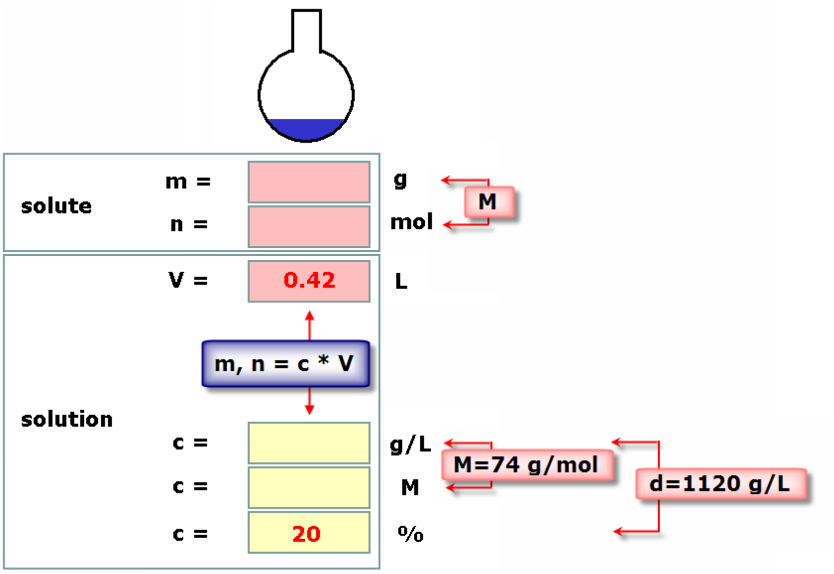
LIZARDI BHI 2009-10	Topics:	Marks:
Batxilergoko 1. maila	Organic Nomenclature	
2nd. term	Gases, Solutions	
2010-01-19	Chemical Calculus	

1	**A solution of calcium hydroxide has a volume of 420 mL and contains 20 percent of $Ca(OH)_2$ by mass. The density of this solution is 1.12 g / mL. Calculate:** **a) the concentration in mol / L and g / L** **b) the amount of solute in grams and moles**
Atomic weights: Ca=40; O=16; H=1	



① ⓐ $c(g/L) = \frac{20\ g\ Ca(OH)_2}{100\ g\ solution} \cdot \frac{1120\ g\ solution}{1\ L\ solution} = 224\ \frac{g\ Ca(OH)_2}{L}$

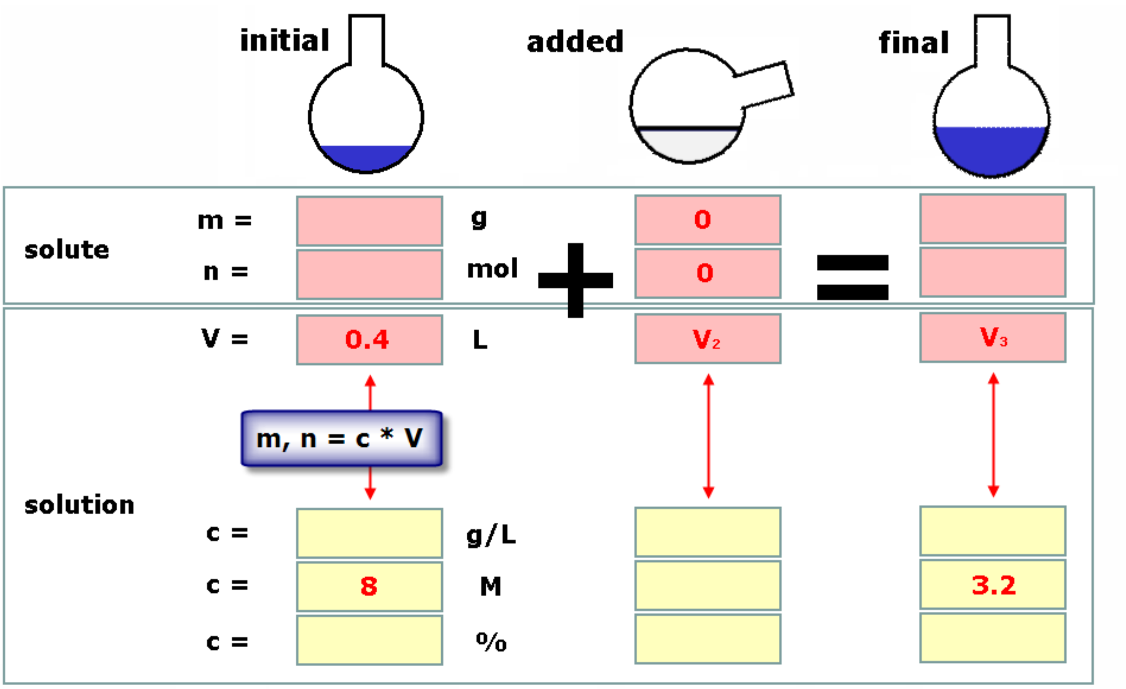
$c(mol/L) = 224\ \frac{g\ Ca(OH)_2}{L} \cdot \frac{1\ mol\ Ca(OH)_2}{74\ g\ Ca(OH)_2} = 3.03\ \frac{mol\ Ca(OH)_2}{L}$

