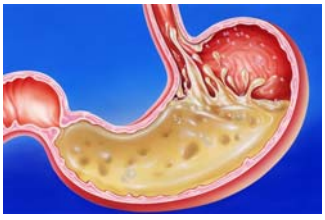
Grade 10 Science

Chemical Reactions

Class 3

Acids

- Acids – an aqueous solution that:
  - Conducts electricity
  - Tastes sour (don't taste test!)
  - Neutralizes base
- Commonly found in:
  - Preservatives
  - Digestive juices
  - Citrus fruits (lemons, oranges)
  - Soda pop



Reactions with Acids

- Reaction with Metals – typically produce hydrogen gas

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

- Reaction with Nonmetals – typically produce carbon dioxide gas

$$CH_3COOH + NaHCO_3(aq) \rightarrow CO_2(g) + H_2O(l) + NaCH_3COO\ (aq)$$

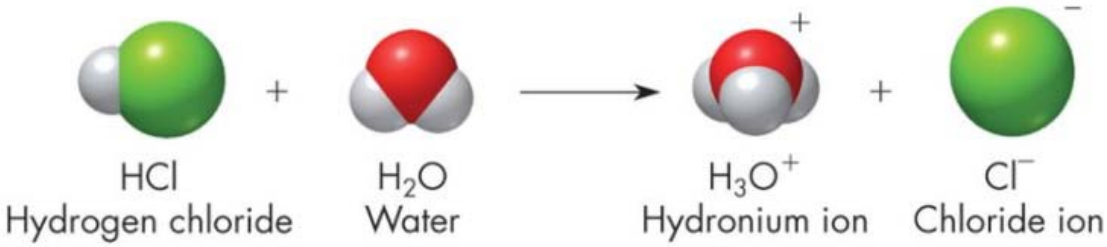
- Conductivity – breaks apart into ions

$$HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)$$

Arrhenius Acid

- An acid is any substance that release a H^+ when they dissolve in water

  – Ex: $HCl(aq) + H_2O \rightarrow H_3O^+(aq) + Cl^-(aq)$



- Common Binary Acids

Acid name	Chemical formula	Use
hydrofluoric acid	HF(aq)	etching glass
hydrochloric acid	HCl(aq)	cleaning concrete
hydrobromic acid	HBr(aq)	to make cleaning compounds
hydrosulfuric acid	H_2S(aq)	purifying metals

- Common Oxyacids

Acid	Chemical formula	Related polyatomic ion	Polyatomic ion name
acetic acid	$HC_2H_3O_2$(aq)	$C_2H_3O_2^-$(aq)	acetate
nitric acid	HNO_3(aq)	NO_3^-(aq)	nitrate
carbonic acid	H_2CO_3(aq)	CO_3^{2-}(aq)	carbonate
sulfuric acid	H_2SO_4(aq)	SO_4^{2-}(aq)	sulfate
phosphoric acid	H_3PO_4(aq)	PO_4^{3-}(aq)	phosphate

Base

- Base – a substance that:
  - Conducts electricity
  - Tastes bitter (don't taste test!)
  - Feel slippery
  - Neutralizes acids
- Common Uses:
  - Soap
  - Antacids (Tums, Alka-Seltzer, Milk of Magnesia)
  - Baking Soda (HCO_3^-)

Arrhenius Base

- Base is a substance that releases OH^-

$$Ba(OH)_2(aq) \rightarrow Ba^{2+}(aq) + 2OH^-(aq)$$

Base	Chemical formula	Uses
sodium hydroxide	NaOH(aq)	making paper
calcium hydroxide	$Ca(OH)_2(aq)$	decreasing the acidity of lakes and soil
ammonium hydroxide	$NH_4OH(aq)$	window cleaners
magnesium hydroxide	$Mg(OH)_2(aq)$	antacids
aluminum hydroxide	$Al(OH)_3(aq)$	heartburn medications
sodium hydrogen carbonate (baking soda)	$NaHCO_3(aq)$	making baked goods rise an abrasive cleaner

Checkpoint

Name the following and categorize each as an acid or base:

a) H_3PO_4 (aq)

b) HBr (aq)

