Lesson 2 For Book 2

Exercise 1 Review for the concept of Molarity

30.0 cm^3 of 0.10 M KOH is completely neutralised by 20.0 cm^3 of dilute H_2SO_4 to form K_2SO_4 solution. What is the molarity of the salt solution obtained ?

A. 0.03 M
B. 0.05 M
C. 0.06 M
D. 0.10 M

pH scale and indicator

- **pH scale** (0-14) is used to define the acidic/alkaline property of a solution. It measures the concentration of ___ ions (but not OH^-)in a solution

  → pH = -log[H_3O^+]

- Noted the following three descriptive terms

  1) **Acidic** → when [H_3O^+] > [OH-] and pH is _____ than 7
  2) **Basic** → [H_3O^+] < [OH-] and pH is _____ than 7
  3) **Neutral** → when [H_3O^+] = [OH-] and pH is equal to 7

Further thinking *Can pH be a neg. number?* The answer is YES.

Calculate the pH of the following acid.

a) 0.1M [H_3O^+] b) 1M [H_3O^+] c) 10M [H_3O^+]

- An **acid-base indicator** is used to have a brief examine of the pH value of a solution. They can serve as an indicator as they *change their colours with respect to the* ___ *of a solution.* The common ones are Litmus paper , methyl orange and phenolpthalein.
- Methyl orange and phenolpthalein are commonly used in **titration**. They are ***weak acid*** in nature. Their pH ranges are shown below: (Please remember them!)

	Acidic colour	Basic colour
Methyl orange	red when pH < 4.4	Yellow when pH > 7
Phenolpthalein	Colourless when pH < 8.3	Red when pH >10

→ To measure the pH value of a solution accurately, we can use **pH meter**.

→ pH value of a solution has NO direct relationship with its acidic strength.

i.e 10M CH_3COOH (an organic acid) has a lower pH than 1M HCl , but HCl is stronger. We can **only** say that 10M CH_3COOH is more a_____ than 1M HCl.

Exercise 2

a) What is the $[H_3O+]$ of a sample of rainwater with pH 5.7?

b) Match five aqueous solutions *NaOH, NH_3, KCl, CH_3COOH and rainwater* of equal molarity with the following pH shown on the pH scale below.

→ On the left, it is the _____ range ; On the right, it is the _____ range.

→ A solution of metal salt has the pH of 7 = neutral.

Comparison of the strength of acids and alkalis

- Noted that a strong (weak) acid is one which completely (only slightly) ionizes in water to give out ____ ions ; while a strong (weak) alkali is one which completely (only slightly) ionizes in water to give out ____ ions.

→ **Stength** refers to the degree of **i**_____ of an acid/alkali in the solution.

1) By measuring pH of solution , **if** all samples are in the **same molarity.**

→ For two acids/alkali (A / B) in the same molarity, A has a lower (higher) pH means that A can give a higher molarity of ____ ions (____ ions) , i.e., the ionization of A is more c_____. → A is a stronger one.

2) By measuring the electrical conductivity of solutions with the same molarities.

→ For two acids/alkali (A / B) in the same molarity, A has a higher electrical conductivity means that A can give a higher molarity of ____ / ____ ions, i.e., the ionization of A is more c_____. → A is a stronger one.

Exercise 3 Reversibility vs Irreversibility

Below is the respective ionization equation of three different acids. Arrange their strengths in descending order by looking at their equations.

i) $CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$

ii) $HClO_4 + H_2O \rightarrow ClO_4^- + H_3O^+$

iii) $H_2CO_3 + H_2O \rightleftharpoons CO_3^{2-} + H_3O^+$

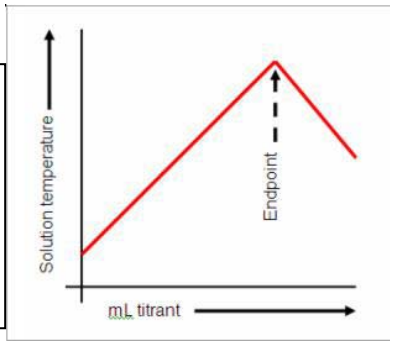
→ Reversible ionization = weak acid/base ; Irreversible ionziation = strong acid/base

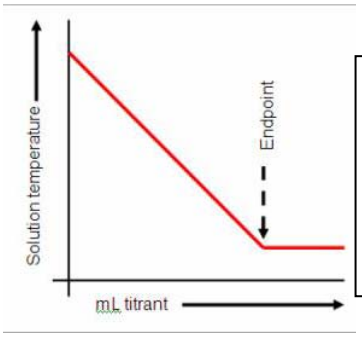
→ Organic acids should be _____ than inorganic acids.

