BC Science 10

Ultimate Review Guide

Ultra Condensed Version

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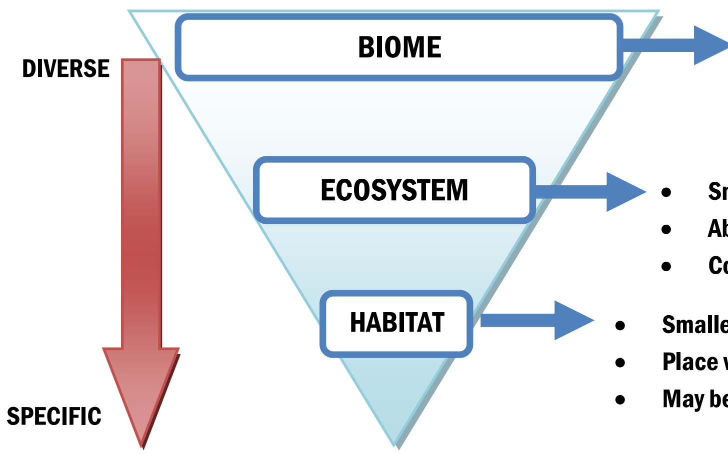
1.1 BIOMES

Environments are made up of the 2 components:

Biotic: Living — **Plants, animals, fungi, bacteria**

Abiotic: Non-Living — **Temperature, Rainfall**



BIOME
- **Large Region**
- **Similar BIOTIC FACTORS: Plants, Animals**
- **Similar ABIOTIC FACTORS: Rainfall & Temperature**
- **Contain MANY ecosystems and habitats**

ECOSYSTEM
- **Smaller Region**
- **Abiotic components interact with biotic components**
- **Contain many habitats**

HABITAT
- **Smallest Region**
- **Place where a specific organism (species) lives**
- **May be the home to a population of the same species**

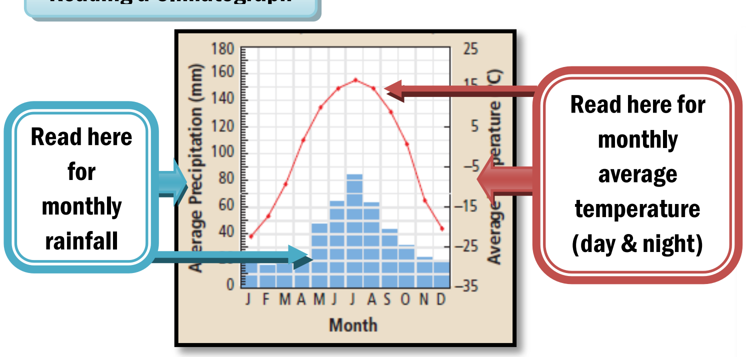
Biomes

There are 8 land (terrestrial biomes)**:**

BIOMES are found across the world but they are found in **SPECIFIC** places since they share similar **ABIOTIC** and **BIOTIC** factors

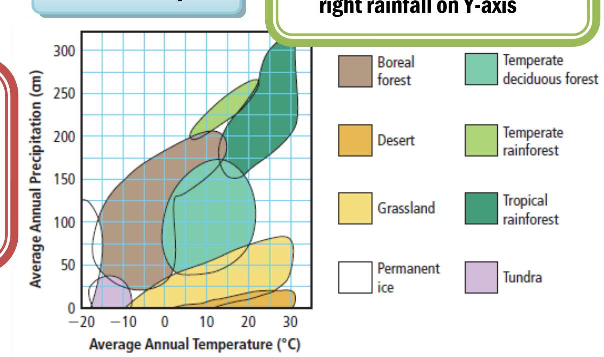
- **Temperature and Precipitation are the 2 most important ABIOTIC factors** that define a biome and where it will be located on Earth.
- A third ABIOTIC FACTOR of a biome is LATTITUDE, which is the distance north or south from the equator.
- <u>Rain Forest Biomes</u> are located near coast lines since WARM, MOIST air is found here.
- To measure the CLIMATE (weather pattern over 30 years) of a biome, scientists use a **CLIMATOGRAPH to measure rainfall and temperature**

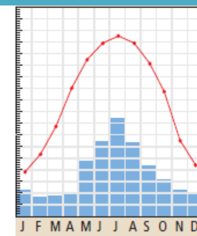
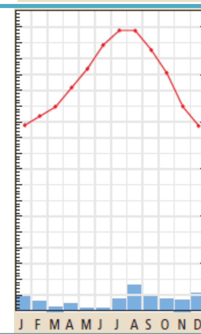
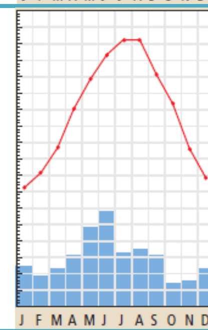
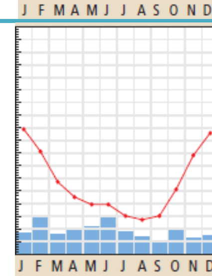
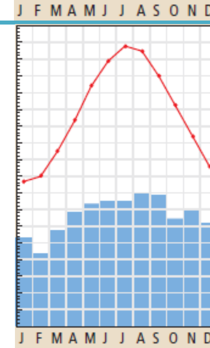
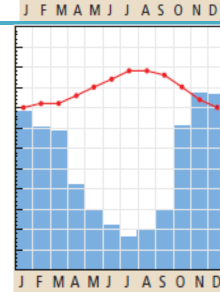
Reading a Climatograph

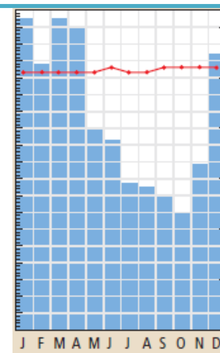
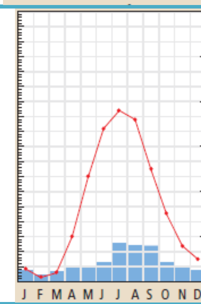


Biome Graph

1. Find Temperature on X-axis
2. Move up until you are at the right rainfall on Y-axis



Biome Name	Characteristics	Climatograph (Rain and Temp)
Boreal Forest	**-found in Northern hemispheres -temperatures very cold in the winter -trees are mainly coniferous (cone-bearing) -animals have thicker coats to prevent heat loss -very few reptiles/amphibians**	
Desert	**-very little rainfall -temperatures fluctuate greatly between night and day -salty soils -very few plants, plants have “waxy” leaves to prevent water loss - cacti do a special form of photosynthesis that requires less water**	
Grassland	**-known as the prairies in Canada -very rich soil in temperate regions, but less rich for grasslands in tropical regions (because of soil erosion from heavy rain)**	
Permanent Ice	**-found in Arctic, Antarctica, Greenland -very cold temperatures -mainly lichens and moss -animals have blubber and coats to minimize heat loss**	
Temperate Deciduous Forest	**-found mainly in E. Canada -trees shed their leaves in fall -large amount of biodiversity**	
Temperate Rainforest	**-found near coastlines in less warm climates than tropical rainforests -very tall trees -lichens can line tree branches since light is too little at forest floor -animals live mainly on forest floor since they are protected from wind and rain**	

Tropical Rainforest	**-located near the equator -very little soil nutrients (heavy rainfall washes away nutrients) -trees are tall to maximize sunlight exposure -Leaves are narrow to allow rain to run off -greatest biodiversity of all biomes -found near coastlines**	
Tundra	**-Layer of permafrost -no trees -short grasses, lichens, moss -animals reproduce less**	

Adaptations

Structural Adaptation: physical feature of an organism that allows it to better survive or reproduce in its environment
e.g: Arctic fox has a white coat in the winter and a brownish-grey goat in the summer

Physiological Adaptation: physical or chemical event inside an organism that allows it to better survive in its environment
e.g. Cacti have a slightly different type of photosynthesis that only needs half the amount of water needed in regular photosynthesis

Behavioural Adaptation: a unique behaviour shown by an organism that improves its survival or chance for mating
e.g. Burrowing owl lines its underground nests with cow dung to hide the scent of its young from predators

1.2 ECOSYSTEMS

Ecosystems

ABIOTIC COMPONENTS INTERACT WITH **BIOTIC COMPONENTS**

There are many habitats in an ecosystem

Habitat 1 | **Habitat 2** | **Habitat 3** | **Habitat 4**

Habitat is a specific place where an organism lives

Abiotic Interactions

The amount of abiotic components in an ecosystem influences what kind of organisms will be able to live in that ecosystem:

- **Amount of water**
- **Nutrients (Nitrogen, Phosphorus)** → **For plant/animal growth**  
- **Light levels** → **For photosynthesis** 

Biotic Interactions

BIOME

ECOSYSTEM A

SPECIES

Organisms that can reproduce with one another

POPULATION

All the members of ONE species in ONE ecosystem

NICHE

The way an organism fits into an ecosystem; its job or role

COMMUNITY

All the populations in ONE ecosystem that interact

ECOSYSTEM B

ECOSYSTEM C

ECOSYSTEM D

ECOSYSTEM E

Symbiotic Relationships

Mutualism: both species benefit

For example, a bee gathering nectar from a flower

Commensalism: one species benefits, one is not affected

For example, the barnacles on a whale

Parasitism: one species benefits, the other is harmed

For example, hookworm living in dogs

Competition: When two organisms compete for the SAME resources (FOOD, HABITAT)

<u>COMPETITION IS NOT A SYMBIOTIC RELATIONSHIP</u>

<u>Both organisms are harmed by competition</u>

Biodiversity: large variety of organisms

Predation

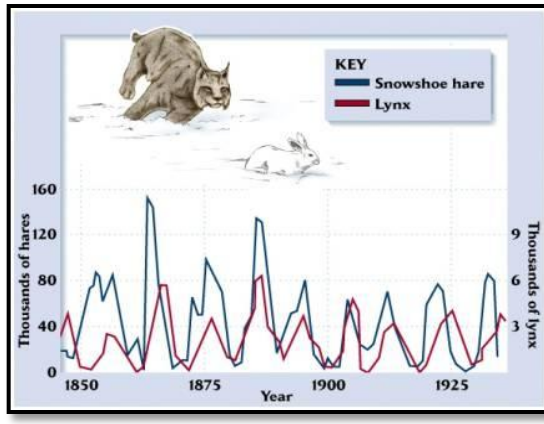
Predation is the term use to describe the interactions between:

Predators = Prey

Predators: carnivores (meat eaters) that hunt prey
-have adaptations to help catch prey: claws, excellent eyesight, smell

Prey: animals that are food for predators
-have adaptations to help escape or hide from predators: spines, camouflage

Prey leads to a in predators because now there is little food available to the predator



2.1 ECOSYSTEMS

Core Ideas:

Biomass: total mass of all living and dead organic material (kg/m^2)

Energy Flow: energy that moves from an ecosystem to an organism or between organisms

Carnivores: eat only other animals
Herbivores: eat only plants
Ominivores: eat a variety of plants and animals

Producers  **VS** **Consumers** 

Producers
- Produce their own food through photosynthesis
- Convert sun's energy into stored carbohydrate (glucose)

Consumers
- Cannot produce their own food
- Must eat other organisms (plants and/or animals for energy)

Biodegradation

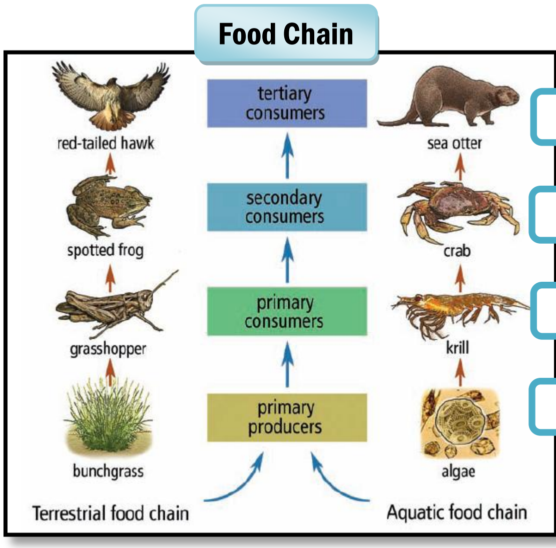
Decomposers VS Detrivores

Decomposers
- Breakdown wastes and dead organisms to allow nutrients to re-used in the ecosystem
- Secrete enzymes to breakdown material and then absorb; they DO NOT EAT
- Simple organisms
- e.g. Bacteria and fungi

Detrivores
- Eat wastes and dead organisms to allow nutrients to re-used in the ecosystem
- They eat dead organic matter
- More complex organisms
- e.g. Earthworm and beetles

Both feed at every trophic level. Without decomposers or detrivores, energy would be lost from an ecosystem once an organism died. Soil would have little to no nutrients as well

Food Chain, Webs, Energy Pyramids

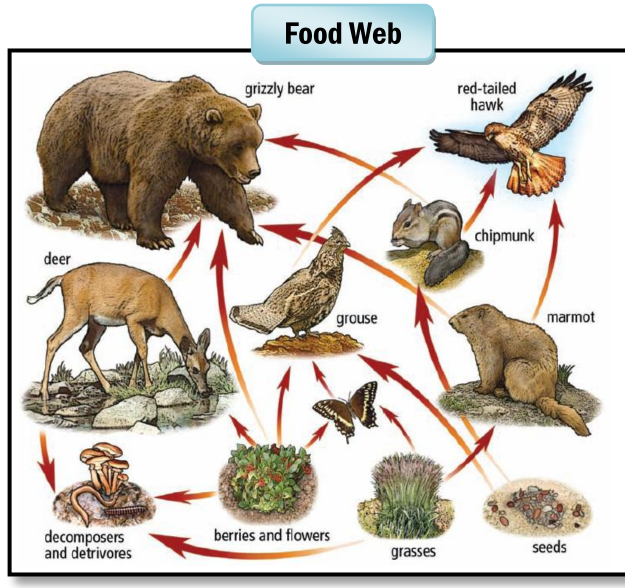


4th Tropic Level

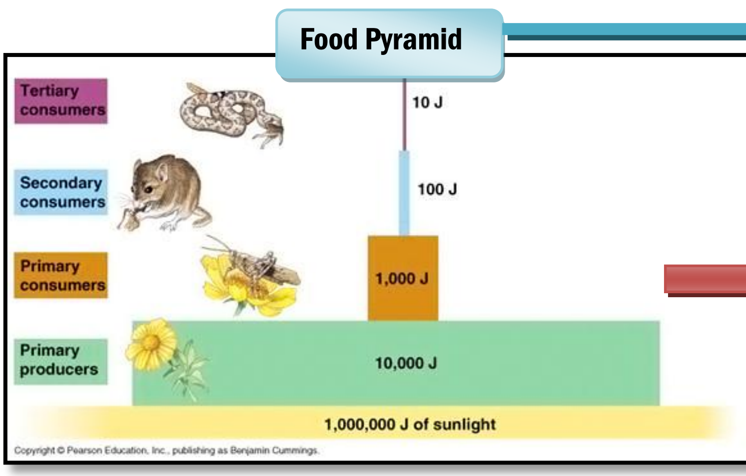
3rd Tropic Level

2nd Tropic Level

1st Tropic Level



Animals are really part of more than one FOOD CHAIN eat more than one kind of organism. **These interactions of multiple FOOD CHAINS is called a FOOD PYRAMID**.