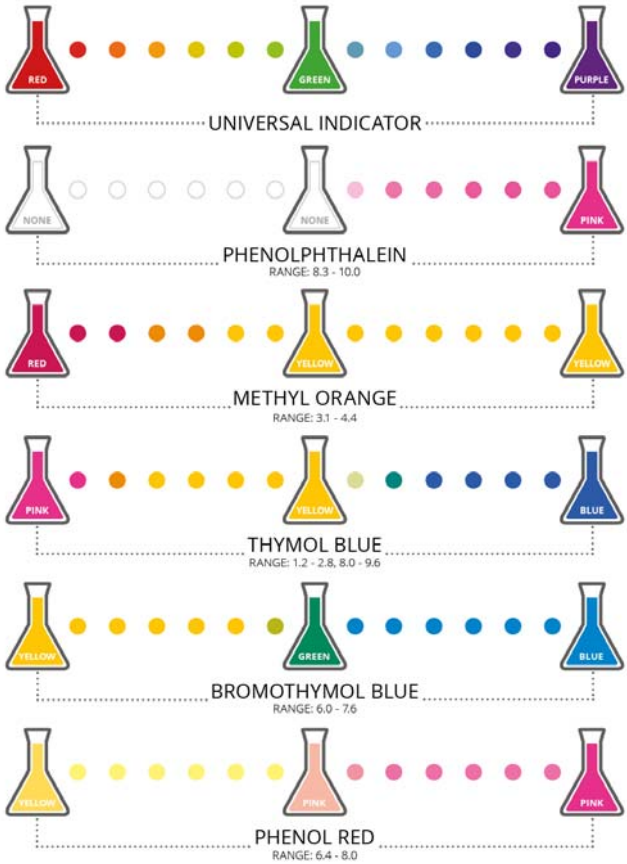
c) $Fe(OH)_3$

d) $Ca(HCO_3)_2$

Acid-Base Indicators

- A substance that changes colour depending on whether something is an acid or base

Indicator	Colour in acid	Colour in base
bromothymol blue	yellow	blue
phenolphthalein	colourless	pink
phenol red	yellow	red/pink
litmus	red	blue
methyl orange	red	orange/yellow

