GENSET EDUCATION ACADEMY

CHEMISTRY 1000

ASSIGNMENT SHEET 1 SOLUTIONS

COMPILED BY TUTOR POUL

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THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF CHEMISTRY
ACADEMIC YEAR 2022
TERM 1
CHE 1000: INTRODUCTORY CHEMISTRY

ASSIGNMENT SHEET 1 **14th April 2023**

Answer all the problems in a HARD COVER book and submit in ROOM 124 before 10:00 hrs on Monday, 19th April 2023

1. The major air pollutant of coal-burning power plants is a colorless, pungent gaseous compound containing only sulfur and oxygen. Chemical analysis of a 1.078 g sample of this gas showed that it contained 0.540 g of S and 0.538 g of O. What is the empirical formula of this compound?
2. A piece of iron ore is found to contain a compound containing 72.3% iron and 27.7% oxygen with a molecular mass of 231.4 g/mol. What is the molecular formula of the compound?
3. An ace chemistry student heats a piece of iron (Fe) metal in a crucible. The reaction is:

$$Fe(s) + O_2(g) \rightarrow Fe_xO_y(s)\ .$$

Complete the data below. Determine the empirical formula of iron oxide.

Mass of crucible	27.50 g
Mass of crucible + Fe	28.62 g
Mass of Fe	
Mass of crucible +iron oxide	29.10 g
Mass of iron oxide	
Moles of Fe	
Mass of oxygen	
Moles of oxygen	

4. Silver nitrate solution is added to 25.00 mL of a 0.500 M potassium chloride solution until no more precipitate forms. What mass of silver chloride will be formed?
5. Calculate the number of moles of $CuSO_4$ contained in 100mL of 1 M $CuSO_4$ solution. Calculate the number of SO_4^{-2} ions in $CuSO_4$.
6. What volume of a 0.01 M sodium carbonate solution is required to neutralise 25 cm^3 of a solution containing 0.98 g l^{-1} of sulfuric acid? The equation for the reaction is

$$H_2SO_{4(aq)} + Na_2CO_{3(aq)} \rightarrow Na_2SO_{4(aq)} + H_2O_{(l)} + CO_{2(g)}$$

7. What would be the limiting reagent if 75 grams of $C_2H_3Br_3$ reacted with 50.0 grams of O_2 in the following reaction:

$$4C_2H_3Br_3 + 11O_2 \rightarrow 8CO_2 + 6H_2O + 6Br_2.$$

8. Suppose 316.0 g aluminium sulphide reacts with 493.0 g of water. What mass of the excess reactant remains?

$$Al_2S_3 + H_2O \rightarrow Al(OH)_3 + H_2S$$

9. How many grams of IF_5 would be produced using 44.01 grams of I_2O_5 and 101.0 grams of BrF_3?

$$6I_2O_5 + 20BrF_3 \rightarrow 12IF_5 + 15O_2 + 10Br_2$$

10. Hydrogen cyanide is produced industrially from the reaction of gaseous ammonia, oxygen and methane:

$$2NH_3(g) + 3O_2(g) + 2CH_4(g) \rightarrow 2HCN(g) + 6H_2O(g)$$

If 5.00 x 10^3 kg each NH_3, O_2 and CH_4 are reacted, what mass of HCN and of H_2O will be produced, assuming 100% yield?

11. A sample of 1.00L of C_2H_2 at a temperature of 373.15 K and pressure of 1.00 atmospheres reacted completely with oxygen according to the reaction:

$$2C_2H_2(g) + 5O_2(g) \rightarrow 4CO_2(g) + 2H_2O(g)$$

(a) Use the ideal gas equation to calculate the initial moles of C_2H_2
(b) Determine the moles of CO_2 and $H_2O(g)$ produced
(c) Given that the total volume of the gas mixture at the end of the reaction was 3.00 L at a total pressure 1.00 atmospheres. Calculate the partial pressure of Carbon dioxide and water.

12.

