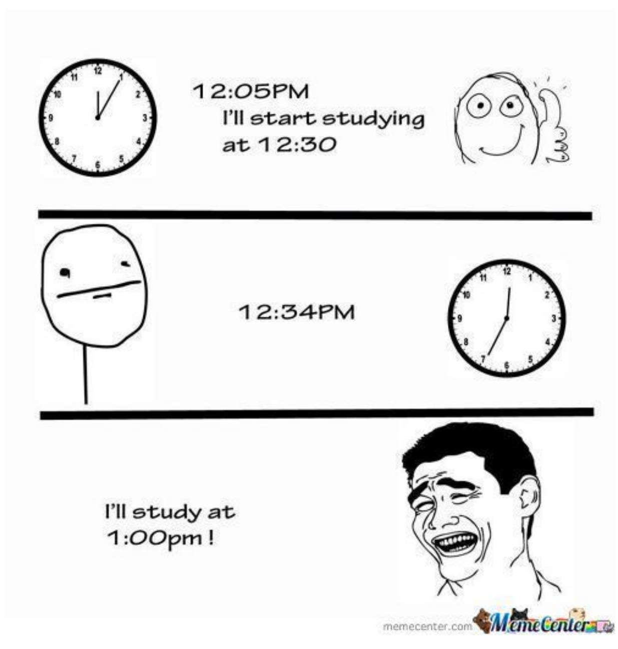
247
Mp
MR. PALERMO

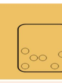
Chemistry Review Notes Units 8-14



Regents Review Unit 8

Gases

Comparing States of Matter

		
• ***Particle arrangement***: *Close, Ordered, vibrate in place* • ***Intermolecular forces of attraction:*** *high* • ***Shape:*** *definite* • ***Volume:*** *definite* • ***Entropy:*** *low*	• ***Particle arrangement:*** *Less ordered, flow around each other* • ***Intermolecular forces of attraction:*** *medium* • ***Shape:*** *take shape of container* • ***Volume:*** *definite* • ***Entropy:*** *medium*	• ***Particle arrangement***: *Far apart, disorder, RANDOM movement* • ***Intermolecular forces of attraction:*** *low* • ***Shape:*** *takes shape of container* • ***Volume:*** *fills container* • ***Entropy:*** *high*

****Gases** are **most** affected by changes in temperature, pressure, and volume.*

Ideal vs real gases

IDEAL GASES	REAL GASES
• Imaginary	• Actual gas, what we work with in lab
• Follows the gas laws	• Do not follow gas laws exactly
• Particles are NOT attracted to each other	• Particles DO attract each other (have some intermolecular forces of attraction)
• Particles have NO volume (negligible)	• Particles DO have some volume… atomic radii
• Particles move in straight line motion	• Particles DO not necessarily move in straight lines
• Have elastic collisions	• Non elastic collisions

- Ideal Gases are perfect gases. They have:
  - No mass
  - No volume
  - No attractive forces
- When will real gases behave as Ideal Gases?
  - When they are spread out
  - Temperature is High
  - Pressure is Low

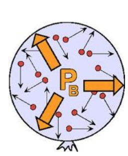
PLIGHT

Gas Pressure

- Force exerted on container walls by particles in a gas
- Units we use: kPa, atm
- STP (Standard Temperature and Pressure) refer to **Table A**

Table A
Standard Temperature and Pressure

Name	Value	Unit
Standard Pressure	101.3 kPa 1 atm	kilopascal atmosphere
Standard Temperature	273 K 0°C	kelvin degree Celsius

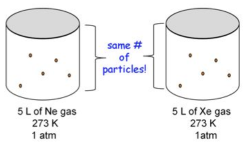


Factors AFfecting Pressure

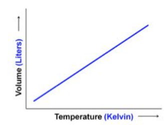
Amount of Gas (number of moles)	Increasing amount will increase Pressure and dec amount will dec pressure	
Temperature	Increasing temp. will increase Pressure and dec temp will decrease pressure	
Volume	Decreasing volume will increase P, increasing volume decreases P	

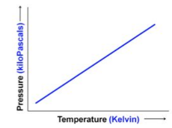
Avagadro's Law

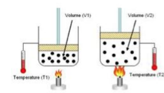
- EQUAL VOLUMES of different gases at the same temperature and pressure contain EQUAL NUMBERS OF PARTICLES



Direct Relationship: Temp changing







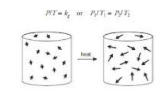
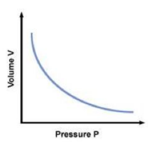
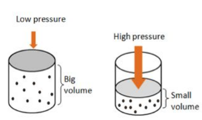


Figure 8.5 Pressure–temperature relationship for gases. As the temperature increases, the gas particles have greater kinetic energy (longer arrows) and collisions are more frequent and forceful.

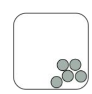
Inverse Relationship: Temperature constant





Graham's Law of Diffusion

•Gases move from high to low concentrations. Lighter gases diffuse faster.



Combined Gas Law

Table T

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Table A
Standard Temperature and Pressure

Name	Value	Unit
Standard Pressure	101.3 kPa 1 atm	kilopascal atmosphere
Standard Temperature	273 K 0°C	kelvin degree Celsius

- Temperature must be in Kelvin
- Make sure units are the same on both sides
- If a variable is held constant or not mentioned, cross it out of equation

Example

A gas in a rigid container has a pressure of 3.5 atmospheres at 200. K. Calculate the pressure at 273K.

Example:

A 32.9L sample of a gas at constant pressure increases in temperature from 25 to 45C. Should the volume increase or decrease? Calculate the new volume.

Example

A 45 mL sample of gas at standard pressure is heated from 20.°C to 50.°C. The pressure of the gas increases to 107.9 kPa. What is the new volume of the gas?

Regents Review Unit 9

Solutions

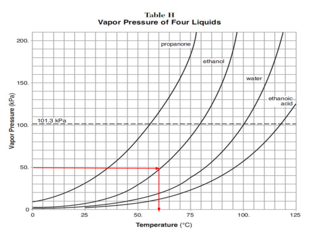
Boiling and Attractive Forces (Intermolecular Forces)

Boiling occurs when heat energy overcomes attractive forces between molecules.

