Exam: CHEMICAL CALCULUS 1. Batxilergoa	
Name:	**Group:**

1	**Part of the SO_2 that is introduced into the atmosphere by combustion of sulfur-containing compounds ends up being converted to sulfuric acid. The net reaction is:** $SO_2\ (g) + O_2\ (g) + H_2O\ (l) \rightarrow H_2SO_4\ (aq)$ **(unbalanced)** **How much H_2SO_4 (in grams and moles) can be formed from 5 mol of SO_2, 64 g of O_2, and an unlimited quantity of water?**
Atomic weights: S=32; H=1; O=16	

① The balanced chemical equation:

$$2\ SO_2\ (g) + O_2\ (g) + 2\ H_2O\ (\ell) \rightarrow 2\ H_2SO_4\ (aq)$$

$2\ SO_2$	O_2	$2\ H_2O$	$2\ H_2SO_4$
2 mol	1 mol	2 mol	2 mol
128 g	32 g	36 g	196 g

$M\ (SO_2) = 32 + (2 \times 16) = 64\ g/mol$

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

$M\ (H_2O) = (2 \times 1) + 16 = 18\ g/mol$

$M\ (H_2SO_4) = (2 \times 1) + 32 + (4 \times 16) = 98\ g/mol$

Determination of the limiting reactant:

$x\ (SO_2) = \dfrac{5\ mol\ SO_2}{2\ mol\ SO_2} = 2.5$ times the value of the table

$x\ (O_2) = \dfrac{64\ g\ O_2}{32\ g\ O_2} = 2$ times the value of the table

$x\ (H_2O) = \dfrac{\text{unlimited}}{36\ g} \rightarrow \infty$

↳ **the limiting reactant is O_2**

Amount of H_2SO_4 formed:

↳ $m\ (H_2SO_4) = 64\ g\ O_2\ \dfrac{196\ g\ H_2SO_4}{32\ g\ O_2} =$ **$392\ g\ H_2SO_4$**

↳ $n\ (H_2SO_4) = 64\ g\ O_2\ \dfrac{2\ mol\ H_2SO_4}{32\ g\ O_2} =$ **$4\ mol\ H_2SO_4$**

2	**Solid lithium hydroxide (LiOH) is used in space vehicles to remove exhaled carbon dioxide. The lithium hydroxide reacts with gaseous carbon dioxide to form solid lithium carbonate and liquid water.** **How much carbon dioxide** • **in moles,** • **grams and** • **volume at P=800 mmHg and T=20 °C** **can be absorbed by 100 grams of lithium hydroxide?**

Atomic weights: Li=6.94; O=16; H=1; C=12.01

$R = 0.082 \dfrac{\text{atm.L}}{\text{K.mol}}$

② The balanced chemical equation:

$$2\ LiOH + CO_2 \rightarrow Li_2CO_3 + H_2O$$

2 LiOH	CO_2	Li_2CO_3	H_2O
2 mol	1 mol	1 mol	1 mol
47.88 g	44.01 g	73.89 g	18 g
91.89 g (total)		91.89 g (total)	

$M(LiOH) = 6.94 + 16 + 1 = 23.94\ g/mol$

$M(CO_2) = 12.01 + (2 \times 16) = 44.01\ g/mol$

$M(Li_2CO_3) = (2 \times 6.94) + 12.01 + (3 \times 16) = 73.89\ g/mol$

$M(H_2O) = (2 \times 1) + 16 = 18\ g/mol$

Amount of carbon dioxide formed:

$$n(CO_2) = 100g\ LiOH \frac{1\ mol\ CO_2}{47.88\ g\ LiOH} = \boxed{2.09\ mol\ CO_2}$$

