HW 1 Worksheet (Goals 1 & 2) - Kinetic Molecular Theory Unit 7

1. Describe how gases, liquids, and solids compare using the following table.

<table>
<thead>
<tr>
<th>Solids</th>
<th>Liquids</th>
<th>Gases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (definite or indefinite)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molecular Motion (high, med, low)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance Between Molecules</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Read page 385: What is kinetic energy? Describe kinetic molecular theory.

3. Identify each statement as True or False.
   According to the basic assumption of kinetic molecular theory gas particles:
   a. are far apart
   b. have a significant volume with respect to the volume of the container they occupy
   c. move rapidly in a constant random motion
   d. lose kinetic energy when colliding

4. Give one reason why industrial companies prefer to store a condensed fuel as a liquid rather than a gas.

5. Using the kinetic molecular theory, explain why a gas can be easily compressed, while a liquid and a solid cannot?

6. Read pages 386-387: Describe the cause of pressure inside of any container filled with a gas. List three common units of pressure and their value at atmospheric pressure.

7. Read pages 388-389: How does temperature relate to kinetic energy?

8. How are Kelvin (K) and celcius (°C) related?

9. Why must absolute temperature be used when working with gas data?

(#’s 10-12) Using the terms particles, collisions, pressure, volume, and temperature answer the following questions.

10. Describe the effect of adding a gas to a container that cannot expand.
11. Describe the effect of making the container size smaller.

12. Describe the effect of cooling a gas in a container.

Unit 7 – HW 2 Worksheet (Goals 2 – 4) - Relationship Between Gases and Liquids
1. What determines the strength of attractive forces in a substance?

Read pages 390-395: Define the following terms:

- Vapor Pressure -

- Boiling Point -

2. Why does increasing the temperature increase the vapor pressure of a liquid?

3. For each of the following situations predict whether the attractive forces between particles are weak or strong.
   a. low boiling point –

   b. high vapor pressure –

4. Look up the boiling points of the compounds on page 395, Table 13.2, in your textbook.

<table>
<thead>
<tr>
<th>COMPOUND</th>
<th>BOILING POINT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CS₂</td>
<td></td>
</tr>
<tr>
<td>2. CHCl₃</td>
<td></td>
</tr>
<tr>
<td>3. C₂H₆O</td>
<td></td>
</tr>
<tr>
<td>4. H₂O</td>
<td></td>
</tr>
</tbody>
</table>

   Explain the differences in the boiling points in terms of attractive forces.

   - Highest b.p. –

   - Lowest b.p –

5. Read pages 401 – 403: When heated at standard pressure, I₂ sublimes. What does this mean?
6. Discuss the following using your knowledge of attractive forces:
   a. Acetone has a greater vapor pressure than ethyl alcohol at 25°C. Predict which substance has stronger attractive forces. Why?
   
   b. The boiling point of ethyl alcohol is 78.5°C. Will the boiling point of acetone be lower or higher? Why?

7. Using Figure 13.15 on page 403, estimate the physical state of water under the following conditions:
   a. 75 kPa and 50°C –
   b. 125 kPa and -50°C –
   c. 100 kPa and 125°C –
   d. 15 kPa and 10°C –
   e. 150 kPa and 25°C –
   f. 25 kPa and 75°C –
   g. At what point does water boil at standard atmospheric pressure?
   h. At what point does water melt at standard atmospheric pressure?
   i. At what pressure and temperature is the triple point of water?
   j. At which point(s) is liquid water in equilibrium with water vapor?

8. What phases are present at a triple point of a substance?

Unit 7 – HW 3 Worksheet (Goal 5-7) - Boyle’s Law, Charles’s Law, and Gay-Lussac’s Law
1. A child brings an inflatable ball on a small plane. Before take-off, the 2.00 L ball has a pressure of 101.3 kPa. The pilot flies the plane at an altitude where the air pressure is 75.0 kPa. What is the volume of the ball at this altitude if the temperature in the plane remains constant?

2. At a depth of 30 meters, the combined pressure of air and water on a diver is about four times the normal atmospheric pressure (400. kPa rather than 100. kPa). Suppose a diver exhales into the water, and one of the air bubbles has a volume of 10.0 mL. What will be the volume of this bubble when it reaches the surface of the water, assuming that it does not break apart and that its temperature does not change?