IMF	Effect on Boiling Pt	Reason
The stronger the IMF	The higher the boiling pt	Takes **MORE** energy to break the forces of attraction (IMF's) between particles
The weaker the IMF	The lower the boiling pt	Takes **LESS** energy to break the forces of attraction (IMF's) between particles

Table H: Boiling pts

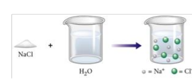
Example: What is the boiling point of ethanol at 50kPa?



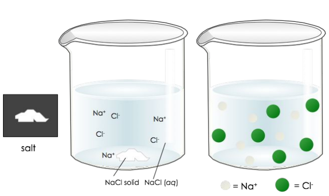
Solution:

- **Homogenous Mixture**
- **SOLUTE:** dissolved substance
- **SOLVENT:** substance solute is dissolved in
- Ex. $NaCl_{(s)}$ + $H_2O_{(l)}$ ⟹ $NaCl_{(aq)}$

Solute Solvent Solution (mixture)



Electrolytes: Ionic Compounds (salts)



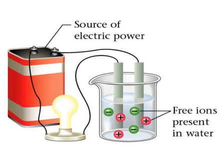


Table F: Solubility

- If substance is in the **soluble** column it dissolves in H_2O (aq)
- If substance is in the **insoluble** column it doesn't dissolve (s) this is called a ***precipitate.***

***If substance is in exceptions column it is the opposite

Table F
Solubility Guidelines for Aqueous Solutions

Ions That Form *Soluble* Compounds	Exceptions
Group 1 ions (Li^+, Na^+, etc.)	
ammonium (NH_4^+)	
nitrate (NO_3^-)	
acetate ($C_2H_3O_2^-$ or CH_3COO^-)	
hydrogen carbonate (HCO_3^-)	
chlorate (ClO_3^-)	
halides (Cl^-, Br^-, I^-)	when combined with Ag^+, Pb^{2+}, or Hg_2^{2+}
sulfates (SO_4^{2-})	when combined with Ag^+, Ca^{2+}, Sr^{2+}, Ba^{2+}, or Pb^{2+}

Ions That Form *Insoluble* Compounds*	Exceptions
carbonate (CO_3^{2-})	when combined with Group 1 ions or ammonium (NH_4^+)
chromate (CrO_4^{2-})	when combined with Group 1 ions, Ca^{2+}, Mg^{2+}, or ammonium (NH_4^+)
phosphate (PO_4^{3-})	when combined with Group 1 ions or ammonium (NH_4^+)
sulfide (S^{2-})	when combined with Group 1 ions or ammonium (NH_4^+)
hydroxide (OH^-)	when combined with Group 1 ions, Ca^{2+}, Ba^{2+}, Sr^{2+}, or ammonium (NH_4^+)

*compounds having very low solubility in H_2O

Example (exception): Determine which product is the precipitate.

$AgNO_{3(aq)} + PbCl_{2(aq)} \Rightarrow AgCl + Pb(NO_3)_2$

Table F
Solubility Guidelines for Aqueous Solutions

Ions That Form *Soluble* Compounds	Exceptions
Group 1 ions (Li^+, Na^+, etc.)	
ammonium (NH_4^+)	
nitrate (NO_3^-)	
acetate ($C_2H_3O_2^-$ or CH_3COO^-)	
hydrogen carbonate (HCO_3^-)	
chlorate (ClO_3^-)	
halides (Cl^-, Br^-, I^-)	when combined with Ag^+, Pb^{2+}, or Hg_2^{2+}
sulfates (SO_4^{2-})	when combined with Ag^+, Ca^{2+}, Sr^{2+}, Ba^{2+}, or Pb^{2+}

Ions That Form *Insoluble* Compounds*	Exceptions
carbonate (CO_3^{2-})	when combined with Group 1 ions or ammonium (NH_4^+)
chromate (CrO_4^{2-})	when combined with Group 1 ions, Ca^{2+}, Mg^{2+}, or ammonium (NH_4^+)
phosphate (PO_4^{3-})	when combined with Group 1 ions or ammonium (NH_4^+)
sulfide (S^{2-})	when combined with Group 1 ions or ammonium (NH_4^+)
hydroxide (OH^-)	when combined with Group 1 ions, Ca^{2+}, Ba^{2+}, Sr^{2+}, or ammonium (NH_4^+)

*compounds having very low solubility in H_2O

How to complete a Double Replacement Reaction

$\boxed{NaCl + AgNO_3 \longrightarrow NaNO_3 + AgCl}$

Na^+ Ag^+

Cl^- NO_3^- $\Rightarrow$ $(Na^+ \; NO_3^-)$ $(Ag^+ \; Cl^-)$

1. Positive ions switch partners
2. Look up oxidation states and perform criss cross to make new products.
3. Use table F to determine which (if any) product forms a precipitate.

Example: Complete the following double replacement rx and determine the insoluble product:

$\boxed{NaCl + AgNO_3 \longrightarrow NaNO_{3(aq)} + AgCl_{(s)}}$

Table F
Solubility Guidelines for Aqueous Solutions

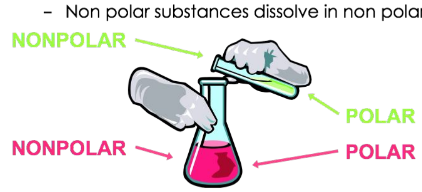
Ions That Form *Soluble* Compounds	Exceptions
Group 1 ions (Li^+, Na^+, etc.)	
ammonium (NH_4^+)	
nitrate (NO_3^-)	
acetate ($C_2H_3O_2^-$ or CH_3COO^-)	
hydrogen carbonate (HCO_3^-)	
chlorate (ClO_3^-)	
halides (Cl^-, Br^-, I^-)	when combined with Ag^+, Pb^{2+}, or Hg_2^{2+}
sulfates (SO_4^{2-})	when combined with Ag^+, Ca^{2+}, Sr^{2+}, Ba^{2+}, or Pb^{2+}

