Honors Chemistry - Problem Set Chapter 13
Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

________ 1. Atmospheric pressure is 760 mm Hg.
________ 2. The SI unit of pressure is the pascal.
________ 3. Atmospheric pressure increases as you climb a mountain because the air layer that surrounds the earth thins out.
________ 4. When particles of a substance are heated, some of the energy is absorbed by the particle and stored in the form of potential energy.
________ 5. The Kelvin temperature of a substance describes the total kinetic energy of the particles in the substance.
________ 6. At any given temperature, the particles of all substances have the same average kinetic energy.
________ 7. The particles of a liquid do not have enough kinetic energy to overcome the attractive forces between them to escape.
________ 8. When a liquid occupies a closed container, there are more particles entering the vapor than condensing.
________ 9. The change of a substance directly from a solid to a gas or vapor is called condensation.
________ 10. The rates of evaporation and condensation are equal at equilibrium.
________ 11. Adding heat to a liquid will increase the temperature of the liquid.

Answer the following on a separate sheet of paper.

26. A gas is at a pressure of 4.30 atm. What is this pressure in kilopascals? In mm Hg?
27. Describe the motion of particles of a gas according to kinetic theory.
28. Explain what happens at the particle level when a solid melts.
29. Explain how some solids can go to the vapor state and condense back to solids without passing through the liquid state. What is the process called?
30. When the physical state of a substance changes during a phase change, what happens to the temperature of the system?

Choose the best answer and write its letter in the blank.

________ 31. The average kinetic energy of water molecules is greatest in:
   a. steam at 200 °C.   c. liquid water at 373 K.
   b. liquid water at 90 °C   d. ice at 0 °C.
________ 32. According to the kinetic theory of gases:
   a. the particles in a gas move rapidly.
   b. the particles in a gas are far apart.
   c. the particles of a gas move independently of each other.
   d. all of the above are true.
________ 33. The temperature at which the motion of particles theoretically ceases is:
   a. 0 °C   c. 2273 K
b. 273 °C  
d. 0 K

34. The average kinetic energy of particles of a substance is:
   a. not affected by the temperature of the substance.
   b. raised as the temperature of the substance is lowered.
   c. proportional to the temperature of a substance.
   d. equal to 0.

35. Which of these statements is not true, according to kinetic theory?
   a. There is no attraction between particles of gas.
   b. Only particles of matter in the gaseous state are in constant motion.
   c. The particles of a gas collide with each other and with other objects.
   d. All collisions between particles of gas are perfectly elastic.

36. Standard conditions when working with gases are defined as:
   a. 0 K and 101.3 kilopascals.
   b. 0 K and 1 mm Hg.
   c. 0 °C and 101.3 kilopascals.
   d. 0 °C and 1 mm Hg.

37. The pressure of a gas in a container is 76 mm Hg. This is equivalent to:
   a. 0.1 atm.
   b. 1 atm.
   c. 0.2 atm.
   d. 0.76 atm.

38. A phase diagram gives information on:
   a. volumes of gases.
   b. temperature and pressure at which a substance exists as a solid, liquid, and gas.
   c. volumes of liquids and solids.
   d. mass changes of solids, liquids, and gases.

39. An increase in the temperature of a contained liquid:
   a. causes the vapor pressure above the liquid to increase.
   b. decreases the vapor pressure above a liquid.
   c. causes fewer particles to escape the surface of the liquid.
   d. has no effect on the kinetic energy of the liquid.

40. Water could be made to boil at 105 °C by:
   a. applying a great deal of heat.
   b. increasing the air pressure above the water.
   c. heating more gradually.
   d. decreasing the air pressure above the water.

41. The direct change of a substance from a solid to a gas is called:
   a. evaporation  
   b. sublimation.
   c. condensation.
   d. boiling.

42. Most solids:
   a. are amorphous.
   b. consist of particles in chaotic motion.
   c. are dense and incompressible.
   d. have very low melting points.

43. The escape of gas molecules from the surface of an uncontained liquid is known as:
   a. boiling.  
   b. sublimation.  
   c. evaporation.
   d. condensation.
Classify each of these statements as always true, sometimes true, or never true.

