperature.

Q7.4.18

A sample of gas has a volume of 2.75 L at a temperature of 100 K. What is the volume of the gas when the temperature increases to 200 K? Assume constant pressure and moles.

Q7.4.19

What is the final volume of a gas that was originally at 0.75 L at 25°C and a final temperature of 50°C? Assume constant pressure and moles.

Q7.4.20

A sample of nitrogen is at 45°C with a volume of 2.5 L. What is the final temperature in °C if the volume is compressed to 1.4 L? Assume constant pressure and moles.

Q7.4.21

A 2.00 mole sample of gas is in a 3.50 L container. What happens to the volume when an additional 0.75 moles of gas is added? Assume pressure and temperature are constant.

Q7.4.22

A 1.85 mole sample of helium has a volume of 2.00 L. Additional helium is added at constant pressure and temperature until the volume is 3.25 L. What is the total moles of helium present in the sample? What mass of helium was added?

Q7.4.23

If the temperature of a fixed amount of a gas is doubled at constant volume, what happens to the pressure?

Q7.4.24

If the volume of a fixed amount of a gas is tripled at constant temperature, what happens to the pressure?

7.5: Aqueous Solutions

(click here for solutions)

7.5.1

Describe the solution, solvent, and solute.

Q7.5.2

How do solutions differ from compounds? Are solutions heterogeneous or homogeneous mixtures?

Q7.5.3

When KNO_3 is dissolved in water, the resulting solution is significantly colder than the water was originally. Is the dissolution of KNO_3 an endothermic or an exothermic process?

Q7.5.4

What are the differences between strong, weak and non-electrolytes.

Q7.5.5

Write dissociation equations for the following strong electrolytes.

a. $NaCl(s)$
b. $CoCl_3(s)$
c. $Li_2S(s)$
d. $MgBr_2(s)$

e. $CaF_2(s)$

Q7.5.6

Based on the given information, identify each as a strong, weak, or non-electrolyte.

a. $C_6H_{12}O_6(s) \rightarrow C_6H_{12}O_6(aq)$
b. NaCl is added to water and the conductivity increases dramatically.
c. 1.5 moles of HCl are added to a container of water. The resulting solution has 1.5 moles of H^+ ions and 1.5 moles of $Cl^{\backslash -}$ ions.
d. Acetic acid (CH_3COOH) partially dissociates in water.
e. An HCN solution contains 0.50 moles of HCN molecules and 0.05 moles of H^+ ions and 0.05 moles of $Cl^{\backslash -}$ ions.
f. Acetone is added to water and the conductivity does not change.

7.6: Colloids and Suspensions

(click here for solutions)

7.6.1

How can you distinguish between a suspension and a solution?

Q7.6.2

How big are the particles in a colloid compared to those of a suspension and a solution?

Q7.6.3

What is the Tyndall effect? Why don't solutions demonstrate the Tyndall effect?

Q7.6.4

Explain the difference between the dispersed phase and the dispersing medium of a colloid.

Q7.6.5

Identify each of the following descriptions or examples as being representative of a solution, suspension, or colloid. More than one answer may apply.

a. dispersed particles can be filtered out
b. heterogeneous
c. particles are not visible to the unaided eye
d. paint
e. lemonade with no pulp
f. particle size larger than 1 nm
g. milk
h. particles do not settle upon standing
i. fog

7.7: Solubility

(click here for solutions)

7.7.1

Describe the difference between saturated and unsaturated solutions.

Q7.7.2

What are two things that you could do to change an unsaturated solution into a saturated solution?

Q7.7.3

A given solution is clear and colorless. A single crystal of solute is added to the solution. Describe what happens in each of the following situations.

a. The original solution was saturated.
b. The original solution was unsaturated.

Q7.7.4

List the original states (solid, liquid, or gas) of the solute and solvent that are combined to make each of the following solutions.

a. an alloy
b. salt water
c. carbonated water
d. oil in gasoline

Q7.7.5

Answer the following using the solubility curve diagram.

a. How many grams of NH_4Cl are required to make a saturated solution in 100 g of water at 70°C?
b. How many grams of NH_4Cl could be dissolved in 200 g of water at 70°C?
c. At what temperature is a solution of 50 grams of KNO_3 dissolved in 100 grams of water a saturated solution?
d. Which two substances in the above graph have the same solubility at 85°C?
e. How many grams of $NaNO_3$ can be dissolved in 100 grams of water to make a saturated solution at 25°C?
f. How much KI can be dissolved in 5 grams of water at 20°C to make a saturated solution?

