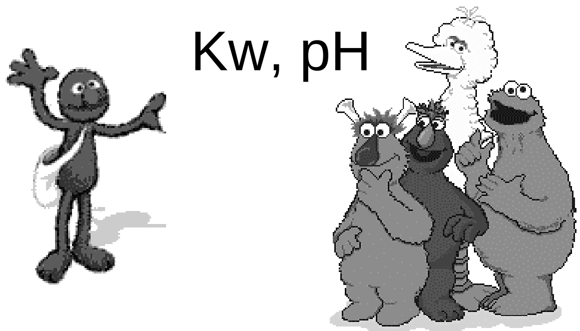
Today's lesson is brought to you by 7, 14, and the letters

Kw, pH



Kw: the ion-product constant of water

Q: will pure distilled water conduct electricity
A: As the demo shows, it will (slightly).

- If water conducts electricity, ions must exist
- Water exists as an equilibrium, which is referred to as the self-ionization of water:

$$H_2O + H_2O \leftrightarrow H_3O^+(aq) + OH^-(aq)$$

$$Kc = \frac{[H_3O^+]\,[OH^-]}{[H_2O]^2} \quad \text{or} \quad Kw = [H_3O^+]\,[OH^-]$$

Simplified reaction: $H_2O \leftrightarrow H^+(aq) + OH^-(aq)$

$$Kc = \frac{[H^+]\,[OH^-]}{[H_2O]^2} \quad \text{or} \quad Kw = [H^+]\,[OH^-]$$

Note: H^+ is just shorthand for H_3O^+

Kw

- What is the value of Kw?
- It has been measured at 1.0×10^{-14} (25 °C)
- Notice (pg. 600) that by definition:

when	the solution is
$[H^+] > [OH^-]$	acidic
$[H^+] < [OH^-]$	basic
$[H^+] = [OH^-]$	neutral

- Pure water is neutral since $[H^+]$ and $[OH^-]$ must be identical (both come from one H_2O)
- As temperature increases Kw increases

Q: Rewrite the equilibrium of water with heat as a product or reactant (based on above point)
Q: Do PE 1 (refer to example 15.1)

pH

- Notice (PE1) that a change in $[H^+]$ is matched by a change in $[OH^-]$, since Kw is constant (see middle columns of table 15.2 – pg. 603)
- $[H^+]$ is commonly referred to because it is critical to chemical and biochemical reactions
- A quick method of denoting $[H^+]$ is via pH
- By definition $pH = -\log [H^+]$
- The pH scale, similar to the Richter scale, describes a wide range of values
- An earthquake of '6' is10x as violent as a '5'
- Thus, the pH scale condenses possible values of $[H^+]$ to a 14 point scale
- Also, it is easier to say pH=7 vs. $[H^+]=1\times10^{-7}$

Calculations with pH

- $pH = -\log [H^+]$, what is pH if $[H^+] = 6.3 \times 10^{-5}$?
  Enter 6.3×10^{-5} ('6.3', 'exp', '5', '+/-')
  Then hit 'log', followed by '+/-'
- What is $[H^+]$ if pH = 7.4?
- To solve this we must rearrange our equation
  $[H^+] = 10^{-pH}$ mol/L
  Enter '10', 'x^y', '7.4', '+/-', '='
- Finally, notice on pg. 603 that pH + pOH = 14
- This is related to $Kw = 1.0 \times 10^{-14}$
- You do not need to know how equations are derived; you need to know how to use them

Equations and practice

- You will need to memorize the following:

$$[H^+] = 10^{-pH}$$
$$[OH^-] = 10^{-pOH}$$
$$pH = -\log [H^+]$$
$$pOH = -\log [OH^-]$$
$$pH + pOH = 14$$

- Read footnote on 601 about significant digits
- Do PE 2 – 4 on pg. 605
- Use examples 15.2 – 15.4 as reference

Measuring pH

- pH can be measured in several ways
- Usually it is measured with a coloured acid-base indicator (see pg. 606) or a pH meter
- Coloured indicators are a crude measure of pH, but are useful in certain applications
- pH meters are more accurate, but they must be calibrated prior to use
- Calibration means setting to a standard
- A pH meter is calibrated with a solution of known pH often called a buffer
- "Buffer" indicates that the pH is stable

Using pH meters

1. Always rinse pH meter in distilled water prior to placing it in a solution (buffer or otherwise)
2. Place the pH meter in a buffer with about the same pH as that of your solution (4, 7, or 10)
3. While your meter is in the buffer, turn the dial on the back so the pH reads the same as the known pH of the buffer (adjust with a key)
   - Some meters have both 7 and 4/10 dials
   - If you have only a 7 dial, adjust pH with this
   - If you have both, first use the 7 in buffer 7, then the 4/10 in a second buffer (4 or 10)
4. Measure the pH of your solution