Unit 9 – Acids and Bases

- Acids, Bases
- pH
- Reactions

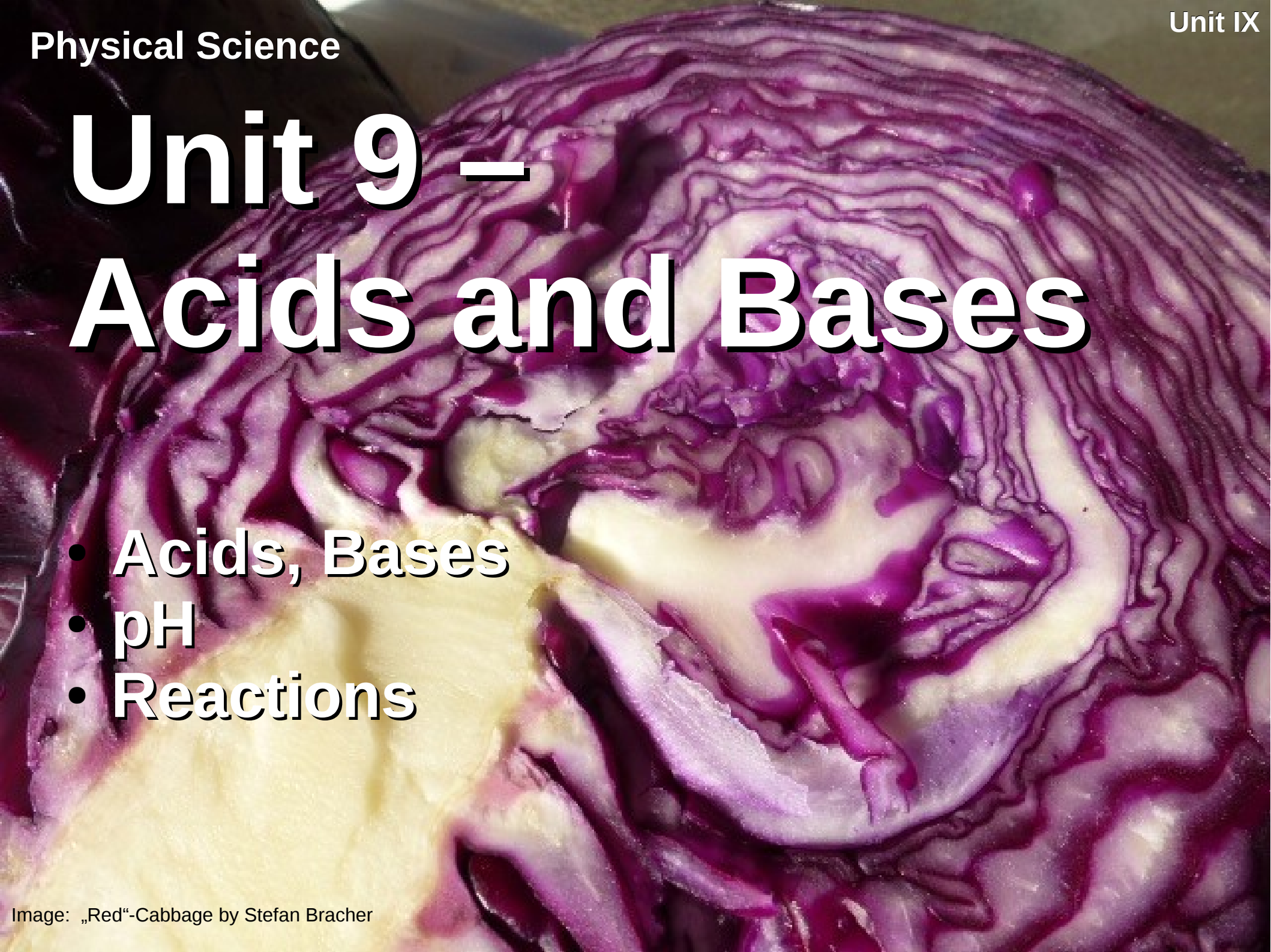


Image: „Red“-Cabbage by Stefan Bracher

Competencies

The student will be able to:

