Review – Gases
Ch. 5

$\frac{V_1 P_1}{T_1}$

1. As you increase the pressure of a gas (keeping the temperature constant), the volume would decrease
2. As you decrease the temperature of a gas (keeping the volume constant), the pressure would decrease.
3. As you decrease the temperature of a gas (keeping the volume constant), the speed of the molecules would decrease.
4. As you increase the volume a gas occupies (keeping temperature constant), the pressure would decrease.
5. As you increase the temperature of a gas sample, the kinetic energy of the sample would increase.

Conversion factors and useful info!!
1 atm = 760 torr = 760 mm Hg = 76 cm Hg = 14.7 psi = 29.9 in. Hg = 101.3 Kpa
R = 0.08206 L x atm/ mol x K R = 8.3145 J / mol x K

6. A balloon is filled to a volume of 546 mL of air at a temperature of 25 C. The balloon is then heated at a constant pressure to a temperature of 43 C. What is the final volume of the balloon?

$V_1 = 546\ mL$ $V_2 = x$ $T_1 = 298K$ $T_2 = 315K$ $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\frac{.546\ L}{298} = \frac{x}{315}$ $\boxed{x = .577L}$

7. A bike tire with a pressure of 20.9 psi at 22 C is driven on hot pavement until the temperature increases to 67 C. What is the new pressure in the tire?

$P_1 = 20.9\ psi$ $P_2 = x$ $T_1 = 295K$ $T_2 = 340$ $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ $\frac{20.9}{295} = \frac{x}{340}$ $x = \boxed{24.1 psi}$

8. What is the volume of 35 grams of helium gas at STP?

$\#mole = 35g\ He \times \frac{1 mole}{4g} = 8.75$ $(1atm)(x) = (8.75)(.0821)(273)$ $\boxed{x = 196.1L}$

9. Find the root mean square velocity of hydrogen gas at 30 C.

$H_2 = 2g/mole = .002\ kg/mole$

$v_{rms} = \sqrt{\frac{3RT}{FW}} = \sqrt{\frac{(3)(8.315)(303)}{.002}}$ $\boxed{v_{rms} = 1944 m/s}$

10. What volume of oxygen gas, measured at 30 C and 725 torr, can be produced by the complete decomposition of 4.1 g mercuric oxide?

2HgO (s) → 2Hg (l) + O_2 (g)

$\#mole\ O_2 = 4.1g\ HgO \times \frac{1 mole}{217g} \times \frac{1 mol O_2}{2 mol HgO} = .00945 mole$

$(.954)(x) = (.00945 mol)(.0821 \frac{L\cdot atm}{mol\cdot K})(303) = \boxed{.246 L}$

11. Calculate the density of ammonia gas at 27 C and 635 torr.

$MM = \frac{DRT}{P}$ $17 = \frac{x(.0821)(300)}{.836}$ $= \boxed{.577 g/L}$

12. Consider 3 identical flasks filled with different gases.
   Flask #1 – CO at 760 torr and 0 C MM = 28 g.
   Flask #2 – N_2 at 250 torr and 0 C MM = 28 g
   Flask #3 – H_2 at 100 torr and 0 C MM = 2g
   a. In which flask will the molecules have the greatest average kinetic energy? Equal all at same temp
   b. In which flask will the molecules have the greatest root mean square velocity?
   H_2, it has the lowest mass

13. Calculate the ratio of diffusion rates of NH_3 and HCl. (Use Graham's Law)

$\frac{rate\ NH_3}{rate\ HCl} = \sqrt{\frac{36}{17}}$ ratio = 1.46

NH_3 diffuses 1.46 times faster than HCl

14. Under what three conditions are real gases most ideal? Explain why.

↑ Temperature, high K.E. low temp increase attractive forces stick together

↓ pressure, bc. volume is large making volume of gas negligible

↓ MM, reduces interaction of particles

15. Propane, C_3H_8, is a hydrocarbon that is commonly used as fuel for cooking.

(a) Write a balanced equation for the complete combustion of propane gas, which yields $CO_{2(g)}$ and $H_2O_{(l)}$.

$2C_3H_8 + 10O_2 \rightarrow 6CO_2 + 8H_2O$

mole

(b) Calculate the volume of air at 30°C and 1.00 atmosphere that is needed to burn completely 10.0 grams of propane. Assume that air is 21.0 percent O_2 by volume.

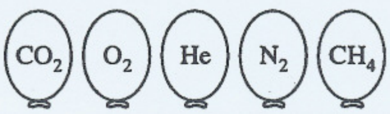
$\# \text{ mol } O_2 = 10.0g\ C_3H_8 \times \frac{1 \text{ mol } C_3H_8}{44g} \times \frac{10 \text{ mol } O_2}{2 \text{ mol } C_3H_8} = 1.14 \text{ mol } O_2$ $\quad .21 = \frac{1.14 O_2}{x \text{ mol air}}$ $\quad x = 5.41 \text{ mole air}$

delete $(1.0)(x) = (5.41)(.0821)(303)$ $\boxed{x = 136L}$

16. A certain gas effuses 4 times as fast as oxygen gas. What is the molar mass of the unknown gas?

(x) O_2

$\frac{\text{rate } x}{\text{rate } O_2} \left(\frac{4}{1}\right)^2 = \left(\sqrt{\frac{32}{x}}\right)^2$ $\quad \frac{16}{1} = \frac{32}{x}$ $\quad \boxed{x = 2g/mol}$



17. Represented above are five identical balloons, each filled to the same volume at 25°C and 1.0 atmosphere pressure with the pure gases indicated.

(a) Which balloon contains the greatest mass of gas? Explain. CO_2 same # moles, CO_2 has highest MM

(b) Compare the average kinetic energies of the gas molecules in the balloons. Explain. Same, temp same

(c) Which balloon contains the gas that would be expected to deviate most from the behavior of an ideal gas? Explain. CO_2 ↑ MM

(d) Twelve hours after being filled, all the balloons have decreased in size. Predict which balloon will be the smallest. Explain your reasoning. He, highest velocity escaped

18. A gaseous mixture of O_2, H_2 and N_2 contains 8.2 g of each gas and has a pressure of 1.5 atm. Find the partial pressure of each.

$\# \text{ mole } O_2 = 8.2g \times \frac{1 \text{ mol}}{32g} = .256 \text{ mol}$ $\quad x = \frac{.256}{4.65} = (.0550)(1.5) = .0825$ atm

$\# \text{ mole } H_2 = 8.2g \times \frac{1 \text{ mol}}{2g} = 4.1 \text{ mol}$ $\quad x = \frac{4.1}{4.65} = (.882)(1.5) = 1.32$ atm

$\# \text{ mole } N_2 = 8.2g \times \frac{1 \text{ mol}}{28g} = .293 \text{ mol}$ $\quad \frac{}{4.65}$ $\quad x = \frac{.293}{4.65} = (.0630)(1.5) = .095$ atm

19. Answer:

(a) PH2 = Patm - PH2O = (745 - 23.8) mm Hg

= 721.2 mm Hg

n = (PV)/(RT) = (721.2 mm Hg 90.0 mL)/(62400 mm Hg.mL/mol.K 298.15K)

= 3.49X10-3 mol

(b) nH2O = (23.8 mm Hg 90.0 mL)/(62400 mm Hg.mL/mol.K 298.15K)

6.022X1023 molecules/mol = 6.93X1019 molecules