Pyramids can be 3 types:

1. **Biomass**
2. **Numbers of organisms**
3. **Energy (one shown to left)**

90% of energy is lost moving up each TROPIC LEVEL:

LOST AS HEAT TO THE ENVIRONMENT

2.2 NUTRIENT CYCLES IN ECOSYSTEMS

Carbon Cycle

Carbon is stored 2 ways:

Short Term:

- Living Animals and Plants
- Decaying Organic Material
- Dissolved CO_2 in top layer of the ocean

Long Term:

- Fossil fuels: gas, oil, coal
- Sedimentation layers that eventually form rock (limestone)
- Dissolved CO_2 in top layer of the ocean
- As marine shells (carbonate)

Carbon Cycling:

Carbon dioxide	Water	Glucose	Oxygen
CO_2	H_2O	$C_6H_{12}O_6$	O_2

1. **Photosynthesis**

Sun's Energy

Carbon dioxide + water → Glucose + oxygen

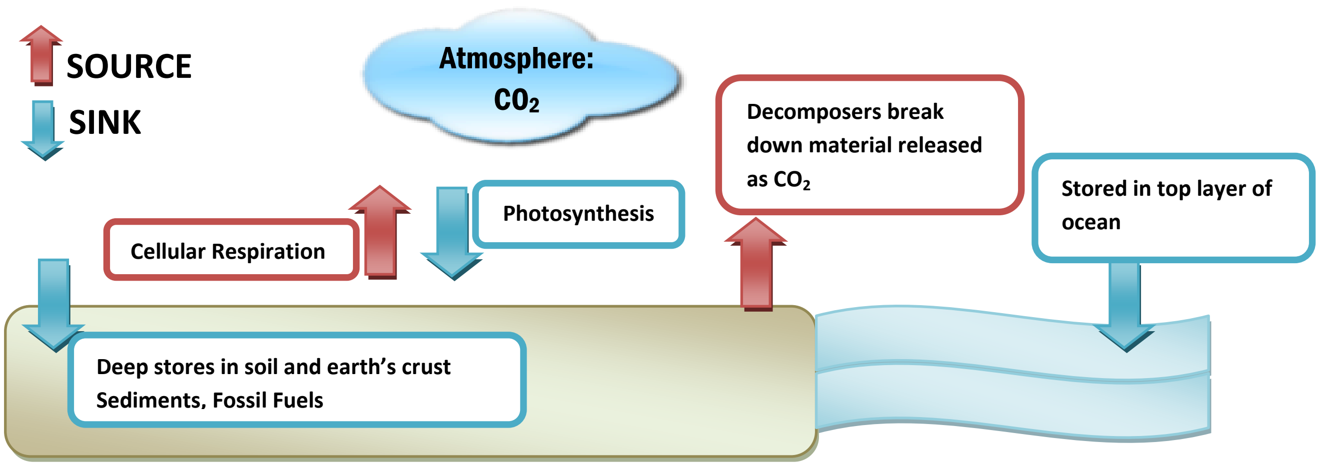
Performed ONLY by: Plants & some Bacteria

2. **Cellular Respiration**

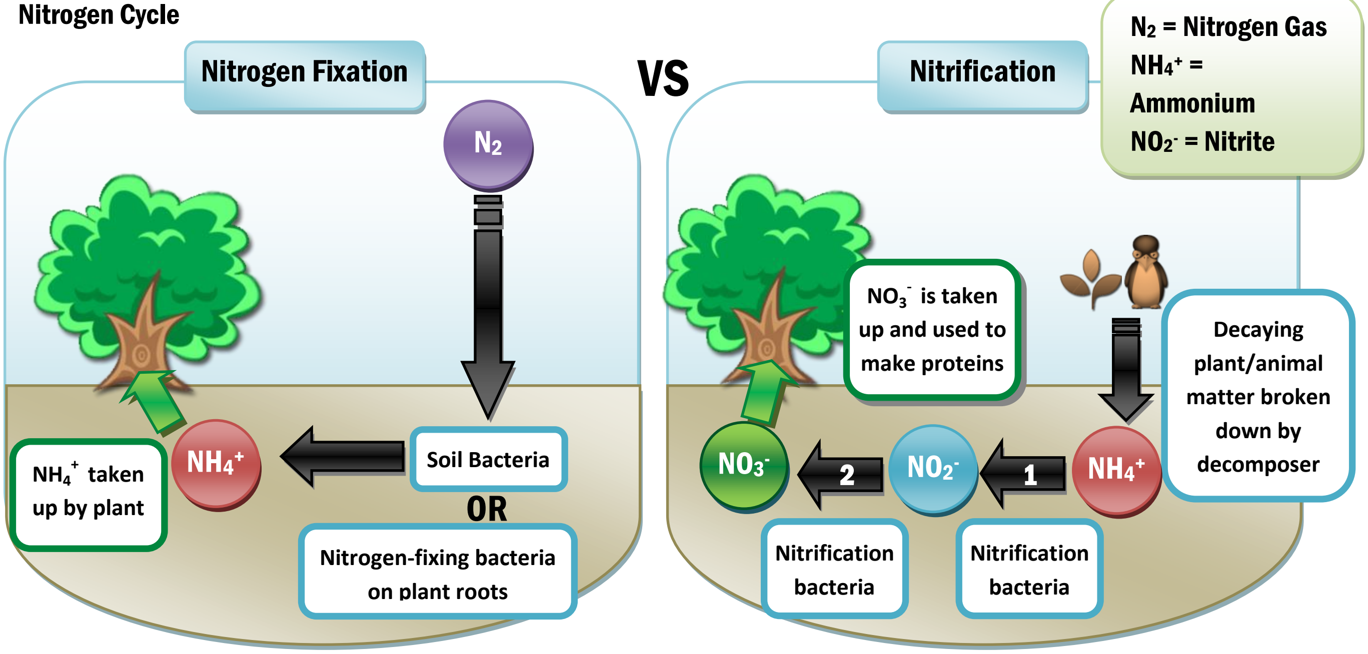
Energy released to organisms for use

Glucose + oxygen → Carbon dioxide + water

Performed by BOTH: Plants & Animals (& bacteria)



Nitrogen Cycle



Nitrogen fixation can occur also in the atmosphere during lightning storms

Nitrates are needed by plants for proteins.

Denitrification: NO_3^- converted back to N_2

Nitrogen STORES (sinks)

- NO_3^- and NH_4^+ used by plants
- Unused NO_3^- and NH_4^+ eventually form rocks

Nitrogen SOURCES

- Dentrification bacteria: NO_3^- to N_2
- Volcanoes (as NO_2)

Excess Nitrogen

- Industry has doubled the amount of available nitrogen (nitrogen not trapped in rocks or proteins)
- Excess NO_2 leads to acid rain
- Excess fertilizers increase amount of NO_3^- and NH_4^+ leaches into water systems
- This results in **EUTRIPHICATION**: excess nutrients lead to increased unwanted plant growth such as **ALGAE BLOOMS:**

$\uparrow$ Algae = $\uparrow$ O_2 use = $\downarrow$ O_2 for other plants & animals

Leads to plant and animal death; some blooms can release neurotoxins that kill animals

Phosphorus Cycle

Phosphorus STORES (sinks)

- Stored as PHOSPHATES (PO_4^{-3}) in rocks and sediments

Phosphorus SOURCES

- Weathering of rocks
- Decomposition of dead organisms

<u>Phosphorus is NOT stored in the atmosphere. It is stored in rock and sediments.</u>

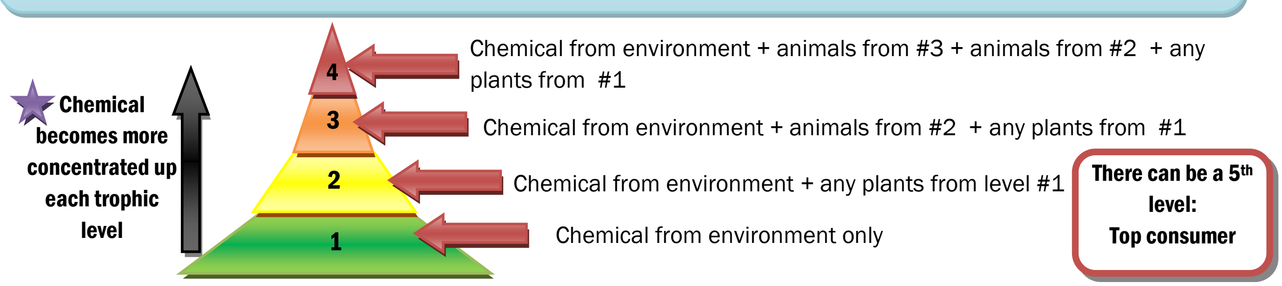
Excess Phosphorus

- Loss of forested areas increases erosion and leaching leading to more phosphorus entering water systems
- Excess use of fertilizers increases phosphorous levels in an ecosystem
- Excess phosphorous can kills certain organisms and harm plants

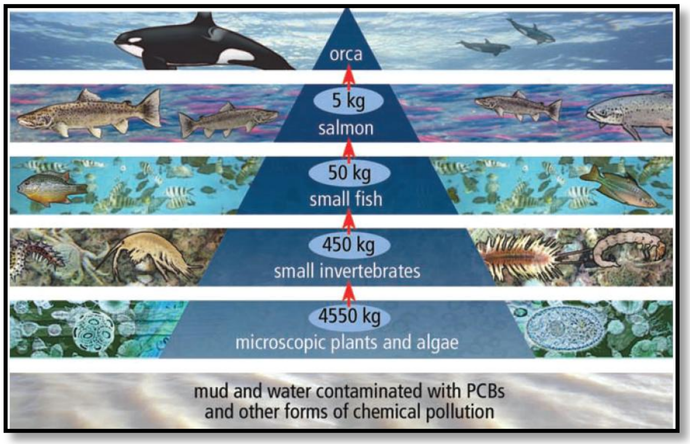
2.3 EFFECT OF BIOACCUMULATION ON ECOSYSTEMS

Core Concepts

Keystone Species: species that can greatly affect population numbers and health of an ecosystem (e.g. salmon in BC forest ecosystems)
Biomagnification: chemicals accumulate <u>but become more concentrated at each tropic level</u>



Biomagnification from PCBs: Orcas in BC



1. Store PCB toxins LONG-TERM in their fat called BLUBBER
2. Orcas do not use this BLUBBER for energy unless food is scarce (salmon).
3. If salmon levels are low then orcas will burn their BLUBBER releasing PCBs into their bloodstream
4. PCBs in the bloodstream lowers immune function making the orca more likely to get sick

Other toxins

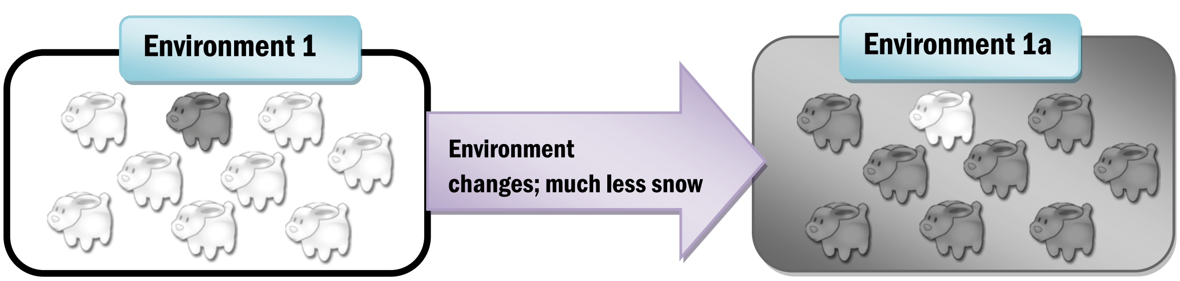
1. **POPs:** <u>include organic toxins such as DDT and PCBs.</u>
These stay in the environment for many years
2. **Heavy metals:** <u>Lead, Cadmium, Mercury</u>
Cannot be broken down. Affect nervous system, immune function, red blood cell function

Bioremediation: <u>using living organisms to clean up toxins</u>
e.g. certain trees that soak up toxins from soil, bacteria that breakdown chemical spills

3.1 How Changes Occur Naturally in Ecosystems

How organisms change over time: Natural Selection

Natural Selection: the environment selects FOR and AGAINST certain traits.
This means some organisms will have an ADVANTAGE to SURVIVE and REPRODUCE.
Over time the characteristics (or traits) of a population of a species may change. The environment creates this change. <u>THE ANIMAL DOES NOT WILLINGLY CHANGE ITSELF</u>



- Snowy environment
- **White rabbit** has an advantage: blends in with the environment
- **Black rabbit** is at a disadvantage
- **There will be more white rabbits than black: more white rabbits will survive and reproduce**

