

## Practice Calculations: Grade 11

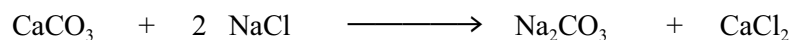
SCH4U\_06 - 07

1. Boron and hydrogen form a series of compounds called boranes, which have been used as rocket fuels. The percentage composition and molar mass of one of these boranes is given below :

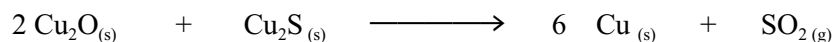
% by mass boron	81.2
% by mass hydrogen	18.8
molar mass (g/mol)	53.3

Calculate the empirical and molecular formula of the borane.

2. The molar mass of a compound with the empirical (simplest ) formula  $\text{CH}_2\text{O}$  was found to be 240 g/mol. What is the molecular formula of the compound ?
3. Sodium carbonate,  $\text{Na}_2\text{CO}_3$ , is used in the manufacture of glass and is made from calcium carbonate,  $\text{CaCO}_3$ , and sodium chloride,  $\text{NaCl}$ , according to the equation:

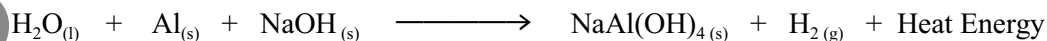


- a) What mass in kg of  $\text{NaCl}$  is required to completely react with 1.00 kg of  $\text{CaCO}_3$  ?
- b) What mass of  $\text{Na}_2\text{CO}_3$  could be produced from the reaction of 1.00 kg of  $\text{CaCO}_3$  ?
4. Iron (II) sulphide,  $\text{FeS}$ , reacts in air,  $\text{O}_2$ , to produce  $\text{Fe}_2\text{O}_3$ , and  $\text{SO}_2$
- a) Write a balanced equation for the reaction of  $\text{FeS}$  in air.
- b) How many grams of  $\text{Fe}_2\text{O}_3$  are produced when 20.9 g of  $\text{FeS}$  react with 14.1 g of  $\text{O}_2$  ?
5. One of the reactions involved in the smelting of copper sulphide ores involves copper (I) oxide and copper (I) sulphide, according to the following equation:



If 50.0 g of  $\text{Cu}_2\text{O}$  is heated with 25.8 g of  $\text{Cu}_2\text{S}$ , then:

- a) determine which reagent, if any, is in excess.
- b) calculate the theoretical yield of copper.
- c) determine the percent yield if 58.0 g of copper is actually obtained.
6. Some commercial drain cleaners contain sodium hydroxide and powdered aluminum. When the mixture is poured into a drain full of water and dirt, the exothermic reactions is as follows:



a) Show the balanced chemical reaction please.

b) The heat generated by the reaction helps to melt any grease, and the gas being generated stirs up the particles and helps to unclog the drain. If you use 5.6 g of  $\text{Al}$  and excess  $\text{NaOH}$ , how many litres of gaseous hydrogen measured at 99.8 kPa and 22 °C are produced?

## Solutions

1. no. moles:	B	:	H
	81.2 / 10.8	:	18.8 / 1.01
=	7.52	:	18.8
	1	:	2.5
	2	:	5

Empirical formula =  $B_2H_5$

Molar mass of empirical formula,  $B_2H_5 = 26.6 \text{ g mol}^{-1}$

Hence correct molecular formula =  $2(B_2H_5) = B_4H_{10}$

2. Molar mass of empirical formula,  $CH_2O = 30 \text{ g mol}^{-1}$   
 multiple whole number =  $240 / 30 = 8$   
 correct molecular formula =  $8(CH_2O) = C_8H_{16}O_8$



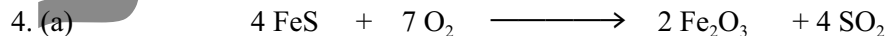
(a) no. moles  $1.00 \text{ g } CaCO_3 = 1000 \text{ g} / 100 \text{ g mol}^{-1} = 10$

mol	:	mol
$CaCO_3$	:	$NaCl$
1	:	2
10	:	x

$\therefore x = \text{no. moles } NaCl = 20$

mass of  $NaCl = \text{no. moles} \times M_R = 20 \times 58.5 = 1.17 \text{ kg}$

(b) Mass of  $Na_2CO_3$  produced from  $10.0 \text{ g } CaCO_3 = 1.06 \text{ kg}$



(b) no. moles:

$FeS$	:	$O_2$
$\frac{20.9 \text{ g}}$	:	$\frac{14.1 \text{ g}}$
$87.85 \text{ g mol}^{-1}$	:	$32 \text{ g mol}^{-1}$
= 0.238	:	0.441

$\therefore$  Limiting reactant =  $FeS$

mol	:	mol
$FeS$	:	$Fe_2O_3$
4	:	2
0.238	:	x

$\therefore x = \text{no. moles } Fe_2O_3 = 0.119$

Hence, mass of  $Fe_2O_3 = \text{no. moles} \times M_R = 0.119 \text{ mol} \times 159.8 \text{ g mol}^{-1} = 19.0 \text{ g}$



(b) no. moles:

$Cu_2O$	:	$Cu_2S$
$\frac{50.0 \text{ g}}$	:	$\frac{25.8 \text{ g}}$
$143 \text{ g mol}^{-1}$	:	$159 \text{ g mol}^{-1}$
= 0.349	:	0.162

$\therefore$  Limiting reactant =  $Cu_2S$

Excess reagent is  $Cu_2O$

mol	:	mol
$Cu_2S$	:	$Cu$
1	:	6
0.162	:	x

$\therefore x = \text{no. moles } Cu = 0.972$

Hence, mass of  $Cu = \text{no. moles} \times M_R = 0.972 \text{ mol} \times 63.55 \text{ g mol}^{-1} = 61.77 \text{ g}$

(c) % yield  $Cu = \frac{\text{actual}}{\text{theoretical}} \times 100 = \frac{58.0}{61.77} \times 100 \% = 93.9 \%$