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 Na_2O_2 will be needed for a 24-h trip in a single-person submarine using the following equation:

$Na_2O_2 + CO_2 \rightarrow \quad Na_2CO_3 + O_2$

a. We balance the equation:

$2Na_2O_2 + 2CO_2 \rightarrow \quad 2Na_2CO_3 + O_2$
This tells us that from 2 moles of Na_2O_2 we get 1 mole of oxygen 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 24x2 = 48 moles of Na_2O_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 (Na_2O_2) = 2x23 + 2x16 = 78 g/mole
We will need: 78g/mole x 48 moles = 3744g or 3 kg 744 g of Na_2O_2.

Hydrogen

There are a lot of ways to obtain H_2.
It can be displacement reactions, where metals displace hydrogen from one of the compounds containing hydrogen element.
For example:
$Zn + 2HCl \rightarrow H_2(g) + ZnCl_2$

On the industrial scale a lot of hydrogen gas can be obtained from methane. Here is the summery of the process at 1100^0 C:

$CH_4 + 2H_2O \rightarrow 4H_2 + CO_2$

Questions:

1. We have zinc and hydrochloric acid reacting. How many grams of zinc do we need to obtain 1.12 L of 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:

   $H_2 + N_2 \longrightarrow \quad NH_3$

   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?