- define an acid and a base according to the Arrhenius Theory.
- **name and write formulas of common acids and bases described in class.**
- describe tests that can be used to distinguish between an acid, base and a salt.
- **list three properties of acids and three properties of bases.**
- describe the auto-ionization of water.
- **define pH, and given H^+ concentration as 10^{-x} mol/L calculate pH = x and given pH = y calculate H^+ concentration as 10^{-y} for integers between 1 to 14.**
- describe the difference between a weak and a strong acid, and between a weak and a strong base.
- describe the relative acidity of a solution, given the pH.
- define and describe electrolytes, electrical conductivity in solutions, and relative strength of electrolytes
- define and describe indicators; name two indicators and describe their colour changes.
- **write and balance neutralization reactions between acids and bases.**

Introduction

Do it at home experiment: “Red”-Cabbage https://youtu.be/MNr4NBCpUQA

Images: Stefan Bracher

Acids

Acids:
- Compounds in aqueous solution formed by hydrogen and an anion (except hydroxide)
- Produce H^+ or H_30^+ (Hydronium) in water
- Have a sour taste
- Are electrolytes
- Neutralize bases

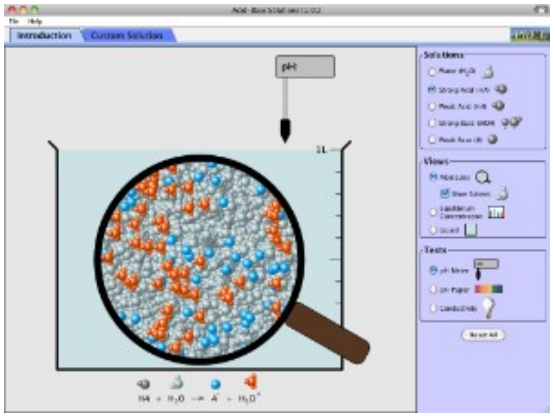
$HXYZ \rightarrow H^+(aq) + XYZ^-(aq)$

Formula: HXYZ

Ionizable Hydrogen Atom(s)

Examples:

hydrochloric acid	HCl(aq)
sulfuric acid	H_2SO_4
sulfurous acid	H_2SO_3



Phet-Simulation:
http://phet.colorado.edu/sims/html/acid-base-solutions/latest/acid-base-solutions_en.html

Acids - Nomenclature

Acids – Nomenclature: (see Unit 5)

Anion Name	Acid Type	Acid Name
…+ ide	Binary acid	hydro + anion + ic acid
… + ate	Oxy-acid (Anion contains Oxygen)	anion + ic acid
… + ite	Oxy-acid (Anion contains Oxygen)	anion + ous acid

Don't forget to determine the correct amount of hydrogen in the formula, based on the charge of the anion!

Examples:

hydrochloric acid	HCl(aq)
sulfuric acid	H_2SO_4
sulfurous acid	H_2SO_3

Bases

Bases:
- Produce OH^- in water
- Have a bitter taste
- Feel soapy
- Are electrolytes
- Neutralize acids

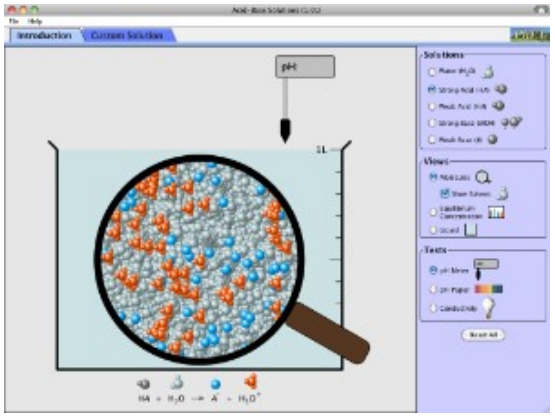
$XYZOH \rightarrow XYZ^+(aq) + OH^-(aq)$

Formula: **XYZOH**

Nomenclature: Follows the rules of ionic compounds → See Unit 5

Examples:

sodium hydroxide	NaOH
aluminum hydroxide	$Al(OH)_3$
iron (III) hydroxide	$Fe(OH)_3$



