General Gas Law Problems

1. Synthetic diamonds can be manufactured at pressures of 6.00×10^4 atm. If we took 2.00 liters of gas at 1.00 atm and compressed it to a pressure of 6.00×10^4 atm, what would the volume of that gas be? (3.33×10^{-5} L)

2. A gas takes up a volume of 17 liters, has a pressure of 2.3 atm, and a temperature of 299 K. If the temperature of the gas is increased to 350 K and the pressure is reduced to 1.5 atm, what is the new volume of the gas? (31 L)

3. Divers get "the bends" if they come up too fast because gas in their blood expands, forming bubbles in their blood. If a diver has 0.050 L of gas in his blood under a pressure of 250 atm, then rises instantaneously to a depth where his blood has a pressure of 50.0 atm, what will the volume of gas in his blood be? Do you think this will harm the diver? (0.25 L)

4. A gas has a temperature of 14°C, and a volume of 4.5 liters. If the temperature is raised to 29°C and the pressure is not changed, what is the new volume of the gas? (4.7 L)

5. How hot will a 2.3 L balloon have to get to expand to a volume of 40.0 L? Assume that the initial temperature of the balloon is 25°C. (4900°C)

6. I have an unknown volume of gas held at a temperature of 115 K in a container with a pressure of 60.0 atm. If by increasing the temperature to 225 K and decreasing the pressure to 30.0 atm causes the volume of the gas to be 29 liters, how many liters of gas did I start with? (7.4 L)

7. A soda bottle is flexible enough that the volume of the bottle can change even without opening it. If you have an empty soda bottle (volume of 2.0 L) at room temperature (25.0°C), what will the new volume be if you put it in your freezer (-4.0°C)? (1.8 L)

8. A gas has a pressure of 0.370 atm at 50.0°C. What is the pressure at standard temperature [Hint: Temperature from STP]? (0.313 atm)

9. A bottle of gas has its Kelvin temperature doubled. Assume that the volume stays constant and the bottle is sealed. What will the final pressure be for the gas if the initial pressure before doubling the temperature was 56.0 kPa? Is the situation likely to happen? Explain your reasoning. (112 kPa)

10. The temperature inside my refrigerator is about 4.0°C. If I place a balloon in my fridge that initially has a temperature of 22°C and a volume of 0.50 liters, what will be the volume of the balloon when it is fully cooled by my refrigerator? (0.47 L)

11. 10.0 L of a gas is found to exert 97.0 kPa at 25.0°C. What would be the required temperature (in Celsius) to change the pressure to standard pressure? (38.2°C)

12. If I have 2.9 L of gas at a pressure of 5.00 atm and a temperature of 50°C, what will be the temperature of the gas if I decrease the volume of the gas to 2.4 L and decrease the pressure to 3.00 atm? (-113°C)

13. If I have 17 liters of gas at a temperature of 67°C and a pressure of 88.89 atm, what will be the pressure of the gas if I raise the temperature to 94.0°C and decrease the volume to 12.0 liters? (136 atm)

14. The temperature of a sample of gas in a steel container at 30.0 kPa is increased from -100.0°C to 1.00×10^3 °C. What is the final pressure inside the tank? (221 kPa)

15. A scientist has made a thermometer that measures temperature by the compressing and expanding of gas in a piston. The scientist measured that at 100°C the volume of the piston is 20.0 L. What is the temperature outside if the piston has a volume of 15.0 L? What would be appropriate clothing for the weather? (6.71°C)

16. A balloon contains 125 L of air at 35°C. What will the new volume become if the temperature drops to -35°C while the pressure is kept constant? (97 L)

17. A gas in a rigid container with a volume of 250.0 mL has a pressure of 99.7 kPa at 25.0°C. What will the pressure inside of the container be if:

    a. The Celcius temperature is doubled (108 kPa)
    b. The Kelvin temperature is doubled (199 kPa)

Ideal Gas Law Problems

1. A sample of 1.00 moles of oxygen gas at 50°C and 98.6 kPa occupies what volume? *(27 L)*

2. If a steel cylinder with a volume of 1.50 L contains 10.0 moles of oxygen, under what pressure is the oxygen if the temperature is 27.0 °C? *(1.66×10^4 kPa)*

3. When the pressure in a certain gas cylinder with a volume of 4.50 L reaches 500. atm, the cylinder is likely to explode. If this cylinder contains 40.0 moles of argon at 25.0 °C, is it on the verge of exploding? Calculate the pressure in atmospheres. *(218 atm)*

4. What volume is occupied by 0.25 grams of oxygen gas measured at 25.0 °C and 100.66 kPa? *(0.19 L)*

5. At 22.0 °C and a pressure of 100.6 kPa, a gas was found to have a density of 1.14 g/L. Calculate the molecular mass of the gas. *(27.8 g/mol)*

6. The density of a certain gas at 27.0 °C and 98.66 kPa is 2.53 g/L. Calculate the molecular mass. *(63.9 g/mol)*

7. What is the molecular mass of a gas if 2.82 grams of the gas occupies 3.16 L at STP? *(20.0 g/mol)*

8. In a gas thermometer, the pressure needed to fix the volume of 0.200 g of Helium at 0.500 L is 113.30 kPa. What is the temperature? *(-137°C)*

