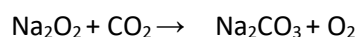


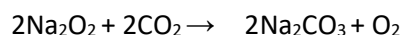
## HW21 Hydrogen

Below is the solution to the problem #1 from the previous HW.

A person needs about 1 mole of oxygen per hour to breath. Calculate how much  $\text{Na}_2\text{O}_2$  will be needed for a 24-h trip in a single-person submarine using the following equation:



a. We balance the equation:



This tells us that from 2 moles of  $\text{Na}_2\text{O}_2$  we get 1 mole of oxygen  $\text{O}_2$ .

b. For a 24-h trip we will need: 1 mole/hr x 24 hr = 24 moles of oxygen. If to get 1 mole of oxygen we need 2 moles of sodium peroxide, then to get 24 moles of oxygen we will need  $24 \times 2 = 48$  moles of  $\text{Na}_2\text{O}_2$ .

c. To obtain the answer in grams, we calculate the molar mass of sodium peroxide and multiply it by the number of moles that we need (48):

$$M(\text{Na}_2\text{O}_2) = 2 \times 23 + 2 \times 16 = 78 \text{ g/mole}$$

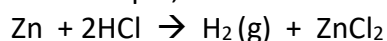
We will need:  $78 \text{ g/mole} \times 48 \text{ moles} = 3744 \text{ g}$  or 3 kg 744 g of  $\text{Na}_2\text{O}_2$ .

## Hydrogen

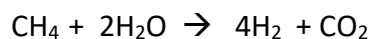
There are a lot of ways to obtain  $\text{H}_2$ .

It can be displacement reactions, where metals displace hydrogen from one of the compounds containing hydrogen element.

For example, look at the reaction of zinc with hydrochloric acid:



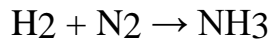
On the industrial scale a lot of hydrogen gas can be obtained from methane. Here is the summary of the process at  $1100^\circ \text{C}$ :



### Questions:

1. We have zinc and hydrochloric acid reacting. How many grams of zinc do we need to obtain 1.12 L of  $\text{H}_2$  under normal conditions (STP – standard temperature and pressure)?

2. We have 448 L of methane. It reacts with extremely hot water vapor. How many liters of hydrogen will be formed under normal conditions?
3. One of the most important hydrogen containing compound is ammonia, which is obtained through high- temperature, high-pressure reactions of hydrogen and oxygen in the presence of a catalyst that facilitates the reaction:



- a) Balance the reactions
- b) How many moles of ammonia forms from each mole of nitrogen?
- c) How many moles of ammonia forms from each mole of hydrogen?