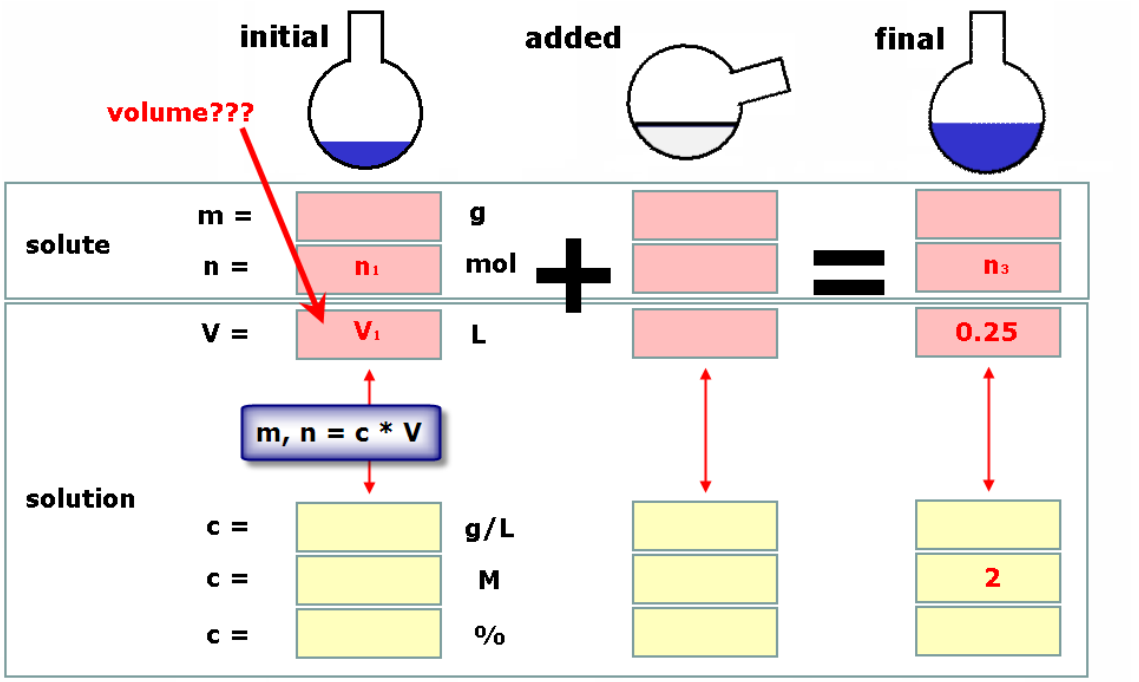
Chemical Calculus – Exam Batxilergoa 1	
Name:	Group:

1. **From a solution of sodium chloride that has a concentration of 300 g/L we want to prepare 250 mL of a solution that is 2 M. Calculate the volume (in mL) we need to take from the initial solution to get the final one (by dilution)**
Atomic weights: Cl=35.5 Na=23



Strategy:

1. calculate the number of moles of the final solution
2. calculate the number of moles of the initial solution
3. calculate the volume of the initial solution

$$n_3 = 0.25\ L \times \frac{2\ mol\ NaCl}{1\ L\ solution} = 0.5\ mol\ NaCl$$

$$n_1 = n_3 = 0.5\ mol\ NaCl$$

$$M\ (NaCl) = 23 + 35.5 = 58.5\ g/mol$$

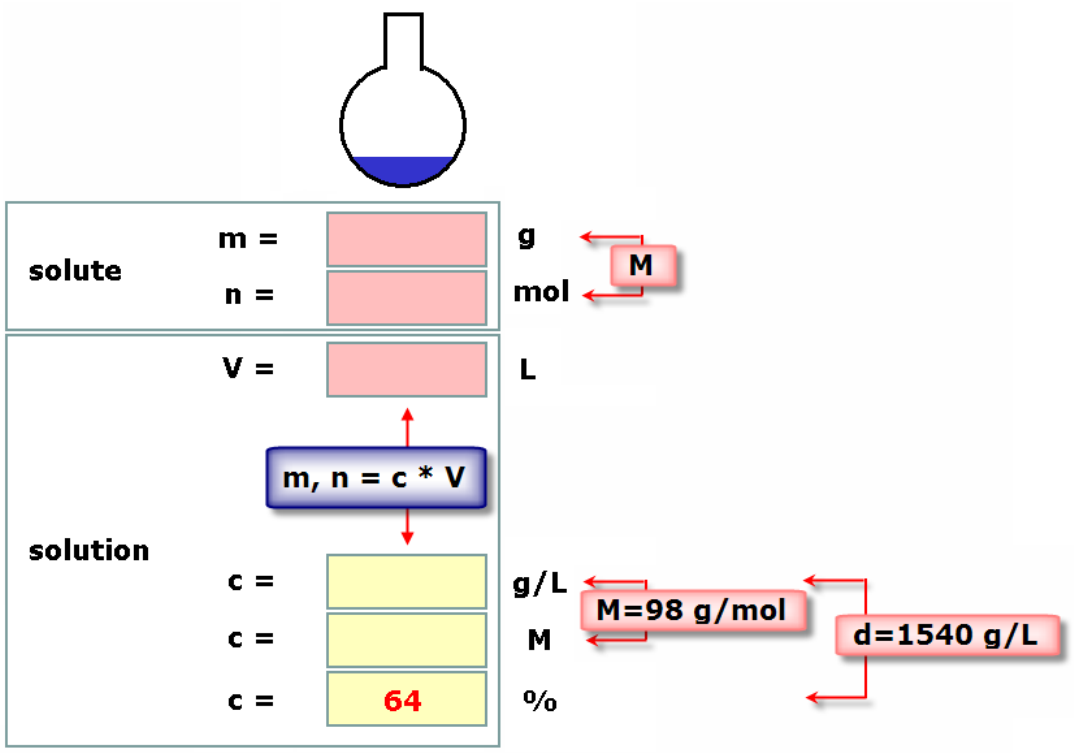
$$V_1 = 0.5\ mol\ \frac{1\ L\ solution}{300\ g\ NaCl}\ \frac{58.5\ g\ NaCl}{1\ mol} =$$

