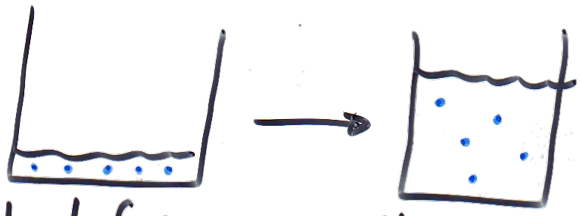
From last class... 12.0 mol HCl = 1 L

8.5 mL of 12.0 M HCl is diluted by adding water, so that the final volume is 120 mL. What is the new conc?

KEY IDEA



#mol HCl before = #mol HCl after

#mol before:

$$8.5\,\text{mL} \times \frac{1\,\text{L}}{1000\,\text{mL}} \times \frac{12.0\,\text{mol HCl}}{1\,\text{L}} = 0.10\,\text{mol HCl}$$

#mol after: = 0.10 mol

$$[HCl] = \frac{\#\text{mol HCl}}{\#\text{L}} = \frac{0.10\,\text{mol HCl}}{0.12\,\text{L}}$$

120 mL = 0.12 L

$$= 0.83\,\frac{\text{mol}}{\text{L}}\ \text{HCl}$$

$$= 0.83\,\text{M HCl}$$

Short-cut

#mol before (initial) = #mol after (final)

$$M_i V_i = M_f \cdot V_f$$

M_i: init. molar conc; V_i: init. volume; M_f: final molar conc; V_f: final volume

ex: 12.0 M HCl, 8.5 mL (M_i, V_i) → ? M, 120 mL (M_f, V_f)

$$M_i V_i = M_f V_f$$

$$\Rightarrow M_f = \frac{M_i V_i}{V_f} = \frac{12.0\,\text{M} \times 8.5\,\text{mL}}{120\,\text{mL}}$$

$$= 0.85\,\text{M}$$

ex: inject 1.0×10^{-8} L of $Tc(NO_3)_{4\,(aq)}$ with a conc of 0.0010 M into a patient's bloodstream.

- If final conc. is 2.1×10^{-12} M, what volume was the blood?

$$M_i V_i = M_f V_f$$

M_i: 0.0010 M; V_i: 1.0×10^{-8} L; M_f: 2.1×10^{-12} M; V_f: Blood volume

$$V_f = \frac{M_i V_i}{M_f} = \frac{0.0010\,\cancel{M} \times 1.0 \times 10^{-8}\,L}{2.1 \times 10^{-12}\,\cancel{M}}$$

$$= 4.8\,L$$

Soln Stoich

g $\leftrightarrow$ mol — molar mass

mol $\leftrightarrow$ mol — coefficients in balanced eqs.

L $\leftrightarrow$ mol — molar conc. $xM = \frac{x\ mol}{1\ L}$

---

ex: 18.0 mL of 1.25 M $HNO_{3\,(aq)}$ reacts with an XS of $Na_2CO_{3\,(aq)}$.

- Q: How many grams of CO_2 is formed?

Balanced Chem Eq

$$2\,HNO_{3\,(aq)} + Na_2CO_{3\,(aq)} \rightarrow 2\,NaNO_{3\,(aq)} + CO_{2\,(g)} + H_2O_{(l)}$$

18.0 mL HNO_3 —(molar conc)→ mol HNO_3 —(coefficients)→ mol CO_2 —(molar mass)→ g CO_2

1.25M HNO_3

1.25 mol HNO_3 = 1 L ✓ ✓

2 mol HNO_3 = 1 mol CO_2 ✓ ✓

CO_2 44.01 g CO_2 = 1 mol CO_2 ✓

$1 \times C = 1 \times 12.01$

$2 \times O = \frac{2 \times 16.00}{44.01}$

(3 sf) 3 sf. ∞ 4

$$18.0\ \text{mL} \left| \frac{1\ \text{L}}{1000\ \text{mL}} \right| \frac{1.25\ \text{mol HNO}_3}{1\ \text{L}} \left| \frac{1\ \text{mol CO}_2}{2\ \text{mol HNO}_3} \right| \frac{44.01\ \text{g CO}_2}{1\ \text{mol CO}_2}$$

∞ sf ∞ ∞

$= 0.495\ \text{g CO}_2$

Acid-Base Titration

easy method to determine soln conc.

ex: 15.2 mL of NaOH was completely neutralised by 27.8 mL of 0.232 M H_2SO_4 (aq).

Q [NaOH] = ?

Need a balanced chem eq!

$2NaOH_{(aq)} + H_2SO_{4(aq)} \rightarrow Na_2SO_{4(aq)} + 2H_2O_{(l)}$

$Na^+ OH^-$ $H^+ SO_4^{2-}$ $Na^+ SO_4^{2-}$ $H^+ OH^-$

$$[NaOH] = \frac{\#\ \text{mol NaOH}}{\#\ \text{L}} = \frac{0.0129\ \text{mol}}{0.0152\ \text{L}} = 0.849\ M_{NaOH}$$

?? 0.0129 mol NaOH

15.2 mL = 0.0152 L

H_2SO_4

$$27.8\ \text{mL} \left| \frac{1\ \text{L}}{1000\ \text{mL}} \right| \frac{0.232\ \text{mol } H_2SO_4}{1\ \text{L}} \left| \frac{2\ \text{mol NaOH}}{1\ \text{mol } H_2SO_4} \right. = 0.0129\ \text{mol NaOH}$$

ex: A 18.1mL sample of HCl requires 7.25mL of 0.083M $Sr(OH)_2$ to fully neutralize it. Q. [HCl] = ?

Balanced Chem Eq:

$2HCl_{(aq)} + Sr(OH)_{2\,(aq)} \rightarrow SrCl_2 + 2H_2O$

$[HCl] = \frac{\#\text{mol HCl}}{\#\text{L HCl}}$ ← 0.0012 mol HCl

18.1mL = 0.0181 L

$Sr(OH)_2$

$7.25\,\text{mL} \mid \frac{1\,\text{L}}{1000\,\text{mL}} \mid \frac{0.083\,\text{mol } Sr(OH)_2}{1\,\text{L}} \mid \frac{2\,\text{mol HCl}}{1\,\text{mol } Sr(OH)_2}$

$= 0.0012\,\text{mol HCl}$

$[HCl] = \frac{0.0012\,\text{mol}}{0.0181\,\text{L}} = 0.066\,\text{M HCl}$

10.5mL of a $NaOH_{(aq)}$ soln requires 15.0mL of a 0.250M H_3PO_4 to fully neutralize.

Q. [NaOH] = ?

$H_3PO_4 + 3NaOH \rightarrow Na_3PO_4 + 3H_2O$

$[NaOH] = \frac{\#\text{mol NaOH}}{\#\text{L NaOH}}$ ← ? ← 10.5mL = 0.0105L

$15.0\,\text{mL} \mid \frac{1\,\text{L}}{1000\,\text{mL}} \mid \frac{0.250\,\text{mol } H_3PO_4}{1\,\text{L}} \mid \frac{3\,\text{mol NaOH}}{1\,\text{mol } H_3PO_4}$

$= 0.0113\,\text{mol NaOH}$

$[NaOH] = \frac{0.0113\,\text{mol}}{0.0105\,\text{L}} = 1.07\,\text{M NaOH}$

EXAM 2

FRI 14th October.