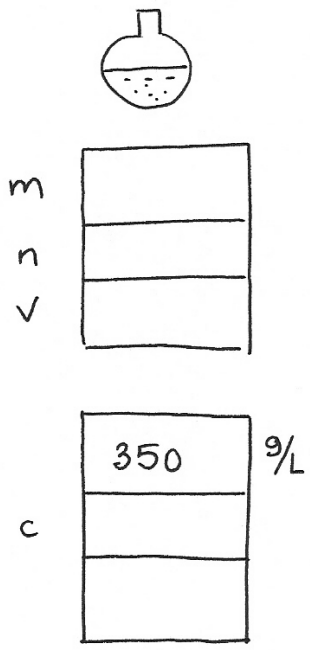
EXAM: GASES, SOLUTIONS and CHEMICAL REACTIONS	
Name:	**Group:**

1	**A tank contains a solution of nitric acid 350 g/L. The density of that solution is 1.2 g/mL** **a) Calculate the molarity of the solution** **b) Calculate the concentration in mass %** c) **Calculate the number of molecules of solute in 100 mL**
Atomic weights: N=14; O=16; H=1 $N_A = 6.02 \times 10^{23}$	

(1)



$M = 1 + 14 + (3 \times 16) = 63\ g/mol$

(a) Molarity

$$c(M) = 350\ \frac{g\ HNO_3}{L}\ \frac{1\ mol}{63\ g} = \boxed{5.56\ M}$$

(b) Mass %

$$c(\%) = 350\ \frac{g\ HNO_3}{L}\ \frac{1\ L}{1200\ g\ solution}\ 100 =$$

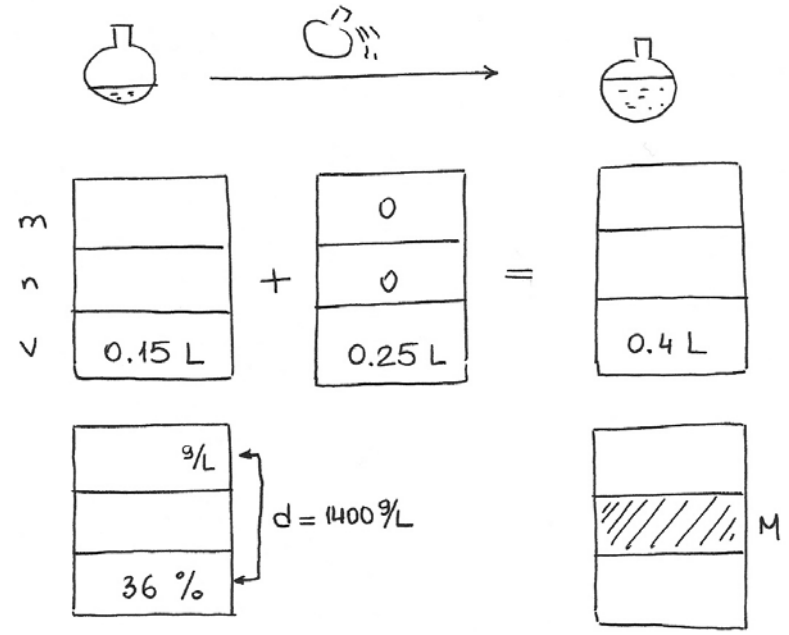
$$= \boxed{29.2\ \%}$$

(c) Number of molecules

$$x = 0.1\ L\ \frac{5.56\ mol}{1\ L}\ \frac{6.02 \times 10^{23}\ molecule}{1\ mol} =$$

$$= \boxed{3.35 \times 10^{23}\ \text{molecules } HNO_3}$$

2	**In a container there are 150 mL of a sodium hydroxide solution 36 % in mass; the density is 1.4 g/mL. We add 250 mL of water to that solution. Calculate:** **a) The molarity of the resulting solution** **b) The density of the resulting solution**
Atomic weights: Na=23; O=16; H=1	