→ Do Unit IX Problem 2, 3, 4

Phet-Simulation:
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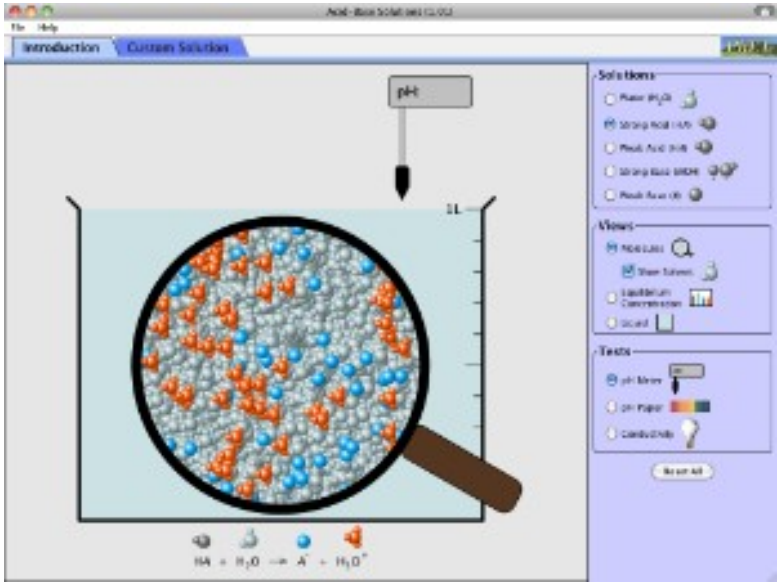
Auto-ionization of water

$$2\ H_2O \leftrightarrow H_3O^+ + OH^-$$



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http://phet.colorado.edu/sims/html/acid-base-solutions/latest/acid-base-solutions_en.html

Indicators

Indicator	Acid solution	Neutral solution	Basic solution
Litmus	red		blue
Phenolphthalein	transparent		red
Cyanidin	red	purple	blue

Red cabbage,
raspberry and others

Images: Stefan Bracher

→ Do Unit IX Problem 1

Reactions

Neutralization:

Acid + Base → Salt + Water

$2HCl(aq) + Ca(OH)_2(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$

Others:

Acid + Metal → Salt + Hydrogen

$2HCl(aq) + Zn(s) \rightarrow ZnCl_2(aq) + H_2(g)$

Acid + Carbonate → Salt + Water + CO_2

$(CH_3CO_2)H + NaHCO_3 \rightarrow Na(CH_3CO_2) + H_2O + CO_2$

pH

pH: - Logarithmic scale to measure the acidity of a solution
- pH < 7 : Acidic
- pH > 7 : Basic

Logarithms

$x=10^{Y} \leftrightarrow y=\log_{10}(x)$

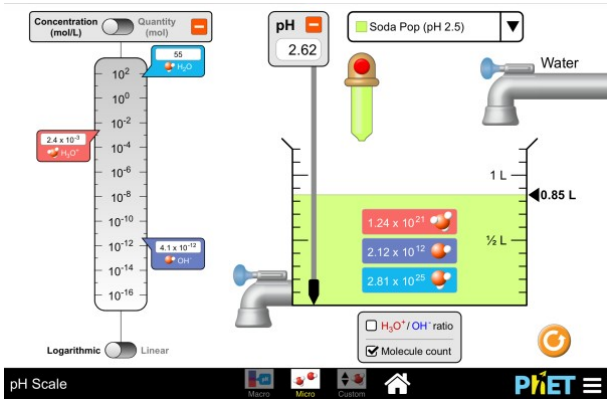
pOH

$pOH = - \log [OH^-]$

$pH + pOH = 14$

pH ⟵ $pH = - \log [H^+]$ ⟶ $[H^+] = 1 \times 10^{-pH}$ ⟶ H^+ Molarity

Molarity	pH	Nature	Example
1.0×10^{-2}	2	Acidic	Lime juice, Vomit
1.0×10^{-5}	5	Acidic	Coffee
1.0×10^{-7}	7	Neutral	Pure Water
1.0×10^{-8}	8	Basic	Detergents
1.0×10^{-12}	12	Basic	Bleach



Phet Simulation: http://phet.colorado.edu/sims/html/ph-scale/latest/ph-scale_en.html

→ Do Unit IX Problems 5-11

Additional Resources

- Acid-Base Equillibria, OpenStax „College Chemistry“
http://cnx.org/contents/havxkyvS@9.230:UhWgb0n7@3/Introduction