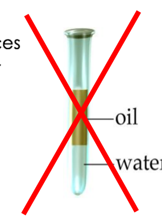
Ions That Form *Insoluble* Compounds*	Exceptions
carbonate (CO_3^{2-})	when combined with Group 1 ions or ammonium (NH_4^+)
chromate (CrO_4^{2-})	when combined with Group 1 ions, Ca^{2+}, Mg^{2+}, or ammonium (NH_4^+)
phosphate (PO_4^{3-})	when combined with Group 1 ions or ammonium (NH_4^+)
sulfide (S^{2-})	when combined with Group 1 ions or ammonium (NH_4^+)
hydroxide (OH^-)	when combined with Group 1 ions, Ca^{2+}, Ba^{2+}, Sr^{2+}, or ammonium (NH_4^+)

*compounds having very low solubility in H_2O

Solubility

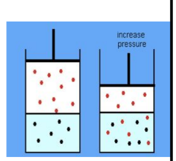
- "Like Dissolves Like"
  - Polar substances dissolve in polar substances
  - Non polar substances dissolve in non polar



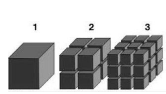


Factors Affecting Solubility

- Solubility:
  - **INCREASES** as temperature increases (solids)
  - **DECREASES** as temperature increases (gases)
  - **INCREASES** as pressure increases (gases)



- Speed up dissolving by
  - Stirring
  - Increasing surface area



Types of Solutions

UNSATURATED SOLUTION	SATURATED SOLUTION	SUPERSATURATED SOLUTION
more solute dissolves	no more solute dissolves	becomes unstable, crystals form

Table G

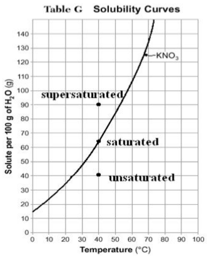


Table G: Solubility Curve

Example: If you dissolve 50g of $NaNO_3$ at 30 C what type of solution did you make?

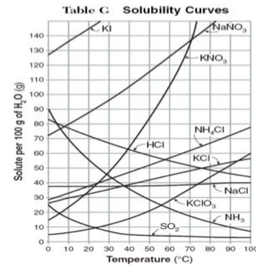


Table G: Solubility Curve

Example: According to table G, what is the maximum amount of KNO_3 that can be dissolved in 100 g H_2O at 60°C?

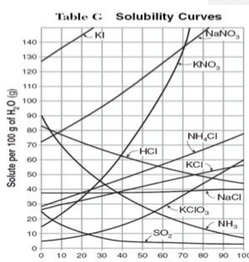
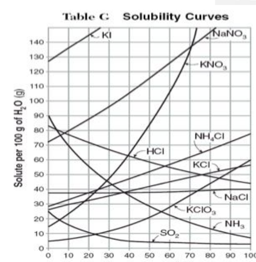


Table G: Solubility Curve

Example: What is the amount of $NaNO_3$ that can be dissolved in 50g of water at 80°C is?



PPM (Table T)

Example: A sample of water is found to contain 0.010 g lead in 15. g solution. What is the concentration in ppm?

$$\textbf{Parts Per Million} = \frac{\textbf{Mass of Solute}}{\textbf{Mass of Solution}} \times \textbf{1,000,000}$$

$$ppm = \frac{0.010g}{15.g} \times 1{,}000{,}000 = 670\ ppm$$

Molarity (concentration) (Table T)

A solution has a volume of 2.5 liters and contains 0.70 mol of NaCl. What is the molarity?

$$\textbf{Molarity (M)} = \frac{\textbf{Moles of Solute (mol)}}{\textbf{Liters of solution (L)}}$$

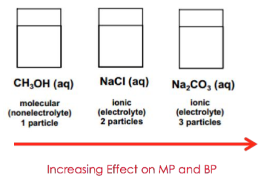
$$M = \frac{0.70\ mol}{2.5\ L} = 0.28M$$

Solutions vs. Pure Water

- Solutions have a higher boiling pt and lower freezing pt than pure water
- The more particles the greater the effect on boiling pt and freezing pt

- Ionic compounds (salts) have greatest effect

  The more particles formed the greater the effect



Example:

Which compound when dissolved in water, will have the highest boiling point?

$CaCl_2$	Ionic: dissociates into Ca^{+2} and $2Cl^-$
NaCl	Ionic: dissociates into Na^{+1} and Cl^-
$C_6H_{12}O_6$	Covalent: doesn't dissociates
NaI	Ionic: dissociates into Na^{+1} and I^{-1}

Regents Review Unit 10

Kinetics and Equilibrium

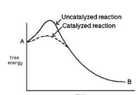
Effective Collisions

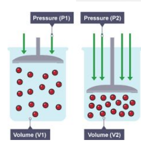
In order for a reaction to occur, reactant PARTICLES MUST COLLIDE (effectively) with the following:

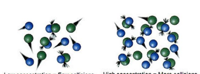
1. Proper amount of ENERGY
2. Proper ORIENTATION (angle)

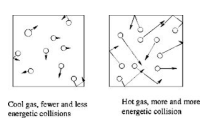
Factors Increasing Reaction Rate

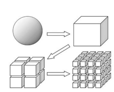
1. Type of reactant (ionic aqueous solutions react fastest)
2. Increase Concentration
3. Increase Temperature
4. Increase pressure (gases only)
5. Increase surface area
6. Add a catalyst











Endothermic

A + B + ENERGY ---> C + D

energy absorbed as reactant

Table I
Heats of Reaction at 101.3 kPa and 298 K

$N_2(g) + O_2(g) \longrightarrow 2NO(g)$	+182.6

*The ΔH values are based on molar quantities represented in the equations. A minus sign indicates an exothermic reaction.

(+) sign indicated energy was absorbed (endothermic)

Exothermic

- Heat is **RELEASED** as a PRODUCT
  - ΔH is (-)
  - More stable reaction
  - Spontaneous

A + B ---> C + D + ENERGY

energy released as a product

Exothermic

Table I
Heats of Reaction at 101.3 kPa and 298 K

$C(s) + O_2(g) \longrightarrow CO_2(g)$	–393.5

*The ΔH values are based on molar quantities represented in the equations. A minus sign indicates an exothermic reaction.

(-) sign indicated energy was released (exothermic)

Reverse Reactions

Example: Is the following endothermic or exothermic?

