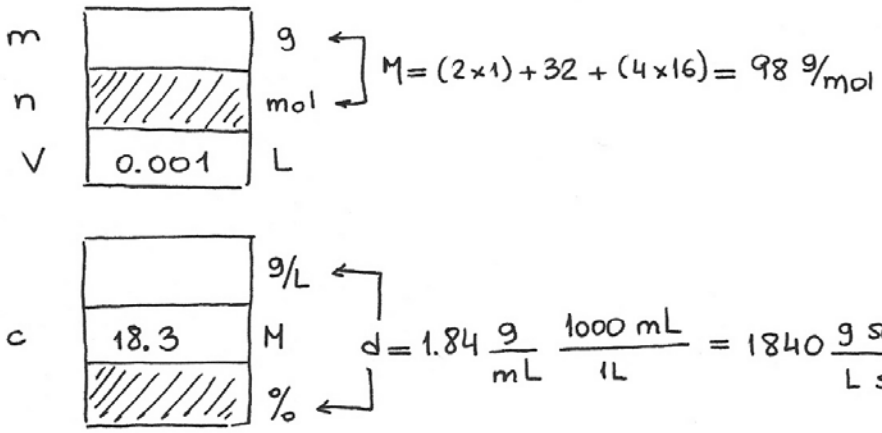
Exam: CHEMICAL CALCULUS 1. Batxilergoa	
Name:	**Group:**

1	**Concentrated sulfuric acid (18.3 M) has a density of 1.84 g/mL** • **how many moles of sulfuric acid are present per milliliter of solution?** • **how many molecules of sulfuric acid are per milliliter?** • **what is the mass % of sulfuric in the solution?**
Atomic weights: S=32; O=16; H=1	

①

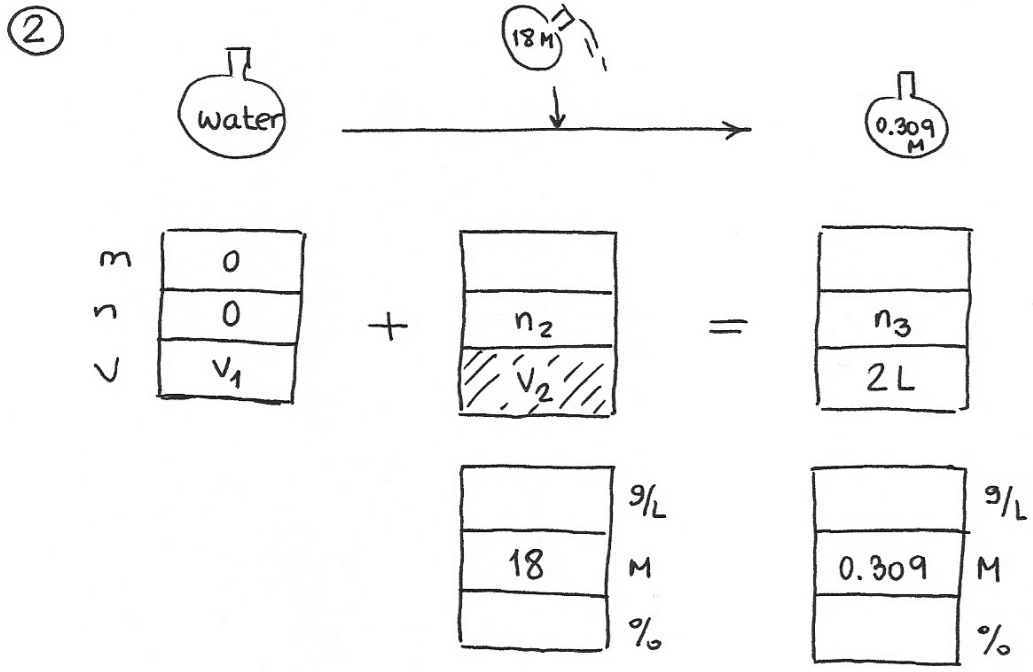


a) $n = 18.3 \frac{\text{mol } H_2SO_4}{L} \times 0.001\,L = \boxed{0.0183 \text{ mol } H_2SO_4}$

b) $x = 0.0183 \text{ mol} \times \frac{6.02 \times 10^{23} \text{ molecule}}{1 \text{ mol}} = \boxed{1.1 \times 10^{22} \text{ molecule } H_2SO_4}$

c) $c(\%) = 18.3 \frac{\text{mol}}{L} \times \frac{98 \text{ g } H_2SO_4}{1 \text{ mol}} \times \frac{1L}{1840 \text{ g solution}} \times 100 = \boxed{97.5\,\%}$