Q7.7.6

An exactly saturated solution of $KClO_3$ is prepared at 90°C using 100 grams of water. If the solution is cooled to 20°C, how many grams of $KClO_3$ will recrystallize (i.e. come out of solution)?

Q7.7.7

Indicate whether the following solutions are unsaturated or saturated.

a. 22 grams of $KClO_3$ is dissolved in 100 g of water at 50°C.
b. 60 grams of KNO_3 is dissolved in 100 g of water at 50°C.
c. 50 grams of NaCl is dissolved in 100 g of water at 50°C.

Q.7.7.8

Under which set of conditions is the solubility of a gas in a liquid the greatest?

a. low temperature and low pressure
b. low temperature and high pressure
c. high temperature and low pressure
d. high temperature and high pressure

Answers

7.1: States of Matter

Q7.1.1

a. solid
b. gas
c. gas
d. solid
e. liquid and gas
f. liquid and gas

Q7.1.2

Which of the following statements are true? Correct any false statements.

a. All substances exist as a liquid at ~~room temperature and pressure~~. at some temperature and pressure.
b. Water changes from liquid to solid at 32~~°C~~ °F.
c. True (although some states are rarely seen for some substances).

Q7.1.3

gas

Q7.1.4

ethanol 78°C; dimethyl ether −24°C

Ethanol has stronger intermolecular forces due to having hydrogen bonding which is not seen in dimethyl ether. The stronger the intermolecular forces, the higher the boiling point.

Q7.1.5

As the altitude increases, the boiling point decreases

Q7.1.6

a. Lexington, KY (altitude = 978 feet)
b. New Orleans, LA (altitude = 2 feet) - HIGHEST
c. Salt Lake City, UT (altitude = 4226 feet) - LOWEST

7.2: Heat and Changes of State

Q7.2.1

a. solid to gas; endothermic
b. liquid to gas; endothermic
c. solid to liquid; endothermic
d. gas to solid; exothermic

Q7.2.2

Any two of fusion, vaporization, or sublimation.

Q7.2.3

Any two of freezing, condensation, deposition.

Q7.2.4

Substance	ΔH_{fus} (kJ/mol)	ΔH_{vap} (kJ/mol)	$\Delta H_{freezing}$ (kJ/mol)	$\Delta H_{condensation}$ (kJ/mol)
oxygen, O_2	0.44	6.82	-0.44	-6.82
ethane, C_2H_6	2.85	14.72	-2.85	-14.72
carbon tetrachloride, CCl_4	2.67	30.0	-2.67	-30.0
lead, Pb	4.77	178	-4.77	-178

Q7.2.5

$1.4\ mol\ \mathrm{NH_3}\left(\frac{23.35\ kJ}{mol}\right) = 33\ kJ$

Q7.2.6

$3.0\ mol\ \mathrm{H_2O}\left(\frac{6.01\ kJ}{mol}\right) = 18\ kJ$

Q7.2.7

$2.0\ mol\ \mathrm{CH_3CH_2OH}\left(\frac{-38.56\ kJ}{mol}\right) = -77\ kJ$

Q7.2.8

$2.2\ mol\ \mathrm{O_2}\left(\frac{-6.82\ kJ}{mol}\right) = -15\ kJ$

Q7.2.9

$\frac{6.01\ kJ}{mol}\left(\frac{1\ mol}{18.02\ g}\right) = \frac{0.334\ kJ}{g}$

$\frac{40.7\ kJ}{mol}\left(\frac{1\ mol}{18.02\ g}\right)=\frac{2.26\ kJ}{g}$

Q7.2.10

a. $655\ g\ \mathrm{H_2O}\left(\frac{1\ mol}{18.02\ g}\right)\left(\frac{-40.7\ kJ}{mol}\right)=-1.48\times10^3\ kJ$
b. $8.20\ kg\ \mathrm{H_2O}\left(\frac{1000\ g}{1\ kg}\right)\left(\frac{1\ mol}{18.02\ g}\right)\left(\frac{-6.01\ kJ}{mol}\right)=-2.73\times10^3\ kJ$
c. $40.0\ mL\ \mathrm{CH_3CH_2OH}\left(\frac{0.789\ g}{1\ mL}\right)\left(\frac{1\ mol}{46.07\ g}\right)\left(\frac{38.56\ kJ}{mol}\right)=26.4\ kJ$
d. $25.0\ mL\ \mathrm{CH_3CH_2OH}\left(\frac{0.789\ g}{1\ mL}\right)\left(\frac{1\ mol}{46.07\ g}\right)\left(\frac{-38.56\ kJ}{mol}\right)=-16.5\ kJ$