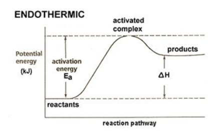
$2H_2O(l)$ --> $2H_2(g) + O_2(g)$

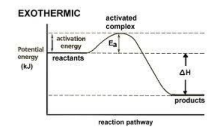
$2H_2(g) + O_2(g) \longrightarrow 2H_2O(\ell)$	–571.6

*****For reverse reactions switch signs of ΔH**

+571.6kJ (endothermic)

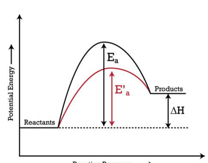
Potential Energy Diagrams

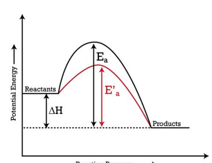




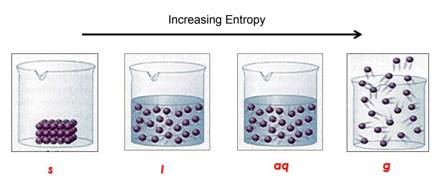
Effects of adding a catalyst

LOWERS activation energy so reaction occurs faster with less energy input





Entropy

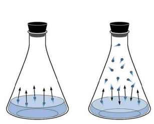


Equilibrium

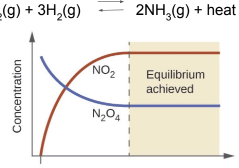
The **rate** of the forward reaction **equals** the **rate** of the reverse reactions

The **concentrations** become **constant**

Ex. $H_2O_{(l)} \rightleftharpoons H_2O_{(g)}$



$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) + heat$



LeChatelier's Principle (equilibrium shifts)

When you **ADD** (increase concentration) a stress, equilibrium shifts **AWAY** from that side to relieve the stress and restore equilibrium.

When you **TAKE AWAY** (decrease concentration) a stress, equilibrium shifts **TOWARDS** that side to restore equilibrium.

FORWARD SHIFT →

Reactants ⇔ Products

← REVERSE SHIFT

Example: $2CO_{(g)} + O_{2(g)} \Leftrightarrow 2CO_{2(g)} + 566\ kJ$

- Increasing concentration of CO or O_2 shift away to product side: increase in CO_2 and heat and decrease in CO and O_2
- Decreasing concentration of CO or O_2 shift towards reactant side: decrease in CO_2 and heat and increase in CO and O_2

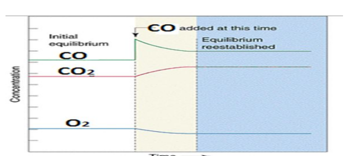
- Increasing concentration of CO_2 or heat shift away to reactant side: decrease in CO_2 and heat and increase in CO and O_2
- Decreasing concentration of CO_2 or heat shift towards product side: increase in CO_2 and heat and decrease in CO and O_2

Example: $2CO_{(g)} + O_{2(g)} \Leftrightarrow 2CO_{2(g)} + 566\ kJ$

- Increase in pressure (affects gases only), shift away from side that has more moles of gas (in this ex. It's the reactant side) to the product side
- Decrease in pressure (affects gases only), shift back towards side that has more moles of gas (in this ex. It's the reactant side)

What can conclude about equilibrium from the graph?

$$2CO_{(g)} + O_{2(g)} \Leftrightarrow 2CO_{2(g)} + 566\ kJ$$



Answer: The concentrations are constant (not changing)

Regents Review Unit 11

Organic Chemistry

Organic Compounds

- Contain Carbon and hydrogen
  - Hydrocarbon: Type of organic molecule that only contains carbon and hydrogen
- Carbon has 4 valence electrons so it forms for bonds

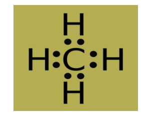


Table P & Q

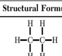
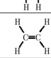
Ex. pentene has 5 carbons and 10 hydrogens

Ex. H—C≡C—H is ethyne

Table P
Organic Prefixes

Prefix	Number of Carbon Atoms
meth-	1
eth-	2
prop-	3
but-	4
pent-	5
hex-	6
hept-	7
oct-	8
non-	9
dec-	10

Table Q
Homologous Series of Hydrocarbons

Name	General Formula	Examples	
		Name	Structural Formula
alkanes	C_nH_{2n+2}	ethane	
alkenes	C_nH_{2n}	ethene	
alkynes	C_nH_{2n-2}	ethyne	H—C≡C—H

n = number of carbon atoms

How to determine the type of hydrocarbon

1.Count up the number of carbons

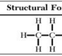
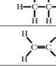
2.If the # of Hydrogen are **double** the **# of carbons** its an **alkene**

3.If **more than double** its an **alkane**, **less than double** its an **alkyne**

Example: C_5H_{12}

(12 is more than double 5 so it's an alkane)

Table Q
Homologous Series of Hydrocarbons

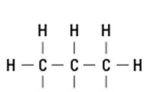
Name	General Formula	Examples	
		Name	Structural Formula
alkanes	C_nH_{2n+2}	ethane	
alkenes	C_nH_{2n}	ethene	
alkynes	C_nH_{2n-2}	ethyne	H—C≡C—H

n = number of carbon atoms

Structural and condensed structural formulas

Example: Propane

C_3H_8

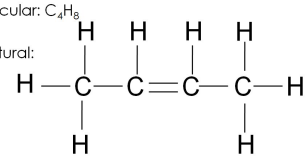


Condensed formula:
$CH_3CH_2CH_3$

EXAMPLE: 2-BUTENE

Molecular: C_4H_8

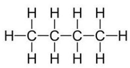
Structural:



Condensed: $CH_3CHCHCH_3$

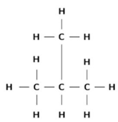
Isomers

Same molecular formula different structural formula resulting in different properties



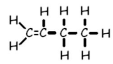
butane

C_4H_{10}



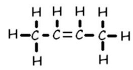
2-methylpropane

C_4H_{10}



1-butene

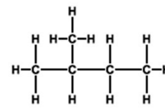
C_4H_8



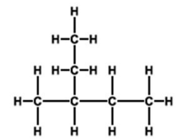
2-butene

C_4H_8

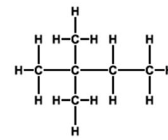
Naming branched alkanes



2-methyl butane



2-ethyl butane

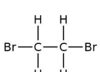


2,2 dimethyl butane

Functional Groups

- Table R
- 1st identify the class of compound in your example
- Then use the example to help you name your compound