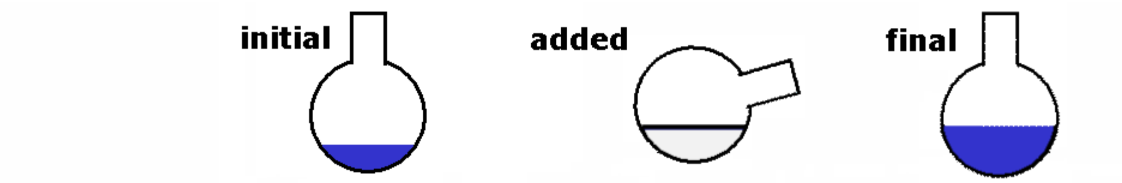
$$m(CO_2) = 100g\ LiOH \frac{44.01\ g\ CO_2}{47.88\ g\ LiOH} = \boxed{91.92\ g\ CO_2}$$

$$V = \frac{nRT}{P} = \frac{2.09\ mol\ CO_2 \times 0.082 \frac{atm.L}{K.mol} \times (20+273)\ K}{800\ mmHg \frac{1\ atm}{760\ mm\ Hg}}$$

$$\boxed{V = 47.7\ L\ CO_2}$$

3	**Calculate the concentration in g/L of the resulting solution when we add 320 mL of a NaOH solution 1.4 M to 400 mL of a NaOH solution 64 g/L.**

Atomic weights: Na=23; O=16; H=1



		initial		added		final
solute	m =		g	+		m_3
	n =		mol		=	
solution	V =	0.4	L	0.32		V_3
		m, n = c * V				
	c =	64	g/L			(circled)
	c =		M	1.4		
	c =		%			

Strategy:

1. calculate the mass of solute of the initial solution (m_1)
2. calculate the mass of solute of the added solution (m_2)
3. calculate the final mass of the solute (m_3)
4. calculate the final volume of the solution (V_3)
5. calculate the concentration of the final solution (in g/L)

③

$$M(NaOH) = 23 + 16 + 1 = 40 \text{ g/mol}$$

$$m_1 = 0.32 \text{ L} \cdot \frac{1.4 \text{ mol NaOH}}{1 \text{ L}} \cdot \frac{40 \text{ g}}{1 \text{ mol}} = 17.92 \text{ g NaOH}$$

$$m_2 = 0.4 \text{ L} \cdot \frac{64 \text{ g NaOH}}{1 \text{ L}} = 25.6 \text{ g NaOH}$$

$$m_3 = m_1 + m_2 = 17.92 \text{ g} + 25.6 \text{ g} = 43.52 \text{ g NaOH}$$

$$V_3 = V_1 + V_2 = 0.32 \text{ L} + 0.4 \text{ L} = 0.72 \text{ L}$$

$$c_3 = \frac{43.52 \text{ g NaOH}}{0.72 \text{ L}} = 60.44 \frac{\text{g NaOH}}{\text{L solution}}$$

4	**When octane, C_8H_{18}, a component of gasoline, burns** **a) How many moles of O_2 are needed to burn 1.5 mol of octane?** **b) How many grams of O_2 are needed to burn 1.5 mol of octane?**
Atomic weights: O=16; H=1; C=12	

(4) The balanced chemical equation:

$$2\,C_8H_{18} + 25\,O_2 \rightarrow 16\,CO_2 + 18\,H_2O$$

$2\,C_8H_{18}$	$25\,O_2$	$16\,CO_2$	$18\,H_2O$
2 mol	25 mol	16 mol	18 mol
228 g	800 g	704 g	324 g
1028 g		1028 g	

$M\,(C_8H_{18}) = (12 \times 8) + (18 \times 1) = 114\ g/mol$

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

$M\,(CO_2) = 12 + (2 \times 16) = 44\ g/mol$

$M\,(H_2O) = (2 \times 1) + 16 = 18\ g/mol$

$$\hookrightarrow n\,(O_2) = 1.5\ mol\ C_8H_{18}\ \frac{25\ mol\ O_2}{2\ mol\ C_8H_{18}} = \boxed{18.75\ mol\ O_2}$$

$$\hookrightarrow m\,(O_2) = 1.5\ mol\ C_8H_{18}\ \frac{800\ g\ O_2}{2\ mol\ C_8H_{18}} = \boxed{600\ g\ O_2}$$