Unit 3—Intermolecular forces and properties
Ch 10 – 14

Comparing states of matter, *ch 11.1*

	Gases	Liquids	Solids
Volume			
Shape			
Compress?			
Flow?			
Diffusion?			
Strength of IMFs			

Intermolecular forces*, ch 11.2*

Intermolecular forces are generally stronger/weaker *(circle one)* than intramolecular bonds.

How are IMFs and boiling points related?

London dispersion forces form between what kinds of molecules?

How do instantaneous/momentary/temporary dipoles form in molecules?

What is "polarizability"?

How does polarizability influence the strength of LDFs?

What factors influence a molecule's polarizability?

Dipole-dipole forces occur in what kinds of molecules?

When comparing two similarly sized molecules, the molecules with dipole-dipole forces will have a higher/lower *(circle one)* boiling point than the molecules with only LDFs.

Draw the dipole-dipole interactions between three molecules of HCl. Label the δ+ and δ- parts of each molecule.

Draw the hydrogen bonding between three molecules of HF. Label the δ+ and δ- parts of each molecule.

What elements must a molecule contain for hydrogen bonding?

When NaBr dissolves in water, it dissociates. Draw the interactions between the water molecules and the cation and anion. Be sure to pay attention to the orientation of the water molecules!

Describe ion-dipole forces.

How can an ion induce a dipole in a non-polar molecule? How can a polar molecule induce a dipole in a non-polar molecule?

List the six intermolecular forces in order from strongest to weakest.

Solids, liquids, and gases, *back to 11.1*

Describe the motion of solids, liquids, and gases

Why are the molar volumes of solids and liquids similar?

Solids, *12.2-12.8, 24.6*

Describe the arrangement of molecules/formula units/atoms in a crystalline solid and an amorphous solid.

How are intermolecular forces related to properties of solids?

What properties of ionic solids are related to the strong attraction between ions? Explain.

What IMFs hold molecules together in molecular solids? How are the IMFs related to properties of the solids?

How are atoms bonded in covalent-network solids?

How are the properties of covalent-network solids related to the question above?

How are the properties of metals and interstitial alloys related to the arrangement of atoms?

In large biomolecules like proteins, how can IMFs exist both between different protein molecules AND within the same protein molecule?

Liquids, *11.3*

How are intermolecular forces related to viscosity and surface tension of liquids?

Gases, *10.1-10.9*

What is the difference between a vapor and a gas?

What causes gas pressure?

Fill in the conversion factors: _____ atm = _____ mmHg = _____ torr

Practice 1: Perform the following calculations:

1. 657 mmHg to atm

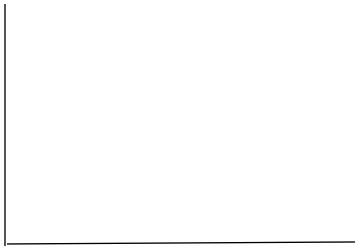
2. 830 torr to atm

3. 1.50 atm to mmHg

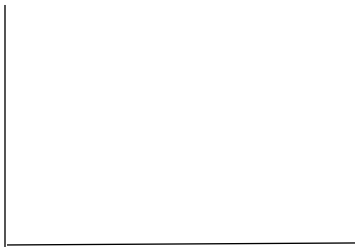
Combined gas law: $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

K = ˚C + 273.15

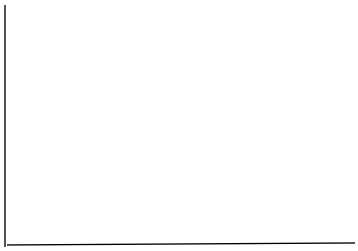
Sketch the following relationships:



P and V, constant T



V and T, constant P



n and V, constant P, T

Practice 2

1. If a 1.23 L sample of gas at 53.0 torr is put under pressure up to a value of 240. torr at a constant pressure, what is the new volume?

2. A gas has a volume of 0.572 L at 35˚C an 1.00 atm pressure. What is the temperature inside a container where this gas has a volume of 0.535 L at 1.00 atm?

3. A gas at 25 ˚C in a closed container has its pressure raised from 150. atm to 160. atm. What is the final temperature of the gas?

Practice 3

1. 20.5 L of nitrogen at 25°C and 742 torr are compressed to 9.8 atm at constant temperature. What is the new volume?

2. What would the final volume be if 247 mL of gas at 22°C is heated to 98°C, if the pressure is held constant?

3. At what temperature would a gas at 40.5 atm at 23.4°C have at a pressure of 81.9 atm at constant volume?

4. A sample of gas has a volume of 4.18 L at 29°C and 732 torr. What would its volume be at 24.8°C and 756 torr?

Summarize the kinetic molecular theory of gases:

Molecules at the same temperature have the _____ average kinetic energy

Kinetic energy $KE = \frac{1}{2}mv^2$

Why don't real gases behave ideally?

When will real gases behave more like ideal gases?

Ideal gas law: PV = nRT R = 8.314 J mol^{-1} K^{-1}; 0.08296 L atm mol^{-1} K^{-1}; 62.36 L torr mol^{-1} K^{-1}

Practice 4

1. A sample of gas in a 500.0 mL flask has a pressure of 1.2 atm and a temperature of 25 ˚C. How many moles of the gas are in the flask? (0.025 mol)

2. A sample of aluminum chloride weighing 0.100 g was vaporized at 350.˚C and 1.00 atm pressure to produce 19.3 mL of vapor. Calculate the molar mass of aluminum chloride. (265 g mol^{-1})

3. What is the density of carbon dioxide at 0.985 atm and 50.0˚C?

$P_T = P_1 + P_2 + P_3 + \ldots$

$P_1 = X_1 P_T$

Mole fraction $X_1 = n_1/n_T$

Practice 5

1. The atmospheric pressure at DIA on 12/2 at 10:20 pm was 624 torr. If air is 78% nitrogen and 21% oxygen,

    a. Determine the partial pressures of nitrogen and oxygen.

    b. If a sample of air contains 10.0 moles of molecules, what is the mole fraction of nitrogen? Oxygen?

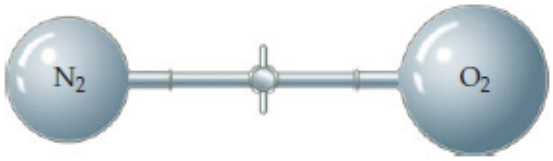
2. A mixture of gases contains 4.46 moles Ne, 0.74 moles Ar, and 2.15 moles Xe. Calculate the partial pressure of each gas if the total pressure is 2.00 atm.

3. The partial pressure of nitrogen in air is 590 torr and the partial pressure of oxygen in air is 160 torr. What is the total pressure of the air?

4. A sample of oxygen is collected over water at 26˚C and 760 mmHg. The vapor pressure of water at 26˚C is 25 mmHg. The total volume of gas is 0.500 L. How many moles of oxygen were collected?

Practice 6

1. Determine the total pressure in the container after the gases mix (without reacting).



1.0 L
3.0 atm
25˚C

1.5 L
1.5 atm
25˚C

What is the difference between effusion and diffusion?

What kind of molecules will diffuse/effuse faster?