3. A 2.0 L helium balloon at a pressure of 1.00 atm on the Earth's surface ascends 10 km into the atmosphere, where the pressure is 0.27 atm. What is the volume of the balloon at that altitude (assume temperature stays the same)?
4. A child receives a balloon filled with 2.30 L of helium from a vendor at an amusement park. The temperature outside is 31°C. What will be the volume of the balloon when the child brings it home to an air-conditioned house at 22°C?

5. A 1.5 L pocket of air with a temperature of 295 K rises in the air. If pressure is not changed, what will be the temperature of the air pocket when the volume decreases to 0.90 L?

6. A helium balloon at room temperature (25°C) occupies a volume of 2.0 L. When the balloon is expanded to 5.0 L, the balloon will finally pop. If the pressure is not changed, at what temperature will this occur?

7. An anesthesiologist is about to administer gas to a patient. The gas has a temperature of 22.4°C and a volume of 0.850 L. When the gas enters the patient's body, it is warmed to a temperature of 37.2°C. Assuming that the gas does not undergo a change in pressure, what will be the new volume?

8. The gas in an aerosol can is at a pressure of 103 kPa at 25°C. If the can is thrown into a fire, what will the pressure be when the temperature reaches 928°C?

9. The pressure in a car tire is 198 kPa at 27°C. After a long drive, the pressure is 225 kPa. What is the temperature of the air in the tire?

10. The pressure in a sealed plastic container is 108 kPa at 48°C. What is the pressure when the temperature drops to 22°C? Assume no change in volume.
Unit 7 – HW 4 Worksheet (Goal 5 -7) - Combined Gas Law and Ideal Gas Law

1. The air in a balloon has a volume of 3.00 L and exerts a pressure of 101.3 kPa at 27°C. What pressure does the air in the balloon exert if the temperature is increased to 400.0 K and the air is allowed to expand to 15.0 L?

2. A sample of carbon dioxide occupies 4.50 L at 750 K and 500.0 kPa. What is the volume of this gas at STP?

3. A sample of methane that initially occupies 850.0 ml at 500.0 kPa and 227.0°C is compressed to a volume of 700.0 ml. To what temperature will the gas need to be cooled to lower the pressure of the gas to 200.0 kPa?

4. A helium balloon has a volume of 500.0 ml at STP. What will be its new volume if the temperature is increased to 152°C and its pressure is increased to 125 kPa?

5. An 8.00 L sample of neon gas at 25°C exerts a pressure of 900. kPa. If the gas is compressed to 2.00 L and the temperature is raised to 225°C, what will the new pressure be?

6. How many moles of sulfur dioxide are contained in a 4.0 L container at 450 K and 5.0 kPa?
7. At what temperature will 7.0 mol of helium gas exert a pressure of 1.2 atm in a 2.50 L tank?

8. What volume is occupied by 0.020 mol of nitrogen gas measured at 1.00 atm and 300.0 K?

9. Suppose you have a 500.0 ml container that contains 0.0500 mol of oxygen gas at 25°C. What is the pressure inside the container?

10. How many grams of nitrogen, N\textsubscript{2}, in a 10.0 L container exert a pressure of 97.0 kPa at a temperature of 31°C?

11. A 500 g block of dry ice (solid CO\textsubscript{2}) vaporizes to a gas at room temperature. Calculate the volume of gas produced at 25°C and 1.00 atm.

Unit 7 – HW 5 Worksheet (Goal 8) - Dalton’s Law and Graham’s Law

1. State Dalton’s law of partial pressures.

2. Hydrogen gas is collected by water displacement at a total pressure of 111.0 kPa. The temperature is 50.0°C, and therefore the partial pressure of water vapor is 12.34 kPa. What is the pressure exerted by the 'dry' gas?
3. A mixture of gases of 3 moles of oxygen, 1 moles of carbon dioxide, and 8 moles of nitrogen. Calculate the mole fraction and partial pressure of each gas in the mixture if the total pressure on the system is 0.65 atm.

4. A mixture of 28.0 g of ammonia and 16.0 g of hydrogen has a total pressure of 1.3 atm. What is the partial pressure of each gas?

5. A container contains 20.0 g of oxygen and 80.0 grams of nitrogen gas.
   a. Calculate the mole fraction of each gas in the mixture.
   b. Determine the partial pressure of each gas if the mixture of gases has a total pressure of 99.3 kPa.

6. Two gases, HCl and NH₃, are put into opposite ends of a tube simultaneously. Will the gases meet at point A, B, or C? Explain your answer.