Neutralization and preparation of ionic salts

- You must know that the mixing of an a____ species and b____ species is called **neutralization**, which gives out **water , salts and heat** → *exo*_____ in nature.
- Due to the ___*thermic* nature of neutralization, we have the question about the interpretation of a graph of **thermometric titration** → temp. change.

For exothermic reaction e.g neutralization





For endothermic reaction

→ **End point** of the titration = the "Hottest" and "Coldest" points

→ After the end point, the solution will be *cool down*.

Solubillity of ionic salts

- Recall that ionic salts are formed by the combination of a c_____(usually from metal) and an a_____. Ionic salts (solute) can be soluble or insoluble in water (solvent). They are determined by the attraction between M^+ and X^-.

Soluble salts	Examples	Insoluble salts	Examples
1. All K^+,Na^+,NH_4^+ salts	✓ KCl, NaCl, …		
2. All (NO_3^-) salts	✓ KNO_3, $Mg(NO_3)_2$ …		
3. All (HCO_3^-) salts	✓ $NaHCO_3$ …		
4. All (Cl^-,Br^-, I^-) →except AgX、PbX_2 and HgX_2	✓ $MgCl_2$, NaBr…	AgX 、 PbX_2 和 HgX_2 (X = Cl、Br or I)	× AgCl , PbBr, HgI_2 ...
5. All (SO_4^{2-})，除了 $BaSO_4$ 和 $PbSO_4$	✓ $MgSO_4$... $CaSO_4$ 只微溶	$BaSO_4$ and $PbSO_4$	× $BaSO_4$ 和 $PbSO_4$
6. (CO_3^{2-}) of K^+ , Na^+ and NH_4^+	✓ KCO_3 ,$NaCO_3$ …		× $CaCO_3$ ... 。
7.Potassium/sodium hydroxide	✓ NaOH … $Ca(OH)_2$ 只微溶		× $Mg(OH)_2$ …
8. Na_2O, K_2O	✓ K_2O, CaO 只微溶		× MgO, BaO …

- Remembering the solubility of salts can h*elp* you select the proper methods to prepare the salts. Also, it helps you write the **ionic equation** of a reaction.

Exercise 4 Please write down the ionic equation of $NaOH + H_2SO_4$ and **$Ca(OH)_2$** + HCl 1) 2) → You will find that $H^+ + OH^- \rightarrow H_2O$ is the basic ionic equation for neutralization.

Preparation of salts

- Two important steps

1) Making the salt by reactions → Neutralization for soluble salts

   i.e. the mixing of **excess** metal/ insoluble base/ insoluble carbonate with acid

   i.e. the mixing of soluble acid and base (by titration → more accurate mixing)

Qu: State a reaction which can prepare the salt, $Cu(NO_3)_2$.

(Hint = From the formula of the salt, we can guess the use of which acid, _____)

e.g.

→ Precipitation for insoluble salts

   i.e. the mixing of two solutions, which contain the required *Cation and Anion*.

Qu: State two solutions required to form the insoluble salt $BaSO_4$ (s)

(Hint = Separate the two required ions, _____ and ____)

e.g.

2) Separating and purifying the salts. → soluble salts are separated by crystallization and then filtration and then drying

→ insoluble salts are separated by filtration and then drying.

(**drying** is sometimes needed when we want to collect an **anhydrous** crystals/salts.)

Special Remarks

→ During the prepartion of salt (e.g. $CuSO_4$), sometimes the **reaction mixture** is heated first and then cooled down. This allows **the formation of salts** as the dissolving power of water d_____when temperature is lowered.

→ If the raw material used to prepare salts is contaminated by **coloured impurities**, we can use **Activated Charcoal** (活性炭) to absorb the coloured impurities, followed by filtration.