$$= 0.0975\ L = \boxed{97.5\ mL}$$

2. A solution of sulfuric acid has a concentration of 64 % in mass proportion and the density is 1.54 g/mL. Calculate:

a) the molarity of the solution
b) the volume we need to take from that solution to get 50 g of solute
c) the number of molecules of solute that are in 100 mL

Atomic weights: S=32; O=16; H=1
Avogadro number: $N_A=6{,}02.10^{23}$



ⓐ $c(mol/L) = \frac{64\ g\ H_2SO_4}{100\ g\ solution}\ \frac{1540\ g\ sol}{1\ L\ sol}\ \frac{1\ mol}{98\ g} =$

$= 10.06\ mol/L$

$M(H_2SO_4) = (2\times1) + 32 + (4\times16) = 98\ g/mol$

ⓑ $V = 50\ g\ H_2SO_4\ \frac{1\ mol}{98\ g\ H_2SO_4}\ \frac{1L}{10.06\ mol} =$

$= 0.05L = \boxed{50\ mL\ solution}$

ⓒ $X = 0.1\ L\ \frac{10.06\ mol}{1L}\ \frac{6.02\times10^{23}\ molecules}{1\ mol} =$

$= 6.056\times10^{23}\ molecules$

3. The volume of a container is 5 L and in it we have propane (C_3H_8) in the following conditions: the pressure is 10 atm and the temperature is 17 °C.

If all that propane is burned (combustion reaction) calculate the volume of carbon dioxide we get in STP conditions.

Atomic weights: O=16; H=1; C=12
R=0.082 atm.L/K.mol

③ The balanced chemical equation is:

$$C_3H_8 + 5\,O_2 \longrightarrow 3\,CO_2 + 4\,H_2O$$

1 mol	5 mol	3 mol	4 mol
44 g	160 g	132 g	72 g

$M(C_3H_8) = (3\times12)+(8\times1) = 44$ g/mol

$M(O_2) = 2\times16 = 32$ g/mol

$M(CO_2) = 12+(2\times16) = 44$ g/mol

$M(H_2O) = (2\times1)+16 = 18$ g/mol

The amount of propane burned in moles

$$n = \frac{PV}{RT} = \frac{10\text{ atm} \times 5\text{ L}}{0.082\ \frac{\text{atm.L}}{\text{K.mol}} \times (273+17)\text{K}} = 2.1\text{ mol } C_3H_8$$

The amount of CO_2 formed in moles

$$n(CO_2) = 2.1\text{ mol } C_3H_8 \frac{3\text{ mol } CO_2}{1\text{ mol } C_3H_8} = 6.3\text{ mol } CO_2$$

The volume in STP

$$V(CO_2) = 6.3\text{ mol } CO_2 \frac{22.4\text{ L } CO_2}{1\text{ mol } CO_2} = \boxed{141.12\text{ L } CO_2}$$

4. When aluminum reacts with hydrochloric acid the products formed are aluminum trichloride and hydrogen. If 9 g of aluminum and 200 mL of a solution of hydrochloric acid 3 M are added,

a) write the adjusted chemical equation
b) determine the limiting reactant
c) determine the excess of the reactant (which one is and the mass in grams)

Atomic weights: Al=27; H=1; Cl=35.5

(4) @ The adjusted chemical equation:

$$2\,Al + 6\,HCl \rightarrow 2\,AlCl_3 + 3\,H_2$$

2 mol	6 mol	2 mol	3 mol
54 g	219 g	267 g	6 g
273 g		273 g	

$M\,(Al) = 27\ g/mol$

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

$M\,(AlCl_3) = 27 + (3 \times 35.5) = 133.5\ g/mol$

$M\,(H_2) = 2\ g/mol$

ⓑ Determination of the limiting reactant

$$x\,(Al) = \frac{9\ g\ Al}{54\ g\ Al} = 0.167$$ times the value of the table

$$x\,(HCl) = \frac{0.2\ L \frac{3\ mol}{1L}\ HCl}{6\ mol\ HCl} = 0.1$$ times the value of the table

HCl is the limiting reactant

ⓒ Determination of the excess

↳ The amount of Al consumed

$$m\,(Al\ consumed) = 0.6\ mol\ HCl \frac{54\ g\ Al}{6\ mol\ HCl} =$$

$$= 5.4\ g\ Al$$

↳ The excess of aluminum

$$m\,(Al\ excess) = 9\ g\ Al - 5.4\ g\ Al = \boxed{3.6\ g\ Al}$$