(a) The cylinder of a bicycle pump has a volume of 1131 cm^3 and is filled with air at a pressure of 1.02 atm. The outlet valve is sealed shut, and the pump handle is pushed down until the volume of the air is 517 cm^3. The temperature of the air trapped inside does not change. Compute the pressure inside the pump.
(b) At some point during its ascent, a sealed weather balloon initially filled with helium at a fixed volume of 1.0 x 10^4 L at 1.00 atm and 30°C reaches an altitude at which the temperature is -10°C yet the volume is unchanged. Calculate the pressure at that altitude.
(c) What mass of Helium gas is needed to fill a weather balloon to a volume of 10,000 L, 1.00 atm and 30°C?

13.

(a) Calculate the density of gaseous hydrogen at a pressure of 1.32 atm and a temperature of -66 °F.
(b) A hydrocarbon is burned in air in a closed container, producing a mixture of gases having a total pressure of 3.34 atm. Analysis of the mixture shows it to contain 0.340 g of water vapor, 0.792 g of carbon dioxide, 0.288 g of oxygen, 3.790 g of

nitrogen, and no other gases. Calculate the mole fraction and partial pressures of carbon nitrogen and water vapor in this mixture.

14.

(a) At a certain speed, the root-mean-square-speed of the molecules of hydrogen in a sample of gas is 1055 ms^{-1}. Compute the root-mean square speed of molecules of oxygen at the same temperature.

(b) A gas mixture contains equal numbers of molecules of N_2 and SF_6. A small portion of it is passed through a gaseous diffusion apparatus. Calculate how many molecules of N_2 are present in the product of gas for every 100 molecules of SF_6.

CHE1000 ASSIGNMENT SHEET 1 SOLUTIONS

QUESTIONS 1

	Sulphur		Oxygen
Elements =>	S		O
Mass =>	0.540	:	0.538
moles =>	$\frac{0.540}{32}$	:	$\frac{0.538}{16}$
	0.016875	:	0.033625
Ratio =>	$\frac{0.016875}{0.016875}$	:	$\frac{0.033625}{0.016875}$
	1	:	1.99259259

Note
$M_r(S) = 32$
$M_r(O) = 16$

1 : 2

∴ Emprical formular is SO_2

(1).

QUESTION 2

* first find the Emprical formula

Element	=>	Iron Fe		Oxygen O
Mass %	=>	72.3	:	27.7
moles	=>	$\frac{72.3}{56}$	:	$\frac{27.7}{16}$
		1.29107143	:	1.73125
Ratio	=>	$\frac{1.29107143}{1.29107143}$	:	$\frac{1.73125}{1.29107143}$
		1	:	1.34094052
		3 (1	:	1.3)
		3	:	3.9
		3	:	4

$A_r(Fe) = 56$
$M_r(O_2) = 16$

(2)

=> Emprical formula is Fe_3O_4

* Let's find the molecular formula Now.

$$\text{Factor} = \frac{\text{molar mass}}{\text{Emprical mass}}$$

* Emprical mass (Fe_3O_4)

$(56 \times 3) + (4 \times 16)$

=> 232

Molar Mass = 231.4 g/mol

$$\text{Factor} = \frac{231.4}{232} = 0.99741 \approx 1$$

$\therefore$ Molecular formular = (Empirical formular)$_{factor}$

$= (Fe_3O_4)_1$

$= Fe_3O_4$

QUESTION 3

(B)

$\Rightarrow$ Mass of Fe = (Mass of Crucible + Fe) — (mass of Crucible)

$= 28.62 - 27.50$

$= 1.12g$

$\Rightarrow$ Mass of Iron oxide = (Mass of Crucible + Iron oxide) — (mass of Crucible)

$= 29.10 - 27.50$

$= 1.60g$

$\Rightarrow$ Moles of Fe $= \frac{mass}{m.mass}$

$= \frac{1.12}{56} = 0.02$ moles

$\Rightarrow$ Mass of oxygen : $Fe_{(s)} + O_{2(g)} \longrightarrow Fe_xO_{y(s)}$