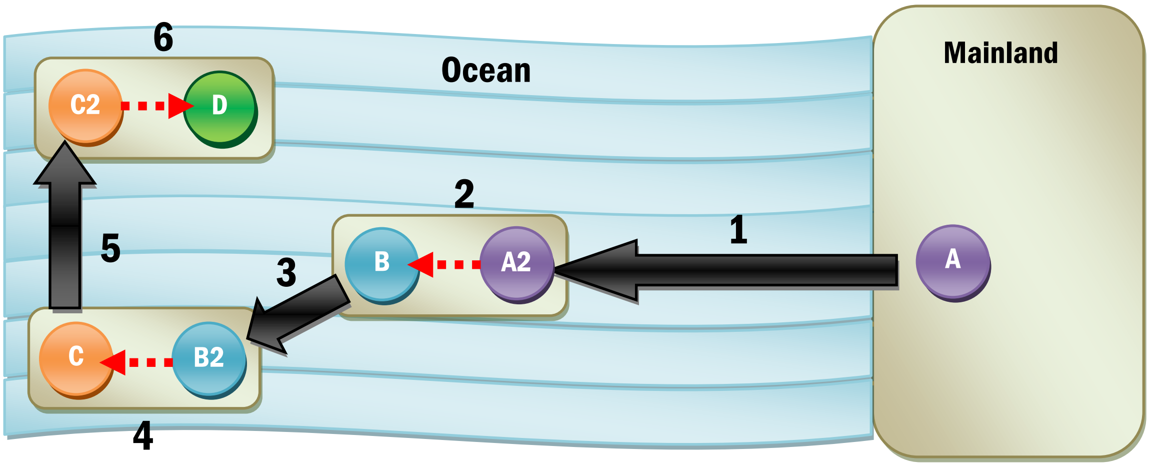
- Rocky environment; little snow
- **Black rabbit** has an advantage: blends in with the environment
- **White rabbit** is at a disadvantage
- **There will be more black rabbits than white: more black rabbits will survive and reproduce**

Adaptive Radiation

Adaptive Radiation: similar to natural selection but it involves the PRODUCTION OF A NEW SPECIES FROM ONE ORIGINAL POPULATION:

1. Original population is split up and isolated in DIFFERENT ENVIRONMENTS
2. Different environments have different selective pressures
3. Over time each sub-population will change depending on the environment it is in (**natural selection**)
4. Over a long period of time each sub-population may become a new species (two organisms that no longer can reproduce with one another)

e.g. Finches in the Galapagos islands; Stickleback fish in North America



1. Part of Pop. A gets stranded on an island. This population is called A2
2. Pop. A2 is exposed to a new environment than the mainland. There are different selective pressures leading to the production of a new species called B.
3. Part of the population from Species B gets separated onto another island. This new population is called B2
4. Population B2 is exposed to new selective pressures on the new island, leading to the production of a new species called C.
5. Part of the population from Species C gets separated onto another island. This new population is called C2
6. Population C2 is exposed to new selective pressures on the new island, leading to the production of a new species called D.

None of the 4 species reproduce with one another

Core ideas: Ecosystem changing over time (the bigger picture)

Ecological Succession: changes that place over time in ALL the organisms that live in area

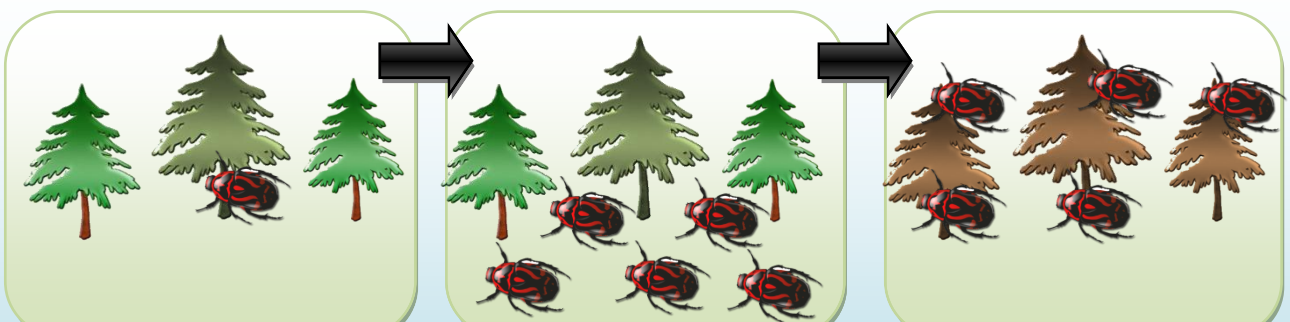
Two types: **Primary** (new ecosystem) and **Secondary** (rebuilding an old ecosystem)

Primary versus Secondary Succession

Primary	VS	Secondary
1. Starts with bare rock 2. Pioneer species (lichen) first organisms in area. 3. Lichens are involved in breaking down rock into soil 4. Soil allows plants to survive 5. Slowly over time different plant species survive 6. Animal species begin to move in to the area **SLOW: Hundreds of Years**		1. Starts with soil and some plants present 2. Result of a damaging event to the ecosystem (e.g. forest fire) 3. New seeds of plants will blow in and begin to rebuild the ecosystem **FAST: decades (tens of years)**

Insect Infestations

Mountain Pine Beetle



- **Mountain pine beetles remove old or dying trees from ecosystem.**
- **YOUNG TREES fight off beetles**

- **WARM temperatures allows more beetles to survive winter**

- **Extra beetles overwhelm healthy young trees too**
- **Pine tree population starts to die**

Pine beetles have a SYMBIOTIC relationship (mutualistic) with a fungus that lives in their mouth: **Fungus inhibits the production of RESIN by Pine trees. RESIN is needed to flush away beetle invaders and allow a tree to survive.**

3.2 How Humans Influence Ecosystems

Core Ideas

Sustainability: choices or decisions that do not affect the biodiversity or health of an ecosystem. In other words, sustainability is decisions that don't reduce the amount of different organisms in an ecosystem or lead to the destruction of an ecosystem.

Habitat Loss: habitats that are lost usually due to human activity

Habitat Fragmentation: breaking up a habitat into smaller sections. This affects the ability of plants and animals to reproduce. Also, more established plants will not survive at the edges.

Deforestation: forests cleared or logged for human use

↑ Deforestation = ↑ Soil Degradation (loss of topsoil which is a layer of rich nutrient-dense layer of organic materials)

*** Topsoil is lost due to wind and water erosion**

Soil Compaction: Farm animals and machines cause soil to be squished together reducing the amount of air that is available to plant roots (plant roots need OXYGEN to survive!)

Overexploitation: The overuse of a resource until it is depleted; this can lead to the extinction of a species.

Extinction: the dying out of a species (gone for good).

Traditional Ecological Knowledge: using knowledge about the environment to make better decisions about every day activities and to think of ways to support an ecosystem.
e.g. controlled burning of forest litter (branches, dead grass) recycles nutrients back into soil as ash; also improves the growth of plants that grow in the understory (shaded region under trees)

3.3 How Introduced Species Affect Ecosystems

Core Ideas

NATIVE SPECIES	INTRODUCED (FOREIGN) SPECIES	INVASIVE SPECIES
Plants or animals that naturally live in an area	Harmless or beneficial to their new environment **e.g. loosestrife-eating beetle**	Take over new habitats from native species OR take over bodies of native species (as parasites) **e.g. purple-loosestrife**

In BC

Eurasian milfoil	Lives in contaminated waters, brought in from boats visiting a lake, forms dense mats on surface of the water, blocks off sunlight to organisms below.
Norway Rat	Large amount of offspring, eat almost any food, steal sea-bird eggs causing a reduction in their population numbers.
American Bullfrog	Brought to BC as food for restaurants, breed rapidly, eat other frogs leading to some becoming endangered, even attack birds and small mammals.
European Starling	Outcompete native bird species for nest space, eat a large amount of crops needed by other animals

Invasive Species Actions

Invasive Species can affect native species 3 ways:

1. **Competition:** invasive species can outcompete native species for resources such as habitats and food.

2. **Predation:** invasive species that are predators may be more successful than native predators because the prey do not have adaptations to escape or fight these new predators.

3. **Disease and Parasites:** invasive species that are parasitic may cause a nativbe species to become weakened increasing the likelihood for disease, and the decreased ability to compete with other organisms for resources.

The GARRY OAK ECOSYSTEM is one very important ecosystem that is currently being helped by researchers in BC. The GARRY OAK is KEYSTONE SPECIES and is the main support species for many other plants and animals. The major competitor to this important species is the **Scotch Broom**, an **invasive species** that ruins the natural meadow habitats for many plants and animals. In addition, Scotch Broom also increases Nitrogen levels in the soil which can disrupt native plant growth

4.1 Atomic Theory and Bonding

Atom

- Composed of **Protons, Neutrons, and Electrons**
- Different atoms are called elements

Compound

- A pure substance made up of TWO or MORE ELEMENTS

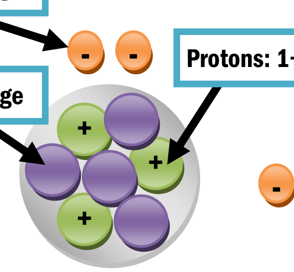
NaCl is a compound

O_2 is NOT a compound

Electrons: 1- charge

Neutrons: NO charge

Protons: 1+ charge



The CHARGE of an ATOM = 0

 # Protons (+) = # Electrons (-)

PROTONS + NEUTRONS + ELECTRONS

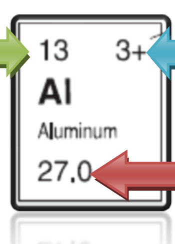
= SUBATOMIC PARTICLES

The mass of an atom
= # PROTONS + # NEUTRONS
(electrons have almost no mass)

ATOMIC # = # of Protons

Reading the Periodic Table

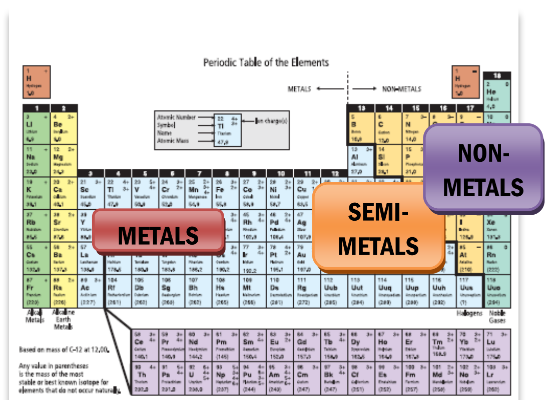
ATOMIC # = # Protons



Charge when an ion.
***Atom has no charge**

ATOMIC MASS = #Protons + #Neutrons

* Atomic Mass should be rounded to nearest whole number EXCEPT when dealing with isotopes



Bohr Diagrams

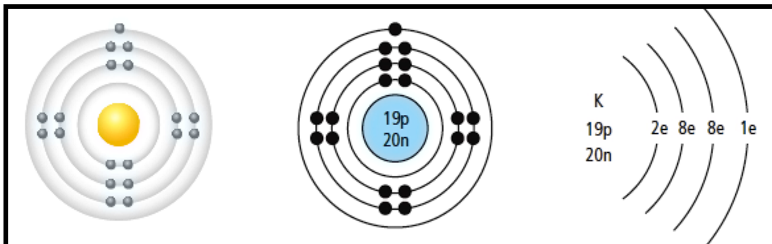
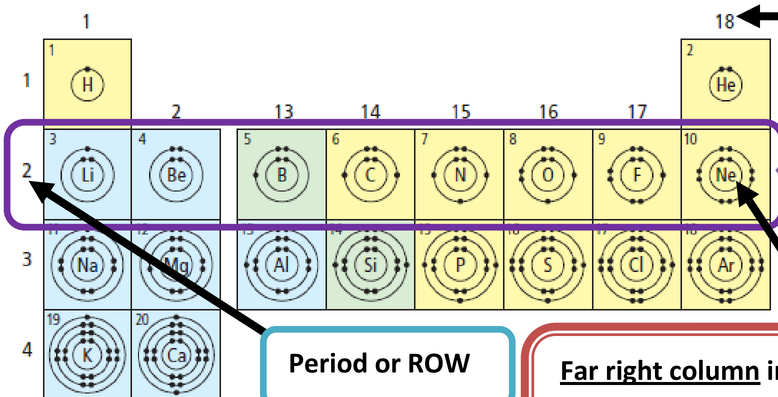


Figure 4.6 Bohr diagrams for potassium

Valence Shell Rule: 2:8:8 RULE

Electrons are organized in shells:
1^{st} Shell: MAX 2 electrons
2^{nd} Shell: MAX 8 electrons
3^{rd} Shell: MAX 8 electrons

Electrons and Periods



Family or COLUMN:
#18 Noble Gases: FULL VALENCE SHELL

As you move RIGHT, ONE MORE ELECTRON is added, until the outer SHELL is FULL (In this case 8 on outer shell)

Period or ROW

<u>Far right column</u> in this row has FULL SHELL, called a <u>STABLE OCTET</u>

Outer shell is called the VALENCE SHELL

Forming Compounds

There are 2 types of compounds:

1. Ionic

- **Formed from + and – charged ions**
- **Involve TRANSFER of ELECTRONS**
- **Held together by IONIC BONDS**

2. Covalent

- **Formed when 2 elements SHARE electrons**
- **There are no IONS formed**
- **Held together by COVALENT BONDS**

Ionic Compounds

Ionic compounds form from IONS:
METAL ATOMS lose ELECTRONS to form a POSITIVE ION (CATION)
NON-METAL ATOMS gain ELECTRONS to form a NEGATIVE ION (ANION)

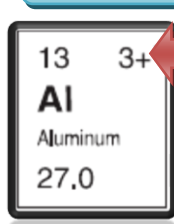
IONS are ATOMS that have either GAINED or LOST ELECTRONS

Non-Metal: Anion (Negative)

Charge of the ion that forms: -1 for Chlorine

Chlorine will GAIN 1 electron to form an ION

Metal: Cation (Positive)

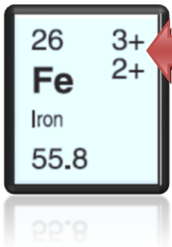


Charge of the ion that forms: +3 for Aluminum

Aluminum will LOSE 3 electrons to form an ION

Some METALS can form MORE THAN ONE ion: called Multivalent

NON-METALS
ARE NEVER
MULTIVALENT

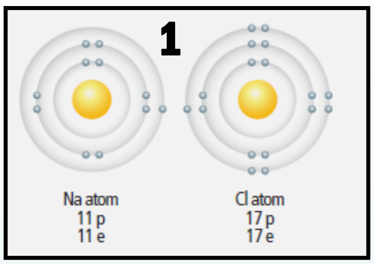


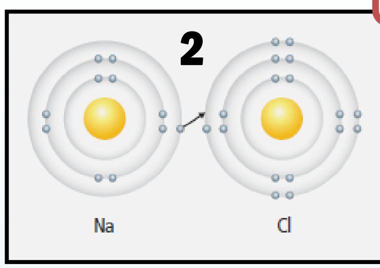
Iron can form either:
+3 charge OR +2 charge