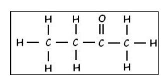
Ex:



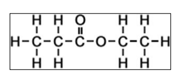
1,2-dibromo ethane

Class of Compound	Functional Group	General Formula	Example
halide (halocarbon)	$-\mathrm{F}$ (fluoro-) $-\mathrm{Cl}$ (chloro-) $-\mathrm{Br}$ (bromo-) $-\mathrm{I}$ (iodo-)	$R-X$ (X represents any halogen)	$CH_3CHClCH_3$ 2-chloropropane
alcohol	$-\mathrm{OH}$	$R-\mathrm{OH}$	$CH_3CH_2CH_2OH$ 1-propanol
ether	$-\mathrm{O}-$	$R-\mathrm{O}-R'$	$CH_3OCH_2CH_3$ methyl ethyl ether
aldehyde	$-\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-\mathrm{H}$	$R-\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-\mathrm{H}$	$CH_3CH_2\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-H$ propanal
ketone	$-\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-$	$R-\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-R'$	$CH_3\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}CH_2CH_2CH_3$ 2-pentanone
organic acid	$-\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-\mathrm{OH}$	$R-\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-\mathrm{OH}$	$CH_3CH_2\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-OH$ propanoic acid
ester	$-\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-\mathrm{O}-$	$R-\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-\mathrm{O}-R'$	$CH_3CH_2\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}OCH_3$ methyl propanoate
amine	$-\overset{\|}{\mathrm{N}}-$	$R-\overset{R'}{\overset{\|}{\mathrm{N}}}-R''$	$CH_3CH_2CH_2NH_2$ 1-propanamine
amide	$-\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-\overset{\|}{\mathrm{N}}\mathrm{H}$	$R-\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-\overset{R'}{\overset{\|}{\mathrm{N}}}\mathrm{H}$	$CH_3CH_2\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-NH_2$ propanamide

Examples:



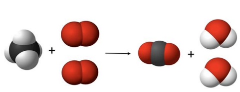
2-butanone



Ethyl propanoate

Class of Compound	Functional Group	General Formula	Example
halide (halocarbon)	$-\mathrm{F}$ (fluoro-) $-\mathrm{Cl}$ (chloro-) $-\mathrm{Br}$ (bromo-) $-\mathrm{I}$ (iodo-)	$R-X$ (X represents any halogen)	$CH_3CHClCH_3$ 2-chloropropane
alcohol	$-\mathrm{OH}$	$R-\mathrm{OH}$	$CH_3CH_2CH_2OH$ 1-propanol
ether	$-\mathrm{O}-$	$R-\mathrm{O}-R'$	$CH_3OCH_2CH_3$ methyl ethyl ether
aldehyde	$-\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-\mathrm{H}$	$R-\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-\mathrm{H}$	$CH_3CH_2\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-H$ propanal
ketone	$-\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-$	$R-\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-R'$	$CH_3\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}CH_2CH_2CH_3$ 2-pentanone
organic acid	$-\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-\mathrm{OH}$	$R-\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-\mathrm{OH}$	$CH_3CH_2\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-OH$ propanoic acid
ester	$-\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-\mathrm{O}-$	$R-\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-\mathrm{O}-R'$	$CH_3CH_2\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}OCH_3$ methyl propanoate
amine	$-\overset{\|}{\mathrm{N}}-$	$R-\overset{R'}{\overset{\|}{\mathrm{N}}}-R''$	$CH_3CH_2CH_2NH_2$ 1-propanamine
amide	$-\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-\overset{\|}{\mathrm{N}}\mathrm{H}$	$R-\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-\overset{R'}{\overset{\|}{\mathrm{N}}}\mathrm{H}$	$CH_3CH_2\overset{\mathrm{O}}{\overset{\|}{\mathrm{C}}}-NH_2$ propanamide

Combustion



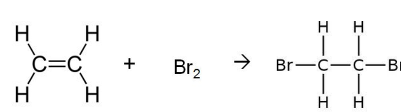
$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

Table I
Heats of Reaction at 101.3 kPa and 298 K

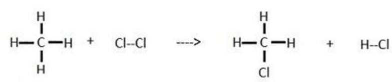
Reaction	ΔH (kJ)*
$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(\ell)$	–890.4
$C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(\ell)$	–2219.2
$2C_8H_{18}(\ell) + 25O_2(g) \longrightarrow 16CO_2(g) + 18H_2O(\ell)$	–10943
$2CH_3OH(\ell) + 3O_2(g) \longrightarrow 2CO_2(g) + 4H_2O(\ell)$	–1452
$C_2H_5OH(\ell) + 3O_2(g) \longrightarrow 2CO_2(g) + 3H_2O(\ell)$	–1367
$C_6H_{12}O_6(s) + 6O_2(g) \longrightarrow 6CO_2(g) + 6H_2O(\ell)$	–2804
$2CO(g) + O_2(g) \longrightarrow 2CO_2(g)$	–566.0
$C(s) + O_2(g) \longrightarrow CO_2(g)$	–393.5
$4Al(s) + 3O_2(g) \longrightarrow 2Al_2O_3(s)$	–3351
$N_2(g) + O_2(g) \longrightarrow 2NO(g)$	+182.6
$N_2(g) + 2O_2(g) \longrightarrow 2NO_2(g)$	+66.4
$2H_2(g) + O_2(g) \longrightarrow 2H_2O(g)$	–483.6
$2H_2(g) + O_2(g) \longrightarrow 2H_2O(\ell)$	–571.6
$N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g)$	–91.8
$2C(s) + 3H_2(g) \longrightarrow C_2H_6(g)$	–84.0
$2C(s) + 2H_2(g) \longrightarrow C_2H_4(g)$	+52.4
$2C(s) + H_2(g) \longrightarrow C_2H_2(g)$	+227.4
$H_2(g) + I_2(g) \longrightarrow 2HI(g)$	+53.0
$KNO_3(s) \xrightarrow{H_2O} K^+(aq) + NO_3^-(aq)$	+34.89
$NaOH(s) \xrightarrow{H_2O} Na^+(aq) + OH^-(aq)$	–44.51
$NH_4Cl(s) \xrightarrow{H_2O} NH_4^+(aq) + Cl^-(aq)$	+14.78
$NH_4NO_3(s) \xrightarrow{H_2O} NH_4^+(aq) + NO_3^-(aq)$	+25.69
$NaCl(s) \xrightarrow{H_2O} Na^+(aq) + Cl^-(aq)$	+3.88
$LiBr(s) \xrightarrow{H_2O} Li^+(aq) + Br^-(aq)$	–48.83
$H^+(aq) + OH^-(aq) \longrightarrow H_2O(\ell)$	–55.8

*Minus sign indicates an exothermic reaction.