9. You want to send chlorine gas safely from Vancouver to Kingston. Chlorine gas is very poisonous and corrosive. You have 5000. L truck cylinder that will withstand a pressure of 100.0 atm. The cylinder will be kept at 2.00 °C throughout the trip. How many moles of chlorine gas can you safely ship? *(2.22×10^3 moles)*

Dalton's Law of Partial Pressure

1. The total pressure of a mixture of carbon dioxide, oxygen, and helium is 92.5 kPa. If the partial pressure of carbon dioxide is 27.3 kPa and the partial pressure of helium is 40.5 kPa, determine the partial pressure of oxygen. {24.7 mL)

2. Air is a mixture of many gases. The partial pressure of nitrogen is 80.0 kPa and the partial pressure of oxygen gas is 20.3 kPa. Atmospheric pressure is 101.3 kPa. What is the partial pressure due to all the other gases present in the air? {1.0 kPa)

3. A volume of 1.10×10^2 mL of hydrogen gas is collected over water at a temperature of 17.0°C and the atmospheric pressure is 95.0 kPa. What is the volume of the dry hydrogen gas at STP? (95.2 mL)

4. If 80.0 mL of oxygen is collected over water at 20.0°C and 95.0 kPa, what volume would the oxygen occupy at STP? (68.2 mL)

5. A volume of 135 mL of nitrogen gas is collected over water at a temperature of 24.0 °C and atmospheric pressure of 92.0 kPa. What mass would the dry nitrogen occupy at 35.0 °C and 120.1 kPa. (0.137 g)

6. If 3.00 moles of N_2 and 4.00 moles of O_2 are placed in a 35.0 L container at a temperature of 25.0°C, what will the pressure of the resulting mixture of gases be? (4.90 atm)

7. Two flasks are connected with a stopcock. The first flask has a volume of 5.00 liters and contains nitrogen gas at a pressure of 0.750 atm. The second flask has a volume of 8.00 L and contains oxygen gas at a pressure of 1.25 atm. When the stopcock between the flasks is opened and the gases are free to mix, what will the pressure be in the resulting mixture. (1.06 atm)

8. What's the partial pressure of carbon dioxide in a container that holds 5.00 moles of carbon dioxide, 3.00 moles of nitrogen, and 1.00 mole of hydrogen and has a total pressure of 1.05 atm? (0.583 atm)

Gas Stoichiometry Problems

For the following, if no pressure and temperature information is given assume that the reactions are being performed at a pressure of 1.00 atm and a temperature of 298 K.

1) Calcium carbonate decomposes at high temperatures to form carbon dioxide and calcium oxide. How many grams of calcium carbonate will be needed to form 3.45 liters of carbon dioxide? (14.1 g)

2) Ethylene burns in oxygen to form carbon dioxide and water vapor:

$$C_2H_{4(g)} + 3\ O_{2(g)} \rightarrow 2\ CO_{2(g)} + 2\ H_2O_{(g)}$$

How many liters of water can be formed if 1.25 liters of ethylene are consumed in this reaction? (2.50 L)

3) When chlorine is added to acetylene, 1,1,2,2-tetrachloroethane is formed:

$$2\ Cl_{2(g)} + C_2H_{2(g)} \rightarrow C_2H_2Cl_{4(l)}$$

How many liters of chlorine will be needed to make 75.0 grams of $C_2H_2Cl_4$? (21.8 L)

4) Methane, CH_4, gas can be made in small quantities by the reaction shown below.

$$Al_4C_3 + 12\ H_2O \rightarrow 4\ Al(OH)_3 + 3\ CH_4(g)$$

How many ml of $CH_4(g)$, at STP will be produced when 1.73 grams of aluminum carbide, Al_4C_3, completely react with water? (808 mL)

5) Carbon dioxide gas can be produced by the action of sodium chlorite upon glucose according to the equation given below.

$$C_6H_{12}O_6 + 6\ NaClO_2 \rightarrow 6\ CO_2(g) + 6\ NaCl + 6\ H_2O$$

If 323 ml of carbon dioxide, CO_2, at STP, came from the above reaction, how many grams of glucose, $C_6H_{12}O_6$, reacted? (0.433 g)

6) The element boron, B, reacts with sulfur dioxide gas, SO_2, to produce boron(III) oxide, B_2O_3, and sulfur, S, according to the following equation. How many grams of boron(III) oxide will be produced if 816 mL of SO_2 at 737 mm Hg pressure and 18ºC react according to the above equation? (1.54 g)

7) Aluminum phosphide, AlP, reacts with oxygen gas, O_2, making aluminum oxide, Al_2O_3, and phosphorous(V) oxide, P_4O_{10}.

$$4\ AlP(s) + 8\ O_2(g) \rightarrow 2\ Al_2O_3(s) + P_4O_{10}(g)$$

What volume of oxygen gas at 879.0 torr and 31.0ºC will be needed to produce 3.76 g of aluminum oxide using the above reaction? (3180 mL)