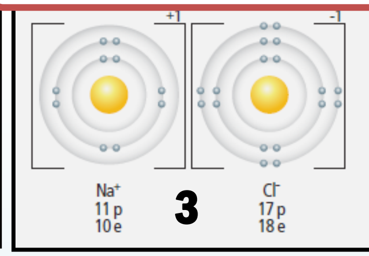
Ionic vs Covalent Compounds

Ionic

SODIUM CHLORIDE FORMED



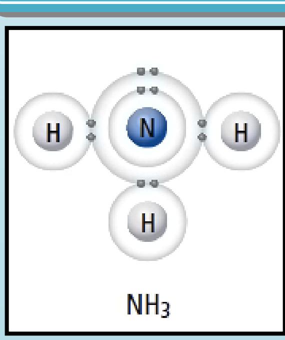




Sodium has one electron on VALENCE shell. It wants to lose this → SODIUM DONATES 1 ELECTRON → SODIUM ION FORMED +1

Chlorine needs ONE more electron on its Valence shell to make 8. It wants to gain one → CHLORINE ACCEPTS 1 ELECTRON → CHLRORINE ION FORMED -1

Covalent (Molecular)

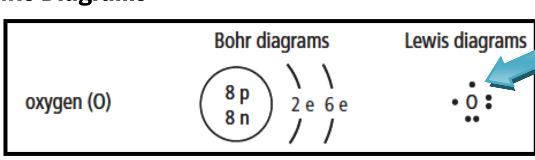


Electrons are SHARED between the Nitrogen atom and the 3 Hydrogen atoms

NO IONS are formed

NO electrons are TRANSFERRED

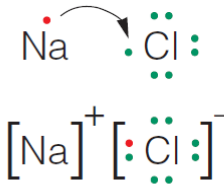
Lewis Diagrams



Lewis diagram shows ONLY the VALENCE electrons (outer shell)

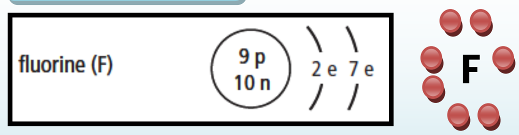
Step 1: Draw 4 dots alone first → Step 2: Add any extra dots as pairs

Lewis diagrams to show Ions and Ionic Compounds

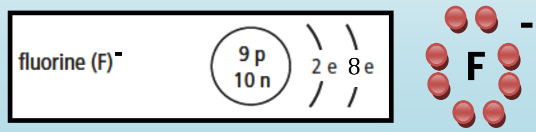


-Sodium loses its only outer valence electron; -Chlorine gains an electron to fill in its last pair

FLUORINE ATOM

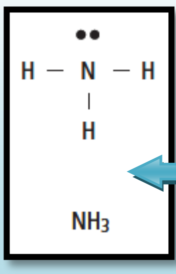


FLUORINE ION

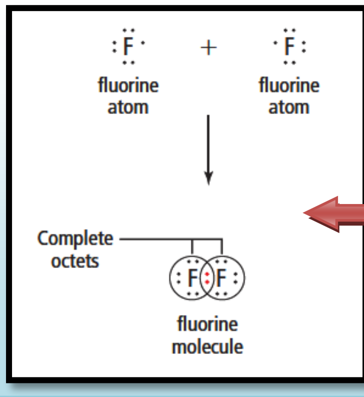


Lewis Diagram of Covalent Molecules

Nitrogen has 5 VALENCE electrons



Nitrogen SHARES 3 electrons with three hydrogen atoms. This leaves 2 electrons not paired to anything



Fluorine has one unpaired electron. Each Fluorine shares its lone electron with the other lone electron.

4.2 Names and Formulas of Compounds

Naming Simple Ionic Compounds

Ionic compounds: compounds composed of POSITIVE CATIONS and NEGATIVE ANIONS

Ionic compounds are named using the IUPAC standard of naming:

Sodium Chloride

Metal :

- Always comes first
- <u>Never ends in "ide"</u>

Non-Metal :

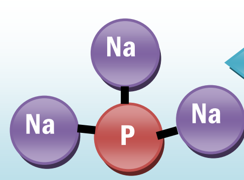
- Always comes last
- <u>Ends in "ide"</u>

Ionic Compound Formulas

Na_3P

When no subscript is written the value is 1

<u>Subscript</u> = # of Na ions in this compound



Means THREE Na ions bind to ONE P ion

Writing Ionic Compound Formulas from Ions (SHORTCUT METHOD)

Step 1: Write out ions	Step 2: Cross Charge #s	Step 3: Write new subscripts	Step 4: Reduce Subscripts (if possible)
Mg^{+2} with N^{-3}	Mg^{+2} with N^{-3}	Mg_3N_2	Mg_3N_2
Mn^{+4} with O^{-2}	Mn^{+4} with O^{-2}	Mn_2O_4	MnO_2

Multivalent Ions

Some METALS can form more than one type of ion = multiple charges

When naming MULTIVALENT IONS you must indicate which charge of ion:

e.g. Fe^{+3} would be Iron (III)

In a compound containing Fe^{+3} you would name this:

Iron (III) Oxide <u>not</u> Iron Oxide

Writing Formulas from Compound Names with Multi-Valent Ions

Vanadium (IV) Oxide

Step 1: Write out ions	Step 2: Cross Charge #s	Step 3: Write new subscripts	Step 4: Reduce Subscripts (if possible)
V^{+4} with O^{-2}	V^{+4} with O^{-2}	V_2O_4	VO_2

Writing Names from Formulas (REVERSE of above)

VO_2

Step 1: Uncross subscripts	Step 2: Write uncrossed numbers as charges	Step 3: Fix the NON-METAL ion to its correct charge	Step 4: Write the names of the ions in your Formula Name
VO_2	V^{+2} with O^{-1}	V^{+4} with O^{-2} (Oxygen must be doubled; so must Vanadium then)	Vanadium (IV) Oxide

Polyatomic Ions

Polyatomic ions are IONS MADE UP OF MORE THAN ONE TYPE OF ATOM:

<u>Made up of :</u>
ONE Nitrogen
THREE Oxygens

→ NO_3^- ←

The entire thing has a TOTAL charge of -1

In the formula $MgSO_4$, to determine if you are dealing with a polyatomic ion look for a normal ion FIRST AND CIRCLE

$MgSO_4$ ← **The remaining ion is not simple so it must be a Polyatomic Ion**

Naming Formulas Containing Polyatomic Ions

$Al(OH)_3$ ← Using methods above, we would see that there is:

One Aluminum ION
Three OH IONS

Name your compound using ions that it contains: **Aluminum Hydroxide**

Reminder that Aluminum does not need Roman Numerals

OH^- is not a regular ion so you must use the provided POLYATOMIC Naming sheet to name

Covalent Compounds

Covalent Compounds DO NOT have IONS: Naming is different from Ionic compounds

There is no NO METAL, making this a COVALENT COMPOUND → **CS_2**

P_4O_{10} ← DO NOT REDUCE THE SUBSCRIPTS FOR COVALENT COMPOUNDS

Naming Rules:

Covalent Compounds are named according to their SUBSCRIPTS

Prefix	Number
mono-	1
di-	2
tri-	3
tetra-	4
penta-	5
hexa-	6
hepta-	7
octa-	8
nona-	9
deca-	10

IDE endings are the same for covalent

N_2O = <u>di</u>nitrogen <u>mono</u>xide

P_4S_{10} = <u>tetra</u>phoshphorus <u>deca</u>sulfide

EXCEPTION TO THE RULE:

If the <u>FIRST</u> element is a ONE you <u>DO NOT</u> use MONO

CO is NOT monocarbon monoxide:

<u>it is carbon monoxide</u>

Formula	Name
CH_4	methane
NH_3	ammonia
H_2O	water

Some COVALENT COMPOUNDS HAVE COMMON NAMES:

4.3 Chemical Equations

Chemical Reaction Structure

Word Equation: nitrogen monoxide + oxygen → nitrogen dioxide

Symbolic Equation: $2NO + O_2 \rightarrow 2NO_2$

Reactants → nitrogen monoxide + oxygen; $2NO + O_2$

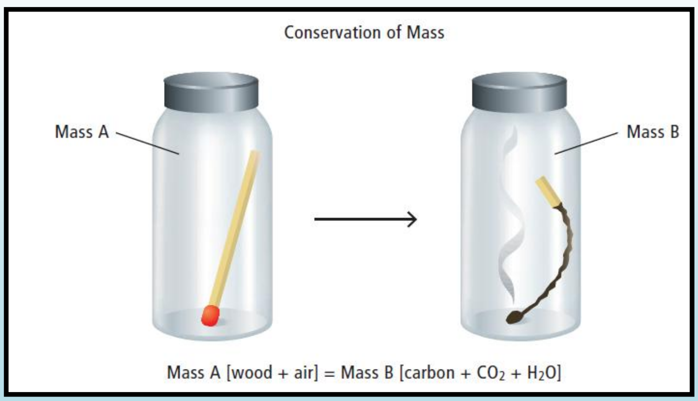
Products → nitrogen dioxide; $2NO_2$

Coefficients are number placed in front of a **FORMULA**

Conservation of Mass in Chemical Change

Conservation of Mass states that mass is conserved in a chemical reaction

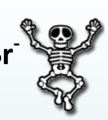
TOTAL MASS REACTANTS = TOTAL MASS PRODUCTS



Writing and Balancing Chemical Equations (SIMPLE)

Step 1: Write out Word Equation: Iron + Bromine → Iron (III) Bromide

Step 2: Write out Skeleton Equation with ions: $Fe + Br_2 \rightarrow Fe^{+3} + Br^{-}$



Step 3: Write out Skeleton Equation: $Fe + Br_2 \rightarrow FeBr_3$

Step 4: Balance the equation by adding COEFFICIENTS $\underline{2}\,Fe + \underline{3}\,Br_2 \rightarrow \underline{2}\,FeBr_3$

- 2 Irons
- 3 x 2 = 6 Bromines
- 2 Irons
- 2 x 3 = 6 Bromines

Writing and Balancing Polyatomic Equations

Step 1: Tin(IV) Nitrite + Potassium Phosphate Potassium Nitrite + Tin (IV) Phosphate

Step 2: $Sn^{+4}\ NO_2^- + K^+\ PO_4^{-3} \rightarrow K^+\ NO_2^- + Sn^{+4}\ PO_4^{-3}$

Use SHORT CUT RULE (SHOWN PREVIOUSLY)

Step 3: $Sn(NO_2)_4 + K_3PO_4 \rightarrow KNO_2 + Sn_3(PO_4)_4$

Treat each POLYATOMIC ION AS A GROUP

Step 4: $\underline{3}\ Sn(NO_2)_4 + K_3PO_4 \rightarrow \underline{3}\ KNO_2 + Sn_3(PO_4)_4$

Four NO_2 | One PO_4 | One NO_2 | Four PO_4

Step 5: $\underline{3}\ Sn(NO_2)_4 + K_3PO_4 \rightarrow \underline{3}\ KNO_2 + Sn_3(PO_4)_4$

Balance Metals

Step 6: $\underline{3}\ Sn(NO_2)_4 + \underline{4}\ K_3PO_4 \rightarrow \underline{12}\ KNO_2 + Sn_3(PO_4)_4$

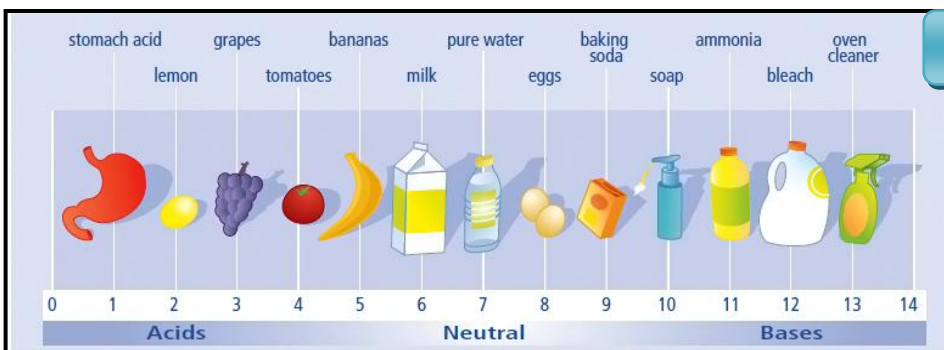
HINT: When balancing equations with OXYGEN and HYDROGEN, balance the CARBON first, then hydrogen, then oxygen

5.1 Acids and Bases

Acids and Bases Core Ideas

	Acid	Base
pH value	0 to less than 7	More than 7 to 14
Corrosive?	YES	YES
Taste	SOUR	BITTER
React with metals?	YES	NO

Acids DONATE H^+ ions
Bases ACCEPT H^+ ions



pH Scale

- 0 to less than 7 =ACID
- More than 7 to 14 = BASE
- 7= NEUTRAL

pH Indicators

Phenolphthalein: COLORLESS TO PINK from 8.2-10.0
Bromothymol blue: YELLOW TO BLUE from 6.0-7.6

See DATA BOOKLET

Naming Acids

Dry → HCl Hydrogen Chloride

HCl (aq) Hydrochloric Acid ← Aqueous (aq) (in solution)

Normal : IDE turns into IC → Hydrogen Chlor**ide** becomes Hydrochlor**ic** Acid

Special: ATE turns into IC <u>but NO hydro</u> → Hydrogen Carbon**ate** becomes <u>Carbon**ic** Acid</u>

ITE turns into OUS → Hydrogen Sulf**ite** becomes <u>Sulfur**ous** Acid</u>

Naming Bases

<u>Bases are H+ acceptors; usually have an OH on the right side of their formula</u>

Caustic: **a solution made from very reactive bases (e.g. concentrated Sodium Hydroxide)**

NaOH	Sodium <u>Hydroxide</u>
$Ca(OH)_2$	Calcium <u>Hydroxide</u>
NH_4OH	Ammonium <u>Hydroxide</u>

Acid versus Bases (In solution)

