

HW19 Calculations involving moles, masses and volumes of gases.

- 1 mole of any gas takes a volume of 22.4 liters at "normal conditions". This is a molar gas volume under the normal conditions. Normal conditions are temperature of 0°C (273 K) and pressure of 1 atm (101 325 Pa)
- For conditions that differ from normal we use the ideal gas equation: $pV = nRT$

n – gas mole number

p – gas pressure (atm)

V – gas volume (liters)

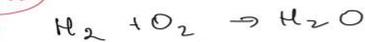
T – temperature (K)

R – gas constant (0.0821 l x atm/mole x K)

Worked examples from the previous homework and from the class (also look at the notes from the previous homework HW18):

(HW)

(1)



1. write down coefficients



The coefficients tell you that hydrogen gas reacts with oxygen gas exactly when we have 2 : 1 molar ratio of the gases

2. 4g of H_2 $n = 4\text{g} / 2\text{g mol}^{-1} = 2 \text{ mole}$

64g of O_2 $n = 64\text{g} / 32\text{g mol}^{-1} = 2 \text{ mole}$

We see that we have 2 moles of H_2 and 2 moles of O_2 , not 2 : 1 we have O_2 in excess.

1 mole of O_2 would be enough but we have 2. It means

1 mole in excess. 1 mole of O_2

$$m = n \cdot M \quad m = 1\text{mol} \times 32\text{g mol}^{-1} = 32\text{g}$$

Answer: 32g of O_2 remain unreacted.

(3)

A gas has a density 3.17g/L

under normal conditions.

Identify the gas. Hint: it has two identical atoms in a molecule

$$1. \quad d = \frac{pm}{RT} \quad M = \frac{d \cdot RT}{p}$$

$$M = \frac{3.17 \times 22.4}{1} = 71\text{g mol}^{-1}$$

2. Look at the per. table and at Hint. 2 identical atoms \rightarrow element's atomic weight $71 : 2 = 35.5$. The element chlorine. The gas Cl_2 .

ideal gas law
 $pV = nRT$
 $n = m/M$
 density
 $d = m/V$,
 where V = volume



If 1 L of oxygen reacts with 0.3 L of methane how much oxygen (O_2) will be left at the end of the reaction.

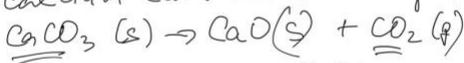
1. We have our coefficients at place, so we can tell that molar ratio of CH_4 and O_2 is

1 to 2

2. We have 0.3 L of CH_4 and 1 L of O_2 . From the molar ratio we know that we need only twice as much O_2 to completely react with CH_4 . It means we need $0.3 \text{ L} \times 2 = 0.6 \text{ L}$ of O_2 .

3. At the beginning we had 1 L of O_2 .
 $1 \text{ L} - 0.6 \text{ L} = 0.4 \text{ L}$ of O_2 remained.

② We have standard conditions Calculate the volume of CO_2 produced when 10 g of calcium carbonate decomposes



1. We have 10 g of CaCO_3 . We can calculate the number of moles.

$$n = \frac{m}{M} \quad \left| \quad \begin{array}{l} M \text{ of } \text{CaCO}_3 = \\ 100 \text{ g mol}^{-1} \\ \text{Ca} - 40 \quad \text{O} = 16 \times 3 = \\ \text{C} - 12 \quad \quad \quad = 48 \end{array} \right.$$

$$n = 10 \text{ g} / 100 \text{ g mol}^{-1}$$

$$n = 0.1 \text{ mol}$$

10 g of CaCO_3 has 0.1 moles

2. Look at the coefficient in the chemical equation. Molar ratio of $\text{CaCO}_3 : \text{CO}_2$ is 1 : 1. It means if we have 0.1 mol of CaCO_3 , we will end up with

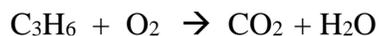
0.1 mol of CO_2

3. Convert moles to volume. Remember 22.4 L will have 1 mole of any gas. It means 2.24 L will have 0.1 mole.

The answer: 10 g of CaCO_3 will produce 2.24 L of CO_2 .

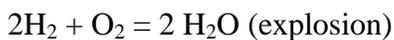
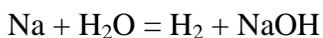
Questions:

1. Propene undergoes combustion



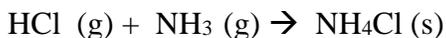
Find equation coefficients. Find the volume of carbon dioxide produced when 0.36 L of propene react with 0.36 L of oxygen at 273K and 100 kPa pressure?

2. An explosion took place because of the following two reactions:



Find equation coefficients for the first equation and calculate how much (by volume) hydrogen exploded if 2.3 g of Na reacted.

3. We have a flask with a volume of 5.6 L. The flask is kept at 0 degrees C, we mix 36.5 grams of HCl and 7.1 grams of Cl₂ and 3.4 grams of NH₃. A reaction occurs in the flask:



The product of the reaction NH₄Cl is in crystal form.

Figure out the atmospheric pressure inside of the flask.