

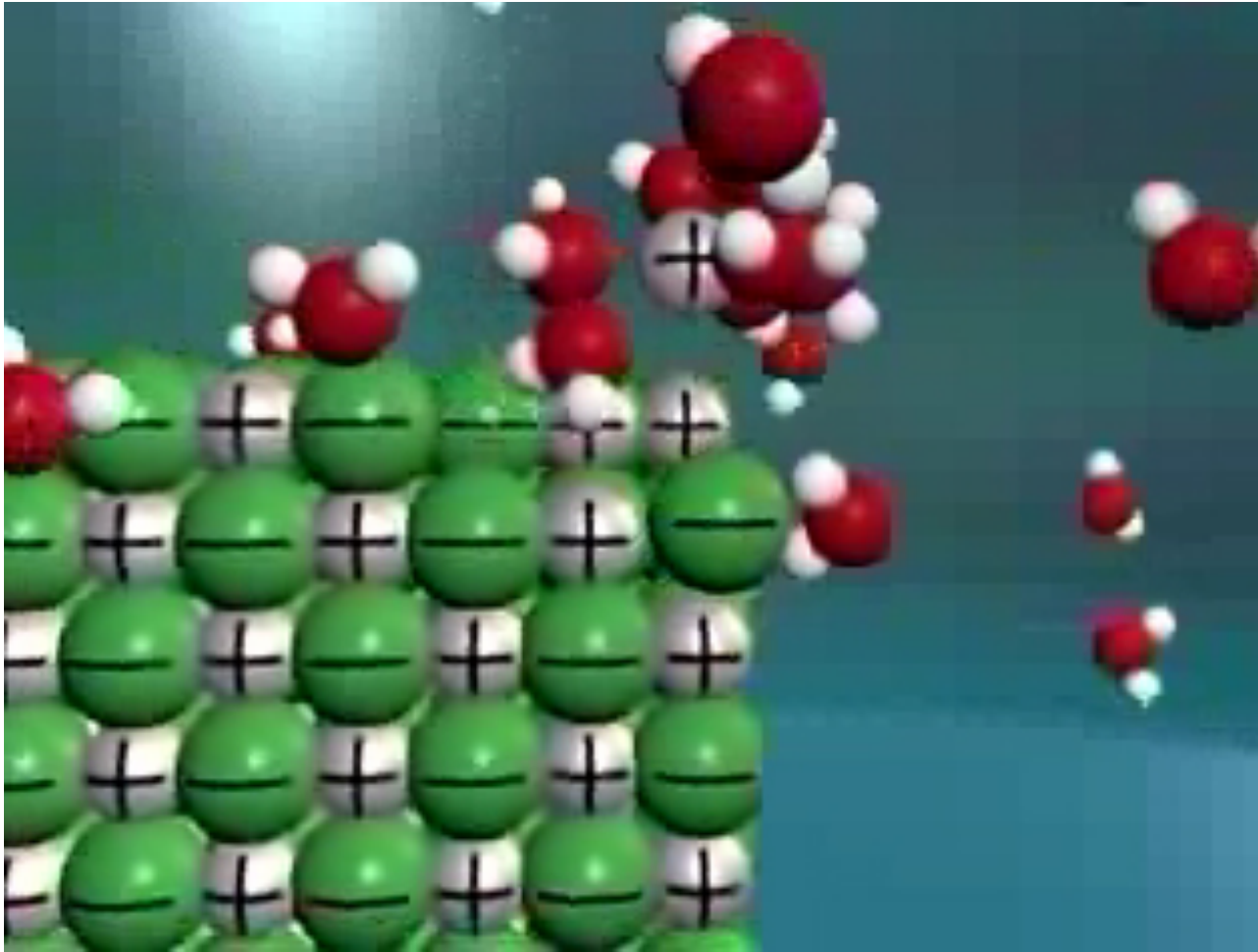
Chapter 4

Aqueous Reactions and Solution Stoichiometry

Solutions:

- Homogeneous mixtures of two or more pure substances.
- The solvent is usually present in greatest abundance.
- Or, the solvent is the liquid when a solid is dissolved
- All other substances are solutes.

Dissociation



- ionic compound dissolves in water
- individual ions are separated.
- dissociation.

ELECTROLYTIC PROPERTIES

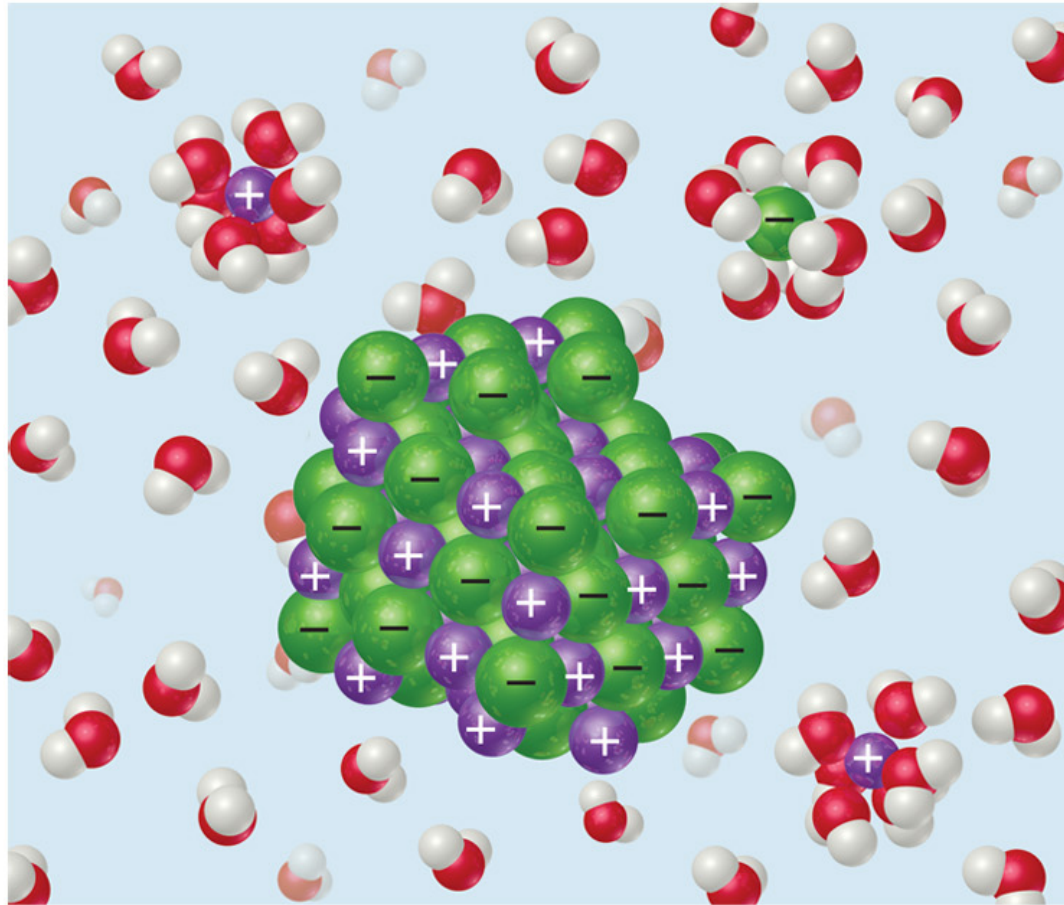
One way to differentiate two aqueous solutions is to employ a device that measures their electrical conductivities. The ability of a solution to conduct electricity depends on the number of ions it contains. An electrolyte solution contains ions that serve as charge carriers, causing the bulb to light.

The diagram consists of three panels, each showing a light bulb connected to a beaker of solution via two electrodes. Below each panel is a circular inset showing the microscopic view of the solution and a text box explaining the results.

- Panel 1 (Left):** The bulb is unlit. The inset shows a circle containing several water molecules (represented by two small spheres, one blue and one white).
 - No ions**
 - A nonelectrolyte solution does not contain ions, and the bulb does not light.
- Panel 2 (Middle):** The bulb is dimly lit. The inset shows a circle containing a few ions (represented by red and blue spheres with '+' or '-' signs) and some water molecules.
 - Few ions**
 - If the solution contains a small number of ions, the bulb will be only dimly lit.
- Panel 3 (Right):** The bulb is brightly lit. The inset shows a circle containing a large number of ions (represented by red and blue spheres with '+' or '-' signs) and some water molecules.
 - Many ions**
 - If the solution contains a large number of ions, the bulb will be brightly lit.

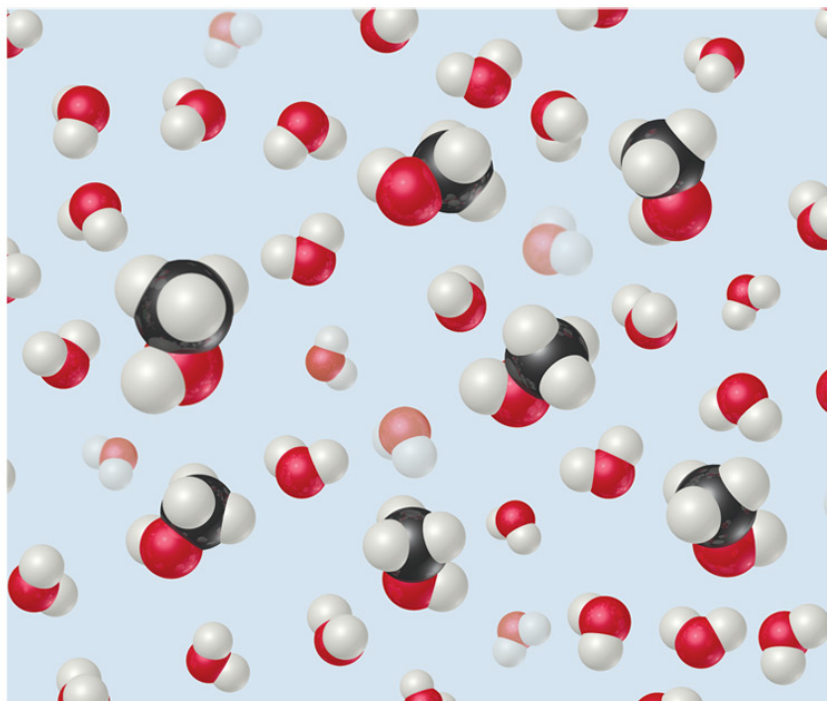
- Substances that dissociate into ions when dissolved in water are electrolytes.
- A nonelectrolyte may dissolve in water,
- but it does not dissociate into ions when it does so.

Electrolytes and Nonelectrolytes



Soluble ionic compounds tend to be electrolytes.

Electrolytes and Nonelectrolytes



Molecular compounds tend to be nonelectrolytes, **except for acids and bases.**

Electrolytes

- A strong electrolyte dissociates completely when dissolved in water.
- A weak electrolyte only dissociates partially when dissolved in water.
- A nonelectrolyte does not dissociate in water

	Strong Electrolyte	Weak Electrolyte	Nonelectrolyte
Ionic	All	None	None
Molecular	Strong acids (see Table 4.2)	Weak acids (H...) Weak bases (NH ₃)	All other compounds

Strong Electrolytes Are...

