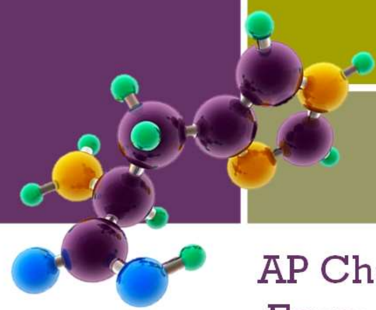
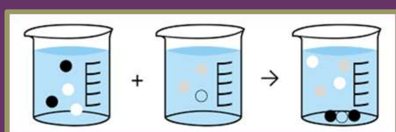
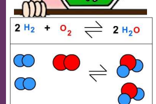


AP Chemistry Exam Review



Big Idea #3
Chemical Reactions



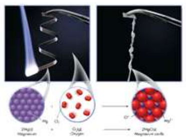
Changes in matter involve the rearrangement and/or reorganizations of atoms and/or the transfer of electrons.

Source

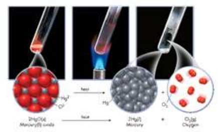
+ Types of Chemical Reactions

Video

Synthesis
A + B → AB

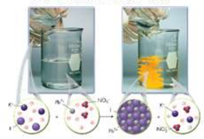


Decomposition
AB → A + B



Single Displacement
A + BC → AC + B

Double Displacement
AB + CD → AD + CB



Images from: Wilbraham, Antony C. *Pearson Chemistry*. Boston, MA: Pearson, 2012. Print.

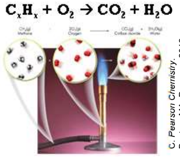
LO 3.1: Students can translate among macroscopic observations of change, chemical equations, and particle views.

Source

+ Types of Chemical Reactions

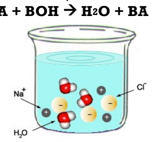
Video

Combustion
$C_xH_x + O_2 \rightarrow CO_2 + H_2O$

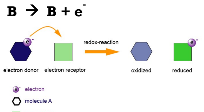


C. *Pearson Chemistry*. Boston, MA: Pearson, 2012. Print.

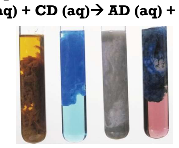
Acid-Base (Neutralization)
HA + BOH → H2O + BA



Oxidation-Reduction
$A^+ + e^- \rightarrow A$
$B \rightarrow B + e^-$



Precipitation
AB (aq) + CD (aq)→ AD (aq) + CB (s)



LO 3.1: Students can translate among macroscopic observations of change, chemical equations, and particle views.

Source

+ Balanced Equations

Complete Molecular: $AgNO_3(aq) + KCl(aq) \longrightarrow AgCl(s) + KNO_3(aq)$

Complete Ionic: $Ag^+(aq) + NO_3^-(aq) + K^+(aq) + Cl^-(aq) \longrightarrow AgCl(s) + K^+(aq) + NO_3^-(aq)$

Net Ionic: $Ag^+(aq) + Cl^-(aq) \longrightarrow AgCl(s)$

Video
Quizlet

TABLE 4.2 Solubility Rules for Common Ionic Compounds in Water at 25°C

Soluble Compounds	Insoluble Exceptions
Compounds containing alkali metal ions (Li^+, Na^+, K^+, Rb^+, Cs^+) and the ammonium ion (NH_4^+)	
Nitrates (NO_3^-), bicarbonates (HCO_3^-), and chlorates (ClO_3^-)	
Halides (Cl^-, Br^-, I^-)	Halides of Ag^+, Hg_2^{2+}, and Pb^{2+}
Sulfates (SO_4^{2-})	Sulfates of Ag^+, Ca^{2+}, Sr^{2+}, Ba^{2+}, Hg_2^{2+}, and Pb^{2+}
Insoluble Compounds	**Soluble Exceptions**
Carbonates (CO_3^{2-}), phosphates (PO_4^{3-}), chromates (CrO_4^{2-}), sulfides (S^{2-})	Compounds containing alkali metal ions and the ammonium ion
Hydroxides (OH^-)	Compounds containing alkali metal ions and the Ba^{2+} ion

Spectator ions should not be included in your balanced equations.

Remember, the point of a Net Ionic Reaction is to show only those ions that are involved in the reaction. Chemists are able to substitute reactants containing the same species to create the intended product.

You only need to memorize that compounds with nitrate, ammonium, halides and alkali metals are soluble.

LO 3.2: The student can translate an observed chemical change into a balanced chemical equation and justify the choice of equation type (molecular, ionic, or net ionic) in terms of utility for the given circumstances.

Source

+ Making Predictions

Solid copper carbonate is heated strongly:

Click reveals answer and explanation.

What evidence of a chemical change would be observed with this reaction?

Click reveals answer and explanation.

What is the percent yield of CO_2 if you had originally heated 10.0g $CuCO_3$ and captured 3.2g CO_2 ?

Click reveals answer and explanation.

How could you improve your percent yield?

Click reveals answer and explanation.