$1.12 \quad m \quad 1.60$

$\therefore$ Mass of oxygen = Mass of Iron oxide — Mass of Iron

$= 160 - 1.12$

$= 0.48g$

$\Rightarrow$ moles of oxygen $= \frac{\text{mass}}{\text{m. mass}}$

$= \frac{0.48}{16}$

$= 0.03$ moles

Mass of Crucible	27.50 g
Mass of Crucible + Fe	28.62 g
Mass of Fe	1.12 g
Mass of Crucible + Iron oxide	29.10 g
Mass of Iron oxide	1.60 g
Moles of Fe	0.02 moles
Mass of oxygen	0.48 g
Moles of oxygen	0.03 moles

(4)

* Finding Empirical formula of Iron oxide...

Elements $\Rightarrow$	Fe		O
Moles $\Rightarrow$	0.02	:	0.03
Ratio $\Rightarrow$	$\frac{0.02}{0.02}$	:	$\frac{0.03}{0.02}$
	1	:	1.5
	2 (1	:	1.5)
	2	:	3

$\therefore$ Empirical formula $\Rightarrow$ Fe_2O_3

QUESTION 4

* Let's write the balanced chemical equation.

$$KCl_{(aq)} + AgNO_{3(aq)} \longrightarrow AgCl_{(s)} + KNO_{3(aq)}$$

Silver Chloride

* Silver Nitrate is in excess.
* Potassium Chloride is the limiting reagent

moles of KCl => Concentration × Volume

= 0.500 × (25/1000) ← convert to litres

= 0.0125 moles

* Get mole ratio from the equation and find moles for AgCl formed.

moles ratios KCl : AgCl

1 : 1

(5) moles AgCl = 0.0125 × $\frac{1 \text{ mol AgCl}}{1 \text{ mol KCl}}$

= 0.0125 mols

* To find the mass, use the moles and the molar mass from the periodic table.

Moles (AgCl) = 0.0125 mols Mr (AgCl) = 143.4g

$$\text{moles} = \frac{\text{mass}}{\text{m. mass}}$$

mass = moles × m. mass

= 0.0125 × 148.4

= 1.7925

= 1.79g

QUESTION 5

$$\text{Conc} = \frac{\text{moles}}{\text{volume}}$$

moles $(CuSO_4)$ = ? Conc $(CuSO_4)$ = 1M Vol $(CuSO_4)$ = 100 mL

$$\text{moles} = \text{Conc} \times \text{volume}$$
$$= 1 \times \left(\frac{100}{1000}\right)$$
$$= 0.1 \text{ moles}$$

* Write the dissociation reaction for $CuSO_4$

(a) $$CuSO_{4(aq)} \longrightarrow Cu^{2+} + SO_4^{2-}$$

Mole ratio of $CuSO_4$ to SO_4^{2-} is 1 : 1

$$\therefore \text{moles}(CuSO_4) = \text{moles}(SO_4^{2-})$$

$$\text{moles}(SO_4^{2-}) = 0.1 \text{ moles}$$

* Let's find the number of ions now.

$$1 \text{ mole} = 6.023 \times 10^{23} \text{ ions}$$
$$0.1 \quad = \quad x$$

$$x = 0.1 \times 6.023 \times 10^{23} \text{ ions}$$
$$= 6.023 \times 10^{22} \text{ ions of } SO_4^{2-}$$

QUESTION 6

* Balance the equation bro

$$H_2SO_4 + Na_2CO_3 \longrightarrow Na_2SO_4 + H_2O + CO_2$$

moles = Conc × volume

$Mr\ (H_2SO_4) = 98.079$

* Find moles of H_2SO_4

$$\text{moles } (H_2SO_4) = \text{Conc} \times \text{volume}$$
$$= \left(\frac{0.98}{98.079}\right) \times \left(\frac{25}{1000}\right)$$
$$= 0.00999 \times 0.025$$
$$= 0.000249975$$
$$= 0.00025 \text{ moles}$$

(7)

* Get mole ratio from the equation.