- Strong acids

Strong Acids	Strong Bases
Hydrochloric, HCl	Group 1A metal hydroxides (LiOH, NaOH, KOH, RbOH, CsOH)
Hydrobromic, HBr	Heavy group 2A metal hydroxides [Ca(OH) ₂ , Sr(OH) ₂ , Ba(OH) ₂]
Hydroiodic, HI	
Chloric, HClO ₃	
Perchloric, HClO ₄	
Nitric, HNO ₃	
Sulfuric, H ₂ SO ₄	

The 7 common strong acids **KNOW THEM**

Strong Electrolytes Are...

- Strong acids
- Strong bases

NOTE THIS IS MORE STUFF YOU NEED TO KNOW

Strong Acids

Hydrochloric, HCl

Hydrobromic, HBr

Hydroiodic, HI

Chloric, HClO₃

Perchloric, HClO₄

Nitric, HNO₃

Sulfuric, H₂SO₄

Strong Bases

Group 1A metal hydroxides (LiOH, NaOH, KOH, RbOH, CsOH)

Heavy group 2A metal hydroxides
[Ca(OH)₂, Sr(OH)₂, Ba(OH)₂]

The strong bases

KNOW THEM!!!!

Strong Electrolytes Are...

- Strong acids
- Strong bases
- Soluble ionic salts
- If the salt doesn't dissolve, it can't conduct.

Exam 1 2019

- Covers chap 1 - 3,
- Chap 1: Matter and measurement
 - Molecules, compounds etc.
 - Separations
 - Units, dimensional analysis, sig figs.
- Chap 2, atoms, molecules, ions.
 - History experiments
 - Gold foil
 - Cathode ray tube
 - Mulliken oil drops
 - radioactivity

Exam 1 2019

- Subatomic particles (2)
 - Alpha particles
 - Beta particles
 - Protons
 - Neutrons
 - Electrons
 - Their properties
- Isotopes
- Atomic and formula weight
- Natural abundance
- Average mass
- Periodic table

Exam 1 2019

- Isotopes
- Atomic and formula weight
- Natural abundance
- Average mass
- Periodic table
- Chemical formulas
- Monoatomic ions
- Ionic compounds
- Polyatomic ions
- Acids
- Naming binary compounds

Exam 1 2019

- Molecules/inorganic compounds/elements (1)
- Sig figs (1)
- Moles (2)
- Homogeneous, heterogeneous, pure mixtures/solutions (1)
- Physical/chemical properties (1)
- Dimensional analysis/conversions (2)
- Periodic table, groups, periods, atomic comp. (1)
- Polyatomic ions/common cations/anions (3)
- Stoichiometry/Limiting reagent/percent cmp (3)
- Balancing chemical equations (2)
- History (1)
- Isotopes (1)
- Naming compounds/ions/acids (1)
- Empirical formula (1)

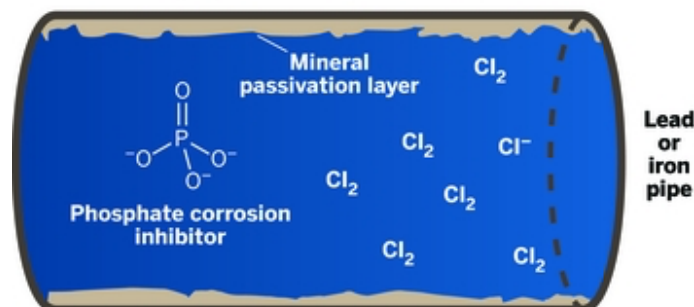
Solubility trends

Soluble Ionic Compounds		Important Exceptions
Compounds containing	NO_3^-	None
	$\text{C}_2\text{H}_3\text{O}_2^-$	None
	Cl^-	Compounds of Ag^+ , Hg_2^{2+} , and Pb^{2+}
	Br^-	Compounds of Ag^+ , Hg_2^{2+} , and Pb^{2+}
	I^-	Compounds of Ag^+ , Hg_2^{2+} , and Pb^{2+}
	SO_4^{2-}	Compounds of Sr^{2+} , Ba^{2+} , Hg_2^{2+} , and Pb^{2+}
Insoluble Ionic Compounds		Important Exceptions
Compounds containing	S^{2-}	Compounds of NH_4^+ , the alkali metal cations, and Ca^{2+} , Sr^{2+} , and Ba^{2+}
	CO_3^{2-}	Compounds of NH_4^+ and the alkali metal cations
	PO_4^{3-}	Compounds of NH_4^+ and the alkali metal cations
	OH^-	Compounds of the alkali metal cations, and NH_4^+ , Ca^{2+} , Sr^{2+} , and Ba^{2+}

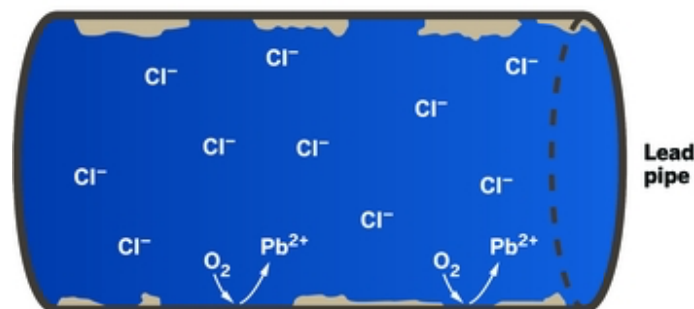
NH_4^+ salts are always soluble

Alkali metal salts are always soluble

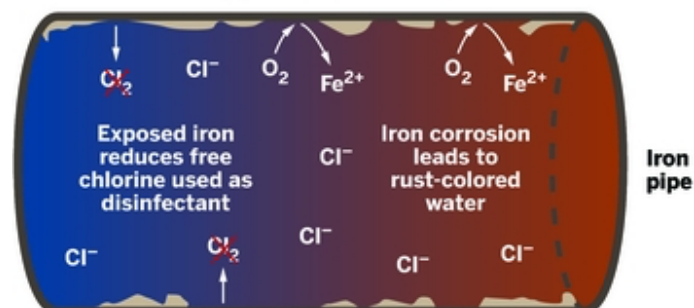
Phosphate corrosion inhibitor helps maintain a mineral passivation layer on the inside of Flint's pipes, protecting them from corrosion. With little corrosion, chlorine disinfectant levels remain stable.



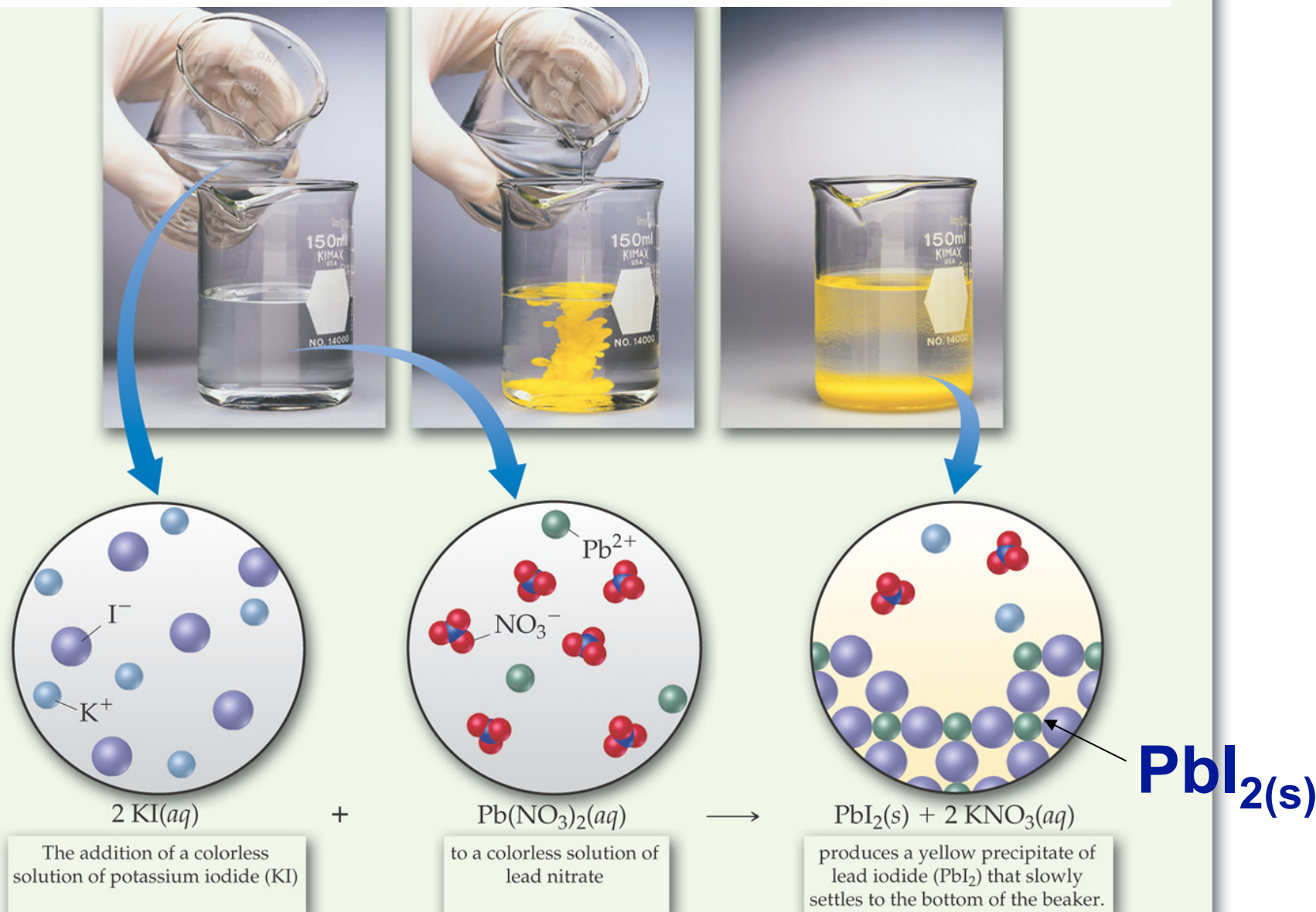
Lack of a corrosion inhibitor, high chloride levels, and other factors cause the passivation layer to dissolve and fall off, leading to increased corrosion in Flint's pipes. As the pipes corrode, chlorine disinfectant breaks down.



Oxidants such as dissolved O_2 corrode pipes and leach soluble metal.



Precipitation Reactions



Metathesis (Exchange) Reactions

- Metathesis comes from a Greek word that means “to transpose”
- It appears the ions in the reactant compounds exchange, or transpose, ions



Metathesis (Exchange) Reactions

- Metathesis comes from a Greek word that means “to transpose”
- It appears the ions in the reactant compounds exchange, or transpose, ions



This is a reaction because the AgCl precipitates. Otherwise, nothing would be happening.



Nothing happens!

Solution Chemistry

- pay attention to *exactly* what species are present in a reaction mixture (i.e., solid, liquid, gas, aqueous solution).
- we must be aware of what is changing during the course of a reaction.

