

8.3 The pH scale

quantitative scale = acid strength based on $[H^+]$
most acids weak \therefore have extremely small
#s \therefore created

$$pH = -\log [H^+]$$

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

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

$$[H^+] = 0.1 \text{ mol dm}^{-3} = 10^{-1} \text{ mol dm}^{-3} \therefore pH = 1$$

$$[H^+] = 0.01 \text{ mol dm}^{-3} = 10^{-2} \therefore pH = 2$$

* useful for quantifying acid strength

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

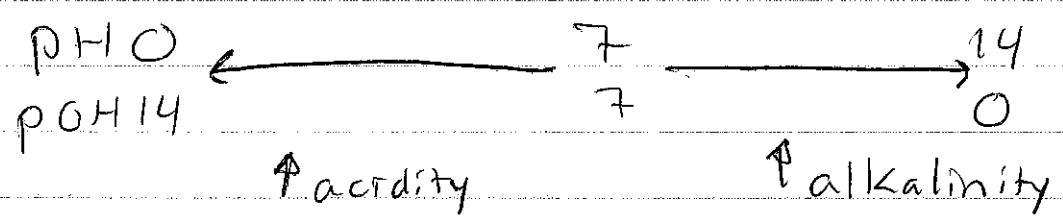
2) pH # inversely related to $[H^+]$
solns w/ higher $[H^+]$, lower pH #
(strong = low pH / weak = high pH)

3) change of 1 pH = 10-fold change in $[H^+]$
 \uparrow pH by 1, \downarrow $[H^+]$ by factor of 10
 \downarrow pH by 1, \uparrow $[H^+]$ by 10

pH scale is logarithmic:

- 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 calculations:

- 1) calc value of pH from known $[H^+]$
 - 2) calc $[H^+]$ from known pH value
- examples pg 357

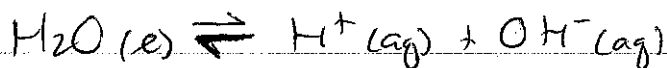
Measuring pH

- color \rightarrow universal indicator (wide range)
specific indicator (narrow range)
 \uparrow ability to interpret color
- pH meter/probe \rightarrow 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



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

↓

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

↓

$$K_w = [H^+][OH^-] \quad \text{in.}$$

↓
ionic product constant of water

fixed value @ 298K, 1.00×10^{-14}

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

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

$[H^+] + [OH^-]$ inverse relationship b/c $[H^+][OH^-] = K_w$
 ↓
 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 : $[H^+] = 4.60 \times 10^{-8} \text{ mols dm}^{-3}$

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

$$1.00 \times 10^{-14} = (4.60 \times 10^{-8})[OH^-]$$

$$2.17 \times 10^{-7} = [OH^-]$$

$[OH^-] > [H^+] \therefore \text{soln basic}$