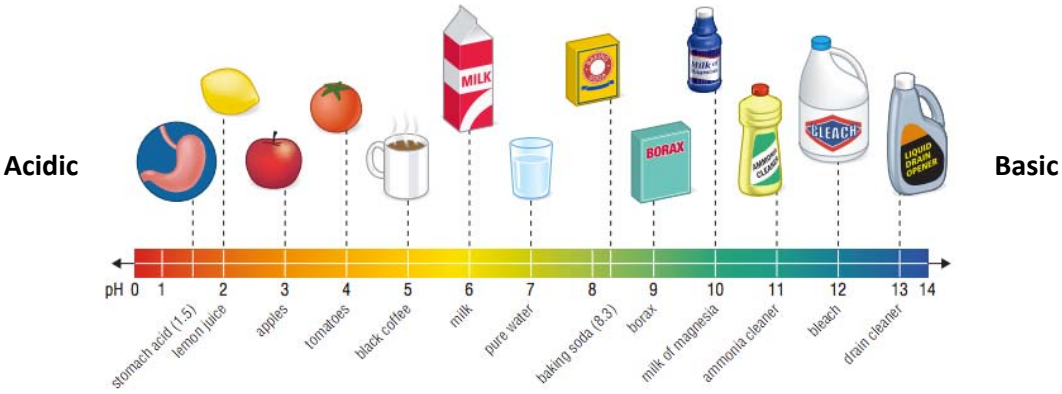


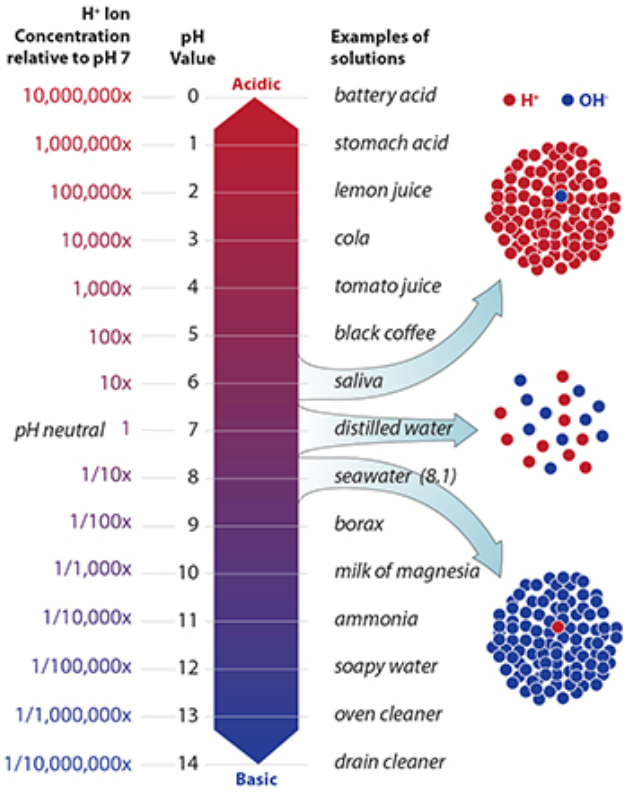
Checkpoint

You are looking for the identity of Substance X. If you add bromothymol blue and Substance X turns yellow, is Substance X acidic or basic?

pH Scale (Power of Hydrogen)

- pH – a measure of acidity and basicity
- pH scale – a numerical scale ranging from 0 to 14 that is used to compare the acidity of solutions





The pH scale is a logarithmic scale

- pH change from 7 to 8 represents a 10X change
- pH change from 7 to 9 represents a 100X change

- pH measures the concentration of H^+ in solution
  - pH < 7 is acidic
  - pH = 7 is neutral
  - pH > 7 is basic
- Ex: HCl → **H^+** + Cl^- (acidic because HCl dissociates into a large number of H^+)
- Ex: NaOH → Na^+ + **OH^-** (basic because more hydroxide ions than hydrogen ions)
- Ex: H_2O → **H^+** + **OH^-** (neutral because hydrogen and hydroxide balance out)

Checkpoint

List the following from most acidic to most basic

Table 1 The pH of Four Liquids

	Liquid	pH
(a)	milk	6
(d)	lemon juice	2
(c)	vinegar	3
(d)	ammonia	11

Checkpoint

Substance A has a pH of 13. Substance B has a pH of 8.

a) How many times did the concentration change from Substance A to Substance B?

b) Which substance is more acidic?

c) Which substance is more basic?

Neutralization Reactions

- A chemical reaction in which an acid and base react to form an ionic compound and water

$$HCl + NaOH \rightarrow NaCl + H_2O$$

acid + base → water + ionic compound

- This is also a double displacement reaction

Predicting Neutralization Products

- Predict the products of the following:

$$HBr(aq) + LiOH(aq) \rightarrow ?$$

1. Identify the acid and the base.

   HBr = acid LiOH = base

2. Break the compounds into their respective ions and polyatomic ions.

$$H^+ Br^- + Li^+ (OH)^- \rightarrow$$

3. Apply the AB + CD → AD + CB pattern.

AB + CD → AD + CB

$H^+ Br^-$ + $Li^+ (OH)^-$ → $H^+ (OH)^-$ + $Li^+ Br^-$

4. Rewrite the reaction without the ionic charges. Turn HOH into H_2O.

$HBr\,(aq)$ + $LiOH$ → H_2O + $LiBr$

Checkpoint

Predict the products of the following neutralization reactions. Remember to balance the equation!

a) Hydrobromic acid + Sodium hydroxide

b) $HI(aq) + NH_4OH(aq)$

c) Phosphoric acid + Potassium hydroxide

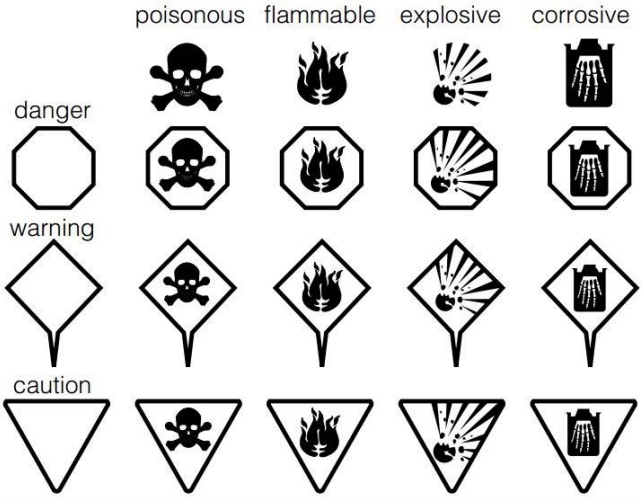
pH in Agriculture

- pH of soil can affect how well crops grow
  - Legumes grow well in slightly basic soil (pH 7-10)
  - Corn thrives in mildly acidic soil (pH 5-6)
  - Potatoes grow best in acidic conditions (pH<5)
- **Acid Leaching** – process of adding an acid solution to soil that is contaminated with heavy metals (basic) from batteries
  - Very expensive and disruptive to ecosystem