Q7.2.11

a. $9.25\ kJ\left(\frac{mol}{6.01\ kJ}\right)\left(\frac{18.02\ g}{mol}\right)=27.7\ g\ \mathrm{H_2O}$
b. $9.25\ kJ\left(\frac{mol}{40.7\ kJ}\right)\left(\frac{18.02\ g}{mol}\right)=4.10\ g\ \mathrm{H_2O}$
c. $9.25\ kJ\left(\frac{mol}{38.56\ kJ}\right)\left(\frac{46.07\ g}{mol}\right)=11.1\ g\ \mathrm{CH_3CH_2OH}$

Q7.2.12

a. $-15.5\ kJ\left(\frac{mol}{-23.35\ kJ}\right)\left(\frac{17.03\ g}{mol}\right)=11.3\ g\ \mathrm{NH_3}$
b. $-15.5\ kJ\left(\frac{mol}{-6.01\ kJ}\right)\left(\frac{18.02\ g}{mol}\right)=46.5\ g\ \mathrm{H_2O}$
c. $-15.5\ kJ\left(\frac{mol}{-38.56\ kJ}\right)\left(\frac{46.07\ g}{mol}\right)=18.5\ g\ \mathrm{CH_3CH_2OH}$

Q7.2.13

Find the moles of benzene.

$20.0\ g\ \mathrm{C_6H_6}\left(\frac{1\ mol}{78.11\ g}\right)=0.256\ mol\ \mathrm{C_6H_6}$

Combine the energy with the moles to calculate the enthalpy of vaporization.

$\Delta H_{vap}=\frac{7.88\ kJ}{0.256\ mol}=\frac{30.8\ kJ}{mol}$

7.3: Kinetic-Molecular Theory

Q7.3.1

Gas particles are much farther from one another than liquid or solid particles.

Q7.3.2

Gases have the most ideal behavior at high temperatures (molecules moving more quickly than at low temperatures so less time to interact) and at low pressure (molecules are farther apart from one another than at high pressure).

Q7.3.3

a. Molecules are very far apart from one another and are compressible.
b. Gases are in constant random motion so they collide with the walls of the container.
c. False. Molecules of the same substance are moving at a range of speeds.
d. Collisions are elastic. Energy is exchanged but not lost when two particles coll
e. False. Particles move in a straight line.

Q7.3.4

A collision in which no energy is lost.

Q7.3.5

a. $1.721\ atm\left(\frac{760\ mmHg}{1\ atm}\right)=1308\ mmHg$
b. $559\ torr\left(\frac{101.3\ kPa}{760\ torr}\right)=74.5\ kPa$
c. $91.1\ kPa\left(\frac{1\ atm}{101.3\ kPa}\right)=0.899\ atm$

d. $2320\ mmHg \left(\frac{1\ atm}{760\ mmHg}\right) = 3.05\ atm$

Q7.3.6

a. $755\ mmHg \left(\frac{1\ atm}{760\ mmHg}\right) = 0.993\ atm\, 755\ mmHg \left(\frac{101.3\ kpa}{760\ mmHg}\right) = 101\ kPa$

b. $615\ mmHg \left(\frac{1\ atm}{760\ mmHg}\right) = 0.809\ atm\, 615\ mmHg \left(\frac{101.3\ kpa}{760\ mmHg}\right) = 82.0\ kPa$

Q7.3.7

Closer to the fire, it is warmer and the kinetic energy of the particles (and therefore the average speed) will be greater.