Chemical Equation

The chemical equation lists the reactants and products, but the fact that ions are dissociated must be inferred.



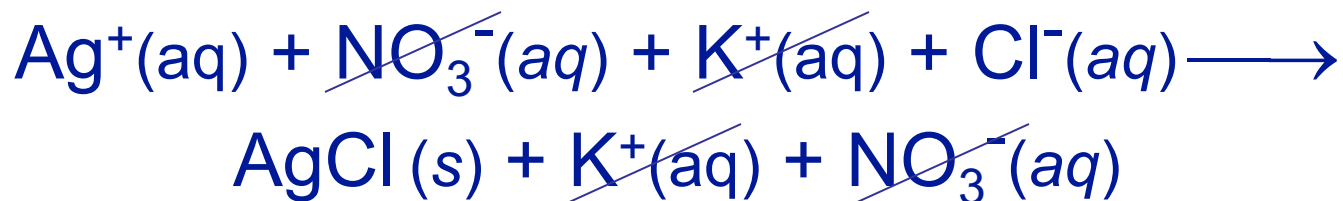
Ionic Equation

- In the ionic equation **all strong electrolytes** (strong acids, strong bases, and soluble ionic salts) are dissociated into their ions.
- reflects the species that are **actually found** in the reaction mixture.
- Separate all the “aq” stuff and leave the “s” stuff alone



Net Ionic Equation

- To form the net ionic equation, cross out anything that does not change from the left side of the equation to the right.



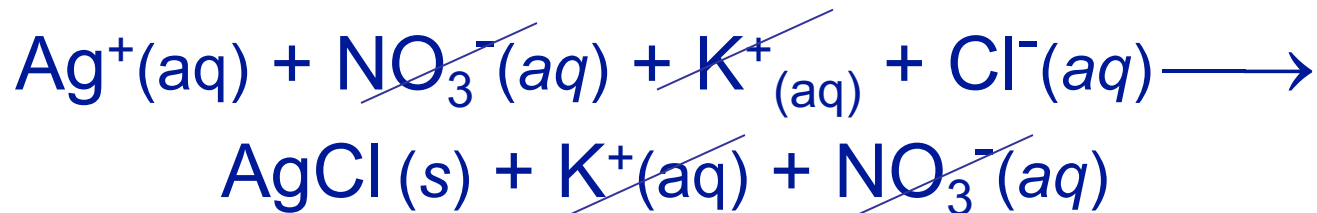
Net Ionic Equation

- To form the net ionic equation, cross out anything that does not change from the left side of the equation to the right.
- The only things left in the equation are those things that change (i.e., react) during the course of the reaction.



Net Ionic Equation

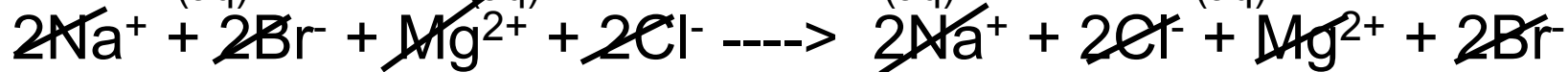
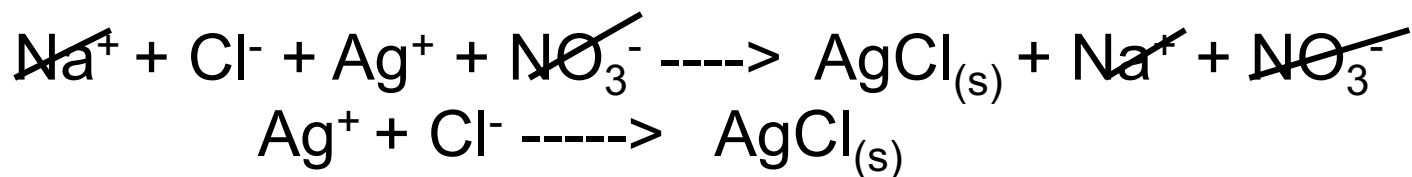
- To form the net ionic equation, cross out anything that does not change from the left side of the equation to the right.
- The only things left in the equation are those things that change (i.e., react) during the course of the reaction.
- Those things that didn't change (and were deleted from the net ionic equation) are called spectator ions.



Writing Net Ionic Equations

1. Write a balanced chemical equation.
2. Dissociate all strong electrolytes.
3. Cross out anything that remains unchanged from the left side to the right side of the equation.
4. Write the net ionic equation with the species that remain.

Writing Net Ionic Equations



Acids:

- Substances that **increase the concentration of H^+** when dissolved in water.



Acids



Strong: Fully dissociate into anion and H^+ (strong electrolytes)

Weak: Do not fully dissociate (weak electrolyte)

There are only seven strong acids:

- Hydrochloric (HCl)
- Hydrobromic (HBr)
- Hydroiodic (HI)
- Nitric (HNO_3)
- Sulfuric (H_2SO_4)
- Chloric (HClO_3)
- Perchloric (HClO_4)
- YOU MUST REMEMBER THESE.

Bases:

- Substances that increase the concentration of OH^- when dissolved in water.



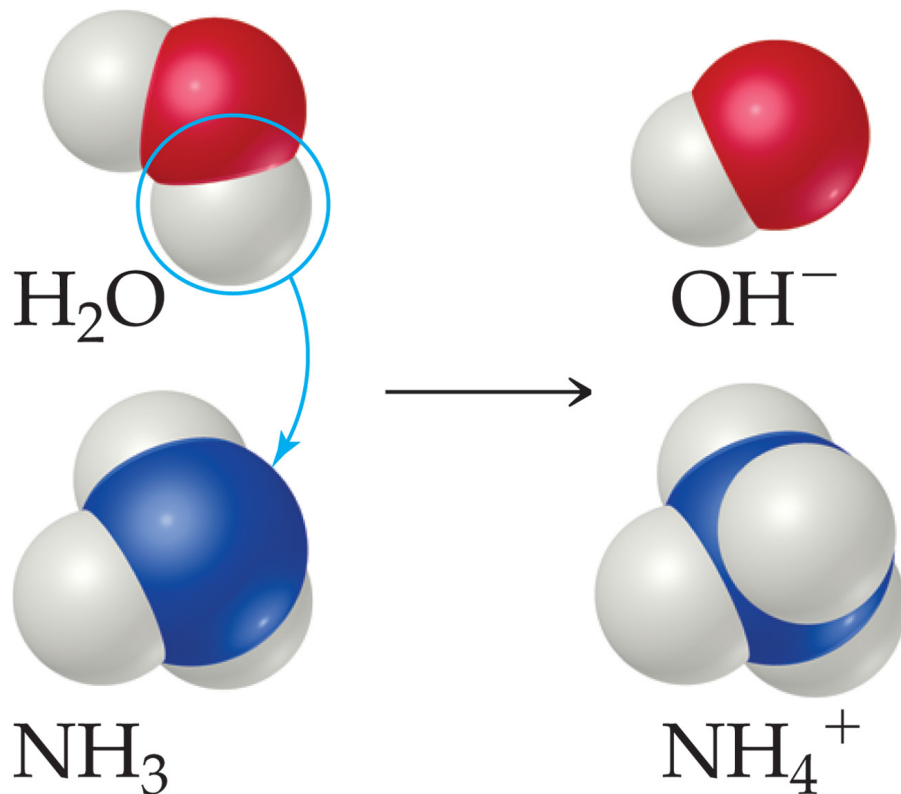
Bases

The strong bases are the soluble salts of hydroxide ion:

- Alkali metals
- Calcium ($\text{Ca}(\text{OH})_2$)
- Strontium ($\text{Sr}(\text{OH})_2$)
- Barium ($\text{Ba}(\text{OH})_2$)



Acid-Base Reactions



In an acid-base reaction, the acid donates a proton (H⁺) to the base.



Neutralization Reactions

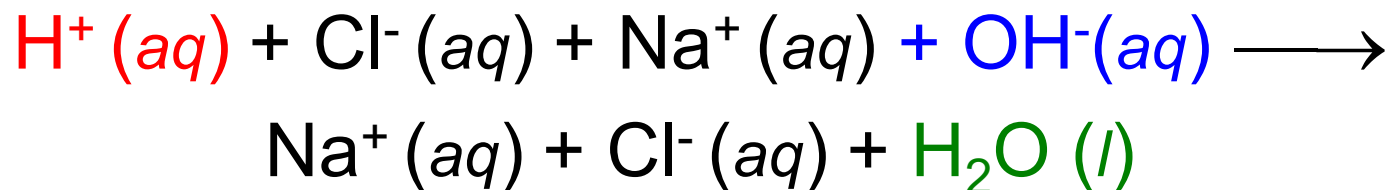
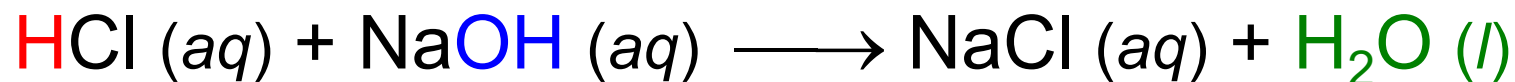
When an acid and a base are combined.

Products are usually a salt and water.



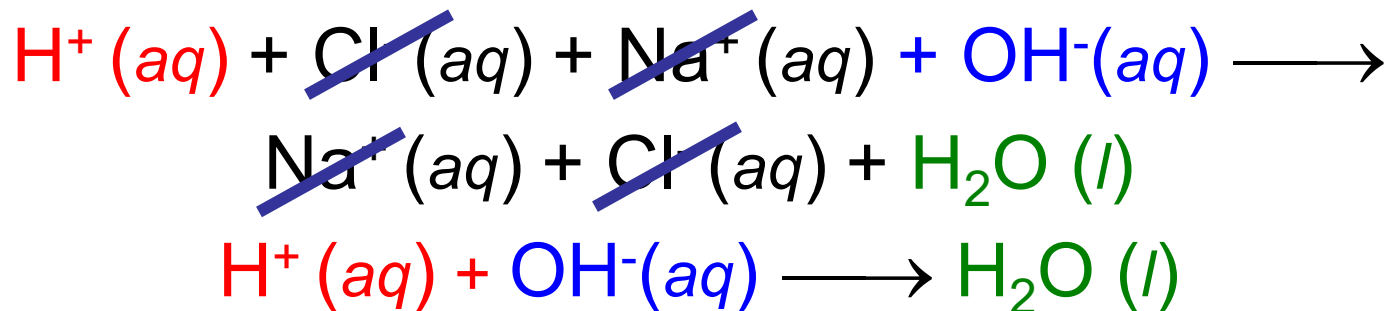
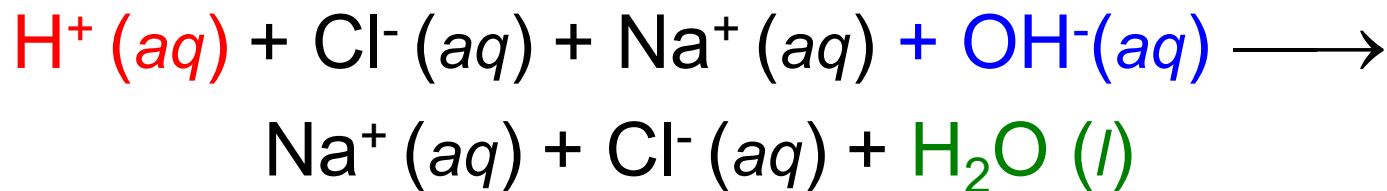
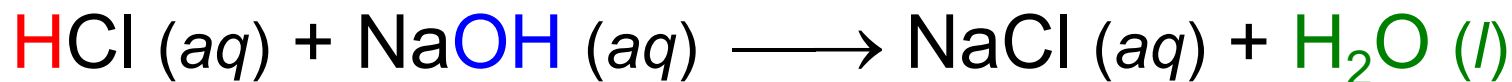
Neutralization Reactions

strong acid strong base reaction net ionic equation:



Neutralization Reactions

When a strong acid reacts with a strong base, the net ionic equation is...