- **Phytoremediation** – the use of certain plants to absorb the metal toxins; plants are then harvested and burned
  - Ex: Sunflowers can extract heavy metals
  - Ex: Aspen trees can remove lead from water

pH in Consumer Products

- Cleaning products are very basic with high concentrations of OH^-
- Look for Hazardous Household Products Symbols



- pH of swimming pools should be 7.2-7.8
  - If pH is less than 7, pool water will irritate eyes
  - If pH is greater than 8, pool water becomes cloudy and chlorine compounds used to disinfect the pool loses its effectiveness
- Pool pH test kits are used to monitor pH
  - Add HCl(aq) (aka muriatic acid) to reduce pool pH
  - Add Na_2CO_3 (aq) to increase pool pH

Acid Precipitation

- Acid precipitation – when pollutants combine with water and fall to the Earth as rain, snow or fog
  - Most common pollutants are:
    - $NO_X(g)$ reacts with water to form $HNO_3(aq)$
    - $SO_2(g)$ reacts with water to form $H_2SO_4(aq)$
  - Normal rainwater pH = 5.6
  - Acid precipitation pH = 4.3 (20X more acidic)

Sulfur Dioxide (SO_2)

- SO_2 is clear, colourless gas with a strong, choking odour
- Main source = Industry

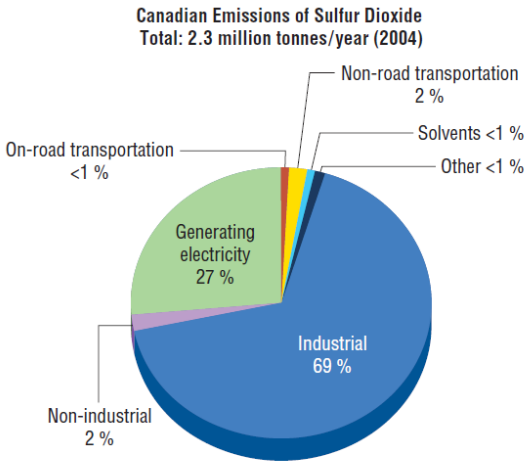


Figure 2 Sources of sulfur dioxide emissions in Canada

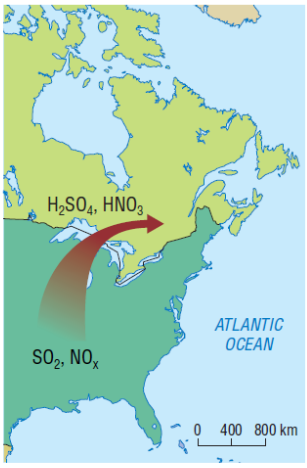


Figure 3 Most of the acid-causing pollutants falling on Ontario come from the United States.

Nitrogen Oxides (NO_x)

- Includes NO and NO_2
- Main Source = Industry and Automobiles
- Produces smog

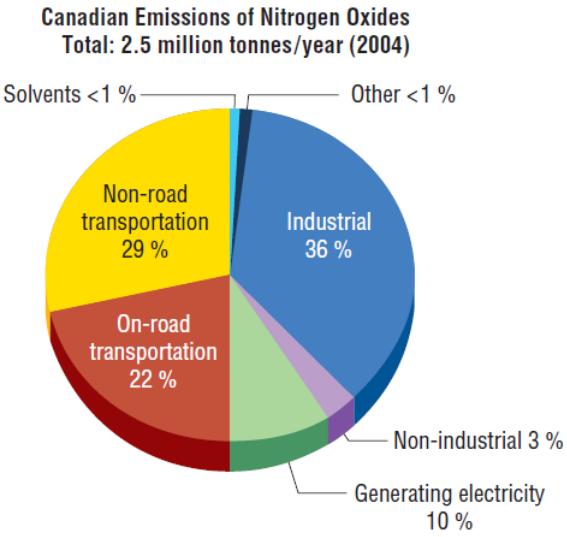


Figure 4 Sources of nitrogen oxide emissions in Canada

Effects of Acid Precipitation

- Reduction in aquatic life
- Acid rain dissolves minerals in the soil
- Weakens forest
- Damages buildings