7.4: The Ideal Gas Equation

Q7.4.1

^oC	^oF	K
25	77	298
37	99	310
32	90	305
-273	-459	0
27	80	300
18	65	291

Q7.4.2

Kelvin

Q7.4.3

P (atm), V (L), n (mol), T (K)

Q7.4.4

A 1.00 mol sample of gas is at 300 K and 4.11 atm. What is the volume of the gas under these conditions?

$$PV = nRT$$
$$(4.11\ atm)\, V = (1.00\ mol) \left(0.08206 \frac{L \cdot atm}{mol \cdot K}\right) (300\ K)$$
$$V = 5.99\ L$$

Q7.4.5

$$PV = nRT$$
$$P\,(2.5\ L) = (2.5\ mol) \left(0.08206 \frac{L \cdot atm}{mol \cdot K}\right) (293\ K)$$
$$P = 24\ atm$$

Q7.4.6

$744\ torr \left(\frac{1\ atm}{760\ mmHg}\right) = 0.979\ atm$

T = 55°C + 273.15 = 328 K

$$PV = nRT$$
$$(0.979\ atm)\,(11.2\ L) = n \left(0.08206 \frac{L \cdot atm}{mol \cdot K}\right) (328\ K)$$
$$n = 0.407\ mol$$

Q7.4.7

T = 25°C + 273.15 = 298 K

$$PV = nRT$$
$$(0.992\ atm)\,V = (8.80\ mol)\left(0.08206 \frac{L\cdot atm}{mol\cdot K}\right)(298\ K)$$
$$V = 217\ L$$

Q7.4.8

x = volume of one breath of air

$3x = 1.7\ L$

$x = 0.57\ L$

Balloon will have a total of 8 breaths of air (3 original plus 5 additional)

$V = 8x = 8(0.57\ L) = 4.6L$

Q7.4.9

$77.8\ g\ N_2 \left(\frac{1\ mol}{28.02\ g}\right) = 2.78\ mol\ N_2$

T = 25°C + 273.15 = 298 K

$$PV = nRT$$
$$P\,(66.8\ L) = (2.78\ mol)\left(0.08206 \frac{L\cdot atm}{mol\cdot K}\right)(298\ K)$$
$$P = 1.02\ atm$$

$1.02\ atm\left(\frac{101.3\ kPa}{1\ atm}\right) = 103\ kPa$

Q7.4.10

$$PV = nRT$$
$$(1.220\ atm)(4.3410\ L) = mol\left(0.08206 \frac{L\cdot atm}{mol\cdot K}\right)(788.0\ K)$$
$$n = 0.08190\ mol\ BF_3$$

$0.08190\ mol\left(\frac{67.82\ g}{mol}\right) = 5.554\ g\ BF_3$

Q7.4.11

a. $\frac{P_i}{T_i} = \frac{P_f}{T_f}$
b. $\frac{P_iV_i}{T_i} = \frac{P_fV_f}{T_f}$
c. $\frac{1}{n_iT_i} = \frac{1}{n_fT_f}$ or $n_iT_i = n_fT_f$
d. $P_iV_i = P_fV_f$
e. $\frac{P_i}{n_i} = \frac{P_f}{n_f}$
f. $\frac{V_i}{T_i} = \frac{V_f}{T_f}$
g. $\frac{P_iV_i}{n_i} = \frac{P_fV_f}{n_f}$

Q7.4.12

$$\frac{P_iV_i}{n_iT_i} = \frac{P_fV_f}{n_fT_f}$$
$$P_iV_i = P_fV_f$$
$$0.56\ atm \cdot 2.0L = P_f \cdot 0.75\ L$$
$$P_f = 1.5\ atm$$

Q7.4.13

$$K = -196^{\circ}C + 273.15 = 77\ K$$
$$K = 100^{\circ}C + 273.15 = 373\ K$$

$$\frac{P_iV_i}{n_iT_i} = \frac{P_fV_f}{n_fT_f}$$
$$\frac{V_i}{T_i} = \frac{V_f}{T_f}$$

$\frac{2.50\ L}{77\ K} = \frac{V_f}{373\ K}$
$V_f = 12\ L$

Q7.4.14

$K = 21^{\circ}C + 273.15 = 294\ K$
$K = -48^{\circ}C + 273.15 = 225\ K$

$745\ torr\left(\frac{1\ atm}{760\ torr}\right) = 0.980\ atm$
$63.1\ torr\left(\frac{1\ atm}{760\ torr}\right) = 0.0830\ atm$

$\frac{P_iV_i}{n_iT_i} = \frac{P_fV_f}{n_fT_f}$
$\frac{P_iV_i}{T_i} = \frac{P_fV_f}{T_f}$
$\frac{0.980\ atm \cdot 1.4 \times 10^4\ L}{294\ K} = \frac{P_i \cdot 0.0830\ atm}{225}$
$P_f = 1.27 \times 10^5\ atm$

