pH and indicators
See pages 248 and 249

Chemists have discovered that pure distilled water conducts a small amount of electricity?

Dissociation of pure water

- The equation on the right is called the self-ionisation of water.
- A very small quantity of water molecules break up to give ions.
- We called this a dissociation constant Kc.
- The equilibrium lies to the left.

$$H_2O \rightleftharpoons H^+ + OH^-.$$

Kw is called the ionic product of water

$$K = \frac{[H^+][OH^-]}{[H_2O]}$$

- The value of K_w was found experimentally to be 1×10^{-14}.
- $K_w = 1 \times 10^{-14}$ $[H^+][OH^-]$ at 25^0C worked out experimentally.
- This value increases as temperature increases.

Important notes on pH.

- A strong acid dissociates (breaks-up) into ions to a much greater extent than a weak acid.
- The pH of a solution is the negative logarithm to the base 10 of the hydrogen ion concentration.
- **$pH = -1og_{10}[H+]$**
- Limitations of the pH scale
- Only works for 0 to 14 and does not work for very strong acids and bases.
- Measuring pH does not tell us the difference between a strong acid and a weak acid. The pH depends on the concentration of H^+ ions in solution.
- The stronger the acid the weaker the conjugate base.
- The weaker the acid the stronger the conjugate base.

pH of strong acids with different concentrations

Concentration of HCl	$pH = -1og_{10}[H+]$
0.001	pH = 3
0.01	
0.1	
1	
2	
3	

What do you notice about your answers?

Once you go above a 1M solution of HCl you cannot predict the actual number of H^+ ions in solution.

pH of H_2SO_4
Remember a dibasic acid

Concentration of H_2SO_4	pH = $-1og_{10}[H+]$
*remember 1mole of H_2SO_4 breaks down into 2 moles of H+	
0.001	pH = $--1og_{10}[0.002]=$
0.01	
0.1	
1	
2	
3	

pH of strong basess with different concentrations

Concentration of NaOH	$pH = -1og_{10}[H+]$
0.001	$pH = -1og_{10}[0.001] = 3[14-3=11]$
0.01	
0.1	
1	
2	$pH = -1og_{10}[2] = -0.3$ 14+0.3= 14.3
3	
4	
5	

Calculating the concentration when given the pH

Concentration of HCl	= antilog(-pH)
	1
	2
	3
	4
	5

More calculation questions

What do you notice about your answers?

Question	[H+]	pH = $-1og_{10}[H+]$
Find the pH of a solution containing 6.3g of nitric acid, (HNO_3) in 250cm^3 of solution.		
Find the pH of a solution containing 5.48g of hydrochloric acid, (HCL) in 250cm^3 of solution.		
Find the pH of a solution containing 12.6g of nitric acid(HNO_3) in 200cm^3 of solution.		
Find the pH of a solution containing 5.8g of sulphuric acid (H_2SO_4) in 250cm^3 of solution.		
Find the pH of a solution containing 1g of NaOH in 500cm^3 of solution.		
Find the pH of a solution containing 0.024g of KOH in 1l of solution.		
Find the pH of a solution containing 0.37g of Calcium hydroxide-$Ca(OH)_2$ in 500cm^3 of solution.		

Calculations involving weak acids and bases

Question	$[H^+] = \sqrt{Ka \times \text{concentration of acid}}$	$pH = -\log_{10}[H^+]$
Find the pH of a solution containing 0.2M of a weak acid, with a dissociation constant of 6.3×10^{-5} units. *What is the concentration of a sulphuric acid solution that has the same pH?*		
Find the pH of a solution containing 0.1M of a weak acid, with a dissociation constant of 2.1×10^{-4} units.		
. Find the pH of a solution containing 0.1M of a weak acid(nitrous acid), with a dissociation constant of 5.0×10^{-4} units. *What is the pH of a nitric acid that has the same concentration?*		
Find the pH of a solution containing 1.48g of propanoic acid. (CH_3CH_2COOH) in 200ml of water , with a dissociation constant of 1.36×10^{-5} units.		

pH of weak acids and bases

Question	$[H^+] = \sqrt{Ka \times \text{concentration of acid}}$	$pH = -1 \log_{10}[H^+]$
Find the pH of a solution containing 0.01M of ammonia , with a dissociation constant of 1.8×10^{-5} units.		
Find the pH of a solution containing 0.002M of a weak acid , with a dissociation constant of 1.8×10^{-4} units.		
Find the pH of a vinegar solution containing 4.5g per 100ml of water , with a dissociation constant of 1.8×10^{-5} units.		

- Most indicators are weak acids. The colour is different in the undissociated molecule the dissociated molecule. In order to understand the colour change in indicators we will have to study equilibrium .

- $HIn \qquad H^+ + Hn^-$