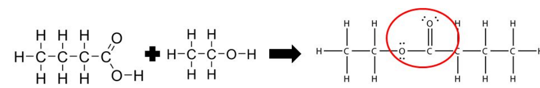
Addition



Substitution



Esterification



ester	$-\overset{O}{\overset{\Vert}{C}}-O-$	$R-\overset{O}{\overset{\Vert}{C}}-O-R'$	$CH_3CH_2\overset{O}{\overset{\Vert}{C}}OCH_3$ methyl propanoate

FERMENTATION

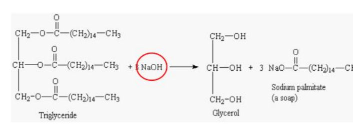
- Enzymatic breakdown of sugar into alcohol (ethanol) and CO_2
- **Identify Alcohol and CO_2 as product**

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$$

alcohol	$-OH$	$R-OH$	$CH_3CH_2CH_2OH$ 1-propanol

Saponification

Making Soap



Polymerization

- Long chains of repeating monomers
- Look for the n or a large number outside the parentheses

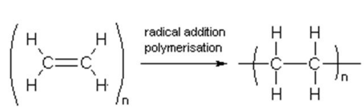


Fig 1: The polymerisation of ethene in to poly(ethene)

Regents Review Unit 12

Acids and Bases

Arrhenius Acid & Bases

Acids yield the hydrogen ion H^+ or Hydronium ion H_3O

$HCl \rightarrow H^+ + Cl^-$

Bases yield the hydroxide ion OH^-

$NaOH_{(s)} \rightarrow Na^{+1}_{(aq)} + OH^{-1}_{(aq)}$

Table K
Common Acids

Formula	Name
$HCl(aq)$	hydrochloric acid
$HNO_3(aq)$	nitric acid
$H_2SO_4(aq)$	sulfuric acid
$H_3PO_4(aq)$	phosphoric acid
$H_2CO_3(aq)$ or $CO_2(aq)$	carbonic acid
$CH_3COOH(aq)$ or $HC_2H_3O_2(aq)$	ethanoic acid (acetic acid)

Table L
Common Bases

Formula	Name
$NaOH(aq)$	sodium hydroxide
$KOH(aq)$	potassium hydroxide
$Ca(OH)_2(aq)$	calcium hydroxide
$NH_3(aq)$	aqueous ammonia

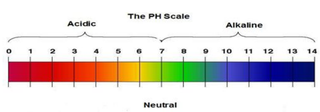
Properties of Acids and Bases

Acids:

- Sour Taste
- Can burn your skin
- React vigorously with metals to make $H_{2(g)}$
- pH is less than 7

Bases:

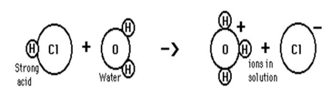
- Bitter taste
- Can be corrosive
- pH greater than 7



Alternate theory of acids and bases

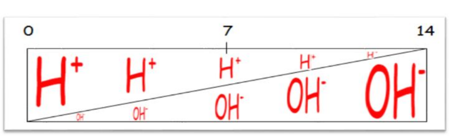
Acids are proton H^+ donors

Bases are proton H^+ acceptors



BAAD

pH



The ratio of $[H^+]$ to $[OH^-]$ determines pH

-In acids **$[H^+] > [OH^-]$**

-In bases **$[H^+] < [OH^-]$**

-When neutral **$[H^+] = [OH^-]$**

Indicators

If it is the left hand color the pH is below that number

If it is the right hand color the pH is above that number

Ex: A solution turns **blue** with bromcresol green (>5.4) and **yellow** with bromothymol blue (<6.0)

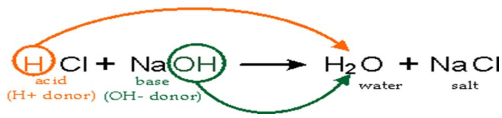
The pH range is between 5.4 and 6.0

Table M
Common Acid–Base Indicators

Indicator	Approximate pH Range for Color Change	Color Change
methyl orange	3.2–4.4	red to yellow
bromthymol blue	6.0–7.6	yellow to blue
phenolphthalein	8.2–10	colorless to pink
litmus	5.5–8.2	red to blue
bromcresol green	3.8–5.4	yellow to blue
thymol blue	8.0–9.6	yellow to blue

Neutralization

Acid + Base → Salt + Water

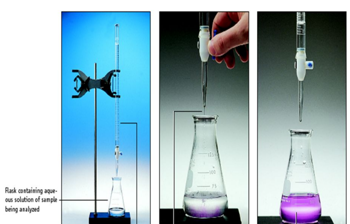


Example:

Complete the neutralization reaction:

$HNO_{3(aq)} + Ca(OH)_{2(aq)} \rightarrow$

Titration



(a) 50-mL buret containing aqueous NaOH of accurately known concentration

(b) A solution of NaOH is added slowly to the sample being analyzed. The sample is mixed.

(c) When the amount of NaOH added from the buret exactly equals the amount of H+ supplied by the acid being analyzed, the dye (indicator) changes color.

Titration Formula

Titration	$M_A V_A = M_B V_B$	M_A = molarity of H^+ V_A = volume of acid	M_B = molarity of OH^- V_B = volume of base

Ex. What is the molarity of NaOH if 100.mL of 3.00M HCl is titrated with 200.mL of NaOH?

Titration Formula

Titration	$M_A V_A = M_B V_B$	M_A = molarity of H^+ V_A = volume of acid	M_B = molarity of OH^- V_B = volume of base

Ex. You have 50 mL of 1.0 M $H_2SO_{4(aq)}$. What volume of 0.5 M NaOH would be required to neutralize the acid?