1. According to the kinetic molecular theory, the volume of all the particles of an ideal gas is negligible compared to the total volume in which the gas is contained.
2. The kinetic theory of gases assumes that, during a collision between two particles, kinetic energy is transferred without loss from one particle to the other.
3. When a sealed container of gas is opened, gas particles tend to cling to the sides of the container.
4. A temperature of -25°C is equivalent to 298K.
5. If temperature is kept constant, halving the number of gas particles in a given sample of gas will cause the pressure to decrease to half of the original pressure.
6. Reducing the volume of a container of gas by one half has the same effect on pressure as reducing the quantity of the gas in the container by one half, if temperature is kept constant.
7. When a sealed container of gas under pressure is opened, gas particles move from the container to the surroundings.
8. When an aerosol can no longer sprays, the pressure inside the can is at 0 kPa.
9. At constant volume, if the Kelvin temperature of a gas is doubled the pressure on the gas is halved.
10. For an ideal gas, pressure and volume are directly proportional to each other when all other factors remain constant.
11. The fractional contribution to pressure exerted by each gas in a mixture does not change as the temperature, pressure or volume changes.
12. The rate of diffusion of a gas is not influenced by its molar mass.
13. When two bodies with different masses have the same kinetic energy, the lighter body moves faster.
14. Diffusion is the tendency of molecules to move towards areas of lower concentration until the concentration is uniform throughout.

Solve:

1. A sample of neon gas occupies a volume of 2.8 L at 1.80 atm. What will its volume be at 1.20 atm?
2. To what pressure would you have to compress 48.0 L of oxygen gas at 99.3 kPa in order to reduce its volume to 16.0 L?
3. A chemist collects 59.0 mL of sulfur dioxide gas on a day when the atmospheric pressure is 0.989 atm. The next day, the pressure has changed to 0.987 atm. What will the volume of the SO₂ gas be on the second day?
4. A balloon full of air has a volume of 2.75 L at a temperature of 18°C. What is the balloon's volume at 45°C?
5. A sample of argon has a volume of 0.43 mL at 24°C. At what temperature in degrees Celsius will it have a volume of 0.57 mL?
6. A cylinder of compressed gas has a pressure of 4.882 atm on one day. The next day, the same cylinder of gas has a pressure of 4.690 atm, and its temperature is 8°C. What is the temperature on the previous day in °C?
7. A maylar balloon is filled with helium gas to a pressure of 107 kPa when the temperature is 22°C. If the temperature changes to 45°C, what will be the pressure of the helium in the balloon?
8. A student collects 450.0 mL of HCl gas at a pressure of 100 kPa and a temperature of 17°C. What is the volume of the HCl at 0°C and 782 mmHg?
9. A chemist collects a sample of H₂S (g) over water at a temperature of 27.0°C. The total pressure of the gas that has displaced a volume of 15.0 mL of water is 207.33 kPa. What is the pressure of the H₂S gas collected?
10. Chlorine gas is collected by water displacement at a temperature of 19 °C. The total volume is 1.45 L at a pressure of 156.5 kPa. Assume that no chlorine gas dissolves into the water. What is the volume of chlorine corrected to STP?

11. Some hydrogen is collected over water at 10°C and 105.5 kPa. The total volume of the sample was 1.93 L. Calculate the volume of the hydrogen corrected to STP.

12. Determine the molar mass of an unknown gas that has a volume of 72.5 mL at a temperature of 68 °C and a pressure of 0.980 atm, and a mass of 0.207 g.

13. A sample of an unknown gas has a mass of 0.116 g. It occupies a volume of 25.0mL at a temperature of 127.0 °C and a pressure of 155.3 kPa. Calculate the molar mass of the gas.

14. A student collects ethane by water displacement at a temperature of 15 °C (water vapor pressure at this temp is 1.5988 kPa) and a total pressure of 100.0 kPa. The volume of the collection bottle is 245 mL. How many moles of ethane are in the bottle.

15. A reaction yields 3.75 L of nitrogen monoxide. The volume is measured at 19°C and at a pressure of 1.10 atm. What mass of NO was produced by the reaction?

16. When sodium carbonate decomposes, 3.56L of the gas is collected at 94.9kPa and 27.0°C. How much sodium carbonate decomposed?

17. When 7.68 g of zinc react with hydrochloric acid, what volume of hydrogen gas will be collected at 20.0°C and 740.0mmHg?

Answers:

1. 4.2 L  
7. 115. kPa  
13. 100 g/mol  
2. 297.9 kPa  
8. 407 mL  
14. 0.010 mol  
3. 59.1 mL  
9. 1528.3 mmHg or 203.7 kPa  
15. 5.16 g NO  
4. 3.01 L  
10. 2.09L  
16. 14.4g  
5. 121°C  
11. 1.92 L  
17. 2.88L  
6. 20°C  
12. 81.8 g/mol
Honors Chemistry Review: States of Matter and Gases

Complete all work on a separate sheet of paper.

