Introduction to Acids & Bases

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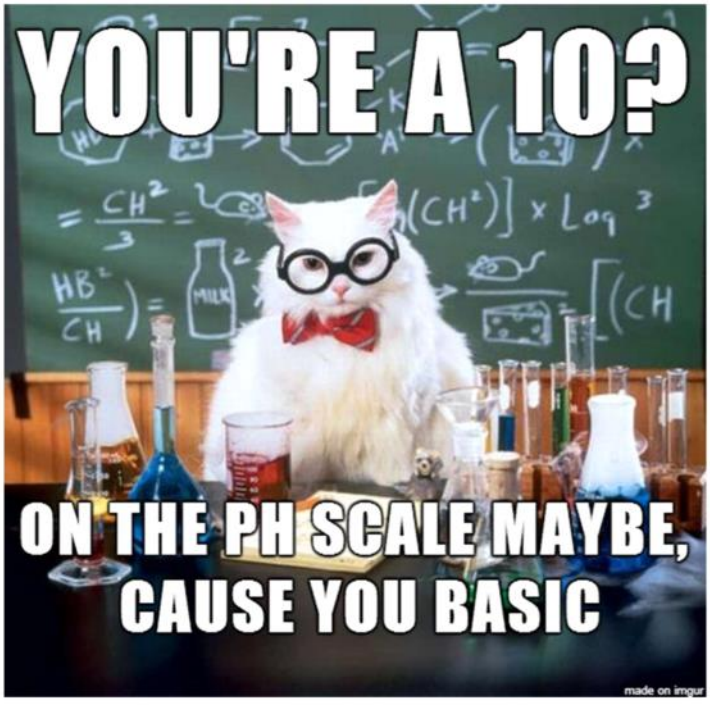
Chemistry 12

Unit IV



Acid/Base I

Name:_____ Block:_____

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[Acid-Base Reactions in Solution: Crash Course Chemistry #8]

I) Introduction to Acids and Bases

"hydrogen proton"
$H^+(aq) = H_3O^+$

What is an acid?

a substance that donates an H^+ to another substance

What are properties of acids?

1. Acids react with bases.
2. Acids create electrolytes (ions) in solution and therefore conduct ⊕/⊖. → acids dissociate in water
3. Acids react with some metals to produce H_2 gas.
   e.g. $2HCl_{(aq)} + Mg_{(s)} \longrightarrow H_{2(g)} + MgCl_{2(aq)}$
4. Acid turns litmus paper Red.
5. Acids taste sour.
6. Acids donate H^+ to other substances.

What is a base?

a substance that accepts H^+ from another substance

What are properties of bases?

1. Bases react with acids.
2. Bases create electrolytes (ions) in solution and therefore conduct ⊕/⊖. → dissociate in water
3. Bases feel slippery.
4. Bases turn litmus paper BLUE.
5. Bases taste bitter.
6. Bases accept H^+ from other substances.

II) Arrhenius Acids and Bases

Svante Arrhenius was a Swedish scientist who lived from 1859-1927. In 1884, he proposed the following definitions for acids and bases.

Arrhenius Acid: a substance that releases H^+ in water

Arrhenius Base: a substance that releases OH^- in water

but... not all bases contain OH. *bases that contain OH^- "Arrhenius base"

These definitions stood until 1923, when they were revised by Bronsted (Danish) and Lowry (English), as we will see shortly.

When an acid reacts with a base (one which contains OH^-), what is produced?

e.g. $HCl_{(aq)} + NaOH_{(aq)} \Rightarrow H_2O_{(\ell)} + NaCl_{(aq)}$

acid + base makes water + salt

The OH^- acts as the base and takes the H^+ to make H_2O.

What type of reaction is this? Double replacement/displacement .... more specifically Neutralization

Acids and bases are both harmful substances, but if they react in stoichiometric amounts (so that there is no excess acid or base left over), the products are not harmful (water + salt).

What is a salt? ionic compound (metal$^{\oplus}$ + non-metal$^{\ominus}$)

When the salt is produced in an acid-base reaction, depending on what salt is produced, what two results can occur?

- if the salt is SOLUBLE $_{(aq)}$ it will remain dissociated as aqueous ions in solution ("spectator ions")
- if the salt is LOW SOLUBILITY $_{(s)}$, it [may] precipitate out of solution as a solid.

Another example: $H_2SO_{4(aq)} + Sr(OH)_{2(aq)} \Rightarrow 2H_2O_{(\ell)} + SrSO_{4(s)}$

acid + base water + salt (low solubility salt.)

$H^+_{(aq)}$ H_3O^+

What is a Net Ionic Equation?

include only the ions → products that react (chemically change)

What is the net ionic equation of the reaction above?

$2H^+_{(aq)} + SO_4^{2-}{}_{(aq)} + Sr^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow 2H_2O_{(l)} + SrSO_{4(s)}$

water + LS salt.

What is the net ionic equation of the first neutralization equation we looked at (remember, only the things that change are included in the net.

Formula Eq: $HCl_{(aq)} + NaOH_{(aq)} \rightarrow H_2O_{(l)} + NaCl_{(aq)}$ ← (soluble salt)

Net Ionic: $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$

Assignment 1: Hebden Read p.109-114 and do p.112 #1-4

III) Bronsted-Lowry Acids and Bases Part 1

Bronsted-Lowry definitions from 1923 → onwards.

Bronsted-Lowry Acid: a substance that donates an H^+ to another substance.

Bronsted-Lowry Base: a substance that accepts a H^+ from another substance

Practice: Label each reactant as an acid or a base depending on if it donates H^+ or accepts H^+. Some of the reactions are 100% and some are at equilibrium. You will learn why soon.

1. $HCl + H_2O \Rightarrow H_3O^+ + Cl^-$ (A, B; $+H^+$)
2. $NH_3 + H_2O \Leftrightarrow NH_4^+ + OH^-$ (B, A)

#1 H_2O is accepting a H^+ ∴ Base
#2 H_2O is donating a H^+ ∴ Acid

What's different about H_2O in #1 compared to 2?

3. $CO_3^{2-} + H_2O \Leftrightarrow HCO_3^- + OH^-$ (B, A)

Why can CO_3^{2-} only be a base? acids donate H^+ and CO_3^{2-} has no hydrogen. can never be an acid.

4. $HPO_4^{2-} + HBr \Rightarrow H_2PO_4^- + Br^-$ (B, A)
5. $HPO_4^{2-} + HCO_3^- \Leftrightarrow H_2PO_4^- + CO_3^{2-}$ (B, A)
6. $H_2PO_4^- + HF \Leftrightarrow H_3PO_4 + F^-$ (B, A, A)
7. $H_2PO_4^- + H_2O \Leftrightarrow HPO_4^{2-} + H_3O^+$ (A, B)

*some substances, like $H_2PO_4^-$ can both accept or donate a H^+. we call these "amphiprotic"

What's different about $H_2PO_4^-$ in #6 & 7?

Notice from the practice equations that when bases do not contain OH^-, the products are not water and salt. Why is water not a product?

In a neutralization rxn where H_2O is formed, the H^+ comes from the acid and the OH^- from the base. Therefore if the base doesn't contain OH, the product CAN NOT be water. (only "Arrhenius bases" will form H_2O ↳ have OH)

Assignment 2: Read Hebden p.116 & do p.117 #11