② 

ⓐ Molarity

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

$$n_1 = \frac{36\ g\ NaOH}{100\ g\ solution} \times \frac{1400\ g\ solution}{1\ L} \times 0.15\ L \times \frac{1\ mol}{40\ g\ NaOH} = 1.89\ mol\ NaOH$$

$n_3 = n_1 = 1.89\ mol\ NaOH$

$$c_3(M) = \frac{1.89\ mol}{0.4\ L} = 4.73\ M$$

ⓑ Density

Total masses: $m_{T_3} = m_{T_1} + m_{T_2}$

$$m_{T_1} = 0.15\ L\ \frac{1400\ g\ solution}{1\ L} = 210\ g\ solution$$

$$m_{T_2} = 0.25\ L\ \frac{1000\ g}{1\ L} = 250\ g\ solution$$

$m_{T_3} = 210\ g + 250\ g = 460\ g\ solution$

$$d_3 = \frac{460\ g\ solution}{0.4\ L} = 1150\ g/L$$

3	**We want to burn 100 g of propane gas.** • **Write the balanced chemical equation and the table of proportions** • **Calculate the volume of oxygen gas we need at STP**
Atomic weights: O=16; H=1; C=12 ; $R = 0.082 \frac{atm.L}{K.mol}$	

③ @ The balanced chemical equation is:

$$C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$$

1 mol 5 mol 3 mol 4 mol

44 g 160 g 132 g 72 g

204 g 204 g

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

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

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

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

⑥ Volume of oxygen at STP

$$n(O_2) = 100g\ C_3H_8 \frac{5\ mol\ O_2}{44g\ C_3H_8} = 11.36\ mol\ O_2$$

two methods

b1) Using the ideal gas equation:

$$V = \frac{nRT}{P} = \frac{11.36\ mol \times 0.082 \frac{atm.L}{K.mol} \times 273K}{1\ atm} =$$

$$= \boxed{254.3\ L\ O_2}$$

b2) Applying the fact that 1 mol of any gas occupies 22.4 L at STP:

$$V = 11.36\ mol\ O_2 \frac{22.4\ L}{1\ mol} = \boxed{254.5\ L\ O_2}$$

4	**When hydrogen gas and nitrogen gas combine together, we get ammonia. In a container, we have 70 g of nitrogen and 80 L of hydrogen (at P=2 atm and T=17°C)** **a) Write the balanced chemical equation** **b) Determine the limiting reactant** **c) Calculate the amount of ammonia in grams** **d) Calculate the amount of the reactant in excess (in grams)**
Atomic weights: N=14; H=1; $R = 0.082 \frac{atm.L}{K.mol}$	

(4) (a) The balanced chemical equation:

$$3\ H_2 + N_2 \rightarrow 2\ NH_3$$

3 mol 1 mol 2 mol

6 g 28 g 34 g

34 g

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

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

$M(NH_3) = 14 + (3 \times 1) = 17\ g/mol$

(b) Determination of the limiting reactant

$x(N_2) = \frac{70\ g\ N_2}{28\ g\ N_2} = 2.5$ times the value of the table

$n(H_2) = \frac{PV}{RT} = \frac{2\ atm \times 80\ L}{0.082 \frac{atm.L}{K.mol} \times 290\ K} = 6.73\ mol\ H_2$

$x(H_2) = \frac{6.73\ mol\ H_2}{3\ mol\ H_2} = 2.24$ times the value of the table

↳ Hydrogen is the limiting reactant

(c) The amount of ammonia in grams

$m(NH_3) = 6.73\ mol\ H_2 \frac{34\ g\ NH_3}{3\ mol\ H_2} = 76.3\ g\ NH_3$

(d) The excess of nitrogen (in grams)

↳ Nitrogen consumed:

$m(N_2) = 6.73\ mol\ H_2 \frac{28\ g\ N_2}{3\ mol\ H_2} = 62.8\ g\ N_2$

↳ Excess of nitrogen

$m(N_2) = 70\ g\ N_2 - 62.8\ g\ N_2 = 7.2\ g\ N_2$