Regents Review Unit 13

Electrochemistry

Assigning Oxidation Numbers

- Elements not in compounds have a zero oxidation state
- Assign the most electronegative element first
- If there is more than two elements, assign the middle last.
- Remember that the sum of the oxidation states is zero for compounds

Example: H_2 $CaClO_3$

Oxidation & Reduction

Example

- Oxidation #'s can change as a result of a rxn.

$$\overset{0}{2Na} + \overset{0}{Cl_2} \rightarrow 2\overset{+1}{Na}\overset{-1}{Cl}$$

leo ger

Leo Ger

Na went from 0 to +1: Na was oxidized

Cl went from 0 to -1: Cl was reduced

LEO → Oxidation # increases

-4 -3 -2 -1 0 +1 +2 +3 +4

← Oxidation # decreases GER

Remember

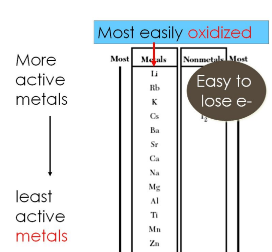
Single Replacement Rx's are **ALWAYS** Redox

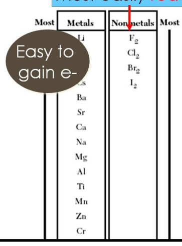
$$\overset{0}{Zn(s)} + \overset{+1\ -1}{HCl(aq)} \rightarrow \overset{0}{H_2(g)} + \overset{+2\ -1}{ZnCl_2(aq)}$$

Double Replacement Rx's are **NEVER** redox

$$\overset{+1\ -2\ +1}{NaOH_{(aq)}} + \overset{+1\ -1}{HCl_{(aq)}} \rightarrow \overset{+1\ -2}{H_2O_{(l)}} + \overset{+1\ -1}{NaCl_{(aq)}}$$

Table J





More active nonmetals

least active nonmetals

Half Reactions

$$\overset{0}{Cu} + 2\overset{+1}{Ag}\overset{-1}{NO_3} \rightarrow \overset{+2}{Cu}\overset{-1}{(NO_3)_2} + 2\overset{0}{Ag}$$

red

ox

Ox: $Cu^0 \rightarrow Cu^{+2} + 2e^-$

Red: $Ag^{+1} + 1e^- \rightarrow Ag^0$

Balancing Redox Reactions

$$\overset{0}{Cu} + 2\overset{+1}{Ag}\overset{-1}{NO_3} \rightarrow \overset{+2}{Cu}\overset{-1}{(NO_3)_2} + 2\overset{0}{Ag}$$

red

ox

Ox: $Cu^0 \rightarrow Cu^{+2} + 2e^-$ Ox: $Cu^0 \rightarrow Cu^{+2} + 2e^-$

Red: $Ag^{+1} + 1e^- \rightarrow Ag^0$ Red: $2Ag^{+1} + 2e^- \rightarrow 2Ag^0$

Now MASS and CHARGE are CONSERVED

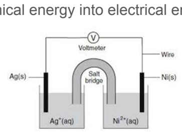
Example: Balance the following redox rx

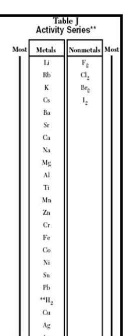
$$Mg + N_2 \rightarrow Mg_3N_2$$

Voltaic Cell (battery)

- Label flow of e- (Electrons flow from high to low on table J)
- Label which half cell is oxidized and which is reduced (use Leo Ger)
- Use an ox and red cat to label the anode & cathode Anode is negative and cathode is positive
- Spontaneously converts chemical energy into electrical energy

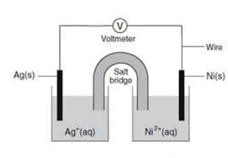
Electrons allows flow from anode to cathode in any cell





Salt bridge

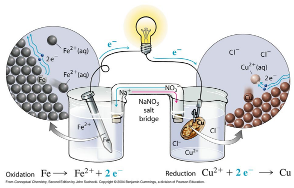
Allows **IONS** to flow to maintain neutrality



Changes in mass

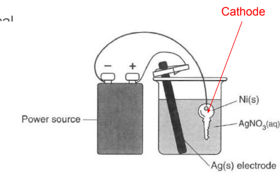
Anode: atoms form ions so mass of anode decreases

Cathode: ions form atoms so mass of cathode increases



Electrolytic Cell

- Label flow of electrons from the negative terminal of battery
- Label anode and cathode (Electrons flow from anode to cathode)
- Anode is positive and cathode is negative
- Nonspontaneous reaction
- Converts electrical energy to chemical



Regents Review Unit 14

Nuclear chemistry

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Nuclear Decay Equations

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- Make sure both sides are equal in terms of mass and charge (conservation)
- Look up the decay mode on table N then use table O to write the notation in the equation

$^{198}_{79}Au \longrightarrow$

Table O
Symbols Used in Nuclear Chemistry

Name	Notation	Symbol
alpha particle	$^{4}_{2}He$ or $^{4}_{2}\alpha$	α
beta particle (electron)	$^{0}_{-1}e$ or $^{0}_{-1}\beta$	β^-
gamma radiation	$^{0}_{0}\gamma$	γ
neutron	$^{1}_{0}n$	n
proton	$^{1}_{1}H$ or $^{1}_{1}p$	p
positron	$^{0}_{+1}e$ or $^{0}_{+1}\beta$	β^+

Table N
Selected Radioisotopes

Nuclide	Half-Life	Decay Mode	Nuclide Name
^{198}Au	2.69 d	β^-	gold-198
^{14}C	5730 y	β^-	carbon-14
^{37}Ca	175 ms	β^+	calcium-37

Penetrating power

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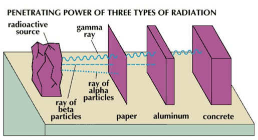