mole ratio : H_2SO_4 : Na_2CO_3

1 : 1

$\therefore$ moles (H_2SO_4) = moles (Na_2CO_3) = 0.00025 moles

moles (Na_2CO_3) = 0.00025 moles Conc (Na_2CO_3) = 0.01 M

$$\text{Volume } (Na_2CO_3) = \frac{\text{moles}}{\text{Conc}}$$
$$= \frac{0.00025}{0.01}$$
$$= 0.024975 \text{ L}$$
$$= 0.024975 \times 1000$$
$$= 24.975$$
$$= 25 \text{ cm}^3$$

QUESTION 7

* Write balance equation.

$$4\,C_2H_3Br_3 + 11O_2 \longrightarrow 8CO_2 + 6H_2O + 6Br_2$$

* find moles of $C_2H_3Br_3$

mass $(C_2H_3Br_3) = 75g$

$Mr(C_2H_3Br_3) = 267 g/mol$

$$n = \frac{mass}{Mr}$$

$$= \frac{75}{267}$$

$$= 0.28089888 \text{ mols}$$

* find moles of O_2

mass $(O_2) = 50g$

$Mr(O_2) = 16 \times 2 = 32 g/mol$

$$n = \frac{mass}{Mr}$$

$$= 50/32$$

$$= 1.5625 \text{ mols}$$

* Get mole ratio from the equation.

mole ratio of $C_2H_3Br_3$: O_2

4 : 11

(8)

$$0.28089888 \text{ mol } C_2H_3Br_3 \times \frac{11 \text{ mol } O_2}{4 \text{ mol } C_2H_3Br_3}$$

0.77247191 mols of Oxygen

∴ 0.28089888 mol $C_2H_3Br_3$ need 0.77247191 mol of O_2.

⇒ But in the question we have more than 0.77247191 moles of oxygen (1.5625 mols). Oxygen is in Excess.

∴ $C_2H_3Br_3$ is the limiting reagent.

QUESTION 9

* write balanced equation.

$$Al_2S_3 + 6H_2O \longrightarrow 2Al(OH)_3 + 3H_2S$$

* moles Al_2S_3

mass (Al_2S_3) = 316 g

Mr(Al_2S_3) = 150 g/mol

$$n = \frac{mass}{Mr} = \frac{316}{150} = 2.1066667 \text{ mol}$$

(9)

* moles of H_2O

mass (H_2O) = 493 g

Mr(H_2O) = 18 g/mol

$$n = \frac{mass}{Mr} = \frac{493}{18} = 27.388889 \text{ mol}$$

* Get mole ration from the equation

mole ratio of Al_2S_3 : H_2O

1 : 6

$$2.1066667 \text{ mol } Al_2S_3 \times \frac{6 \text{ mol } H_2O}{1 \text{ mol } Al_2S_3}$$

12.64 mol of Water

∴ 2.1066667 mol Al_2S_3 need 12.64 mol of H_2O.

⇒ But in the question we have more than 12.64 moles of water (27.389 mol). Water is in Excess.

Excess Water = water available − Water reacted

= 27.388889 − 12.64

= 14.7 g

QUESTION 9

* Write the balance chemical equation.

$$6I_2O_5 + 20BrF_3 \longrightarrow 12IF_5 + 15O_2 + 10Br_2$$

FIND THE LIMITING REAGENT

* finding moles of I_2O_5

Mass (I_2O_5) = 44.01 g

Mr (I_2O_5) = 334 g/mol

n = mass / Mr

= 44.01 / 334

= 0.13176647 mol

* finding moles of BrF_3

mass (BrF_3) = 101.0 g

Mr (BrF_3) = 137 g/mol

n = mass / Mr

= 101 / 137

= 0.73722628 mol

(10).

* Get mole ratio from the equation.

mole ratio of I_2O_5 : BrF_3

6 : 20

0.13176647 mol ~~I_2O_5~~ × $\frac{20 \text{ mol } BrF_3}{6 \text{ mol } I_2O_5}$

0.43922156 mol of BrF_3

∴ 0.13176647 mol of I_2O_5 needs 0.43922156 mol of BrF_3

=> But in the question, we have more than 0.43922156 moles of BrF_3 (0.73722628 mol). BrF_3 is in Excess.

