8.3 The pH scale

quantitative scale = acid strength based on $[H^+]$
Most acids weak ∴ have extremely small #'s ∴ created

$pH = -\log[H^+]$ or $[H^+] = 10^{-pH}$

pH is a negative # to which base 10 is raised to give $[H^+]$

$[H^+] = 0.1$ mols $dm^{-3} = 10^{-1}$ mols dm^{-3} ∴ pH = 1
$[H^+] = 0.01$ mols $dm^{-3} = 10^{-2}$ ∴ pH = 2

* useful for quantifying acid strength

1) pH #'s usually positive w/ no units
theoretically infinite → most acids / bases fall in 0-14 range (1 mols dm^{-3} to 10^{-14} mol dm^{-3})

2) pH # inversely related to $[H^+]$
solns w/ higher $[H^+]$, lower pH #
(strong = low pH / weak = high pH)

3) Change of 1 pH = 10-fold change in $[H^+]$
↑ pH by 1, ↓ $[H^+]$ by factor of 10
↓ pH by 1, ↑ $[H^+]$ by 10

pH scale is logrithmic:
- compresses wide range of $[H^+]$ into small scale #'s $\therefore$ small pH change = large $\Delta[H^+]$

pH = pOH $\uparrow [H^+] \downarrow [OH^-]$ (vice versa)
(both present in aq solns)

pH 0 $\longleftarrow$ 7 $\longrightarrow$ 14
pOH 14   7   0
$\uparrow$ acidity $\uparrow$ alkalinity

pH calculations:
1) calc value of pH from known $[H^+]$
2) calc $[H^+]$ from known pH value

examples pg 357

Measuring pH
- color $\longrightarrow$ universal indicator (wide range)
  specific indicator (narrow range)
  ☆ ability to interpret color
- pH meter/probe $\longrightarrow$ accurate measurements
  must be calibrated w/ buffer soln &
  standardized for temp as pH is temp
  dependent

Ionization of water

- majority of a/b rxns involve ionization in aq solns

- H_2O ionizes as well

$$H_2O\,(l) \rightleftharpoons H^+\,(aq) + OH^-\,(aq)$$

$$K_c = \frac{[H^+][OH^-]}{[H_2O]} \longrightarrow \text{small } K_c \therefore [H_2O] \text{ is constant}$$

$$\downarrow$$

$$K_c[H_2O] = [H^+][OH^-]$$

$$\downarrow$$

$$K_w = [H^+][OH^-]$$

K_w ↓ ionic product constant of water

fixed value @ 298K, 1.00×10^{-14}

pure $H_2O \Rightarrow [H^+] = [OH^-] \quad \therefore [H^+] = \sqrt{K_w}$

$= 1.00 \times 10^{-7}$, pH = 7

$[H^+]$ + $[OH^-]$ inverse relationship b/c $[H^+][OH^-] = \underbrace{K_w}_{\text{constant value}}$

at 298K	acid	$[H^+] > [OH^-]$	pH < 7
	base	$[H^+] < [OH^-]$	pH > 7
	neutral	$[H^+] = [OH^-]$	pH = 7

if know $[H^+]$ or $[OH^-]$ + K_w, can find unknown

example : $[H^+] = 4.60 \times 10^{-8}$ mols dm^{-3}

$$K_w = [H^+][OH^-]$$
$$1.00 \times 10^{-14} = (4.60 \times 10^{-8})[OH^-]$$
$$2.17 \times 10^{-7} = [OH^-]$$

$[OH^-] > [H^+]$ ∴ soln basic