More H^+ than OH^- ACIDS	$H^+ = OH^-$ NEUTRAL	More OH^- than H^+ BASES

<u>**Pure water has the same amount of H+ and OH- ions**</u>:

MEANING there are <u>NO EXTRA</u> H^+ ions or OH^- ions

$$H^+ + OH^- \rightarrow H_2O$$

Since ACIDS and BASES produce IONS they CONDUCT ELECTRICITY

5.2 Salts

Core Concepts

Salt: Contain a positive ion (from a base) and a negative ion (from an acid) **e.g. NaCl**

$Na^+ OH^-$ $H^+ Cl^-$

ACID + BASE → SALT + WATER

Acid/Base Neutralization

ACID BASE SALT WATER

$3\ H_2SO_4\ +\ 2\ Al(OH)_3 \rightarrow Al_2(SO_4)_3\ +\ 6\ H_2O$

Oxides Reacting with water

Metal Oxides react with water to form a BASE

$Na_2O(s)\ +\ H_2O \rightarrow 2\ NaOH\ (aq)$

Non-Metal Oxides react with water to form an ACID

$SO_2(g)\ +\ H_2O \rightarrow H_2SO_3\ (aq)$

An oxide is a compound with a METAL or NON-METAL with OXYGEN

Acids and Metals

Acids will react with METALS to form a SALT and HYDROGEN GAS

$2\ HCL\ (aq)\ +\ Mg\ (s) \rightarrow MgCl_2\ (aq) + H_2\ (g)$

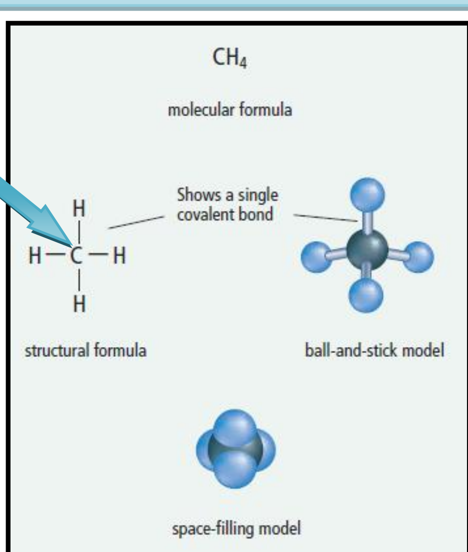
5.3 Organic Compounds

Core Ideas

Organic: Compounds that contain CARBON

Inorganic: Compounds that do NOT contain CARBON (**exceptions are: CO_2 + CO + CO_3^{-2} + Carbides**)

Carbon has 4 electrons in its valence shell

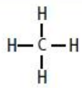
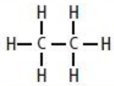
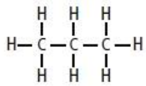
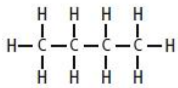


Carbon forms 4 COVALENT BONDS

Carbides are IONIC compounds that have CARBON as a NON-METAL:

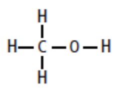
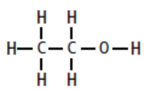
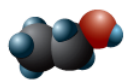
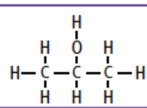
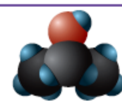
e.g. Al_4C_3

Hydrocarbon examples

Name	Molecular Formula	Structural Formula	Shortened Structural Formula	Space-Filling Model	Common Uses
methane	CH_4		CH_4		• Natural gas heaters
ethane	C_2H_6		CH_3CH_3		• Manufacturing plastic
propane	C_3H_8		$CH_3CH_2CH_3$		• Camp fuel
butane	C_4H_{10}		$CH_3CH_2CH_2CH_3$		• Hand-held lighters

HYDROCARBONS:
Organic compound that only contains CARBON and HYDROGEN

Alcohol examples

Name	Molecular Formula	Structural Formula	Shortened Structural Formula	Space-Filling Model	Common Use
methanol	CH_4O		CH_3OH		• Solvent
ethanol	C_2H_6O		CH_3CH_2OH		• Fuel
isopropyl alcohol	C_3H_8O		$(CH_3)_2CHOH$		• Sterilizer • Cleaner

ALCOHOLS:
Organic compound that only contains CARBON, HYDROGEN, & OXYGEN

6.1 Types of Chemical Reactions

Reaction Types

Synthesis:

$A + B \rightarrow C$

$2\,Na + Cl_2 \rightarrow 2\,NaCl$

$\underset{\text{ATOM}}{2\,Na} + \underset{\text{ATOM}}{Cl_2} \rightarrow \underset{\text{ION}}{2\,Na^+}$ and $\underset{\text{ION}}{2\,Cl^-}$

SYNTHESIS

Decomposition:

$AB \rightarrow A + B$

$2\,NaCl \rightarrow 2\,Na + Cl_2$

$\underset{\text{ION}}{2\,Na^+}$ and $\underset{\text{ION}}{2\,Cl^-} \rightarrow \underset{\text{ATOM}}{2\,Na} + \underset{\text{ATOM}}{Cl_2}$

DECOMPOSITION

Single Replacement VS Double Replacement Reactions

$2Al + 3CuCl_2 \rightarrow 3Cu + 2AlCl_3$

M M NM M M NM

SINGLE REPLACEMENT

A **METAL** CAN SWITCH WITH A **METAL**

OR

A **NON-METAL** WITH A **NON-METAL**

Remember:

A METAL forms + IONS

NON-METAL forms - IONS

SINGLE

$Pb(NO_3)_2 + 2NaI \rightarrow 2NaNO_3 + PbI_2$

DOUBLE REPLACEMENT

+ ION switches with a **+ ION**

AND

- ION switches with a **- ION**

DOUBLE

Neutralization Reaction

ACID + BASE $\rightarrow$ SALT + WATER

$H_2SO_4 + Ca(OH)_2 \rightarrow CaSO_4 + 2\ HOH$

$H^+ + OH^- \rightarrow H_2O$

(HOH)

Neutralization

Combustion Reaction

HYDROCARBON + O_2 $\rightarrow$ CO_2 + H_2O

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

SUGARS such as Glucose ($C_6H_{12}O_6$) will also undergo combustion

Combustion

6.2 Factors Affecting the Rate of Chemical Reactions

Rate of Reaction: How quickly or slowly reactants turn into products

Every chemical reaction occurs at a certain RATE

4 things AFFECT REACTION RATE:

1. Temperature
2. Concentration
3. Surface Area
4. Presence of a Catalyst

1. Temperature

$\uparrow$ **Temp** = $\uparrow$ **Reaction Rate**

Increased temp. means an increase in KINETIC ENERGY = More particles colliding

2. Concentration

$\uparrow$ **Concentration** = $\uparrow$ **Reaction Rate**

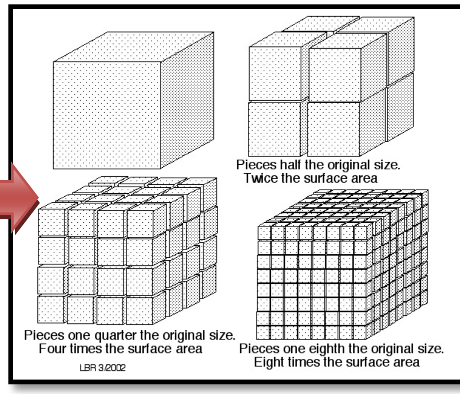
Increased conc. means that there are more molecules in a solution to collide with one another

3. Surface Area

↑ Surface Area = ↑ Reaction Rate

Surface area is a measure of how much area of an object is exposed

The greater the surface area the more of a solid is available to react



4. Catalysts

A substance that speeds up the rate of a chemical reaction

Catalysts LOWER the energy needed to break bonds for a reaction to occur

Catalysts allow REACTANTS to better line up and properly collide making a reaction easier to occur

Catalysts are not used up in a chemical reaction

Biological Catalysts are called ENZYMES

7.1 Atomic Theory, Isotopes, Radioactive Decay

Core Ideas

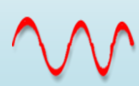
Discovered by Roentgen and later Marie Curie that uranium caused photographic plates to darken: this led to the discovery of what she called RADIOACTIVITY

Radioactivity: release of HIGH ENERGY PARTICLE <u>OR</u> WAVES

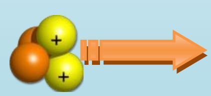
Natural Background Radiation: radiation that occurs in our environment. This radiation has the potential to interact with ATOMS creating IONS

Two types of Radiation

1. Electromagnetic Radiation: (energy waves) RADIO WAVES to GAMMA WAVES



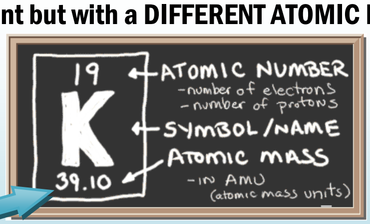
2. High energy particles: ALPHA and BETA PARTICLES



Isotopes

Isotope: the SAME particular element but with a DIFFERENT ATOMIC MASS

Note that the ATOMIC MASS listed is the AVERAGE mass for ALL the K atoms in nature: <u>SOME ARE HEAVIER than 39 but the AVERAGE K weighs 39.1 AMU</u>



Some ISOTOPES are RADIOACTIVE and undergo DECAY

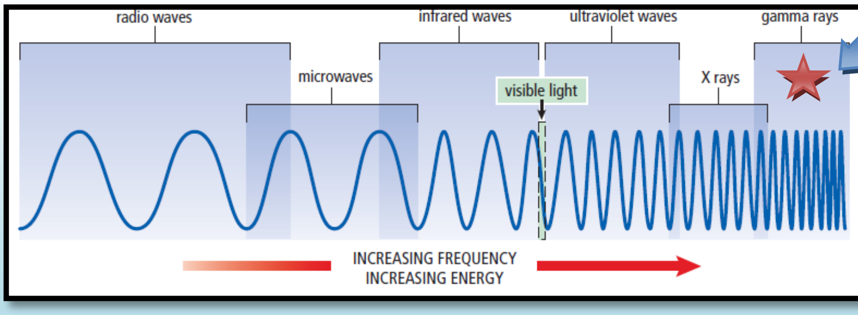
POTASSIUM has 3 isotopes:

K-39	K-40	K-41
19 P	19 P	19 P
20 N	21 N	22 N

ONLY THE # OF NEUTRONS IS DIFFERENT

Radiation Types

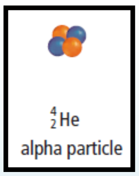
Electromagnetic Radiation



GAMMA RAYS are high energy destructive waves released by certain radioactive ATOMS

The more frequent (compressed) the energy waves are the more ENERGY they carry

Radioactive Decay: these include **ALPHA** and **BETA** particles

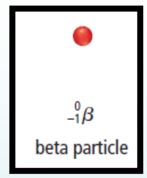


Alpha α

- **Positively Charged**
- **Same as a helium nucleus**
- **Low-penetration**

Beta β

- **Negatively Charged**
- **Same as an electron**
- **Higher-penetration**



BOTH ARE EJECTED FROM A NUCLEUS DURING RADIOACTIVE DECAY

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

MASS is conserved meaning it is the SAME on both SIDES of ARROW

$$^{131}_{53}I \rightarrow {}^{131}_{54}Xe + {}^{0}_{-1}e$$

Parent

Daughter

Bottom #s = CHARGES

Gamma γ

- **NO CHARGE or MASS**
- **ARE WAVES not particles**
- **HIGHEST-penetration**

$$^{60}_{28}Ni^{*} \rightarrow {}^{60}_{28}Ni + {}^{0}_{0}\gamma$$

7.2 Half Life

Core Ideas

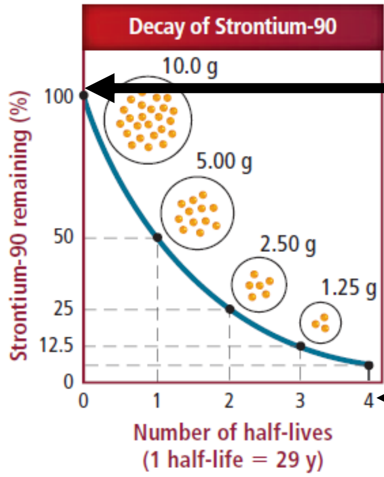
Radiocarbon Dating: determining the age of an object by measuring the amount of Carbon-14 remaining

Half Life: The amount of time it takes for HALF of the nuclei in a sample to decay (THIS IS A CONSTANT)

At start:	100%
1st Half-life	50%
2nd Half-life	25%
3rd Half-life	12.5%

The time it TAKES to get to each half life is specific for each radioactive atom

Using a Decay Curve



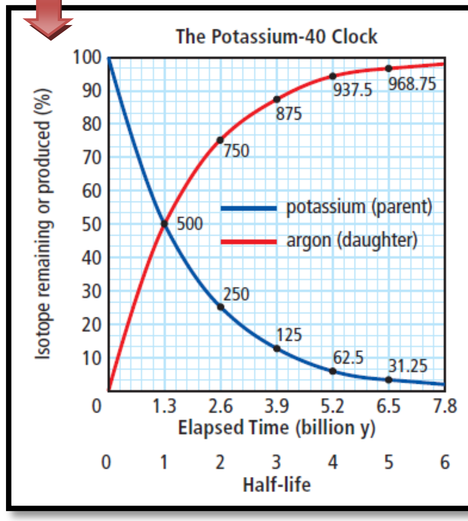
Use this scale to read what % is remaining

You can use this graph to find out HOW much PARENT is left at ANY point in time (even between half lives)

Use this scale to read how much time has passed

Remember:

Parent % + Daughter % = 100%



7.3 Nuclear Reactions

Core Ideas

Nuclear Fission VS Nuclear Fusion

Nuclear Fission

The splitting **APART** of a BIGGER nucleus into 2 SMALLER NUCLEI, LOTS OF ENERGY, and SUBATOMIC PARTICLES

Nuclear Fusion

The fusion of 2 SMALLER NUCLEI (JOIN **TOGETHER**) to make a BIGGER NUCLEUS, LOTS OF ENERGY, and SUBATOMIC PARTICLES

ENERGY

$${}^{1}_{0}n + {}^{235}_{92}\mathrm{U} \rightarrow {}^{92}_{36}\mathrm{Kr} + {}^{141}_{56}\mathrm{Ba} + 3\ {}^{1}_{0}n + \text{energy}$$