Video

LO 3.3: The student is able to use stoichiometric calculations to predict the results of performing a reaction in the laboratory and/or to analyze deviations from the expected results.

Source

+ Limiting Reactants – D.A.

$Al_2S_3 + 6\ H_2O \text{ ---> } 2Al(OH)_3 + 3\ H_2S$

15.00 g aluminum sulfide and 10.00 g water react

a) Identify the Limiting Reactant

Click reveals answer and explanation.

b) What is the maximum mass of H_2S which can be formed from these reagents?

Click reveals answer and explanation.

c) How much excess reactant is left in the container?

Click reveals answer and explanation.

Video
Sim
pHet

***Dimensional Analysis is not the only way to solve these problems. You can also use BCA tables (modified ICE charts), which may save time on the exam →*

LO 3.4: The student is able to relate quantities (measured mass of substances, volumes of solutions, or volumes and pressures of gases) to identify stoichiometric relationships for a reaction, including situations involving limiting reactants and situations in which the reaction has not gone to completion.

Source

+ Limiting Reactants – BCA Table

15.00 g aluminum sulfide and 10.00 g water react according to the following equation:

$Al_2S_3 + 6\ H_2O \text{ ---> } 2Al(OH)_3 + 3\ H_2S$

a) Identify the Limiting Reactant

Click reveals answer and explanation.

b) What is the maximum mass of H_2S which can be formed from these reagents?

Click reveals answer and explanation.

c) How much excess reactant is left in the container?

Click reveals answer and explanation.

Video

LO 3.4: The student is able to relate quantities (measured mass of substances, volumes of solutions, or volumes and pressures of gases) to identify stoichiometric relationships for a reaction, including situations involving limiting reactants and situations in which the reaction has not gone to completion.

+ Experimental Design

Source

Video

Synthesis

A sample of pure Cu is heated in excess pure oxygen. Design an experiment to determine quantitatively whether the product is CuO or Cu_2O.

Click reveals basic steps

Decomposition $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

Design a plan to prove experimentally that this reaction illustrates conservation of mass.

Click reveals basic steps

LO3.5: The student is able to design a plan in order to collect data on the synthesis or decomposition of a compound to confirm the conservation of matter and the law of definite proportions.

+ Data Analysis

Source

Video

When tin is treated with concentrated nitric acid, and the resulting mixture is strongly heated, the only
remaining product is an oxide of tin. A student wishes to find out whether it is SnO or SnO2.

Mass of pure tin 5.200 grams.
Mass of dry crucible 18.650 g
Mass of crucible + oxide after first heating 25.500 g
Mass after second heating 25. 253 g
Mass after third heating 25. 252 g

How can you use this data, and the law of conservation of mass, to determine the formula of the product?

Click reveals answer and explanation.

LO 3.6: The student is able to use data from synthesis or decomposition of a compound to confirm the conservation of matter and the law of definite proportions.

+ Bronsted-Lowery Acids & Bases

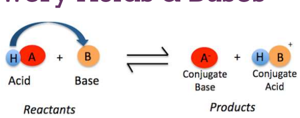
Source

Video

Quizlet

According to Bronsted-Lowery (B.L.) an acid is a "proton donor" and a base is a "proton acceptor." The proton here is shown as a hydrogen.

The acid's conjugate base is the anion.
The base's conjugate acid now has the proton (hydrogen ion).



- Hydrogen fluoride: A Brønsted–Lowry acid

$HF(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + F^-(aq)$

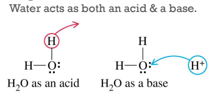
Acid, Base, Conjugate acid, Conjugate base

- Ammonia: A Brønsted–Lowry base

$NH_3(aq) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$

Base, Acid, Conjugate acid, Conjugate base

Amphoteric nature of water
Water acts as both an acid & a base.



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

LO 3.7: The student is able to identify compounds as Bronsted-Lowry acids, bases and/or conjugate acid-base pairs, using proton-transfer reactions to justify the identification.

+ Redox Reactions

Source

- When an electron is transferred, it is called a ***redox reaction***. When something is reduced, the RED part of redox, it gains electrons. You may have

Question:
Zinc ions will react with aluminum metal according to the following chemical reaction:

$$2\,Al_{(s)} + 3\,Zn^{2+}_{(aq)} \rightarrow 2Al^{3+}_{(aq)} + 3\,Zn_{(s)}$$

Answer:
The correct answer is "c" 2.0 moles. For each Zn^{2+} ion 2 electrons are needed to convert it in to a Zn atom. If we are consuming 1 mole of Zn^{2+} we will need to transfer 2 moles of electrons.