8) Magnesium reacts vigorously with gaseous tin(IV) chloride to produce magnesium chloride and tin.

$$2\ Mg(s) + SnCl_4(g) \rightarrow 2\ MgCl_2(s) + Sn(s)$$

When 1215 mL of $SnCl_4$ at 917 torr and 15.0 ºC react, how many grams of magnesium chloride will be produced by the reaction above? (11.8 g)

Gas Laws Unit Review

Multiple Choice

1. Four gases are mixed together in the same container. Their partial pressure are
   gas A - 65 kPa gas B - 40 kPa gas C - 160 kPa gas D - 80 kPa
   Select the correct completion. The number of molecules of gas D
   (a) is less than the number of molecules of gas A
   (b) is double the number of molecules of gas C
   (c) is half the number of molecules of gas B
   (d) is half the number of molecules of Gas C

2. Consider two identical flasks, both at 25°C and 101 kPa pressure. One contains SO_2 gas and the other contains O_2 gas. Which of the following statements is correct
   (a) a different number of molecules is contained in each container
   (b) the average kinetic energy of the molecules is the same in both containers
   (c) the average velocity of the molecules is the same in both containers
   (d) the flask filled with SO_2 will have the same mass as the flask filled with O_2

Gas Laws Review

1. What is the final volume if 3.4 L of nitrogen gas at 400. K is cooled to 200. K at constant pressure? (1.7 L)

2. A weather balloon contains 2.50 m^3 of helium gas at 15.0 °C and 98.0 kPa pressure. What volume would this gas occupy at STP? (2.29 m^3)

3. A welder needs 5.00×10^3 L of oxygen gas at 1.50×10^2 kPa at a temperature of 21.0 °C. To what pressure must a 50.0 L tank be filled at 13.0 °C. (1.46×10^4 kPa)

4. Calculate the density of uranium (VI) fluoride, UF_6, at 70.0 °C and 25.0 kPa. (3.08 g/L)

5. An unknown monatomic gas X has a density of 5.37 $g \cdot L^{-1}$ at 25.0 °C and 101.3 kPa. Calculate the molar mass of the gas and determine its identity. (131 g/mol, Xe)

6. If a 9.87 g block of air freshener, that has an active ingredient of paradichlorobenzene, is vapourized in a 1.50 L container at 125 °C, the resulting pressure is 148.2 kPa. Determine the molar mass of paradichlorobenzene. (147 g/mol)

7. Hydrogen gas was collected over water. The temperature was recorded at 24.0 °C, pressure is 99.20 kPa and 250. mL of gas was collected. If the water vapour pressure is 2.98 kPa at 24.0 °C, what is the mass of hydrogen collected? (0.0197 g)

8. If 4.00 moles of a gas at a pressure of 5.4 atmospheres have a volume of 120.0 liters, what is the temperature? (1.7×10^3 °C)

9. A gas with an initial pressure of 84.0 kPa and a temperature of 35.0 °C and the gas is heated an additional 230.0 degrees, what will the new pressure be? Assume the volume of the container is constant. (147 kPa)

10. My car has an internal volume of 2600. liters. If the sun heats my car from a temperature of 20.0°C to a temperature of 55.0° C, what will the pressure inside my car be? Assume the pressure was initially 760.0 mm Hg. (113 kPa)

11. How many moles of gas are in my car in the previous problems? (108 moles)

12. A toy balloon filled with air has an internal pressure of 1.25 atm and a volume of 2.50 L. If I take the balloon to the bottom of the ocean where the pressure is 95.0 atmospheres, what will the new volume of the balloon be? How many moles of gas does the balloon? Assume T = 285 K. (32.8 mL, 0.133 moles)

13. Given the following reaction: $2\ BBr_3 + 3\ H_2 \rightarrow 2\ B + 6\ HBr$
    What volume of boron bromide at 300.0 °C and 65.0 kPa would produce 600.0 L of hydrogen bromide? (200.0 L).

14. Given the following reaction: $2\ Al + 3\ H_2SO_4 \rightarrow 3\ H_2 + Al_2(SO_4)_3$
    What pressure of hydrogen can be produced at a temperature of 23.0 °C and a volume of 25.2 L from 1.04 g of aluminum and 25.0 mL of 0.250 M sulphuric acid solution? (0.616 kPa)

<u>Gas Stoichiometry Review</u>

1) How many liters of ammonia can be produced at a temperature of 27.0 °C degrees Celsius and a pressure of 760. torr, if 20.0 moles of nitrogen gas are consumed with excess hydrogen gas? (985 L)

2) How many liters of hydrogen gas will be required for the Haber Process (production of ammonia from hydrogen and nitrogen gas) at a temperature of 27.0 °C and 3.00 atm of pressure to consume 56.0 grams of nitrogen gas? (49.3 L)

3) What volume of ammonia will be produced if 10.0 liters of nitrogen gas are consumed with excess hydrogen gas? (20.0 L)