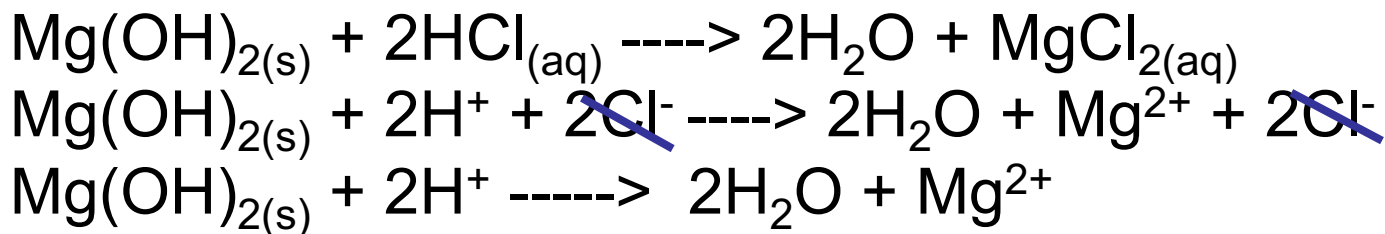


Neutralization Reactions



Reaction between
Milk of Magnesia,
 $\text{Mg}(\text{OH})_2$, and HCl .

A phase change
results as
 $\text{Mg}(\text{OH})_{2(s)}$ goes into
solution.



Gas-Forming Reactions

- metathesis reactions that give an unexpected product (acid base).
- Because expected product decomposes to give a gas (CO_2 or SO_2).



Gas-Forming Reactions

- This reaction gives the predicted product, but you had better carry it out in the hood, or you will be very unpopular!
- Just as in the previous examples, a gas is formed as a product of this reaction:



Stinky



Solution Stoichiometry

- Chemistry arithmetic in solution

Molarity

- Molarity is a measure of concentration of a solution.

$$\text{Molarity (M)} = \frac{\text{moles of solute}}{\text{volume of solution in liters}}$$

A unit of concentration.

Example

Make 300. mL of a 0.250 M solution of NaCl.

Needed: grams of NaCl.

Must find: moles NaCl ($M = \text{mol/L}$)

MW NaCl: $23 + 35.4 = 58.4 \text{ g/mol}$

$300. \text{ mL} = 0.300 \text{ L}$

$0.250 \text{ mol/L}(0.300 \text{ L})(58.4\text{g/mol}) = 4.38 \text{ g}$

Mixing a Solution



Example

What is the molarity of a solution that contains 15 g of sodium acetate in 0.25 L

MW $\text{NaC}_2\text{H}_3\text{O}_2$: 82 g/mol

Needed: moles so you can calculate mol/L

$$\frac{15\text{g}}{82\text{g mol}^{-1}(0.25\text{ L})} = 0.73\text{ mol/L}$$

Dilution



Example

You have a stock solution of 4.2 M $(\text{NH}_4)_2\text{SO}_4$.

How much do you need to make 2.5 L of a 0.3 M $(\text{NH}_4)_2\text{SO}_4$ solution?

Example

You have a stock solution of 4.2 M $(\text{NH}_4)_2\text{SO}_4$.

How much do you need to make 2.5 L of a 0.3 M $(\text{NH}_4)_2\text{SO}_4$ solution?

Needed, moles needed in final solution

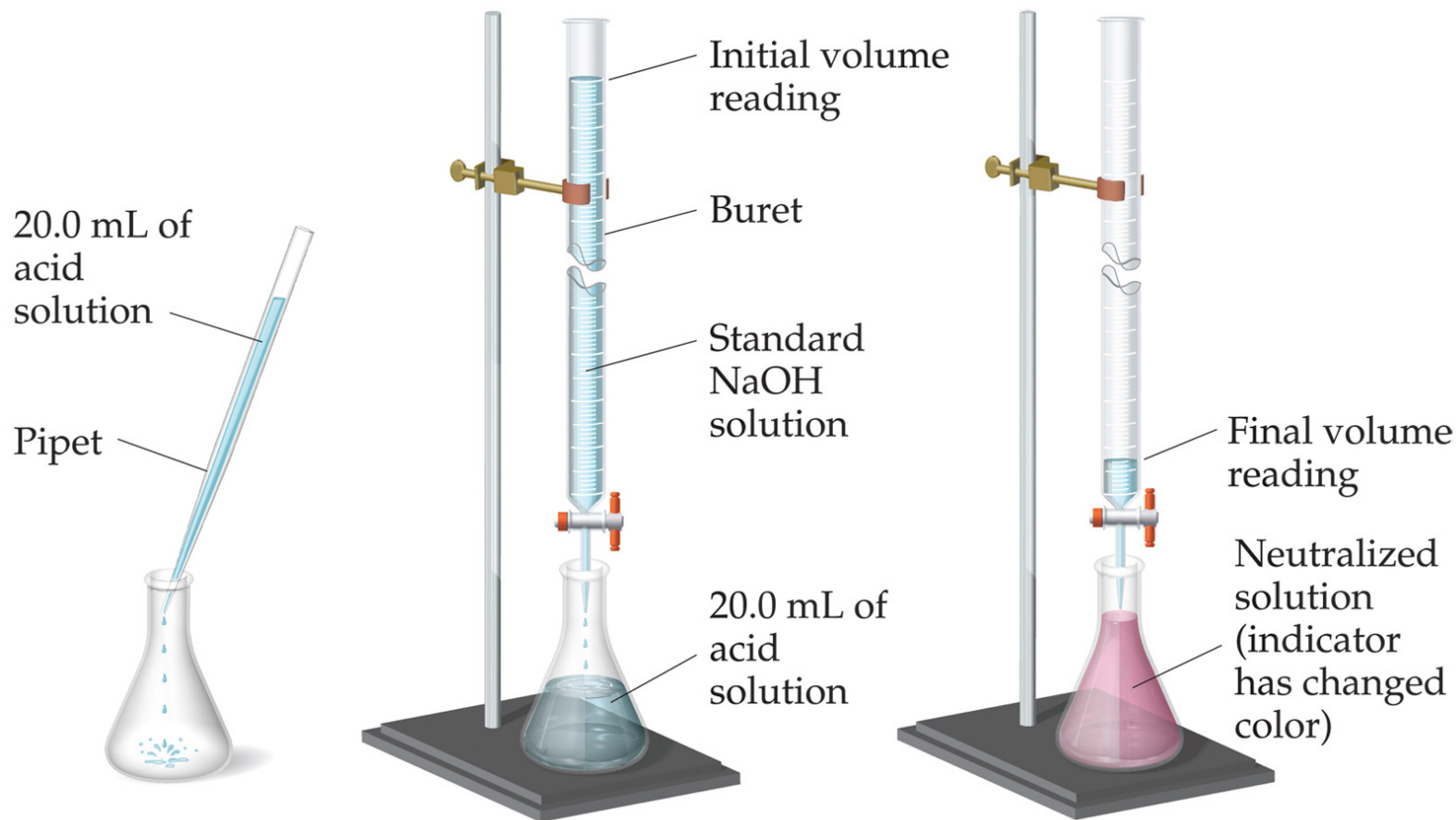
Need: volume of stock that contains the required # of moles

$$\text{moles } \text{NH}_4\text{SO}_4 \text{ needed} = 2.5 \text{ L}(0.3 \text{ mol/L}) = 0.75 \text{ moles}$$

$$\text{Volume of stock} = \frac{(\text{moles } \text{NH}_4\text{SO}_4 \text{ needed})}{(4.2 \text{ M } (\text{NH}_4)_2\text{SO}_4)}$$

$$\text{Volume stock} = \frac{(0.75 \text{ moles})}{(4.2 \text{ mol/L stock})} = 0.18 \text{ L}$$

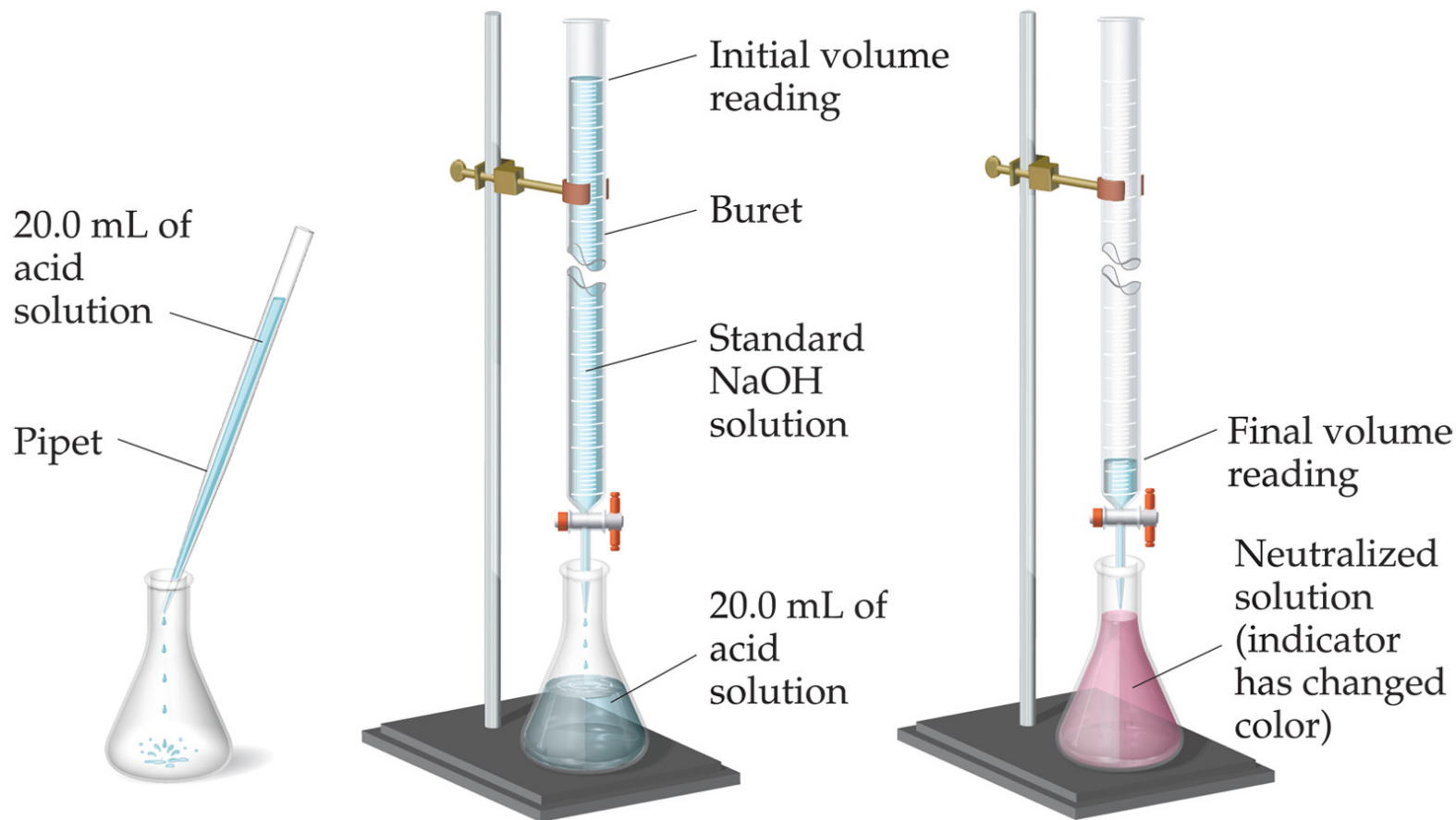
Titration



Use:

Known concentration of a solution and chemical reaction to find amount of an unknown.