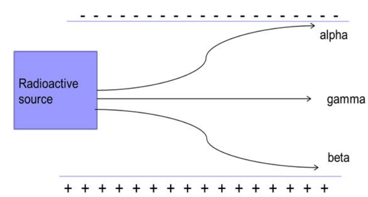
Least penetrating power

Most penetrating power

Table O
Symbols Used in Nuclear Chemistry

Name	Notation	Symbol
alpha particle	$^{4}_{2}He$ or $^{4}_{2}\alpha$	α
beta particle (electron)	$^{0}_{-1}e$ or $^{0}_{-1}\beta$	β^-
gamma radiation	$^{0}_{0}\gamma$	γ
neutron	$^{1}_{0}n$	n
proton	$^{1}_{1}H$ or $^{1}_{1}p$	p
positron	$^{0}_{+1}e$ or $^{0}_{+1}\beta$	β^+

247 Mp MR. PALERMO



Half Life

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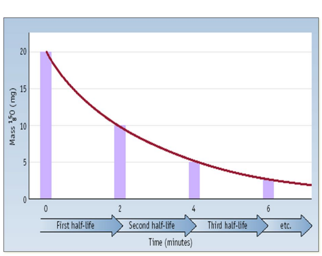

Half Life Problems

$$\frac{\text{Total time}}{\text{Half life (table N)}} = \text{\# of half lives}$$

Half the mass or fraction/percent of the sample for however many half lives you calculated

Table N
Selected Radioisotopes

Nuclide	Half-Life	Decay Mode	Nuclide Name
^{198}Au	2.695 d	β^-	gold-198
^{14}C	5715 y	β^-	carbon-14
^{37}Ca	182 ms	β^+	calcium-37
^{60}Co	5.271 y	β^-	cobalt-60
^{137}Cs	30.2 y	β^-	cesium-137
^{53}Fe	8.51 min	β^+	iron-53
^{220}Fr	27.4 s	α	francium-220
^{3}H	12.31 y	β^-	hydrogen-3
^{131}I	8.021 d	β^-	iodine-131
^{37}K	1.23 s	β^+	potassium-37
^{42}K	12.36 h	β^-	potassium-42
^{85}Kr	10.73 y	β^-	krypton-85
^{16}N	7.13 s	β^-	nitrogen-16
^{19}Ne	17.22 s	β^+	neon-19
^{32}P	14.28 d	β^-	phosphorus-32
^{239}Pu	2.410×10^4 y	α	plutonium-239
^{226}Ra	1599 y	α	radium-226
^{222}Rn	3.823 d	α	radon-222
^{90}Sr	29.1 y	β^-	strontium-90
^{99}Tc	2.13×10^5 y	β^-	technetium-99
^{232}Th	1.40×10^{10} y	α	thorium-232
^{233}U	1.592×10^5 y	α	uranium-233
^{235}U	7.04×10^8 y	α	uranium-235
^{238}U	4.47×10^9 y	α	uranium-238

Source: *CRC Handbook of Chemistry and Physics*, 91st ed., 2010–2011, CRC Press

Half Life Problems

<u>Total time</u> = # of half lives
Half life (table N)

Example: How many grams of N-16 will remain from a 100 gram sample after 21.6 seconds?

21.6/7.13s = 3 half lives

100g→ 50g→ 25g→ 12.5g

1 → ½ → ¼ → ⅛

Table N
Selected Radioisotopes

Nuclide	Half-Life	Decay Mode	Nuclide Name
${}^{198}Au$	2.695 d	β^-	gold-198
${}^{14}C$	5715 y	β^-	carbon-14
${}^{37}Ca$	182 ms	β^+	calcium-37
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${}^{131}I$	8.021 d	β^-	iodine-131
${}^{37}K$	1.23 s	β^+	potassium-37
${}^{42}K$	12.36 h	β^-	potassium-42
${}^{85}Kr$	10.73 y	β^-	krypton-85
${}^{16}N$	7.13 s	β^-	nitrogen-16
${}^{19}Ne$	17.22 s	β^+	neon-19
${}^{32}P$	14.28 d	β^-	phosphorus-32
${}^{239}Pu$	2.410×10^4 y	α	plutonium-239
${}^{226}Ra$	1599 y	α	radium-226
${}^{222}Rn$	3.823 d	α	radon-222
${}^{90}Sr$	29.1 y	β^-	strontium-90
${}^{99}Tc$	2.13×10^5 y	β^-	technetium-99
${}^{232}Th$	1.40×10^{10} y	α	thorium-232
${}^{233}U$	1.592×10^5 y	α	uranium-233
${}^{235}U$	7.04×10^8 y	α	uranium-235
${}^{238}U$	4.47×10^9 y	α	uranium-238

Source: *CRC Handbook of Chemistry and Physics*, 91st ed., 2010–2011, CRC Press

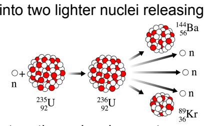
Nuclear Reactions

- Convert matter to energy
- Produce more energy than chemical reactions
- Fusion reactions produce the most energy

Fission vs Fusion

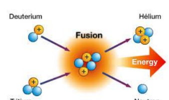
- Fission: splitting of a heavy, unstable nucleus into two lighter nuclei releasing large amounts of energy
  - Produces radioactive waste
  - Chain reaction

$${}^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{139}_{56}Ba + {}^{94}_{36}Kr + 3\,{}^{1}_{0}n$$



- Fusion: process where two light nuclei combine together releasing vast amounts of energy (takes place inside the sun)
  - Less waste
  - More energy released than fission
  - Currently too costly

$${}^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n$$



Natural vs artificial transmutation

Natural: spontaneously decays (look for 1 reactant)

Ex. radioactive decay

$${}^{226}_{88}Ra \rightarrow {}^{222}_{86}Rn + {}^{4}_{2}He$$

Artificial: non spontaneous (look for 2 or more reactants)

Ex. fission and fusion

$${}^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{139}_{56}Ba + {}^{94}_{36}Kr + 3\,{}^{1}_{0}n$$

$${}^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n$$

$${}^{27}_{13}Al + {}^{4}_{2}He \rightarrow {}^{30}_{15}P + {}^{1}_{0}n$$

Pros and Cons of radioactivity

Pros:
- large amounts of energy
- Dating materials
- Medical uses

Cons:
- Radioactive waste
- Dangerous
- mutations

Flower exposed to radiation from Fukushima nuclear facility, Japan

Uses

- Carbon 14- dating organic material
- Uranium-238 dating rocks
- Iodine-131 used to diagnose thyroid disorders
- cobalt -60 used to treat cancer
- Tc-99 locate brain tumors