ENERGY

$${}^{4}_{2}\alpha + {}^{14}_{7}\mathrm{N} \rightarrow {}^{17}_{8}\mathrm{O} + {}^{1}_{1}p$$

FORMS 2 SMALLER NUCLEI: MUST BE <u>FISSION</u>

FORMS A BIGGER NUCLEI: MUST BE <u>FUSION</u>

During FISSION a smaller particle such a NEUTRON (n) may be fired at a the LARGER NUCLEUS to break it apart

Remember, MASS is conserved: This means that the MASS of the LEFT SIDE of the reaction = MASS of the RIGHT SIDE

Chain Reactions

Chain Reaction: One nuclear reaction initiates the next reaction

Must be controlled:

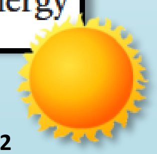
In a **NUCLEAR REACTOR** certain materials are used to control the release of **NEUTRON** which are the **"BULLETS"** that are released by a REACTION and TRIGGER the next reaction
(SEE ABOVE)

In Canada, we use **CANDU** reactors, which are safe yet efficient system to generating **electricity.**
HOWEVER, this **FISSION reactor** produces radioactive waste that must be isolated safely for thousands of years

Scientists are looking for ways to create FUSION nuclear reactors
These usually produce wastes that are NOT radioactive

SUN: The sun is a giant FUSION REACTOR:

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



Heaver isotope of Hydrogen: **Deuterium**

High pressure in the sun FUSES the 2 HYDROGEN NUCLEI together

8.1 The Language of Motion

Core Concepts

Magnitude: how big or small a value is

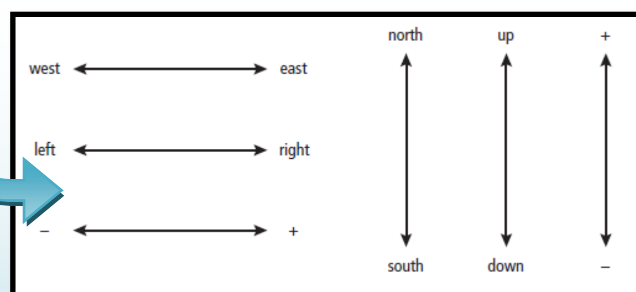
Direction: which direction an object is moving

Vector: a quantity that includes BOTH MAGNITUDE and DIRECTION:

e.g. 30km [E]

Scalar: a quantity that includes ONLY MAGNITUDE

e.g. 30km

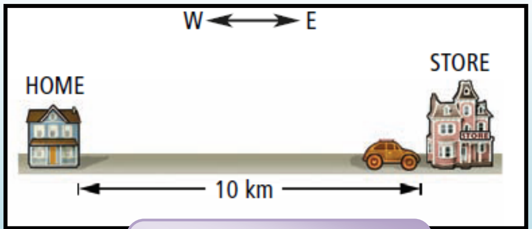


NORTH [N] = +
WEST [W] = -
EAST [E]=+
SOUTH [S]= -

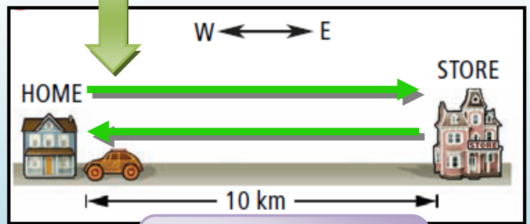
Distance vs Position

Distance is a scalar quantity (NO DIRECTION)
Position is a vector quantity = (WITH DIRECTION)

Distance for trip is the 10km to the store PLUS 10km back home



Distance = 10 km
Position = 10 km [E]



Distance = 20 km
Position = 0 km

Time Interval

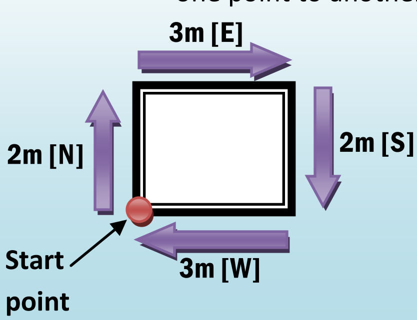
Time Interval ($\triangle$t) is the change in time from the BEGINING of an even to the END:

Time interval = Final Time – Initial Time $$\Delta t = t_f - t_i$$

Displacement vs Distance

Distance: the total distance travelled from point A to B **Scalar = NO DIRECTION**

Displacement: the straight-line distance AND direction from one point to another **Vector= DIRECTION INCLUDED**



The **DISTANCE** = 2m + 3m + 2m + 3m = **<u>10m</u>**

The **DISPLACEMENT**= 2m(N) +3m(E) +2m(S) +3m(W)

OR

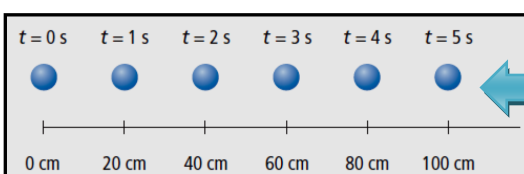
(+2m) + (+3m) + (-2m) + (-3m)

2m + 3m – 2m – 3m = 0

Uniform Motion

Uniform motion means that an object moves in **equal displacements** in **equal time intervals**

E.g.



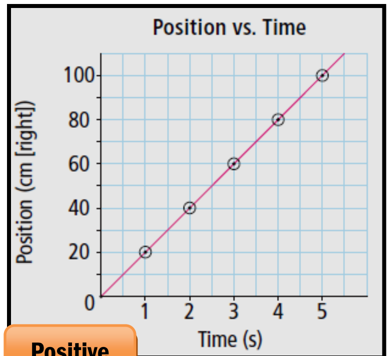
The ball is moving 20cm every second so its motion is UNIFORM

Position Time Graph

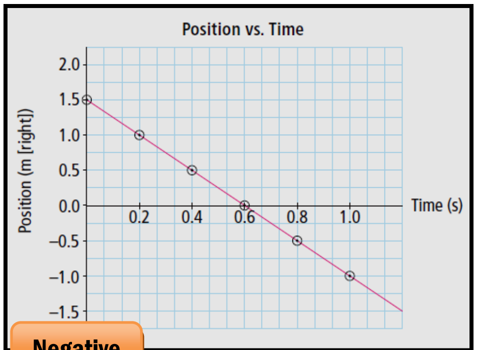
Slope of Position-Time Graph

A **POSITION-TIME** graph will have a **SLOPE** that represents the **VELOCITY** that an object is travelling

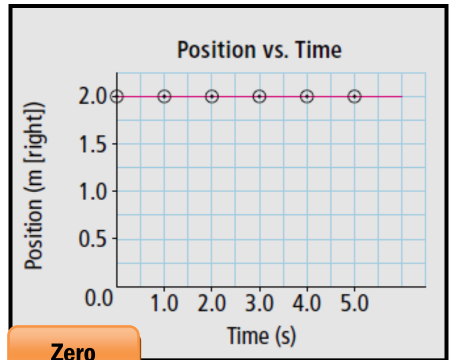
SLOPE can be POSITIVE, NEGATIVE, or ZERO (no velocity)



Positive



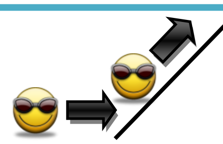
Negative



Zero

To determine if positive or negative:

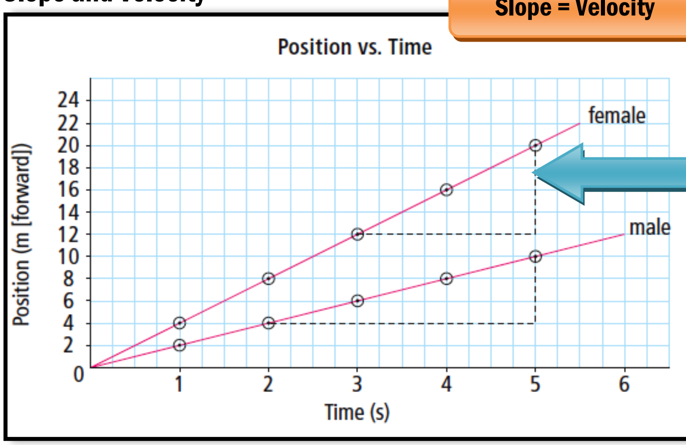
Move LEFT to RIGHT: If you go upwards then the slope is POSITIVE



8.3 Average Velocity

Slope and Velocity

Slope = Velocity



Calculate the SLOPE (VELOCITY) of each line:

$$\text{Slope} = V = \frac{\Delta d}{\Delta t} = \frac{20\text{m} - 12\text{m}}{5\text{s} - 3\text{s}} = \frac{8\text{m}}{2\text{s}} = 4\text{m/s}$$

The top line has a greater VELOCITY or SLOPE because it is STEEPER.

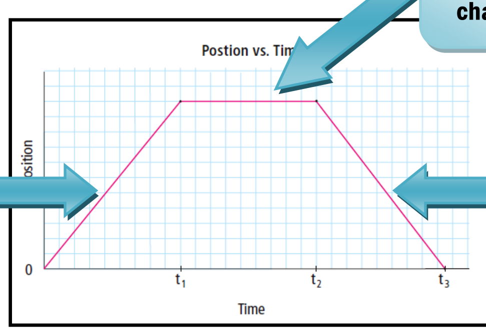
A FLAT LINE HAS A ZERO VELOCITY

Average Velocity

Average velocity is the rate of change in position over a **TIME INTERVAL**

Zero Velocity: Position is not changing. At rest.

Positive Velocity: Position is moving AWAY from START



Negative Velocity: Position is moving back TOWARDS START.

Conversion Factors

To convert units use the following method:

e.g. convert 55km/h into m/s

$$\frac{55\ \text{km}}{1\ \text{h}} \times \frac{1000\ \text{m}}{1\ \text{km}} \times \frac{1\ \text{h}}{3600\ \text{s}} = \frac{55000\ \text{m}}{3600\ \text{s}} = 15\text{m/s}$$

The only unit that remains is m/s

Calculating Velocity and Displacement using a Formula

$$\vec{v}_{av} = \frac{\Delta \vec{d}}{\Delta t}$$

Displacement

Time interval

Average Velocity

Rearrange the Formula

$V_{av} = \frac{\Delta d}{\Delta t}$ → $V_{av}(\Delta t) = \Delta d$

$V_{av}(\Delta t) = \Delta d$ → $\Delta t = \frac{\Delta d}{V_{av}}$

9.1 Describing Acceleration

Acceleration: the rate of change in velocity-in other words, the change in velocity DIVIDED by the change in time (how fast is the velocity changing?)

Acceleration = a = $\frac{\Delta V}{\Delta t}$

BIG MISCONCEPTION:

A ZERO ACCELERATION DOES NOT MEAN AN OBJECT IS NOT MOVING.

AN OBJECT TRAVELLING AT THE SAME SPEED WITHOUT CHANGING HAS ZERO ACCELERATION

Positive and Negative Changes in Velocity

Change in Velocity: when the **SPEED** of an object **CHANGES** OR the **DIRECTION CHANGES**

Positive Velocity Change:

$$\begin{aligned} \Delta \vec{v} &= \vec{v}_f - \vec{v}_i \\ &= +9\ \text{m/s} - (+6\ \text{m/s}) \\ &= +3\ \text{m/s} \end{aligned}$$

The FINAL VELOCITY is GREATER in the SAME DIRECTION

Negative Velocity Change:

$$\begin{aligned} \Delta \vec{v} &= \vec{v}_f - \vec{v}_i \\ &= +2\ \text{m/s} - (+9\ \text{m/s}) \\ &= -7\ \text{m/s} \end{aligned}$$

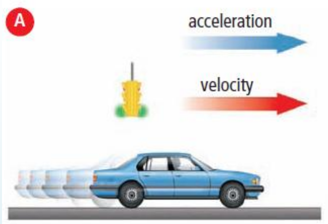
The FINAL VELOCITY is LESS in the SAME DIRECTION, or the VELOCITY is in the OPPOSITE DIRECTION

Acceleration measures HOW fast these POSITIVE or NEGATIVE changes in velocity occur:

Remember, even if you had a large velocity, if it took a million years to happen you wouldn't have much of an acceleration

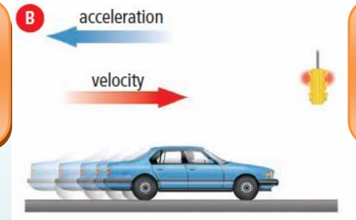
Positive and Negative Acceleration

Positive Acceleration Change:



The acceleration and the velocity are in the SAME direction

Negative Acceleration Change:



The acceleration and the velocity are in the OPPOSITE direction

Find the acceleration if an object changed its VELOCITY FROM <u>-10m/s to -60m/s</u> in 5 seconds

$\Delta V = V_f - V_i$

$\Delta V = -60 - (-10)$

$\Delta V = -50$

$a = \Delta V / \Delta T$ $a = -50/5$ $\underline{a = -10 m/s^2}$

BIG MISCONCEPTION:

<u>A NEGATIVE ACCELERATION DOES NOT ALWAYS MEAN SLOWING DOWN OR DECELERATION</u>

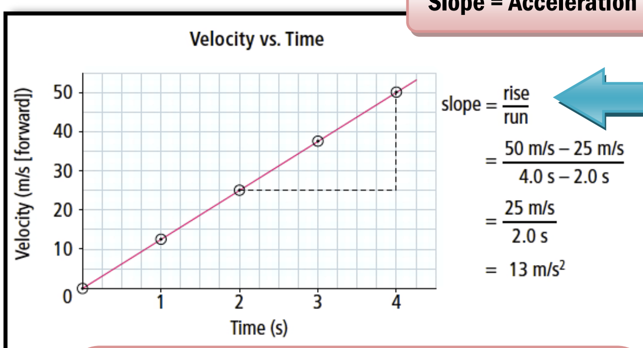
SEE TO THE LEFT:

The object's SPEED has gotten BIGGER but since it is in the W or S direction its VELOCITY is negative

9.2 Calculating Acceleration

Velocity Time Graph

Slope = Acceleration



Calculate the SLOPE (VELOCITY) of each line:

Slope = $a = \frac{\Delta v}{\Delta t} = \frac{50 m/s - 25 m/s}{4s - 2s} = \frac{25 m/s}{2s} = 13 m/s^2$