   HCl                                   A        B        C        NH₃

7. Hydrogen sulfide, H₂S, has a very strong rotten egg odor. H₂S particles travel about 450 m/s. Methyl salicylate C₈H₈O₃, has a wintergreen odor. Benzaldehyde, C₇H₈O, has an almond odor. If vapors for these three substances were released at the same time from across the room, which would you smell first? Explain your answer.
8. A nitrogen molecule travels at 500.0 m/s at room temperature. What is the velocity of a helium molecule at the same temperature?

9. Nitrogen gas effuses through an opening at a rate 2.39 times faster than an unknown gas. What is the molecular mass of the unknown gas?

10. Oxygen gas effuses through an opening at the 1.62 times faster than an unknown gas. What is the molecular mass of the unknown gas?

Unit 7 Review

Keys to Success: Review syllabus goals and key terms, class notes for Unit 7, all homework, and complete review, check answers, and come in for extra help to clarify material if needed.

Key Terms: kinetic molecular theory, pressure, barometer, absolute temperature scale, vapor pressure, forces of attraction, normal boiling point, sublimation, phase diagram, triple point, normal freezing point, Avogadro's Hypothesis, standard temperature and pressure, Charles's Law, Boyle's Law, Graham's Law, Combined Gas Law, ideal gas, Ideal Gas Law, Dalton's Law of Partial Pressure

Calculations:
1. A nitrogen gas molecule, N₂, travels at about 500.0 m/s at room temperature. How fast would a molecule of ethanol, C₂H₅OH, travel at the same temperature?

2. The gas in a beach ball occupies 20.0 L at 300.0 K. The ball will explode if inflated past 25.0 L. At what temperature would the beach ball explode?

3. A 48.0 g sample of neon is sealed in a 10.00 L container and heated to a temperature of 317°C. What is the pressure of the gas?

4. A mixture of gases contains 55.0 g of oxygen (O₂) and 30.0 g of carbon dioxide (CO₂). What is the partial pressure of each gas if the total pressure on the system is 1.05 atm?
5. A helium balloon with a volume of 3.00 L, a pressure of 100.0 kPa, and a temperature of 295.0 K is put into an environment where the pressure is 50.0 kPa and the temperature is 250.0 K. What is the new volume of the balloon?

6. A weather balloon has a volume of 1750 L at 103 kPa. The balloon is released into the atmosphere. At the highest point above the ground, the pressure on the balloon is 35.0 kPa. What is the new volume of the balloon at this height (assuming no change in temperature occurs)?

7. A cylinder was filled with CO₂ to a pressure of 1.00 MPa at 293 K. What would be the new pressure if the cylinder was left out in the sun and allowed to reach a temperature of 393 K?

8. H₂O is produced by the combustion of H₂ and O₂ gas at STP. How many grams of water would be produced if 2.0 L of H₂ is allowed to react with excess O₂ according to the following reaction:

\[ 2 \text{H}_2(g) + \text{O}_2(g) \rightarrow 2 \text{H}_2\text{O(g)} \]

9. How many times faster will gaseous F₂ effuse than gaseous Br₂?

10. What is the total pressure of a mixture of O₂ and N₂ gas if their partial pressures are 22 kPa and 78 kPa, respectively? What are their mole fractions?

True or False:

____ 11. All gases at the same temperature have the same average particle velocities.
____ 12. At 0°C there is no kinetic energy.
____ 13. The density of a gas varies with temperature.
____ 14. The molar volume of a gas is independent of its identity at STP.
____ 15. The partial pressure of a gas in a mixture is not proportional to its mole fraction.

Short Answer:

16. Explain why He effuses faster than Ar.

17. Using the Kinetic Molecular Theory, explain the following relationships:
   a. As temperature decreases, volume decreases.
b. As volume decreases, pressure increases.

c. As temperature increases, the pressure increases.

18. Describe the difference between a liquid and gas using volume, movement, and shape.

19. What variables are used to describe a gas quantitatively?

20. Explain the following relationships:
   a. Boyle’s Law
   b. Charles’ Law
   c. Gay-Lussac’s Law
   d. Dalton’s Law of Partial Pressure
   e. Graham’s Law of Effusion
   f. Ideal Gas Law
   g. Avogadro’s Hypothesis

21. Draw a rough phase diagram for water including triple point, critical point, normal melting point and normal boiling point.

22. Describe how intermolecular attractive forces influence the boiling point, vapor pressure, and volatility of a substance.