1. A metal cylinder contains 1 mol of nitrogen gas at STP. What will happen to the pressure if another mole of gas is added to the cylinder but the temperature and volume do not change?

2. If a gas is compressed from 4 L to 1 L and the temperature remains constant, what happens to the pressure?

3. A gas with a volume of 4 L is allowed to expand to a volume of 12 L. What happens to the pressure in the container if the temperature remains constant?

4. Heating a contained gas at constant volume makes its pressure higher. Why?

5. The gas in a container has a pressure of 3.00 atm at 27.0 °C. What will the pressure be if the temperature is lowered to -173.0 °C?

6. Describe an ideal gas.

7. A gas mixture containing oxygen, nitrogen, and carbon dioxide has a pressure of 250 mm Hg. If \( P_{\text{O}_2} = 50 \text{ mm Hg} \) and \( P_{\text{N}_2} = 175 \text{ mm Hg} \), what is \( P_{\text{CO}_2} \)?

8. A gas with a volume of 4.0 L at a pressure of 0.90 atm is allowed to expand until the pressure drops to 0.20 atm. What is the new volume?

9. A given mass of air has a volume of 6.0 L at 1 atm. What volume will it occupy at 190 mm Hg if the temperature does not change?

10. 3.20 g of calcium reacts with 25.0 mL of water, how much of the gas that is produced would be collected at 24.0°C and 742.4 mm Hg?

11. Five liters of air at -50 degrees C are warmed to 100 degrees C. What is the new volume if the pressure remains constant?

12. An open-ended manometer containing water is used to measure the pressure of a gas. The water level that is open to the atmosphere is higher than the water level open to the gas. If atmosphere pressure at the time of reading is 762.0 mm Hg and the change in height is 154.00 mm, what is the pressure of the gas?

13. The pressure in an automobile tire is 2.0 atm at 27 degrees C. At the end of a journey on a hot sunny day the pressure has risen to 2.2 atm. What is the temperature of the air in the tire? (Assume that the volume has not changed.)

14. A 5.0 L air sample at a temperature of -50 degrees C has a pressure of 800 mm Hg. What will be the new pressure if the temperature is raised to 100 degrees C and the volume expands to 7.0 L?

15. What volume will 12.0 g of oxygen gas \((\text{O}_2)\) occupy at 25 degrees C and a pressure of 0.520 atm?

16. Calculate the number of liters occupied, at STP.
   a. 2.5 mol \(\text{N}_2\)
   b. 0.600 g \(\text{H}_2\)
   c. 0.350 mol \(\text{O}_2\)

17. What pressure will be exerted by 0.450 mol of a gas at 25 degrees C if it is contained in a vessel whose volume is 650 cm\(^3\)?

18. Determine the volume occupied by 0.582 mol of a gas at 15 degrees C if the pressure is 622 mm Hg.
19. Which gas effuses faster at the same temperature: molecular oxygen or atomic argon?
20. Calculate the rate of effusion of helium atoms to neon atoms at the same temperature.
21. Calculate the ratio of the velocity of helium atoms to fluorine molecules at the same temperature.
22. Consider the synthesis of ammonia (NH₃). What volume of hydrogen gas will be needed to produce 800.0 L of ammonia, measured at 55°C and 0.900 atm?
23. Consider the decomposition of 3.60g aluminum chlorate. How many mL of gas are produced at 745.0mmHg and 25.0°C?
24. Consider the reaction between aluminum and hydrochloric acid. If 30.0g of Aluminum react with 500.0mL of .25M Hydrochloric acid, what volume of gas will be formed at 24.0°C and 782.00mmHg?
25. Answer the following questions about the graph below:

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>-238°C</td>
<td>1 atm</td>
</tr>
<tr>
<td>17°C</td>
<td></td>
</tr>
</tbody>
</table>

a. What is the melting point of this substance?
b. What is the boiling point?
c. What is the physical state (s, l, g) of this substance at room temperature?
d. If this substance were removed from the counter and placed in a household freezer, would it undergo a phase change? If so what physical state would it be in after several hours in the freezer?
26. Why does a balloon shrink when it is cooled?
27. Why does your skin feel cold when liquid rubbing alcohol is placed on your skin.
28. Why are pressure cookers recommended for cooking at very high altitudes?
29. Answer the following questions about the graph below:

Temperature

a. Write in the states of matter.
b. Label the normal melting temperature of the substance as "M".
c. Label the normal boiling temperature of the substance as "B".
d. What happens to the boiling point of the substance as pressure increases?
e. What happens to the melting point of the substance as pressure increases?