Titration

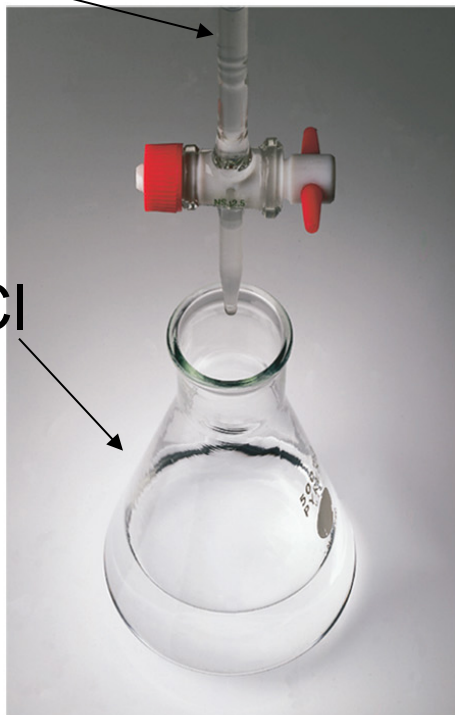


Example: acid/base titration.

Titration

NaOH

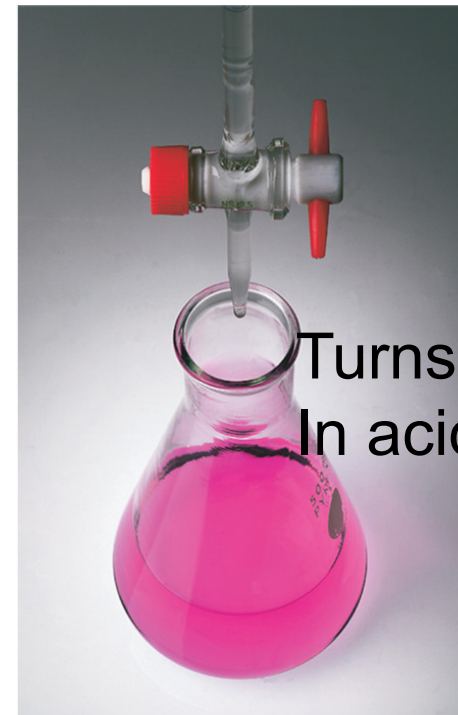
HCl



$[\text{HCl}] > [\text{NaOH}]$



$[\text{HCl}] = [\text{NaOH}]$



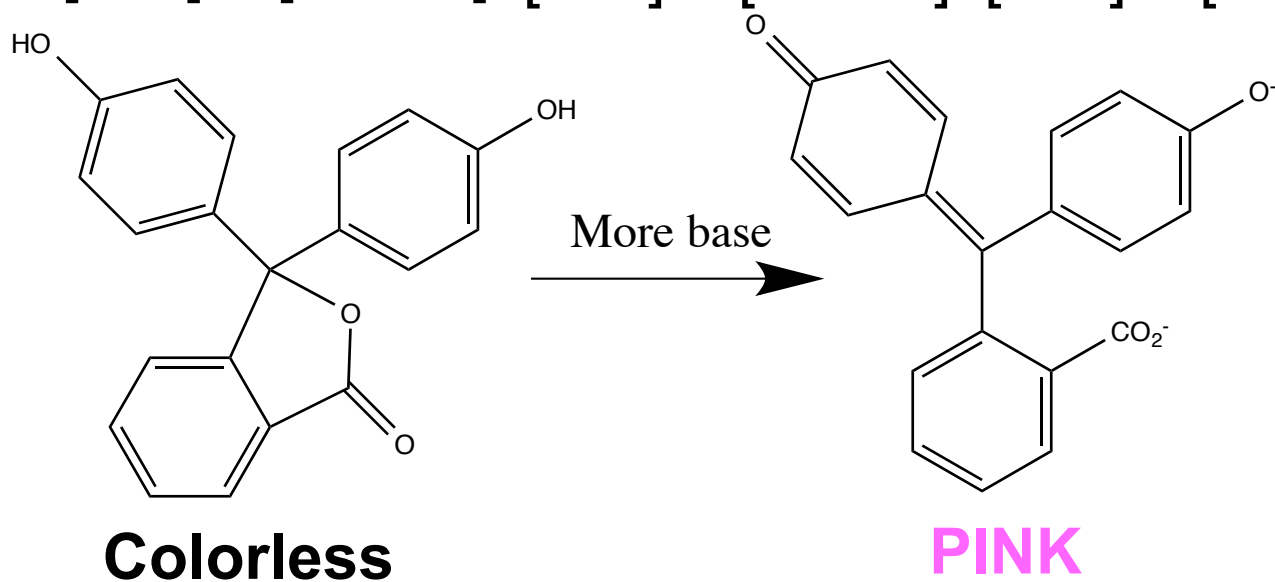
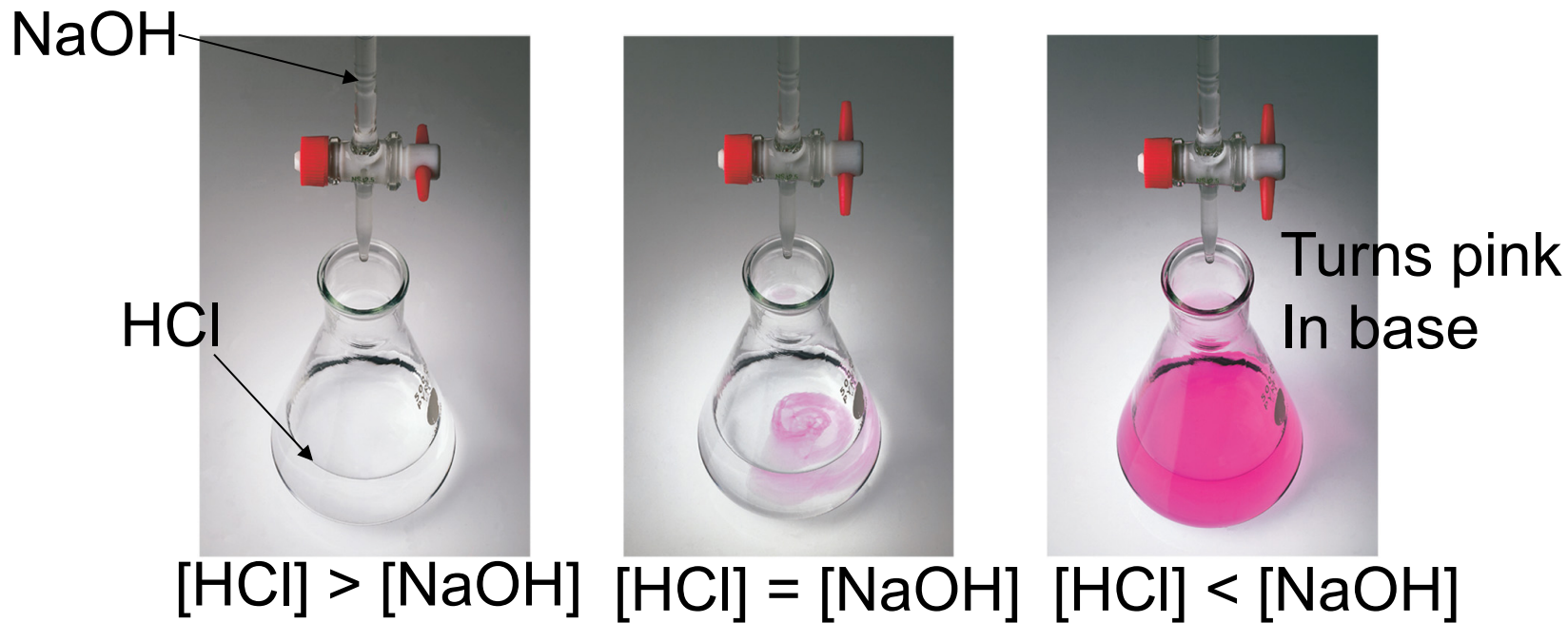
Turns pink
In acid

$[\text{HCl}] < [\text{NaOH}]$

Add one reactant to the other gradually
An indicator show when reactant is used up.
Example, Acid/base:



Titration



Example

0.172 L of an NaOH solution is titrated to its endpoint with 80.32 mL of a 0.0423 M solution of HCl. What was the concentration of the NaOH solution?



