Ideal Gas Laws

1. Assume that one of the cylinders of an automobile engine has a volume of 400 cm$^3$. The engine takes in air at a pressure of 1.00 atm and a temperature of 27°C and compresses it to a volume of 50.0 cm$^3$ at 77°C. What is the final pressure of the gas in the cylinder? (The ratio of before and after volumes, in this case 400:50 or 8:1, is called the compression ratio.)

2. At 46°C and 0.880 atm pressure, a gas occupies a volume of 0.600 L. How many liters will it occupy at STP?

3. A) A large 250 L tank is evacuated and then connected to a 50.0 L bulb filled with compressed argon. After they are joined, the pressure in the bulb falls to 2.2 atm. If the temperature remains at 25°C throughout this process, what was the initial pressure in the 50 L bulb? **HINT** Draw a picture of the tank and bulb connected to one another.

   (a) 2.6 atm  
   (b) 4.4 atm  
   (c) 11.0 atm  
   (d) 13.2 atm  
   (e) 17.6 atm  

   B) How many moles of argon are in the tank and the bulb at the end of the experiment?

   (a) 22.5 moles  
   (b) 4.50 moles  
   (c) 53.6 moles  
   (d) 27.0 moles  
   (e) 322 moles
Gas Density

1. A) Calculate the density of SO$_3$ gas at 0.96 atm and 35°C.

B) Calculate the molar mass of a gas if 4.40 g occupies 3.50 L at 560 torr and 41°C.

2. A hydrocarbon used with oxygen as a general anesthetic is 85.7% C and 14.3% H by mass. If 1.56 g of this hydrocarbon occupies a volume of 1.00 L at 0.984 atm and 50.0°C, what is the **molecular formula** of the gas?

   (a) CH$_4$
   (b) CH$_2$
   (c) C$_3$H$_6$
   (d) C$_6$H$_{12}$
   (e) C$_4$H$_{10}$

3. Forty miles above the earth’s surface the temperature is 250 K and the pressure is only 0.20 mmHg. What is the density of air at this altitude. (For this calculation assume that air is an ideal gas with an average molecular mass of 29.0 g/mol)
Partial Pressures

1. A) 2.5 L of He(g) at 4.2 atm pressure and 25°C and 3.1 L of O₂(g) at 7.4 atm pressure and 25°C are combined at constant temperature into a 7.5 L flask. What is the mole fraction of He(g) in the 7.5 L flask?

   (a) 0.31  
   (b) 0.69  
   (c) 0.45  
   (d) 0.55  
   (e) 0.33  
   (f) 0.66

B. What are the partial pressures of O₂ and He in the 7.5 L flask?

C. What is the total pressure in the 7.5 L flask?

2. If atmospheric pressure is 735 mm Hg, what is the partial pressure of Ar if the mole fractions of N₂, O₂, and Ar in the atmosphere are 0.781, 0.209, and 0.010 respectively?

   (a) 735 mm Hg  
   (b) 574 mm Hg  
   (c) 154 mm Hg  
   (d) 7.35 mm Hg

What are the partial pressures of N₂ and O₂ under these conditions?

3. If a sample of air at 750 torr and 25°C contains 6.0 ppm CO, how many moles of CO are in a 1-L sample?