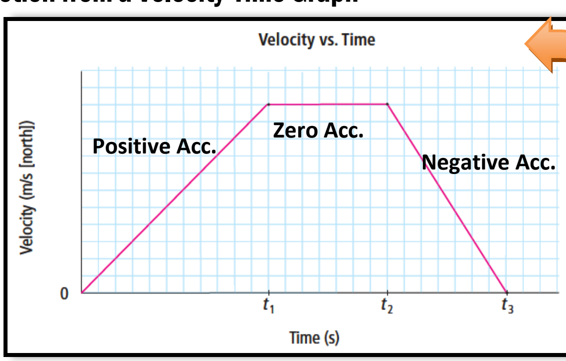
Acceleration is measured in a UNIT of VELOCITY DIVIDED by UNIT OF TIME:

$\frac{m/s}{s} = m/s^2$

Sometimes you will NOT be given the **<u>Δv</u>**
If this is the case, then you will need to find **<u>Δv</u>**
BEFORE you find the ACCELERATION:

$\Delta v = V_f - V_i$

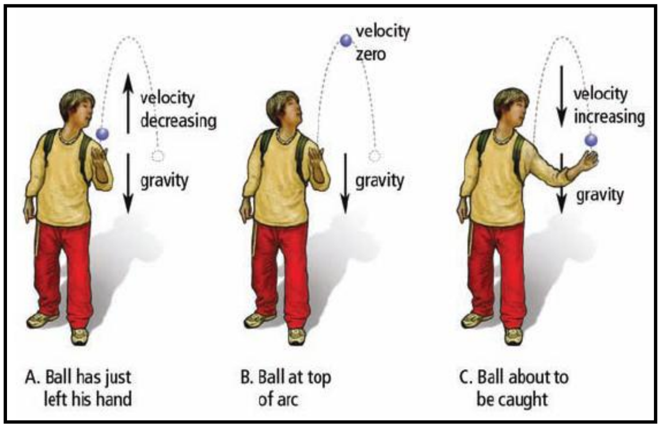
Motion from a Velocity-Time Graph



Time interval	0 to t_1	t_1 to t_2	t_2 to t_3
Acceleration	Positive [N]	Zero	Negative [S]
Velocity	Starts from rest and increases speed at a constant rate travelling north	Travels north at a constant speed	Slows down to a stop at a constant rate while still travelling north

Gravity and Acceleration

Gravity is an example where the ACCELERATION is DOWN direction meaning NEGATIVE



Acceleration due to gravity is given the symbol g and has a value of $-9.8 m/s^2$ or $9.8 m/s^2$ in the DOWN direction

10.1 TEMPERATURE, THERMAL ENERGY, and HEAT

Core Ideas:

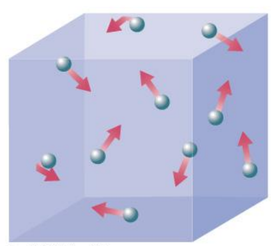
KINETIC ENERGY: Energy of a particle or object due to its motion- in other words, the energy of motion.

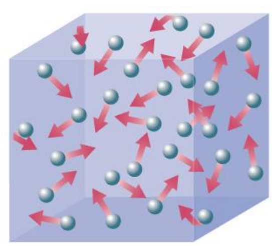
THERMAL ENERGY: Total kinetic energy of all the particles in a liquid, solid or gas

TEMPERATURE: The AVERAGE KINETIC energy of all the particles in a sample of matter. Remember, that as TEMPERATURE increases so does KINETIC ENERGY (particle move more).

HEAT: Heat is similar to THERMAL ENERGY but it is specifically, the transfer of THERMAL ENERGY from one area to another

A.





B.

Low Kinetic Energy
Low Temperature

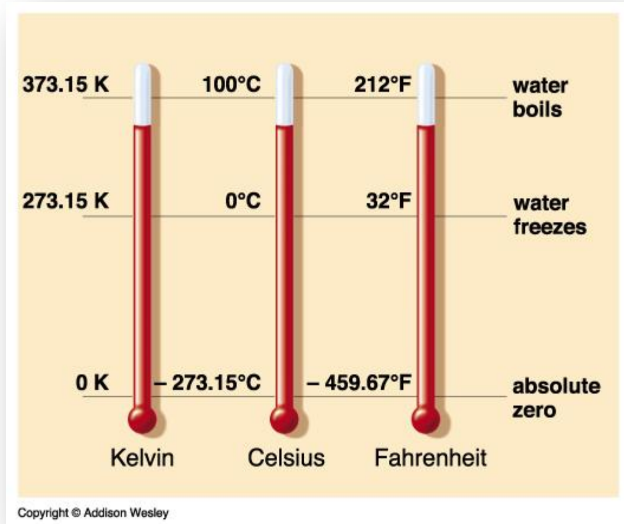
High Kinetic Energy
High Temperature

-In the above example TEMPERATURE would be the AVERAGE KINETIC ENERGY of each particle in the cubes.
-The THERMAL ENERGY would be the total KINETIC ENERGY of all the particles in each cube. Cube B would have more THERMAL ENERGY than cube A.
-HEAT would be the transfer of THERMAL ENERGY. In this example HEAT would be transferred from cube B to cube A (from high thermal energy to low thermal energy)

Temperature Scales

Temperature (average kinetic energy) is measured in 3 scales:

CELSIUS, FAHRENHEIT, or KELVIN



1. **Absolute Zero: the lowest temperature possible**
2. **KINETIC ENERGY is 0**
3. **Particles stop moving**

Density

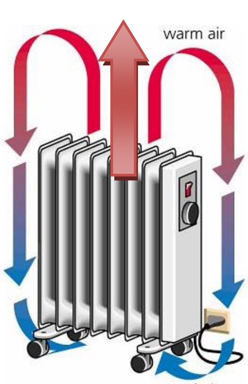
- **Density is a measure of how much mass is present per unit of volume. In simple words, it is a measure of how much STUFF (matter) is present in a set amount of SPACE in an object. If you cram in more STUFF into the SAME amount of space the DENSITY increases**

Two ways to increase density:
1. Add more matter (stuff) to the same amount of volume (space)
2. Decrease the volume (space). You can do this by cooling an object

Three Types of THERMAL ENERGY Transfer

1. **CONDUCTION: Transfer of thermal energy by DIRECT CONTACT**
   Heat transfer occurs from area with HIGH thermal energy to low
   -OCCURS BETTER WITH SOLIDS: PARTICLES ARE CLOSER TOGETHER

2. **CONVECTION: Transfer of thermal energy in a fluid (and gas) with movement of a fluid or gas as convection currents.**
   The fluid moves from areas of high density to areas of low density



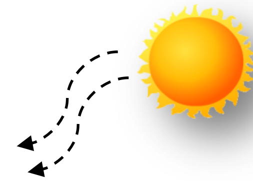
Air is warm and spread out= LESS DENSE

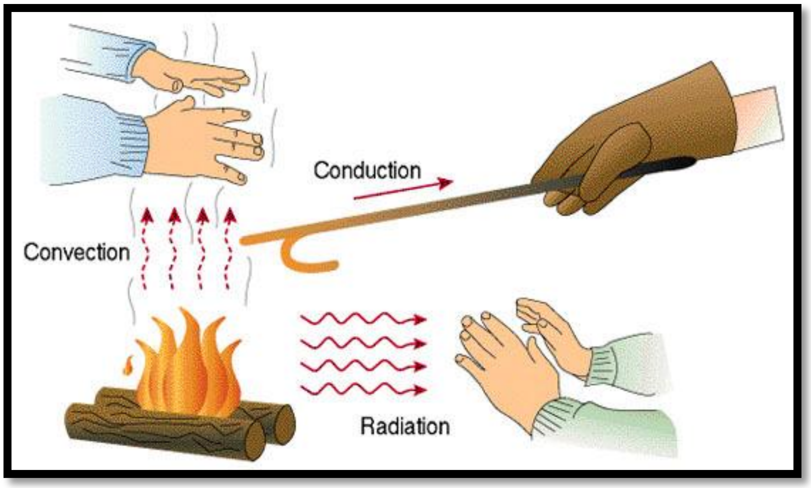
Current moves up; thermal energy moves

Air is cold and compact = MORE DENSE

As HEAT is lost, AIR cools and compacts making it more DENSE

3. **RADIATION: Thermal energy transfer by electromagnetic waves**
INFRARED RADIATION is the type of energy waves that transfer heat; we cannot see them (unless you have an infrared camera)





10.2 ENERGY TRANSFER IN THE ATMOSPHERE

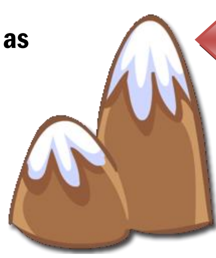
What makes up AIR?

Air is made of 2 main gases:

OXYGEN: 21%
NITROGEN: 78%

1% Remaining is made up of other trace gases

Air becomes thinner or less dense as you move away from the earth



Less air;
Atmospheric pressure LESS

More air;
Atmospheric pressure MORE

Atmospheric Layers: ORGANIZED BY <u>TEMPERATURE</u>

TOP	**EXOSPHERE**	**Layer that merges with space**	**Not well defined**
	THERMOSPHERE	**HOT layer: most amount of solar radiation; Northern lights occurs in this layer**	**1500 to 3000°C HOT!!!**
	MESOSPHERE		**-100°C**
	STRATOSPHERE	**-Contains OZONE: blocks UV rays**	**-55°C**
BOTTOM	**TROPOSPHERE**	**Most dense layer; weather occurs here; contains most dust of all layers ~10km thick**	**15°C**

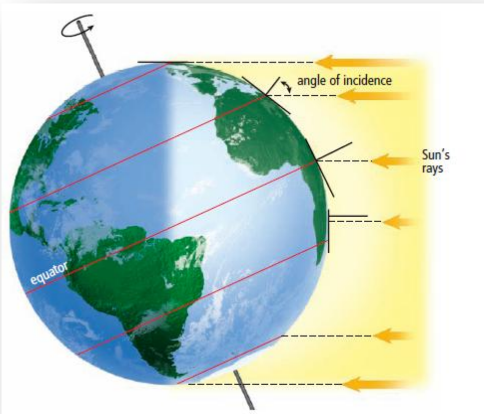
LOWEST PRESSURE

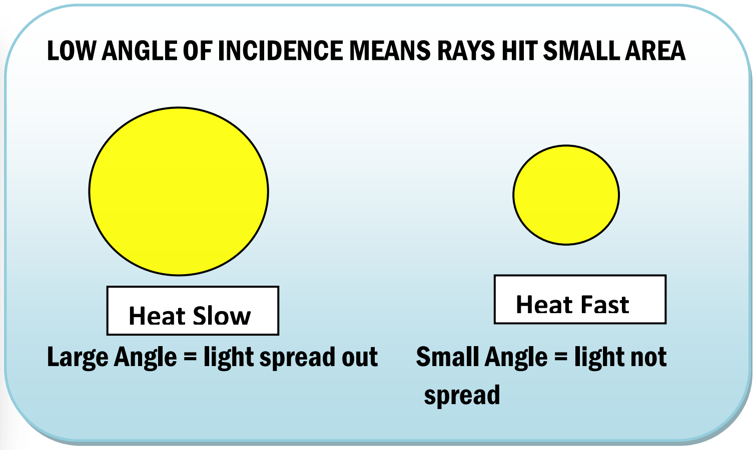
HIGHEST PRESSURE

SOLAR RADIATION and ATMOSPHERE

Core Ideas:

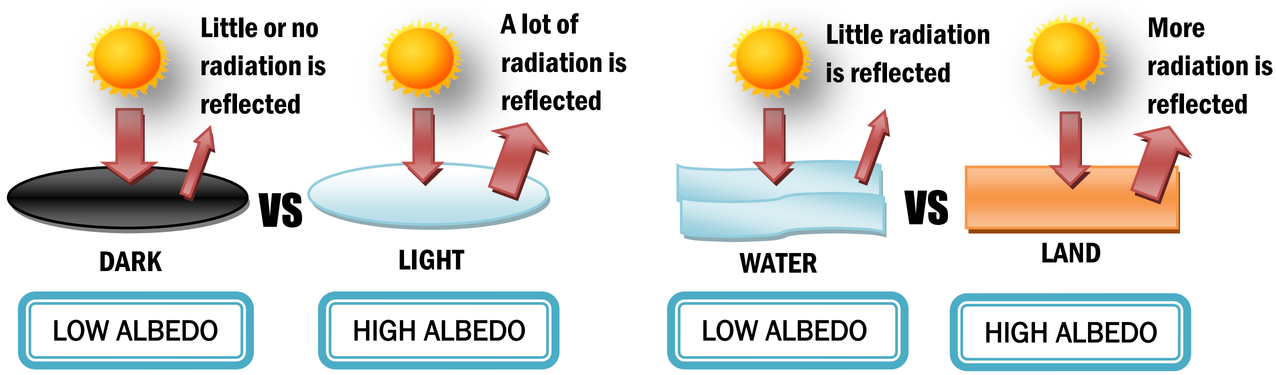
1. **INSOLATION:** Total solar radiation that reaches a certain area
2. **ANGLE OF INCIDENCE:** Angle between the solar rays and a line perpendicular to surface. Simply put, since the Earth is tilted the rays hitting the earth are at an angle. In the summer (in the Northern Hemisphere) the earth pointing towards the sun so more light rays hit the surface. The angle at the equator is ZERO.





3. **Radiation Budget:** Not all SOLAR RADIATION is absorbed by Earth. Only 50% reaches the earth and is absorbed The rest is reflected but NOT ALL of the reflected radiation is lost to space. Some is absorbed by clouds in the atmosphere. Eventually the radiation energy is released towards the earth and space. Ultimately, the energy absorbed by earth and atmosphere will eventually be lost to space.