$M(Ca(OH)_2) = 40 + (2 \times 16) + (2 \times 1) = 74\ g/mol$

ⓑ $m(Ca(OH)_2) = 0.42\ L \cdot \frac{224\ g\ Ca(OH)_2}{1L} = 94.08\ g\ Ca(OH)_2$

$n(Ca(OH)_2) = 0.42\ L \cdot \frac{3.03\ mol\ Ca(OH)_2}{1L} = 1.27\ mol\ Ca(OH)_2$

2	Calculate the volume of water we need to add to an initial solution of 0.4 L and 8 M in order to get a solution 3.2 M.



Strategy:

1. determine the number of moles of the initial solution
2. determine the number of moles of the final solution
3. determine the volume of the final solution
4. determine the volume of water

$$n_1 = 0.4\,L \cdot \frac{8 \text{ mol solute}}{1\,L} = 3.2 \text{ mol solute}$$

$$n_3 = n_1 = 3.2 \text{ mol solute}$$

$$V_3 = 3.2 \text{ mol} \cdot \frac{1\,L}{3.2 \text{ mol}} = 1\,L$$

$$V_1 + V_2 = V_3 \rightarrow 0.4\,L + V_2 = 1\,L \rightarrow V_2 = 0.6\,L \text{ water}$$

3	**Magnesium and nitric acid (HNO_3) react to form magnesium nitrate, $Mg(NO_3)_2$, and hydrogen.** **If we have 250 g of magnesium and 400 mL of a solution of nitric acid (40 % of concentration and density 1.28 g / mL)** **a) determine which is the limiting reactant** **b) how much magnesium nitrate is formed (in moles and grams)** **c) how much reactant is in excess (in grams)** **d) the volume of hydrogen formed at 4 atm and 27 ºC**
Atomic weights: N=14; H=1; O=16; Mg=24 R=0.082 atm.L/K.mol	

③

$$Mg + 2\,HNO_3 \longrightarrow Mg(NO_3)_2 + H_2$$

1 mol	2 mol	1 mol	1 mol
24 g	126 g	148 g	2 g

a) The limiting reactant

HNO_3 added:

$$m = 0{,}4\,L\ sol \times \frac{1280\ g\ sol}{1\ L\ sol} \times \frac{40\ g\ HNO_3}{100\ g\ sol} = 204{,}8\ g\ HNO_3$$

$$HNO_3: \frac{204.8\ g\ HNO_3\ added}{126\ g\ HNO_3\ in\ table} = 1.63\ times$$

$$Mg: \frac{250\ g\ Mg\ added}{24\ g\ Mg\ in\ table} = 10.4\ times$$

HNO_3 is the Limiting reactant.

b) The amount of $Mg(NO_3)_2$ formed

$$x = 204.8\ g\ HNO_3 \times \frac{1\ mol\ Mg(NO_3)_2}{126\ g\ HNO_3} = 1.63\ mol\ Mg(NO_3)_2$$

$$x = 204.8\ g\ HNO_3 \times \frac{148\ g\ Mg(NO_3)_2}{126\ g\ HNO_3} = 240.6\ g\ Mg(NO_3)_2$$

c) Reactant in excess

Mg that reacts $x = 204.8\ g\ HNO_3 \times \frac{24\ g\ Mg}{126\ g\ HNO_3} = 39.01\ g\ Mg$

Mg in excess $x = 250\ g\ Mg - 39.01\ g\ Mg = 210{,}99\ g\ Mg$

d) Hydrogen formed

$$x = 204.8\ g\ HNO_3 \times \frac{1\ mol\ H_2}{126\ g\ HNO_3} = 1.63\ mol\ H_2$$

$$pV = nRT \rightarrow V = \frac{nRT}{P} = \frac{1.63\ mol \times 0.082\ \frac{atm.L}{K.mol} \times (273+27)K}{4\ atm}$$

$V = 10.02\ L\ H_2$

4	Calculate the amount of carbon dioxide (in grams and moles) formed when 120 g of 2-butene (C_4H_8) are burned.
Atomic weights: O=16; H=1; C=12	

④

$$C_4H_8 + 6\ O_2 \longrightarrow 4\ CO_2 + 4\ H_2O$$

C_4H_8	$6\ O_2$	$4\ CO_2$	$4\ H_2O$
1 mol	6 mol	4 mol	4 mol
56 g	192 g	176 g	72 g

$$x = 120\ g\ C_4H_8 \times \frac{176\ g\ CO_2}{56\ g\ C_4H_8} = 377\ g\ CO_2$$

$$x = 120\ g\ C_4H_8 \times \frac{4\ mol\ CO_2}{56\ g\ C_4H_8} = 8.57\ mol\ CO_2$$