Q7.4.15

$K = 25^{\circ}C + 273.15 = 298\ K$
$K = -37^{\circ}C + 273.15 = 310\ K$

$\frac{P_iV_i}{n_iT_i} = \frac{P_fV_f}{n_fT_f}$
$\frac{P_iV_i}{T_i} = \frac{P_fV_f}{T_f}$
$\frac{151\ atm \cdot 35.4\ L}{298\ K} = \frac{1\ atm \cdot V_f}{310}$
$V_f = 5.56 \times 10^3\ L$

Q7.4.16

$\frac{P_iV_i}{n_iT_i} = \frac{P_fV_f}{n_fT_f}$
$P_iV_i = P_fV_f$

Set the initial pressure = x to calculate the factor of change in terms of x.

$\frac{P_iV_i}{n_iT_i} = \frac{P_fV_f}{n_fT_f}$
$P_iV_i = P_fV_f$
$x \cdot 0.50\ L = P_f \cdot 1.50\ L$
$P_f = \frac{1}{3}x$

The final pressure is one third of the original pressure.

Q7.4.17

$\frac{P_iV_i}{n_iT_i} = \frac{P_fV_f}{n_fT_f}$
$P_iV_i = P_fV_f$
$1.0\ atm \cdot 1.0\ L = P_f \cdot 0.50\ L$
$P_f = 2.0\ atm$

Q7.4.18

$\frac{P_iV_i}{n_iT_i} = \frac{P_fV_f}{n_fT_f}$
$\frac{V_i}{T_i} = \frac{V_f}{T_f}$
$\frac{2.75\ L}{100\ K} = \frac{V_f}{200\ K}$
$V_f = 5.50\ L$

Q7.4.19

$K = 25^{\circ}C + 273.15 = 298\ K$
$K = -50^{\circ}C + 273.15 = 323\ K$

$$\frac{P_iV_i}{n_iT_i} = \frac{P_fV_f}{n_fT_f}$$
$$\frac{V_i}{T_i} = \frac{V_f}{T_f}$$
$$\frac{0.75\ L}{298\ K} = \frac{V_f}{323\ K}$$
$$V_f = 0.813\ L$$

Q7.4.20

$$K = 45^{\circ}C + 273.15 = 318\ K$$

$$\frac{P_iV_i}{n_iT_i} = \frac{P_fV_f}{n_fT_f}$$
$$\frac{V_i}{T_i} = \frac{V_f}{T_f}$$
$$\frac{2.5\ L}{318\ K} = \frac{1.4\ L}{T_f}$$
$$T_f = 178\ K$$

$$^{\circ}C = K - 273.15$$
$$^{\circ}C = 178 - 273.15$$
$$^{\circ}C = -95\ K$$

Q7.4.21

$$\frac{P_iV_i}{n_iT_i} = \frac{P_fV_f}{n_fT_f}$$
$$\frac{V_i}{n_i} = \frac{V_f}{n_f}$$
$$\frac{3.50\ L}{2.00\ mol} = \frac{V_f}{2.75\ mol}$$
$$V_f = 4.81\ L$$

Note the final moles is 2.75 because the problem says that 0.75 moles of gas is **added** to the original amount of 2.00 moles.

Q7.4.22

$$\frac{P_iV_i}{n_iT_i} = \frac{P_fV_f}{n_fT_f}$$
$$\frac{V_i}{n_i} = \frac{V_f}{n_f}$$
$$\frac{2.00\ L}{1.85\ mol} = \frac{3.25\ L}{n_f}$$
$$n_f = 3.01\ mol$$

$$\text{moles added} = 3.01\ mol - 1.85\ mol$$
$$\text{moles added} = 1.16\ mol$$

$$1.16\ mol\ He \left(\frac{4.003\ g}{mol}\right) = 4.64\ g\ \text{He}$$

Q7.4.23

$$\frac{P_iV_i}{n_iT_i} = \frac{P_fV_f}{n_fT_f}$$
$$\frac{P_i}{T_i} = \frac{P_f}{T_f}$$

The temperature is doubled so $T_f = 2 \cdot T_i$

Let $P_i = x$ to see the factor the pressure changes.

$$\frac{P_iV_i}{n_iT_i} = \frac{P_fV_f}{n_fT_f}$$
$$\frac{P_i}{T_i} = \frac{P_f}{T_f}$$
$$\frac{x}{T_i} = \frac{P_f}{2 \cdot T_i}$$
$$x = \frac{P_f}{2}$$
$$P_f = 2x$$

The final pressure is twice the initial pressure.