[M]	0.0423	?
-----	--------	---

V	0.08032 L	0.172L
---	-----------	--------

moles	???	???
-------	-----	-----

Need: moles HCl added = moles NaOH in unknown solution

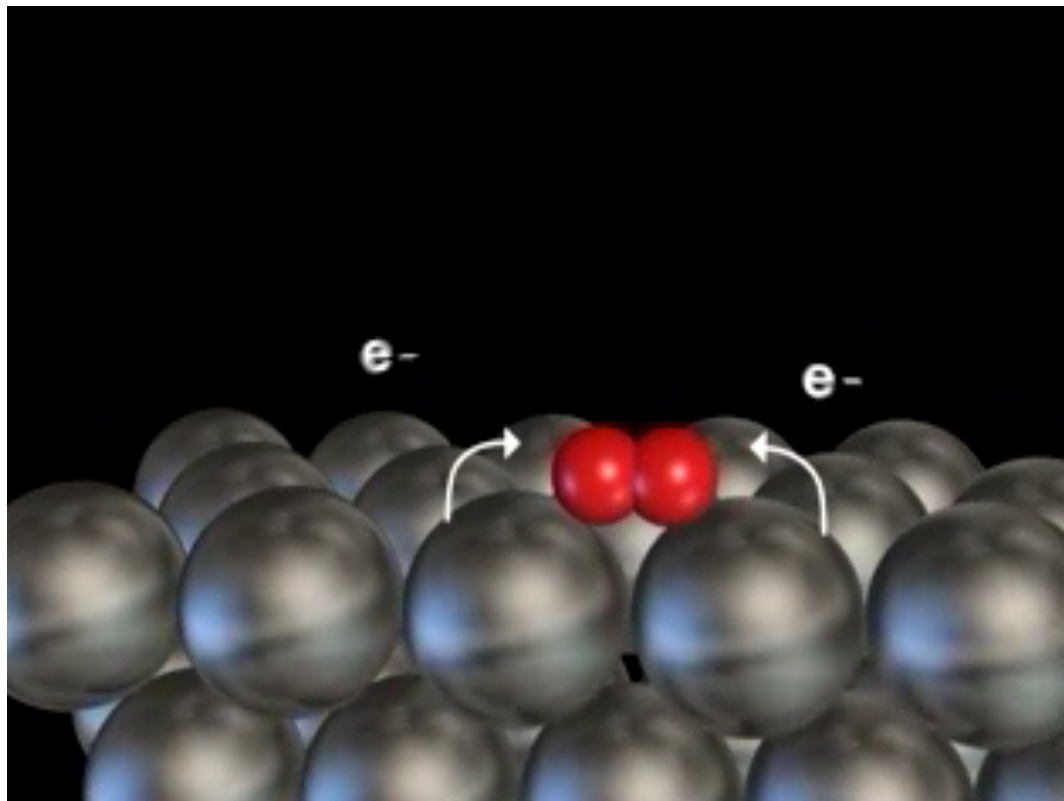
moles HCl = $0.08032 \text{ L}(0.0423 \text{ mol/L}) = 0.00339 \text{ mole HCl}$

$0.00339 \text{ mole HCl} = 0.00339 \text{ mol NaOH in unknown solution.}$

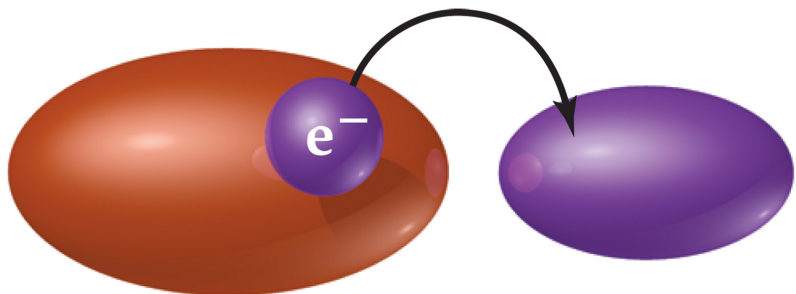
$[\text{NaOH}] = 0.00339 \text{ mol}/0.172\text{L}=0.0197 \text{ mol/L (M).}$

Oxidation-Reduction Reactions

- An oxidation occurs when an atom or ion *loses* electrons.
- A reduction occurs when an atom or ion *gains* electrons.



Oxidation-Reduction Reactions



Substance
oxidized
(loses
electron)

Substance
reduced
(gains
electron)

One cannot occur
without the other.

Oxidation Numbers

But how do you know if oxidation/reduction has happened?

Keep track of the electrons.

Assign a number to each *element*

See how they change from react. To prod.

Book-keeping for electrons

Assigning Oxidation Numbers

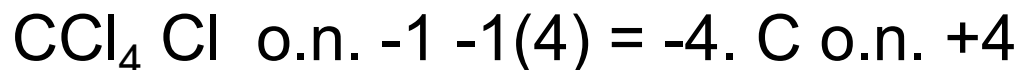
- Elements in their elemental form have an oxidation number of 0.
- The oxidation number of a monatomic ion is the same as its charge.

Na oxidation number 0

Na⁺ oxidation number +1

Oxidation Numbers

- The sum of the oxidation numbers in a neutral compound is 0.
- The sum of the oxidation numbers in a polyatomic ion is the charge on the ion.



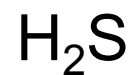
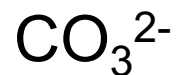
Assigning Oxidation Numbers

- Nonmetals tend to have negative oxidation numbers, but:
 - some are positive in certain compounds or ions (when they are bound to other nonmetals).
- Oxygen has an oxidation number of -2 , except in the peroxide ion (O_2^{2-}) in which it has an oxidation number of -1 .
 - CO_2 , H_2O , CaO etc. O has -2 oxidation number
- Hydrogen is -1 when bonded to a metal, $+1$ when bonded to a nonmetal.
 - NaH H has -1 oxidation number
 - HCl H has $+1$ oxidation number
 - CH_4 H has $+1$ oxidation number

Oxidation Numbers

- Fluorine always has an oxidation number of -1 .
- The other halogens have an oxidation number of -1 when the oxidation number is negative;
- they can have positive oxidation numbers when they are with F or O, most notably in oxyanions.
 - CCl_4 , HCl , Cl o.n. -1
 - ClO_4^- Cl o.n. $+7$ (must be because O is always negative)
 - HCOCl Cl o.n. -1

Oxidation Numbers



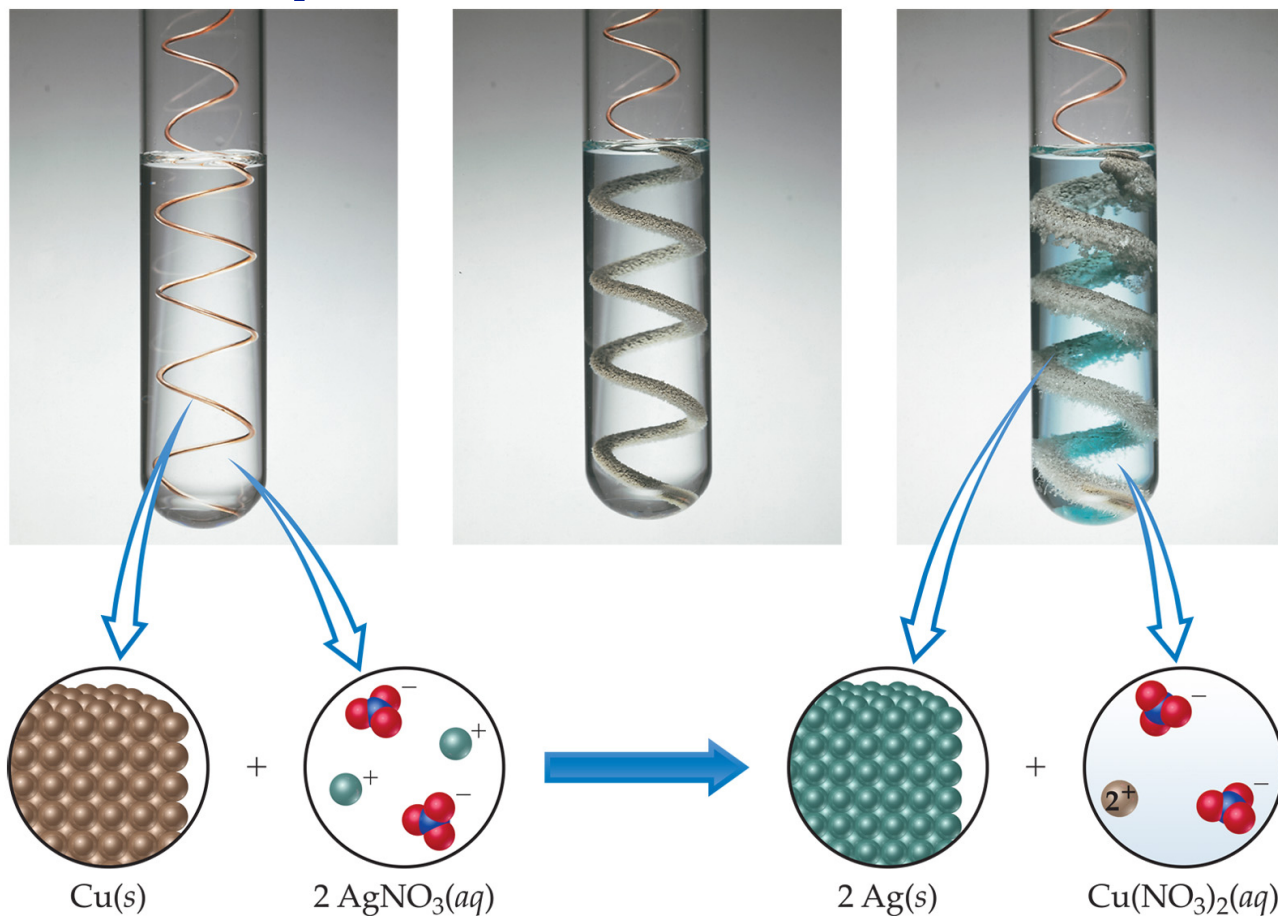
Displacement Reactions



- In displacement reactions, ions oxidize an element.
- The ions, then, are reduced.



Displacement Reactions

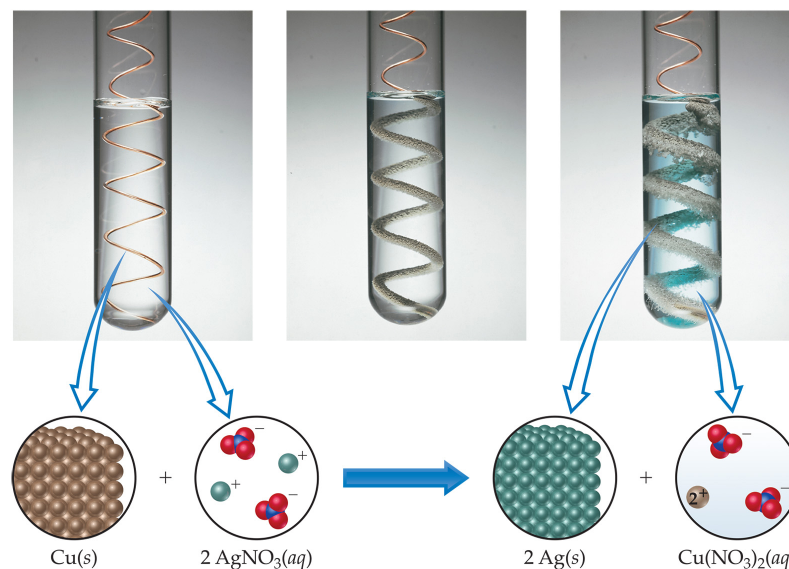


silver ions oxidize copper metal.