LO 3.8: The student is able to identify redox reactions and justify the identification in terms of electron transfer

+ Redox Titrations

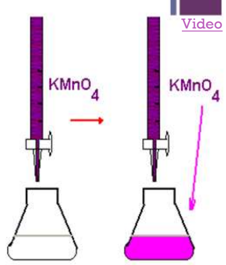
Source

Video

A redox titration (also called an oxidation-reduction titration) can accurately determine the concentration of an unknown analyte by measuring it against a standardized titrant. A common example is the redox titration of a standardized solution of potassium permanganate ($KMnO_4$) against an analyte containing an unknown concentration of iron (II) ions (Fe^{2+}). The balanced reaction in acidic solution is as follows:

$$MnO_4^- + 5Fe^{2+} + 8H^+ \rightarrow 5Fe^{3+} + Mn^{2+} + 4H_2O$$

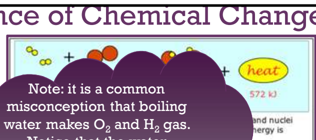
In this case, the use of $KMnO_4$ as a titrant is particularly useful, because it can act as its own indicator; this is due to the fact that the $KMnO_4$ solution is bright purple, while the Fe^{2+} solution is colorless. It is therefore possible to see when the titration has reached its endpoint, because the solution will remain slightly purple from the unreacted $KMnO_4$



LO 3.9: The student is able to design and/or interpret the results of an experiment involving a redox titration

+ Evidence of Chemical Change

Source



Video
Video
Video

Note: it is a common misconception that boiling water makes O_2 and H_2 gas. Notice that the water molecule stays intact as the water boils. Covalent bonds are not broken with this physical change- only intermolecular attractions (hydrogen bonds) between water molecules.

Chemical

Production

$2KClO_{3\,(s)}$ +

Formation of

$AgNO_3)_{(aq)}$ +

Change in color:

Two white solids rea

yellow and a white solid

$Pb(NO_3)_{2\,(s)} + 2KI_{(s)} \rightarrow$ Pb

Production of heat*:

$2\,Mg_{(s)} + O_{2\,(s)} \rightarrow 2MgO_{(s)}$ heat

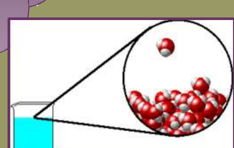
*can also include the absorption of heat

ges:

milar visible evidence (i.e.

creates "bubbles," but bonds are

d reformed. No new substances



LO 3.10: Evaluate the classification of a process as a physical, chemical, or ambiguous change based on both macroscopic observations and the distinction between rearrangement of covalent interactions and noncovalent interactions.

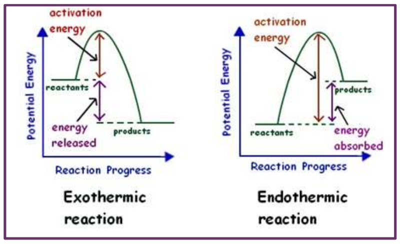
+ Energy Changes

Source

Video

Video

- Chemical reactions involve the formation of new products
- Bonds between atoms or ions in the reactants must be BROKEN (the enthalpy of the system is increasing … ENDOTHERMIC process)
- Bonds are then FORMED between atoms or ions to make the producsts of the reaction. (the enthalpy of hte system is decreasing…EXOTHERMIC process)



LO 3.11: The student is able to interpret observations regarding macroscopic energy changes associated with a reaction or process to generate a relevant symbolic and/or graphical representation of the energy changes.

+ Galvanic Cell Potential

Source

Video

Video

Question:
The following question is based on combining the three different half cells listed below:

Half Cell 1: $Sn^{2+} + 2e^- \longrightarrow Sn$
Half Cell 2: $Ag^+ + e^- \longrightarrow Ag$
Half Cell 2: $Cr^{3+} + 3e^- \longrightarrow Cr$

Galvanic Cell	Half Cells	Reaction	E°_{cell} (V)
X	1 & 2	$Sn + 2Ag^+ \longrightarrow 2Ag + Sn^{2+}$	0.94
Y	2 & 3	$Cr + 3Ag^+ \longrightarrow 3Ag + Cr^{3+}$	1.54
Z	1 & 3	$2Cr + 3Sn^{2+} \longrightarrow 3Sn + 2Cr^{3+}$	?

What is the cell potential of galvanic cell Z?
a. 0.26 V
b. 0.60 V
c. 2.48 V
d. 5.90 V

Click reveals answer and explanation.

LO 3.12: Make qualitative or quantitative predictions about galvanic or electrolytic reactions based on half-cell reactions and potentials and/or Faraday's laws.

+ Redox Reactions and Half Cells

Source

Video

Video

Question:
The following question is based on combining the three different half cells listed below:

Half Cell 1: $Sn^{2+} + 2e^- \longrightarrow Sn$
Half Cell 2: $Ag^+ + e^- \longrightarrow Ag$
Half Cell 2: $Cr^{3+} + 3e^- \longrightarrow Cr$

Galvanic Cell	Half Cells	Reaction	E°_{cell} (V)
X	1 & 2	$Sn + 2Ag^+ \longrightarrow 2Ag + Sn^{2+}$	0.94

Answer:
The correct answer is "c", oxidation occurs in cell X and reduction in cell Z. In galvanic cell X the tin is losing electrons to form the Sn^{2+} ion, this is oxidation. In galvanic cell Z the Sn2+ is gaining electrons to form Sn, this is reduction.

LO 3.13: The student can analyze data regarding galvanic or electrolytic cells to identify properties of the underlying redox reactions