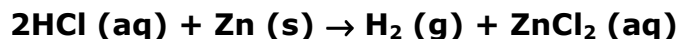


1. In the chemistry lab, you produce 10.0 grams of hydrogen gas from the following chemical reaction:



a) What is the molar mass of HCl and H₂?

Ans. HCl:

Element	Atomic Mass	# of Atoms	Net Molar Mass
H	1.008	1	1.008
Cl	35.45	1	35.45
Molar Mass →			36.46

H₂:

Element	Atomic Mass	# of Atoms	Net Molar Mass
H	1.008	2	2.016
Molar Mass →			2.016

b) How many moles of H₂ are in 10.0 g?

$$\text{Ans. } \# \text{ mol of H}_2 = \left(\frac{10.0 \text{ g H}_2}{1} \right) \left(\frac{1 \text{ mol H}_2}{2.016 \text{ g H}_2} \right) = 4.96 \text{ mol H}_2$$

c) How many moles of Zn are needed to produce 10.0 g of H₂?

$$\text{Ans. } \# \text{ mol of H}_2 = \left(\frac{4.96 \text{ mol H}_2}{1} \right) \left(\frac{1 \text{ mol Zn}}{1 \text{ mol H}_2} \right) = 4.96 \text{ mol Zn}$$

d) How many grams of Zn are needed to produce the 10.0 g of H₂?

$$\text{Ans. } \# \text{ mol of Zn} = \left(\frac{4.96 \text{ mol Zn}}{1} \right) \left(\frac{65.41 \text{ g Zn}}{1 \text{ mol Zn}} \right) = 324. \text{ g Zn}$$

e) How many moles of ZnCl₂ are produced?

$$\text{Ans. } \# \text{ mol of ZnCl}_2 = \left(\frac{4.96 \text{ mol H}_2}{1} \right) \left(\frac{1 \text{ mol ZnCl}_2}{1 \text{ mol H}_2} \right) = 4.96 \text{ mol ZnCl}_2$$

f) How many grams of ZnCl₂ are produced?

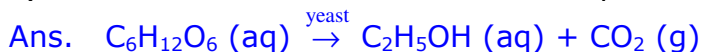
Ans. ZnCl₂:

Element	Atomic Mass	# of Atoms	Net Molar Mass
Zn	65.41	1	65.41
Cl	35.45	2	70.90
Molar Mass →			136.31

$$\text{mass of Zn} = \left(\frac{4.96 \text{ mol ZnCl}_2}{1} \right) \left(\frac{136.31 \text{ g ZnCl}_2}{1 \text{ mol ZnCl}_2} \right) = 676. \text{ g ZnCl}_2$$

2. A container with 100.0 mL of water has 25.0 grams of glucose ($C_6H_{12}O_6$) dissolved in it. When yeast is added to the solution, ethyl alcohol (or ethanol, C_2H_5OH) and carbon dioxide are produced, according to the following chemical reaction:

a) Write out the unbalanced chemical equation for this reaction.



b) Balance this chemical reaction.



c) What is the molar mass for glucose, ethanol and carbon dioxide respectively?

Ans. $C_6H_{12}O_6$:

Element	Atomic Mass	# of Atoms	Net Molar Mass
C	12.01	6	72.06
H	1.008	12	12.096
O	16.00	6	96.00
Molar Mass →			180.16

C_2H_5OH :

Element	Atomic Mass	# of Atoms	Net Molar Mass
C	12.01	2	24.02
H	1.008	6	6.048
O	16.00	1	16.00
Molar Mass →			46.07

CO_2 :

Element	Atomic Mass	# of Atoms	Net Molar Mass
C	12.01	1	12.01
O	16.00	2	32.00
Molar Mass →			44.01

d) How many moles of glucose are in the water before the yeast is added?

Ans. $\# \text{ mol of } C_6H_{12}O_6 = \left(\frac{25.0 \text{ g } C_6H_{12}O_6}{1} \right) \left(\frac{1 \text{ mol } C_6H_{12}O_6}{180.16 \text{ g } C_6H_{12}O_6} \right) = 0.139 \text{ mol } C_6H_{12}O_6$

e) How many moles of ethanol are produced when this reaction runs to completion?

Ans. $\# \text{ mol of } C_2H_5OH = \left(\frac{0.138 \text{ mol } C_6H_{12}O_6}{1} \right) \left(\frac{2 C_2H_5OH}{1 C_6H_{12}O_6} \right) = 0.278 \text{ mol } C_2H_5OH$

f) How many grams of ethanol are produced in the completed reaction?

$$\text{Ans. \# grams of C}_2\text{H}_5\text{OH} = \left(\frac{0.278 \text{ mol C}_2\text{H}_5\text{OH}}{1} \right) \left(\frac{46.07 \text{ g C}_2\text{H}_5\text{OH}}{1 \text{ mol C}_2\text{H}_5\text{OH}} \right) = 12.8 \text{ g C}_2\text{H}_5\text{OH}$$

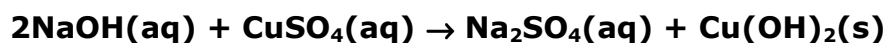
g) How many grams of carbon dioxide are produced in the completed reaction?

$$\text{Ans. \# grams of CO}_2 = 25.0 \text{ g} - 12.8 \text{ g} = 12.2 \text{ g CO}_2$$

Or, alternative solution:

$$\text{\# grams of CO}_2 = \left(\frac{0.278 \text{ mol CO}_2}{1} \right) \left(\frac{44.01 \text{ g CO}_2}{1 \text{ mol CO}_2} \right) = 12.2 \text{ g CO}_2$$

3. In a CH100 lab (not yours), copper(II) hydroxide precipitate is produced from 10.0 grams of copper(II) sulfate:



a) Calculate the molar mass of each reactant and product in this reaction.