Q7.4.24

$\frac{P_i V_i}{n_i T_i} = \frac{P_f V_f}{n_f T_f}$
$P_i V_i = P_f V_f$

The volume is tripled so $V_f = 3 \cdot V_i$

Let $P_i = x$ to see the factor the pressure changes.

$\frac{P_i V_i}{n_i T_i} = \frac{P_f V_f}{n_f T_f}$
$P_i V_i = P_f V_f$
$x \cdot V_i = P_f \cdot 3V_i$
$x = 3P_f$
$P_f = \frac{1}{3}x$

The final pressure is one-third of the initial pressure.

7.5: Aqueous Solutions

Q7.5.1

The solute is present in the smaller amount, the solvent is present in the larger amount, and the solution is the combination of the solute and solvent.

Q7.5.2

Solutions are a homoogeneous mixture of two or more compounds.

Q7.5.3

Endothermic because heat was needed to dissolve the KNO_3. Heat present in the solution was consumed by the dissolution process.

Q7.5.4

Strong electrolytes completely dissociate into ions in aqueous solution and are conductors of electricity. Weak electrolytes partially dissociate into ions in aqueous solutions are are weak conductors of electricity. Non-electrolytes do not dissociate into ions in aqueous solution and are poor conductors of electricity.

Q7.5.5

a. $NaCl(s) \rightarrow Na^+(aq) + Cl^-(aq)$
b. $CoCl_3(s) \rightarrow Co^{3+}(aq) + 3Cl^-(aq)$
c. $Li_2S(s) \rightarrow 2Li^+(aq) + S^{2-}(aq)$
d. $MgBr_2(s) \rightarrow Mg^{2+}(aq) + 2Br^-(aq)$
e. $CaF_2(s) \rightarrow Ca^{2+}(aq) + 2F^-(aq)$

Q7.5.6

Based on the given information, identify each as a strong, weak, or non-electrolyte.

a. non-electrolyte
b. strong electrolyte
c. strong electrolyte
d. weak electrolyte
e. weak electrolyte
f. non-electrolyte

7.6: Colloids and Suspensions

Q7.6.1

A suspension can be separated from the solvent by filtration while a solution cannot because particles settle out of suspensions but not solutions.

Q7.6.2

Particles in a solution are less than 1 nanometer, colloids have particles from 1-1000 nm, and suspensions have particles over 1000 nm.

Q7.6.3

The Tyndall effect is the scattering of visible light by particles. The particles in colloids are large enough to scatter light while the particles in solutions are too small to scatter light. Solutions are transparent (we can see through them) because the particles are so small.

Q7.6.4

The dispersed phase is present in the smaller amount and the dispersing medium is present in a larger amount.

Q7.6.5

a. suspension
b. colloids and suspensions
c. solution
d. colloid
e. solution
f. colloids and suspensions
g. colloid
h. solutions and colloids
i. colloids

7.7: Solubility

Q7.7.1

A saturated solution has the maximum amount of solute dissolved. An unsaturated solution does not have the maximum amount dissolved; additional solute can be added and will dissolve.

Q7.7.2

1. Addition of solute to the solution until no more dissolves.
2. Removal of solvent such as through evaporation.

Q7.7.3

a. The added solute will not dissolve.
b. The added solute will dissolve.

Q7.7.4

a. The solute and solvent are both solids.
b. The solute is a solid and the solvent is a liquid.
c. The solute is a gas and the solvent is a liquid.
d. The solute and solvent are both liquids.

Q7.7.5

a. 60 g NH_4Cl
b. 120 g NH_4Cl
c. 31^{o}C
d. HCl and $KClO_3$
e. 90 g
f. 7 g

Q7.7.6

At 90°C, 50 g of $KClO_3$ will dissolve in 100 g of water for a saturated solution. At 20°C, only 10 g of $KClO_3$ is dissolved in 100 g of water for a saturated solution. 40 grams of $KClO_3$ will precipitate out of solution.

Q7.7.7

a. saturated
b. unsaturated
c. saturated (with additional undissolved solute)

Q.7.7.8

The solubility of a gas in a liquid is the greatest at low temperature and high pressure.