2	**Calculate the volume of 18 M sulfuric acid that must be added to water to prepare 2 L of a 0.309 M solution**
Atomic weights: S=32; O=16; H=1	



a) Determination of n_3 and n_2

$$n_3 = 0.309 \frac{\text{mol } H_2SO_4}{L} \times 2\,L = 0.618 \text{ mol } H_2SO_4$$

$$n_2 = n_3 = 0.618 \text{ mol } H_2SO_4$$

b) Determination of V_2

$$V_2 = 0.618 \text{ mol } H_2SO_4 \times \frac{1\,L}{18 \text{ mol}} = 0.034\,L = \boxed{34\,mL}$$

3	**A sample of impure magnesium was analyzed by allowing it to react with excess HCl solution:** $Mg\ (s) + HCl\ (aq) \rightarrow MgCl_2\ (aq) + H_2\ (g)$ **(not balanced)** **After 1.32 g of the impure metal was treated with 0.1 L of 0.75 M HCl, 0.0125 mol HCl remained. Assuming the impurities do not react with the acid, what is the mass % Mg (purity) in the sample?**
Atomic weights: Mg=24.3; H=1; Cl=35.5	

(3) The balanced chemical equation and proportions are:

$$Mg\ (s) + 2\ HCl\ (aq) \longrightarrow MgCl_2\ (aq) + H_2\ (g)$$

1 mol	2 mol	1 mol	1 mol
24.3 g	73 g	95.3 g	2 g

$M\ (Mg) = 24.3\ g/mol$

$M\ (HCl) = 1 + 35.5 = 36.5\ g/mol$

$M\ (MgCl_2) = 24.3 + (2 \times 35.5) = 95.3\ g/mol$

$M\ (H_2) = 2 \times 1 = 2\ g/mol$

Determination of HCl consumed:

↳ initial

$n_i = 0.75\ \frac{mol}{L} \times 0.1\ L = 0.075\ mol\ HCl$

↳ remaining

$n_r = 0.0125\ mol\ HCl$

↳ consumed

$n = 0.075\ mol\ HCl - 0.0125\ mol\ HCl = 0.0625\ mol\ HCl$

Determination of the amount of Mg that reacts with HCl:

$$m\ (Mg) = 0.0625\ mol\ HCl\ \frac{24.3\ g\ Mg}{2\ mol\ HCl} = 0.76\ g\ Mg$$

The purity of the sample is:

$$x = \frac{0.76\ g\ Mg}{1.32\ g\ sample} \times 100 = \boxed{57.6\%\ purity}$$

4	**Hydrazine (N_2H_4) and dinitrogen tetraoxide (N_2O_4) react on contact to form nitrogen gas and waper vapor.** • **How many grams of nitrogen gas form when 100 g N_2H_4 and 200 g N_2O_4 are mixed?** • **Which is the volume of that gas at P=2.2 atm and T=23 ºC?**

Atomic weights: N=14; O=16; H=1

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

(4) The balanced chemical equation:

$$2\ N_2H_4 + N_2O_4 \rightarrow 3\ N_2 + 4\ H_2O$$

2 mol	1 mol	3 mol	4 mol
64 g	92 g	84 g	72 g

$M(N_2H_4) = (2 \times 14) + (4 \times 1) = 32\ g/mol$

$M(N_2O_4) = (2 \times 14) + (4 \times 16) = 92\ g/mol$

$M(N_2) = 2 \times 14 = 28\ g/mol$

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

Determination of the Limiting reactant:

$x(N_2H_4) = \frac{100\ g\ N_2H_4}{64\ g\ N_2H_4} = 1.56$ times the value of the table

$x(N_2O_4) = \frac{200\ g\ N_2O_4}{92\ g\ N_2O_4} = 2.17$ times the value of the table

↳ N_2H_4 is the Limiting reactant

Amount of nitrogen formed:

$$x = 100\ g\ N_2H_4 \frac{84\ g\ N_2}{64\ g\ N_2H_4} = \boxed{131.25\ g\ N_2}$$

Volume of nitrogen:

$$n(N_2) = 131.25\ g\ N_2 \frac{1\ mol\ N_2}{28\ g\ N_2} = 4.69\ mol\ N_2$$

$$PV = nRT \rightarrow V = \frac{nRT}{P} = \frac{4.69\ mol \times 0.082 \frac{atm.L}{K.mol} \times (23+273)K}{2.2\ atm}$$

$$\boxed{V = 51.74\ L\ N_2}$$