Calculations involving concentrations, stoichiometry

1) Propane gas burns on air producing water and carbon dioxide:

$CH_3CH_2CH_3(g) + O_2(g) \rightarrow H_2O(g) + CO_2(g)$

Balance the equation and then calculate how many grams of water and carbon dioxide will result from complete burning of 10 liters of propane gas (consider molar volume at 25 °C and atmospheric pressure).

2) Nitrogen gas can be prepared by passing a gaseous ammonia over solid copper(II) oxide at high temperatures:

$2NH_3(g) + 3\,CuO(s) \rightarrow N_2(g) + 3\,Cu(s) + 3H_2O(g)$

Suppose you have 20 g of copper oxide and 15 g of gaseous ammonia. How many liters of nitrogen gas can you produce from these reagents? Consider that about 10 % of nitrogen gas will be lost in your apparatus. (AW of copper 63.55, consider molar volume at 25 °C and atmospheric pressure).

3) Baking soda, $NaHCO_3$, is often used as an antacid. It neutralizes hydrochloric acid in the stomach:

$NaHCO_3(s) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l) + CO_2(aq)$

Aqueous suspension of magnesium hydroxide, $Mg(OH)_2$, can also be used as an antacid:

$Mg(OH)_2 + 2HCl(aq) \rightarrow 2\,H_2O(l) + MgCl_2(aq)$

Which is more potent antacid per gram, $NaHCO_3$ or $Mg(OH)_2$?

4) The neutralization reaction between baking soda $NaHCO_3$ and HCl in the stomach produces CO_2 gas. In order to assess whether the gas production can cause a significant gastric discomfort to the patient, calculate the volume of carbon dioxide gas that can originate in the stomach following ingestion of 2 teaspoons (cca 10 grams) of sodium hydrogen carbonate. (Consider molar volume at the body temperature 37 °C).

5) Solid lithium hydroxide is used in space shuttles to remove exhaled carbon dioxide from the living environment:

$2LiOH(s) + CO_2(g) \rightarrow Li_2CO_3(g) + H_2O(l)$

Imagine that you are planning a space mission of two astronauts for 72 hours. One astronaut will produce 250 ml of CO_2 per minute at rest. How many kg of solid lithium hydroxide are needed for the mission?

(1.-3., 5. according to Steven S. Zumdahl: Chemistry, 4th edition, Houghton Mifflin Co., Boston, 1997)

[Correct answers: 1) 29.4 g H_2O and 53.9 g CO_2; 2) 1.845 liters N_2; 3) $Mg(OH)_2$ more potent, 1 g neutralizes 0.034 HCl while 1 g $NaHCO_3$ only 0.012 mol; 4) 3.03 liters CO_2, likely significant discomfort; 5) 4.23 kg LiOH needed for the mission]