Displacement Reactions

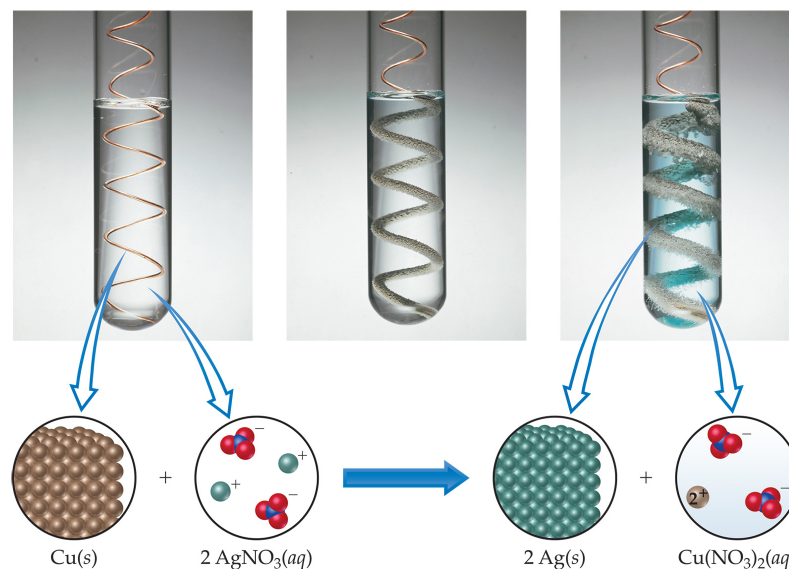
But copper ions will *not* Oxidize silver metal.



Why not??

Displacement Reactions

But copper ions will *not* Oxidize silver metal.



**Taking electrons from Ag is
Harder than taking them from Cu**

Activity Series

Metal	Oxidation Reaction				
Lithium	Li(s)	\longrightarrow	$\text{Li}^+(\text{aq})$	+	e^-
Potassium	K(s)	\longrightarrow	$\text{K}^+(\text{aq})$	+	e^-
Barium	Ba(s)	\longrightarrow	$\text{Ba}^{2+}(\text{aq})$	+	2e^-
Calcium	Ca(s)	\longrightarrow	$\text{Ca}^{2+}(\text{aq})$	+	2e^-
Sodium	Na(s)	\longrightarrow	$\text{Na}^+(\text{aq})$	+	e^-
Magnesium	Mg(s)	\longrightarrow	$\text{Mg}^{2+}(\text{aq})$	+	2e^-
Aluminum	Al(s)	\longrightarrow	$\text{Al}^{3+}(\text{aq})$	+	3e^-
Manganese	Mn(s)	\longrightarrow	$\text{Mn}^{2+}(\text{aq})$	+	2e^-
Zinc	Zn(s)	\longrightarrow	$\text{Zn}^{2+}(\text{aq})$	+	2e^-
Chromium	Cr(s)	\longrightarrow	$\text{Cr}^{3+}(\text{aq})$	+	3e^-
Iron	Fe(s)	\longrightarrow	$\text{Fe}^{2+}(\text{aq})$	+	2e^-
Cobalt	Co(s)	\longrightarrow	$\text{Co}^{2+}(\text{aq})$	+	2e^-
Nickel	Ni(s)	\longrightarrow	$\text{Ni}^{2+}(\text{aq})$	+	2e^-
Tin	Sn(s)	\longrightarrow	$\text{Sn}^{2+}(\text{aq})$	+	2e^-
Lead	Pb(s)	\longrightarrow	$\text{Pb}^{2+}(\text{aq})$	+	2e^-
Hydrogen	$\text{H}_2(\text{g})$	\longrightarrow	$2\text{H}^+(\text{aq})$	+	2e^-
Copper	Cu(s)	\longrightarrow	$\text{Cu}^{2+}(\text{aq})$	+	2e^-
Silver	Ag(s)	\longrightarrow	$\text{Ag}^+(\text{aq})$	+	e^-
Mercury	Hg(l)	\longrightarrow	$\text{Hg}^{2+}(\text{aq})$	+	2e^-
Platinum	Pt(s)	\longrightarrow	$\text{Pt}^{2+}(\text{aq})$	+	2e^-
Gold	Au(s)	\longrightarrow	$\text{Au}^{3+}(\text{aq})$	+	3e^-



**Top: easy
To steal an
Electron**

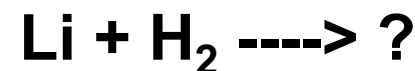
**Bottom,
Hard to
Steal e^-**

Activity Series

Metal	Oxidation Reaction			
Lithium	$\text{Li}(s)$	\longrightarrow	$\text{Li}^+(aq)$	$+ e^-$
Potassium	$\text{K}(s)$	\longrightarrow	$\text{K}^+(aq)$	$+ e^-$
Barium	$\text{Ba}(s)$	\longrightarrow	$\text{Ba}^{2+}(aq)$	$+ 2e^-$
Calcium	$\text{Ca}(s)$	\longrightarrow	$\text{Ca}^{2+}(aq)$	$+ 2e^-$
Sodium	$\text{Na}(s)$	\longrightarrow	$\text{Na}^+(aq)$	$+ e^-$
Magnesium	$\text{Mg}(s)$	\longrightarrow	$\text{Mg}^{2+}(aq)$	$+ 2e^-$
Aluminum	$\text{Al}(s)$	\longrightarrow	$\text{Al}^{3+}(aq)$	$+ 3e^-$
Manganese	$\text{Mn}(s)$	\longrightarrow	$\text{Mn}^{2+}(aq)$	$+ 2e^-$
Zinc	$\text{Zn}(s)$	\longrightarrow	$\text{Zn}^{2+}(aq)$	$+ 2e^-$
Chromium	$\text{Cr}(s)$	\longrightarrow	$\text{Cr}^{3+}(aq)$	$+ 3e^-$
Iron	$\text{Fe}(s)$	\longrightarrow	$\text{Fe}^{2+}(aq)$	$+ 2e^-$
Cobalt	$\text{Co}(s)$	\longrightarrow	$\text{Co}^{2+}(aq)$	$+ 2e^-$
Nickel	$\text{Ni}(s)$	\longrightarrow	$\text{Ni}^{2+}(aq)$	$+ 2e^-$
Tin	$\text{Sn}(s)$	\longrightarrow	$\text{Sn}^{2+}(aq)$	$+ 2e^-$
Lead	$\text{Pb}(s)$	\longrightarrow	$\text{Pb}^{2+}(aq)$	$+ 2e^-$
Hydrogen	$\text{H}_2(g)$	\longrightarrow	$2 \text{H}^+(aq)$	$+ 2e^-$
Copper	$\text{Cu}(s)$	\longrightarrow	$\text{Cu}^{2+}(aq)$	$+ 2e^-$
Silver	$\text{Ag}(s)$	\longrightarrow	$\text{Ag}^+(aq)$	$+ e^-$
Mercury	$\text{Hg}(l)$	\longrightarrow	$\text{Hg}^{2+}(aq)$	$+ 2e^-$
Platinum	$\text{Pt}(s)$	\longrightarrow	$\text{Pt}^{2+}(aq)$	$+ 2e^-$
Gold	$\text{Au}(s)$	\longrightarrow	$\text{Au}^{3+}(aq)$	$+ 3e^-$

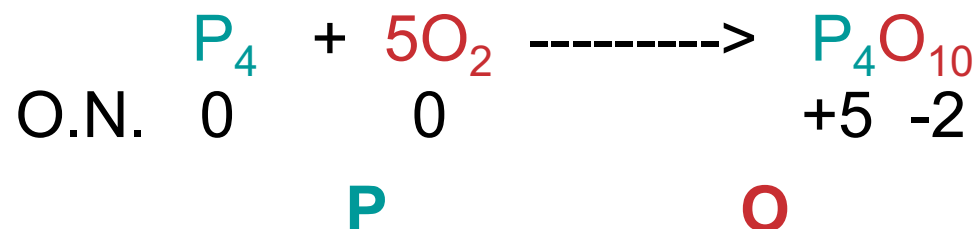


What happens?



Oxidation reduction reactions

A more complicated redox reaction:



$$+5(4) = 20 \quad -2(10) = -20$$

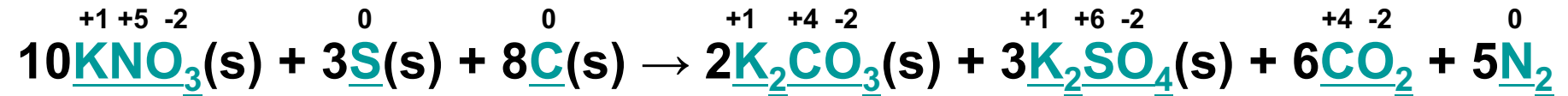
electrons hop from P to O redox reaction

Acid/base reaction is next:



Oxidation reduction reactions

Example: gunpowder



What element is oxidized?

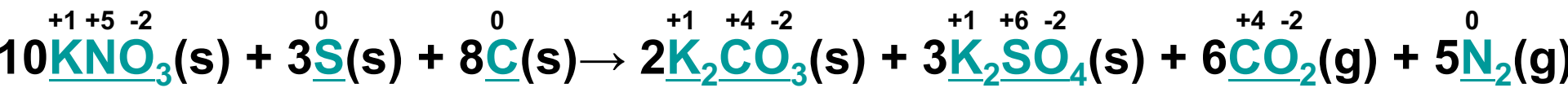
What element is reduced?

What's the reducing agent?

What's the oxidizing agent?

Oxidation reduction reactions

Example: gunpowder



What element is oxidized? C (0 \rightarrow +4), S (0 \rightarrow +6)

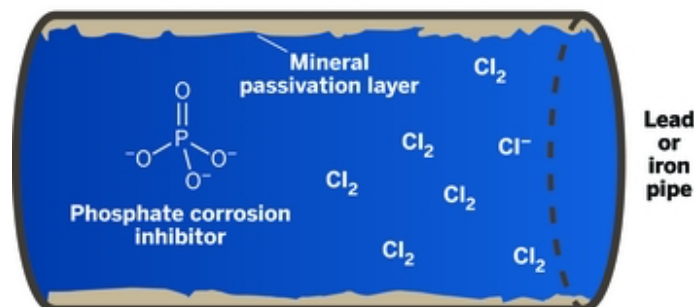
What element is reduced? N (+5 \rightarrow 0),

What's the reducing agent? Carbon and sulphur

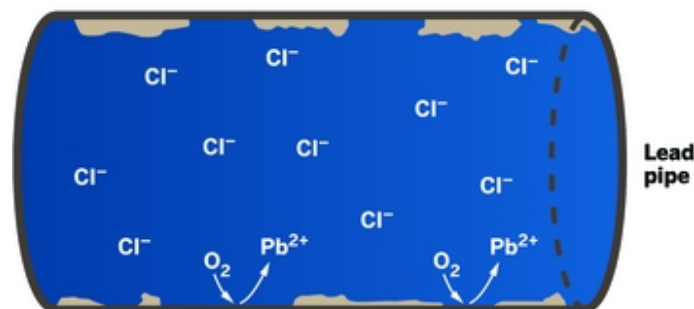
What's the oxidizing agent? Potassium nitrate (salt peter)

Why do you think this is an explosive?

