Attributes of acids affecting pH

1 Strong and weak acids

DEFINITION

Strong acids	Weak acids
completely ionizes in water	does not completely ionizes in water
	
$HA \rightarrow H^+ + A^-$ 单向的 reaction	$HB \rightleftharpoons H^+ + B^-$ reversible reaction
HCl, H_2SO_4, HNO_3	所有其他 acid
↓ pH	↑ pH
(basicity - 样时, H^+ 更多)	(basicity - 样时, H^+ 更少)

DISTINGUISHING STRONG AND WEAK ACIDS

- e.g. HCl and CH_3COOH — basicity 与 concentration 须一样才能比较

PHYSICAL METHOD

a. pH value
- Prepare same volume of 0.1M $HCl_{(aq)}$ and 0.1M $CH_3COOH_{(aq)}$
- Using pH paper, measure the pH value of both solutions
- 0.1M HCl has a lower pH value than 0.1M $CH_3COOH_{(aq)}$.
- strong acids → $[H^+]$↑ → pH ↓

b. Electrical Conductivity
- Prepare same volume of 0.1M $HCl_{(aq)}$ and 0.1M $CH_3COOH_{(aq)}$
- Using a light bulb, test the electrical conductivity of both solutions
- 0.1M $HCl_{(aq)}$ provides a brighter light bulb than 0.1M $CH_3COOH_{(aq)}$.
- strong acids → no# of mobile ions ↑ → electrical conductivity ↑

CHEMICAL METHOD

a. Reaction rate
- React same mass of iron w/ same volume of excess 0.1M $HCl_{(aq)}$ and 0.1M $CH_3COOH_{(aq)}$
  ($Fe + 2H^+ \rightarrow Fe^{2+} + H_2$)
- 0.1M $HCl_{(aq)}$ gives bubbles at a faster rate.
- H^+浓度↑ → 粒子碰撞频率↑ → reaction rate↑

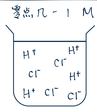
☆ 最后 H_2 的 volume 还是一样的
1. limiting reactant 是铁
2. reaction 会发热 (exothermic)
   放出来的热会使 CH_3COOH 其他 molecules ionize (温度↑, ionize 的 H^+↑)
   最后所有 required 的 CH_3COOH (不包括 excess) 也会被 ionize 了
   可是因为热用来 ∫ ionize, 达成 reaction 净算 activation energy 需时更久
   Reaction rate ↓

SHOWING ... IS STRONG/WEAK ACID

Prepare 0.1M of the acid. → assume basicity = 1
Measure its pH accurately w/ pH meter. $HX \rightarrow H^+ + X^-$ (0.1M → 0.1M)
If acid is completely ionized, $pH = -\log[H^+] = -\log 0.1 = 1$
So, if pH = 1 → strong acid. If pH > 1 → weak acid

2 Concentrated and dilute acids

DEFINITION

Conc. acids	Dilute acids
13 至 15 M	普遍 n - 1 M
	
>水不够, 不能 completely ionize	(HCl: strong acid) Completely ionize

→ May have different acid R.A.s reaction

3 Basicity

DEFINITION

- max. no. of ionizible hydrogen atoms in an acid molecule

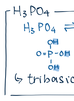
HCl
$HCl \rightarrow H^+ + Cl^-$
H − Cl
↳ monobasic

CH_3COOH
$CH_3COOH \rightleftharpoons H^+ + CH_3COO^-$

↳ monobasic

H_2SO_4
$H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$

↳ dibasic

H_3PO_4
$H_3PO_4 \rightleftharpoons 3H^+ + PO_4^{3-}$

↳ tribasic

MOLE RATIO OF ACID-BASE REACTIONS

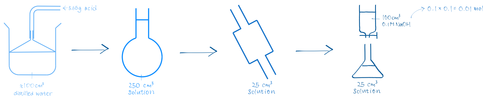
知识点:
- 从 acid 的 basicity 和 base anion 的 charge 判断 mole ratio
- 把两个数字调转, 再约简

→ HCl + NaOH, basicity = 1, anion charge = -1 → 1 : 1
→ H_2SO_4 + NaOH, basicity = 2, anion charge = -1 → 1 : 2
→ H_3PO_4 + Na_2CO_3, basicity = 3, anion charge = -2 → 2 : 3

2g dibasic acid requires $30cm^3$ of 2.15M NaOH for complete neutralisation.
Find its molar mass.

acid mole : NaOH mole = 1 : 2
$n : 2.15 \times 0.03 = 1 : 2$
mole = molarity × volume $n = 0.03 \div 5$
$\frac{mass}{Mr} = mole$
$\frac{2}{Mr} = 0.03 \div 5$
$Mr = 62.0$

3.65g acid in gas state w/ Mr 36.5 is dissolved completely into $100cm^3$ distilled water.
The sol. is poured into $250\ cm^3$ volumetric flask for dilution.
$25\ cm^3$ of the sol. is pipetted out to a conical flask and titrated against 0.1M NaOH
If $100\ cm^3$ of 0.1M NaOH is needed for complete neutralisation, find the basicity of the acid.



$\frac{3.65}{36.5} = 0.1$ mol
0.1 mol (加水 mol 不变)
0.01 mol (抽去的 sol., mol 浓度保不变的)
0.01 mol

mole of acid : mole of alkali
= 0.01 : 0.01
= 1 : 1
∴ monobasic

4 Mixed question types

WHICH IS MORE ACIDIC?

0.1M CH_3COOH / 0.1M HCl → fair test ← conc./dilute 一样; basicity 一样; strong/weak 不一样

0.1M H_2CO_3 / 0.1M HCl → 难定义与判断 (不fair test) ← conc./dilute 一样; basicity 不一样; strong/weak 不一样 → 可是实际上 strength 影响更大 ← 在 weak acid 里, 只有几% 的 ionizable H atom 会 ionize