∴ I_2O_5 is the limiting reagent

=> we can use its relation to find How many grams of IF_5 are produced.

* Get mole ratio from the equation

mole ratio of I_2O_5 : IF_5

6 : 12

$0.13176647 \text{ mol } I_2O_5 \times \frac{12 \text{ mol } IF_5}{6 \text{ mol } I_2O_5}$

$0.26353293 \text{ mol of } IF_5$

moles (IF_5) = 0.26353293 $\quad$ Mr(IF_5) = 222 g/mol

(11)

Mass = moles × Molar Mass

= n × Mr

= 0.26353293 × 222

= 58.5043114

Mass(IF_5) = 58.5 g

QUESTION 10

* Write the balanced chemical equation.

$$2NH_3 + 3O_2 + 2CH_4 \longrightarrow 2HCN + 6H_2O$$

⇒ FIND THE LIMITING REAGENT.

moles of NH_3

$m = 5.00 \times 10^3 \times 10^3 g$ ← convert to grams

$Mr = 17 g/mol$

$n = mass/Mr$

$= \frac{5 \times 10^6}{17}$

$= 0.29411765 \times 10^6$

$= 294,117.65 moles$

moles of O_2

$m = 5.00 \times 10^3 \times 10^3 g$

$Mr = 32 g/mol$

$n = mass/Mr$

$= \frac{5 \times 10^6}{32}$

$= 0.15625 \times 10^6$

$= 156250 moles$

moles CH_4

$m = 5.00 \times 10^3 \times 10^3 g$

$Mr = 16 g/mol$

$n = mass/Mr$

$= \frac{5 \times 10^6}{16}$

$= 0.3125 \times 10^6$

$= 312500 moles$

(12)

* FIND their stoichiometric moles by dividing the number of moles by their coeffient in the balanced Chemical equation.

$n(NH_3) = \frac{294117.65}{2} = 147,058.8 moles$

$n(O_2) = \frac{156250}{3} = 52,083.3 moles$

$n(CH_4) = \frac{312500}{2} = 156,250 moles$

⇒ Oxygen has the lowest number of moles, and so it's the limiting reagent.

* We can use its relation to find what mass of HCN and H_2O is produced.

* Get mole ratio from the equation.

mole ratio of O_2 : HCN

3 : 2

$$156\,250 \text{ mol of } O_2 \times \frac{2 \text{ mol HCN}}{3 \text{ mol of } O_2}$$

104, 166.7 mol of HCN

moles (HCN) = 104 166.7 mol M_r = 27 g/mol

mass = Moles × Molar Mass

(13)

= 104 166.7 × 27

= 2,812,500 g of HCN

* Get mole ratio from the equation.

mole ratio of O_2 : H_2O

3 : 6

$$156\ 250\ \text{mol}\ O_2 \times \frac{6\ \text{mol}\ H_2O}{3\ \text{mol}\ O_2}$$

(14) 312,500 ml of H_2O

moles (H_2O) = 312,500 ml Mr = 18 g/mol

Mass = Moles × Molar Mass

= 312500 × 18

= 5,625,000 g of H_2O

* Get mole ratio from the equation.

mole ratio of O_2 : H_2O

3 : 6

$$156\ 250\ \text{ml}\ O_2 \times \frac{6\ \text{ml}\ H_2O}{3\ \text{ml}\ O_2}$$

(14)

312,500 ml of H_2O

moles (H_2O) = 312,500 ml Mr = 18 g/mol

Mass = Moles × Molar Mass

= 312500 × 18

= 5,625,000 g of H_2O

QUESTION 14

(15). QUESTION 11, 12, 13, 14.

⇒ Ah my ink has finished. Buy me pens. But anyway gas laws are simple. You guys can solve on your own.

⇒ Ah so Iweh ufuna che mpaka Udye Zali Mu Chemistry Assignment? ah iweh.

⇒ Nalema Ine. Nagona. Good Night guys.

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