Ans. NaOH:

Element	Atomic Mass	# of Atoms	Net Molar Mass
Na	22.99	1	22.99
O	16.00	1	16.00
H	1.008	1	1.008
Molar Mass →			40.00

CuSO₄:

Element	Atomic Mass	# of Atoms	Net Molar Mass
Cu	63.55	1	63.55
S	32.07	1	32.07
O	16.00	4	64.00
Molar Mass →			159.62

Na₂SO₄:

Element	Atomic Mass	# of Atoms	Net Molar Mass
Na	22.99	2	45.98
S	32.07	1	32.07
O	16.00	4	64.00
Molar Mass →			142.05

$\text{Cu}(\text{OH})_2$:

Element	Atomic Mass	# of Atoms	Net Molar Mass
Cu	63.55	1	63.55
O	16.00	2	32.00
H	1.008	2	2.016
Molar Mass →			97.57

b) How many moles of copper(II) sulfate are consumed during this chemical reaction?

$$\text{Ans. } \# \text{ mol of CuSO}_4 = \left(\frac{10.0 \text{ g}}{1} \right) \left(\frac{1 \text{ mol CuSO}_4}{159.62 \text{ g CuSO}_4} \right) = 0.0626 \text{ mol CuSO}_4$$

c) How many "molecules" of copper(II) sulfate (numerical quantity not moles) are consumed in this reaction?

Ans.

$$\# \text{ of CuSO}_4 = \left(\frac{0.0626 \text{ mol CuSO}_4}{1} \right) \left(\frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \right) = 3.77 \times 10^{22} \text{ molecules CuSO}_4$$

d) Using the coefficients of this reaction, determine how many moles of sodium hydroxide are reacted in this chemical process?

$$\text{Ans. } \# \text{ mol of NaOH} = \left(\frac{0.0626 \text{ mol CuSO}_4}{1} \right) \left(\frac{2 \text{ mol NaOH}}{1 \text{ mol CuSO}_4} \right) = 0.125 \text{ mol NaOH}$$

e) How many moles of copper(II) hydroxide and sodium sulfate are produced by this reaction?

$$\text{Ans. } \# \text{ mol of Cu}(\text{OH})_2 = \left(\frac{0.0626 \text{ mol CuSO}_4}{1} \right) \left(\frac{1 \text{ mol Cu}(\text{OH})_2}{1 \text{ mol CuSO}_4} \right) = 0.0626 \text{ mol Cu}(\text{OH})_2$$

$$\# \text{ mol of Na}_2\text{SO}_4 = \left(\frac{0.0626 \text{ mol CuSO}_4}{1} \right) \left(\frac{1 \text{ mol Na}_2\text{SO}_4}{1 \text{ mol CuSO}_4} \right) = 0.0626 \text{ mol Na}_2\text{SO}_4$$

f) How many molecules (numerical quantity not moles) of copper(II) hydroxide and sodium sulfate are produced by this reaction?

Ans.

$$\# \text{ of Cu}(\text{OH})_2 = \left(\frac{0.0626 \text{ mol Cu}(\text{OH})_2}{1} \right) \left(\frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \right) = 3.77 \times 10^{22} \text{ molecules Cu}(\text{OH})_2$$

$$\# \text{ of Na}_2\text{SO}_4 = \left(\frac{0.0626 \text{ mol Na}_2\text{SO}_4}{1} \right) \left(\frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \right) = 3.77 \times 10^{22} \text{ molecules Na}_2\text{SO}_4$$

g) How many grams of copper(II) hydroxide and sodium sulfate are produced by this reaction?

$$\text{Ans. } \text{mass of Cu}(\text{OH})_2 = \left(\frac{0.0626 \text{ mol Cu}(\text{OH})_2}{1} \right) \left(\frac{97.57 \text{ g}}{1 \text{ mol}} \right) = 6.11 \text{ g Cu}(\text{OH})_2$$

$$\text{mass of Na}_2\text{SO}_4 = \left(\frac{0.0626 \text{ mol Na}_2\text{SO}_4}{1} \right) \left(\frac{142.05 \text{ g}}{1 \text{ mol}} \right) = 8.89 \text{ g Na}_2\text{SO}_4$$

h) What is the % mass of each element in copper(II) hydroxide?

Ans. Start with the molar mass table constructed above then add 2 columns to calculate the mass ratio and % mass for each element:

Element	Atomic Mass	# of Atoms	Net Molar Mass	Mass Ratio	% Mass
Cu	63.55	1	63.55	0.6513	65.13%
O	16.00	2	32.00	0.3280	32.80%
H	1.008	2	2.016	0.02066	2.066%
Molar Mass →			97.57	1.0000	100.00%