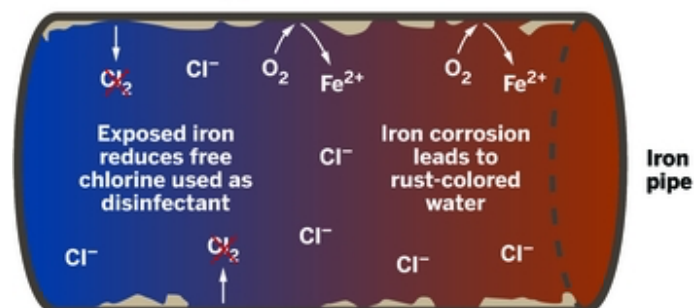
Phosphate corrosion inhibitor helps maintain a mineral passivation layer on the inside of Flint's pipes, protecting them from corrosion. With little corrosion, chlorine disinfectant levels remain stable.



Lack of a corrosion inhibitor, high chloride levels, and other factors cause the passivation layer to dissolve and fall off, leading to increased corrosion in Flint's pipes. As the pipes corrode, chlorine disinfectant breaks down.



Oxidants such as dissolved O_2 corrode pipes and leach soluble metal.



Solubility trends

Soluble Ionic Compounds		Important Exceptions
Compounds containing	NO_3^-	None
	$\text{C}_2\text{H}_3\text{O}_2^-$	None
	Cl^-	Compounds of Ag^+ , Hg_2^{2+} , and Pb^{2+}
	Br^-	Compounds of Ag^+ , Hg_2^{2+} , and Pb^{2+}
	I^-	Compounds of Ag^+ , Hg_2^{2+} , and Pb^{2+}
	SO_4^{2-}	Compounds of Sr^{2+} , Ba^{2+} , Hg_2^{2+} , and Pb^{2+}
Insoluble Ionic Compounds		Important Exceptions
Compounds containing	S^{2-}	Compounds of NH_4^+ , the alkali metal cations, and Ca^{2+} , Sr^{2+} , and Ba^{2+}
	CO_3^{2-}	Compounds of NH_4^+ and the alkali metal cations
	PO_4^{3-}	Compounds of NH_4^+ and the alkali metal cations
	OH^-	Compounds of the alkali metal cations, and NH_4^+ , Ca^{2+} , Sr^{2+} , and Ba^{2+}

NH_4^+ salts are always soluble

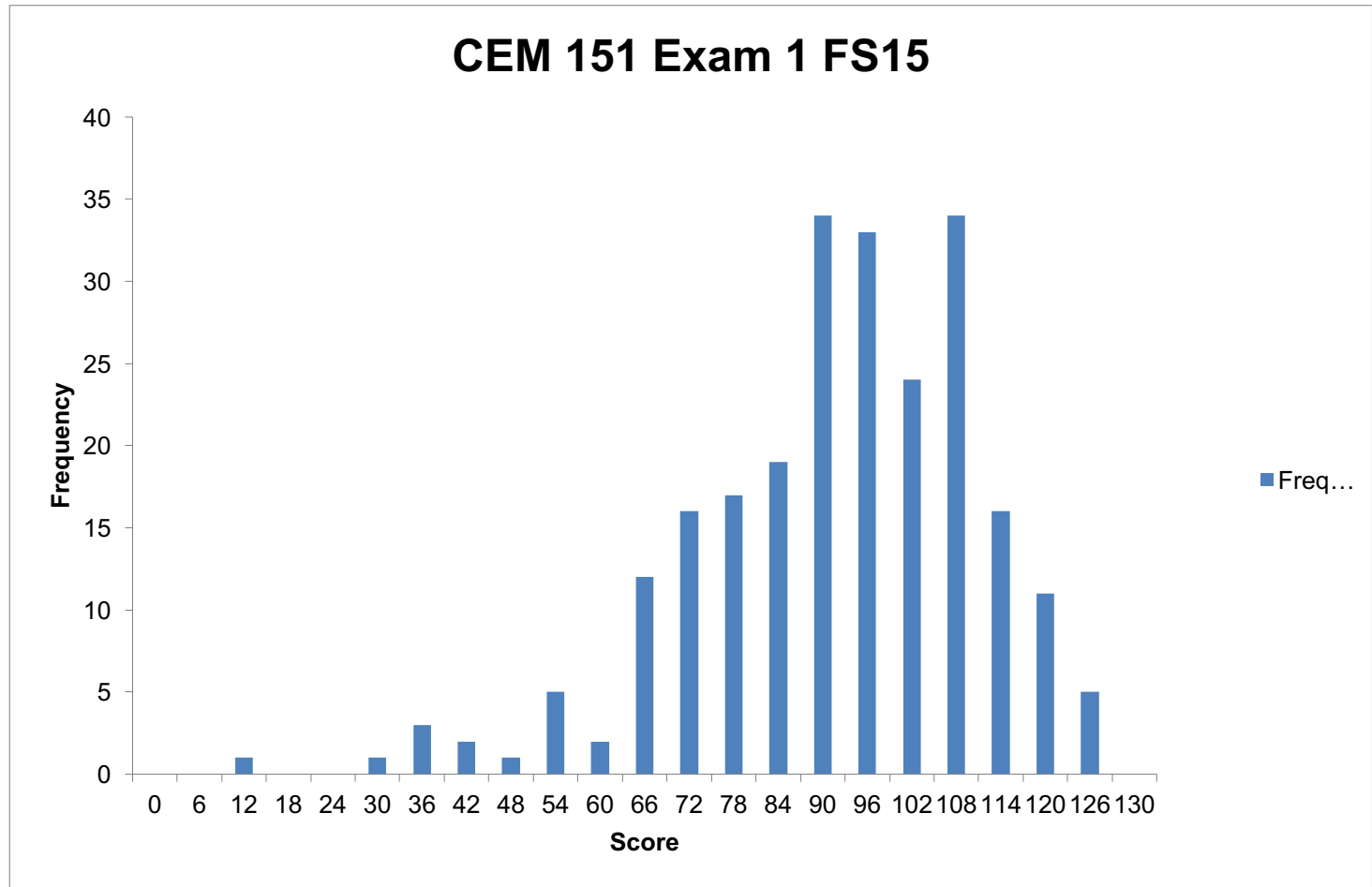
Alkali metal salts are always soluble

- $\text{NaClO} + \text{H}_2\text{O} \rightarrow 2\text{H}_2\text{O} + \text{O}_2$
- $\text{NaClO} + \text{HCl} \rightarrow \text{Cl}_2 + \text{OH}^-$
- $\text{Cl}_2 + \text{stuff} \rightarrow \text{Cl}^- + \text{oxidized stuff.}$

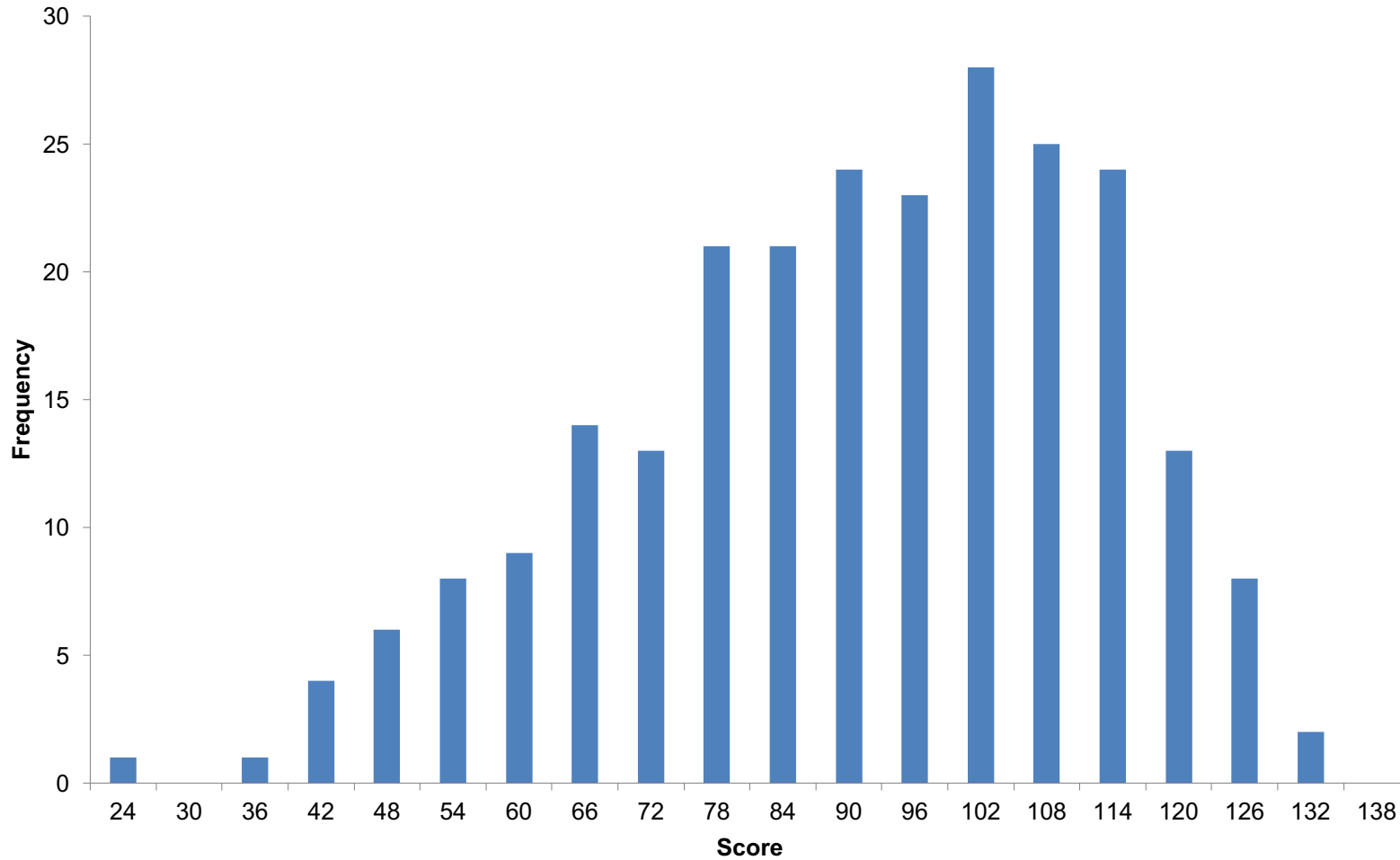
Exam 1 2015

Bin	Frequency
0	0
6	0
12	1
18	0
24	0
30	1
36	3
42	2
48	1
54	5
60	2
66	12
72	16
78	17
84	19
90	34
96	33
102	24
108	34
114	16
120	11
126	5
130	0

Mean	89.03389831
Median	91
Mode	91
Standard	
Deviation	18.95029656
Minimum	12
Maximum	124



CEM 151 Exam 1 FS13



Average: 88.54 68%

Median: 91 70%

Demonstration:



Student Score Histogram Report

Total Possible Points:	105	Median Score:	56	Maximum Score:	98
Total Students:	154	Mean Score:	58.73	Minimum Score:	7
Standard Deviation:	17.84	Reliability Coefficient (KR20):	0.62	Range of Scores:	91

Overall

Mean Score: 55.93%

