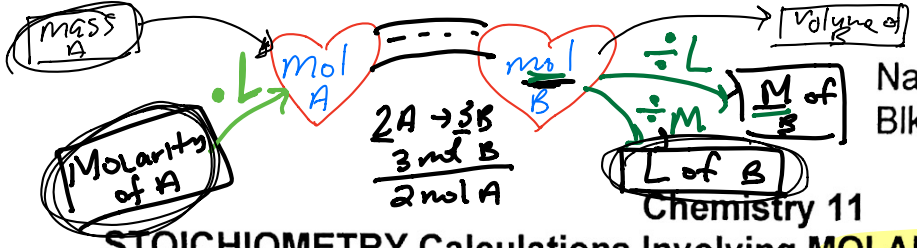

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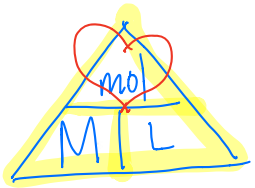
Chemistry 11

STOICHIOMETRY Calculations Involving MOLAR CONCENTRATION

Recall that MOLARITY =

$M = mol \div L$



$mol = M \cdot L$

$L = mol \div M$

IMPT: the only time that you can use the value 22.4 L is when the question states specifically that you have a **gas @ STP**!!!

Example 1. Tums® is an antacid tablet that is made up primarily of $CaCO_3$ (s). It works to neutralize stomach acid (HCl (aq)) to produce ~~solid~~ (aq) calcium chloride , carbon dioxide gas and liquid water.

a. If a single tablet has a mass of 0.750 g, what *volume* of stomach acid, having a [HCl] = 0.0010 M, is neutralized by a single tablet?

- **Step 1**. Write out the balanced equation:

$1\,CaCO_3(s) + 2\,HCl(aq) \rightarrow 1\,CaCl_2(aq) + 1\,CO_2(g) + 1\,H_2O(l)$

Step 2. Use last lesson's diagram + your knowledge of MOLARITY to identify the unknown, the initial and the conversion factors and solve:

0.0010 M HCl → 0.0010 mol HCl / 1 L

$0.750\ g\ CaCO_3 \left(\frac{1\ mol\ CaCO_3}{100.1\ g\ CaCO_3}\right)\left(\frac{2\ mol\ HCl}{1\ mol\ CaCO_3}\right)\left(\frac{1\ L}{0.0010\ mol\ HCl}\right) = 15\ L\ of\ HCl$

1 Ca = 40.1
1 C = 12.0
3 O = 48.0
100.1 g

$L = 1.50 \cdot 10^{-2}\ mol\ HCl \div 0.0010\ M = 15\ L$

b. What *volume of CO_2(g) at STP* is produced if 1.25 L OF 0.0055 M HCl reacts with an excess of $CaCO_3$?

Step 1. Write out the balanced equation:

$1\,CaCO_3(s) + 2\,HCl(aq) \rightarrow 1\,CaCl_2(aq) + 1\,CO_2(g) + 1\,H_2O(l)$

Step 2. Use last lesson's diagram + your knowledge of MOLARITY to identify the unknown, the initial and the conversion factors and solve:

$mol = M \cdot L$

$mol = L \cdot M$ (27)

$1.25\ L \cdot \left(\frac{0.0055\ mol\ HCl}{1\ L}\right)\left(\frac{1\ mol\ CO_2}{2\ mol\ HCl}\right)\left(\frac{22.4\ L}{1\ mol\ CO_2}\right) =$

$0.077\ L\ of\ CO_2 = 7.7 \cdot 10^{-2}\ L\ of\ CO_2$

Ex: 17-20

$1\,K_2CO_3(s) + 2\,HBr(aq) \longrightarrow 1\,H_2CO_3(aq) + 2\,KBr(aq)$

17. A flask containing 450 mL of 0.500 M HBr was accidentally knocked to the floor. How many grams of K_2CO_3 would you need to put on the spill to completely neutralize the acid?

$$450\,mL\left(\frac{1\cdot10^{-3}\,L}{1\,mL}\right)\left(\frac{0.500\,mol\,HBr}{1\,L}\right)\left(\frac{1\,mol\,K_2CO_3}{2\,mol\,HBr}\right)\left(\frac{138.2\,g\,K_2CO_3}{1\,mol\,K_2CO_3}\right) = \boxed{16\,g\,K_2CO_3}$$

18. The acetic acid in a 2.5 mol/L sample of a solution of a kettle scale remover is reacted with an excess of a lead(II) nitrate solution to form a precipitate, which is then filtered and dried. The mass of the precipitate is 8.64 g. What volume of the solution was required to produce that mass?

$$2\,HC_2H_3O_2(aq) + 1\,Pb(NO_3)_2(aq) \longrightarrow 1\,Pb(C_2H_3O_2)_2(s) + 2\,HNO_3(aq)$$

$$8.64\,g\,Pb(C_2H_3O_2)_2\left(\frac{1\,mol\,Pb(C_2H_3O_2)_2}{325.2\,g}\right)\left(\frac{2\,mol\,HC_2H_3O_2}{1\,mol\,Pb(C_2H_3O_2)_2}\right)\left(\frac{1\,L}{2.5\,mol\,HC_2H_3O_2}\right) = \boxed{0.021\,L\ HC_2H_3O_2}$$

19. How many milliliters of a 0.610 M NaOH solution are needed to completely neutralize 25.0 mL of a 0.356 M phosphoric acid solution?

$$1\,H_3PO_4(aq) + 3\,NaOH(aq) \longrightarrow 1\,Na_3PO_4(aq) + 3\,H_2O(\ell)$$

$$25.0\,mL\left(\frac{1\cdot10^{-3}\,L}{1\,mL}\right)\left(\frac{0.356\,mol\,H_3PO_4}{1\,L}\right)\left(\frac{3\,mol\,NaOH}{1\,mol\,H_3PO_4}\right)\left(\frac{1\,L}{0.610\,mol\,NaOH}\right)\left(\frac{1\,mL}{1\cdot10^{-3}\,L}\right) = \boxed{43.8\,mL\ NaOH}$$

20. What volume of hydrogen gas is formed at STP by the reaction of excess zinc metal with 150 mL of 0.185 mol/L hydroiodic acid?

$$2\,HI(aq) + 1\,Zn(s) \longrightarrow 1\,ZnI_2(aq) + 1\,H_2(g)$$

$$150\,mL\left(\frac{1\cdot10^{-3}\,L}{1\,mL}\right)\left(\frac{0.185\,mol\,HI}{1\,L}\right)\left(\frac{1\,mol\,H_2}{2\,mol\,HI}\right)\left(\frac{22.4\,L}{1\,mol\,H_2}\right) = \boxed{0.31\,L\ H_2}$$

#17 K_2CO_3 $2K = 78.2$, $1C = 12.0$, $3O = 48.0$ → $138.2\,g\,K_2CO_3/mol$

#18 $Pb(C_2H_3O_2)_2$ = $1\,Pb = 207.2$, $4\,C = 48.0$, $6\,H = 6.0$, $4\,O = 64.0$ → $325.2\,g\,Pb(C_2H_3O_2)_2/mol$