4. **Albedo:** Simply put, albedo is the amount of radiation an object can REFLECT. Light coloured objects REFLECT a lot of radiation so their ALBEDO would be higher than a dark-coloured object which absorbs more radiation



SOLAR RADIATION is the MAIN SOURCE OF THERMAL ENERGY FOR EARTH'S SURFACE

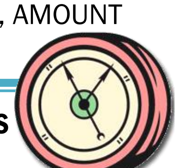
5. **Weather**: all aspects of the atmosphere including TEMPERATURE, ATMOSPHERIC PRESSURE, AMOUNT OF AIR MOSITURE, WIND SPEED and DIRECTION

ATMOSPHERIC PRESSURE:

PRESSURE ↓ **ALTITUDE** ↑

At sea level the pressure is about 100kPA

PRESSURE IS MEASURED WITH A BAROMETER



Air Pressure & Temperature & Humidity

- WARM AIR is more SPREAD OUT= LESS DENSE MOIST AIR contains water vapour.
- Water vapour is lighter than N_2 (78% of air). This makes air LIGHTER when it contains MORE WATER VAPOUR. <u>This means MOIST AIR is LESS DENSE than DRY AIR.</u>

Three Key Terms about Humidity:

1. Specific Humidity: Is the amount of water present in a certain volume of air

2. Relative Humidity: How much of the air is saturated with water. 100% relative humidity means that no more water can be held in the air. 50% means that the volume of air is only holding half the amount of water that it could.

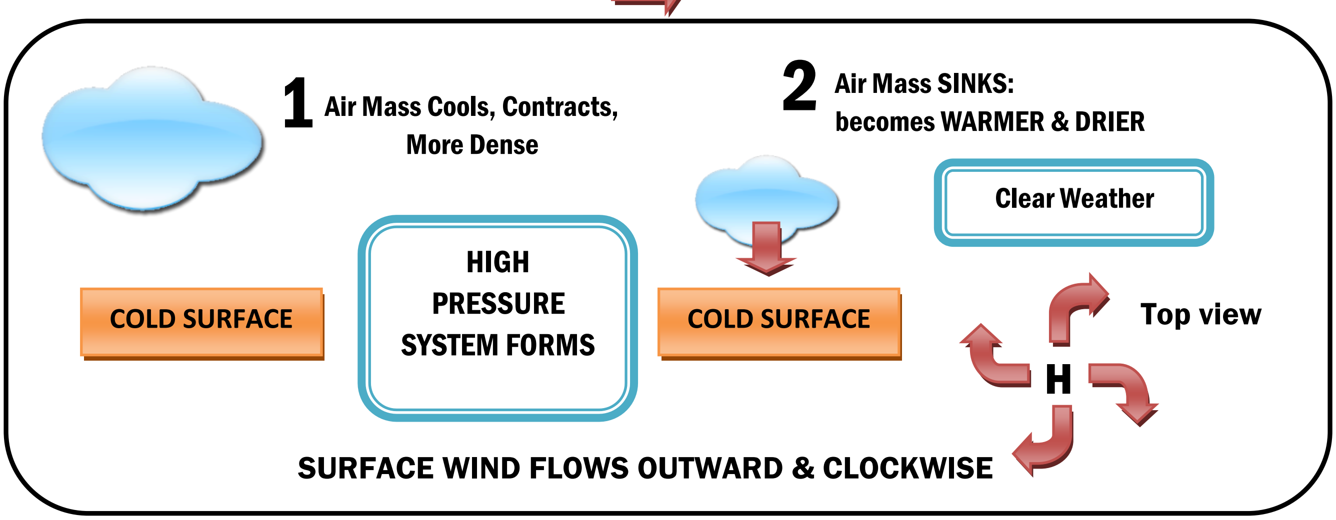
↑ Temperature = ↑ Ability of AIR to hold more WATER

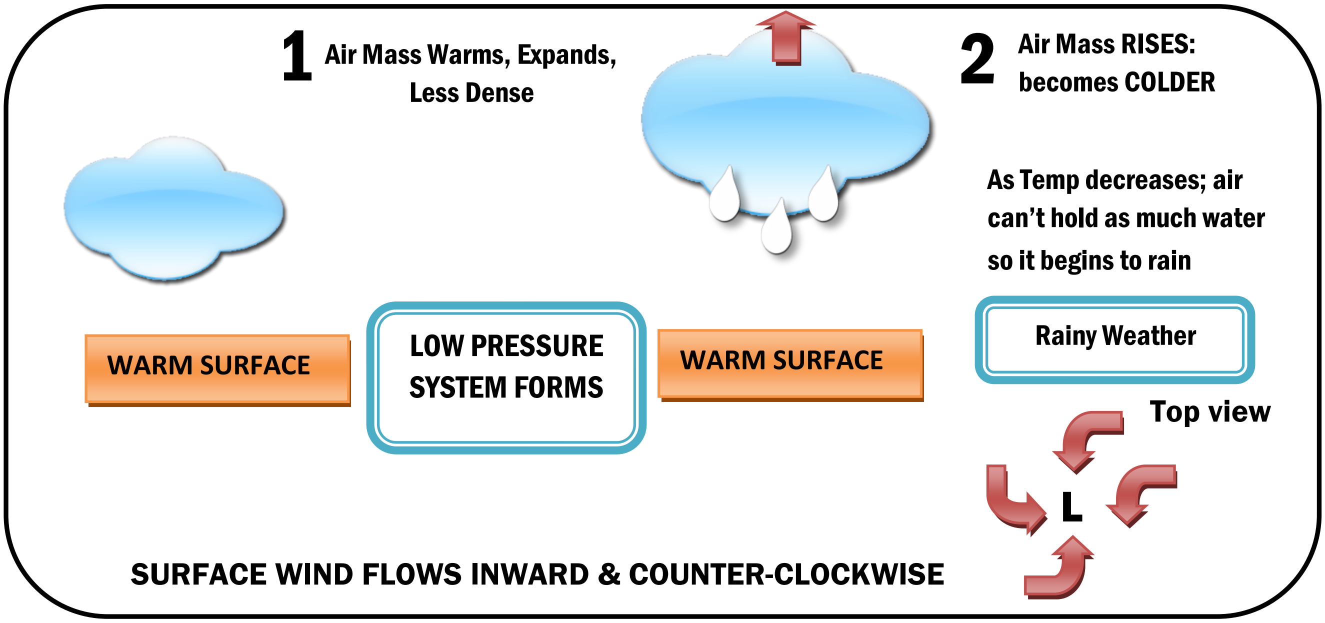
3. Dew Point:

SPECIFIC HUMIDITY = 100 % RELATIVE HUMIDITY (FULLY SATURATED)
-if 100% saturated air is cooled then dew forms

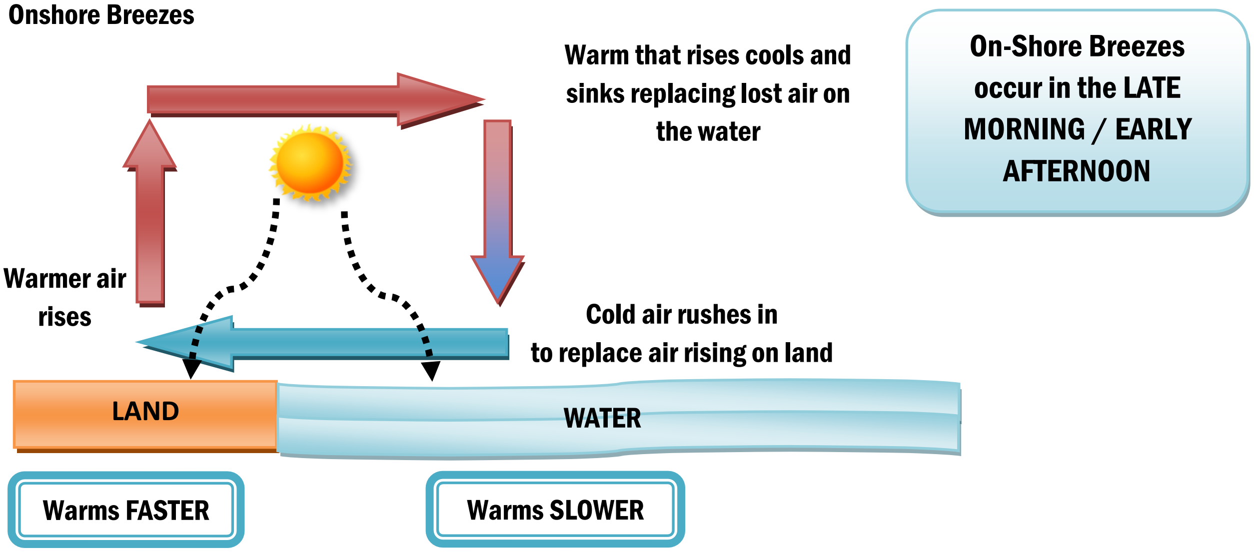
Convection in the Atmosphere

Wind: movement of air from HIGH PRESSURE → LOW PRESSURE



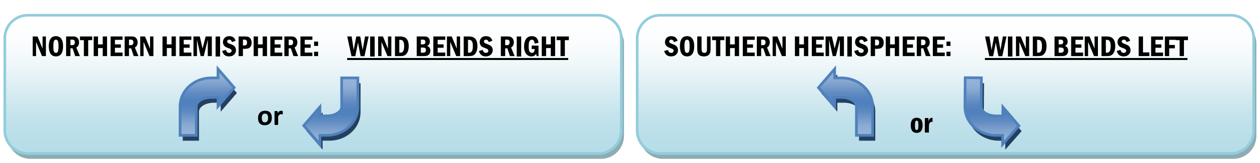


Onshore Breezes



Coriolis Effect: change in direction of moving objects due to Earth's rotation

*See this website for an awesome animation :
http://www.classzone.com/books/earth_science/terc/content/visualizations/es1904/es1904page01.cfm



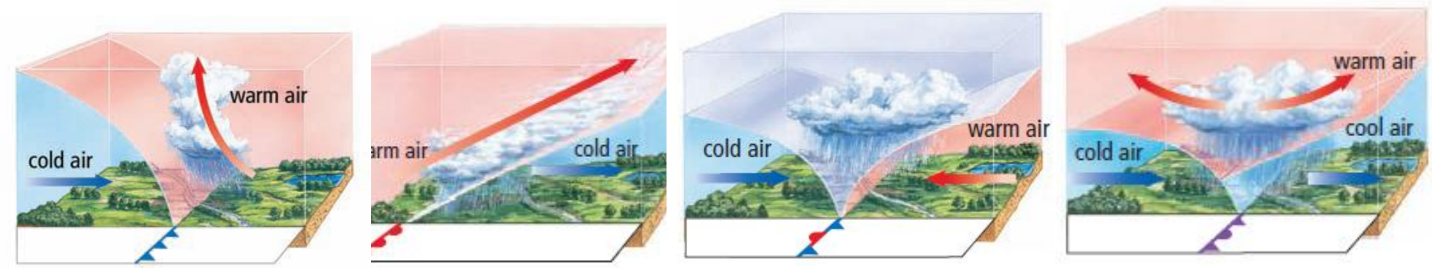
Three Major Global Winds:

1. Trade Winds
2. Prevailing Westerlies (IN BC)
3. Polar Easterlies

Jet Streams: a strong current of wind in the STRATOSPHERE (NOT TROPOSPHERE)

-Commercial air-lines piggy-back on jet streams to save gas.

Fronts



COLD FRONT:
Cold Air advances

WARM FRONT
Warm Air advances

STATIONARY FRONT:
No air mass advances

OCCLUDED FRONT:
Cold Air moves in fast.
Splits warm air mass

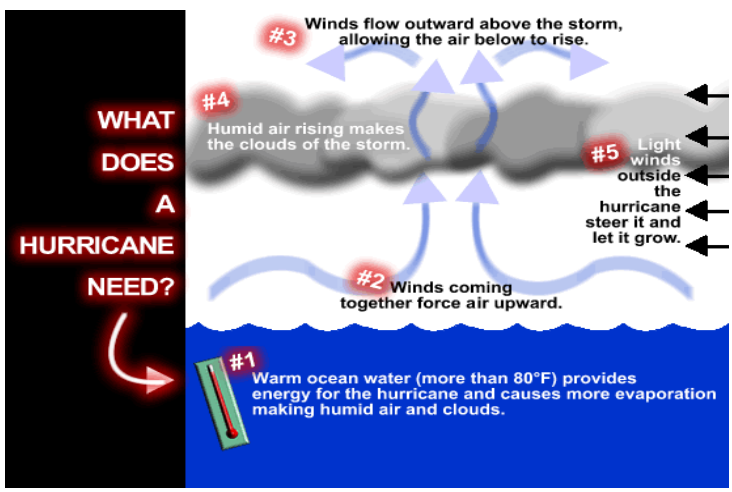
WARM AIR DIRECTION SYMBOL=  **COLD AIR DIRECTION SYMBOL=** 

Extreme Weather

1. **Thunderstorms:** form from rising warm air that cools and releases a lot of rain in a short period of time. Large ANVIL-shaped clouds can form at the top of the troposphere, lead to the formation lightning (release of static electricity)

2. **Tornadoes:** form from very large thunderstorms that meet strong horizontal winds

3. **Tropical Cyclones/Hurricanes:** form over warm water.



11.1 Natural Causes of Climate Change

Describing Climate

CLIMATE: the average of the ATMOSPHERE in a large REGION over 30 YEARS.

Characteristics of Climate:

CLOUDS, PRECIPITATION, TEMPERATURE, HUMIDITY, PRESSURE, SOLAR RADIATION, WIND

Biogeoclimatic Zone: region with a certain:

i) Plant Life ii) Soil iii) Geography iv) Climate

There are 14 biogeoclimatic zones in BC:
e.g. Alpine Tundra, Coastal Western Hemlock

Studying the Past to Learn about Climate Change

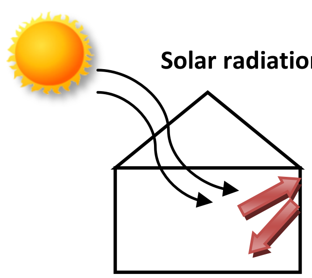
Paleoclimatologists: scientists who study past climates and climate change

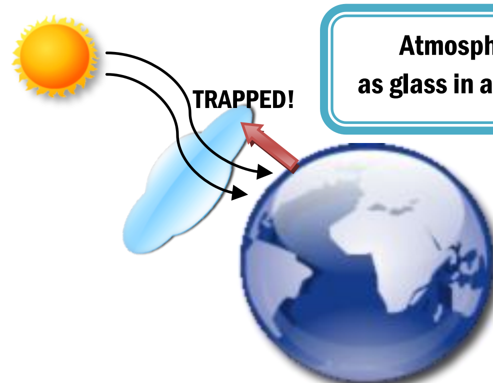
They use the following to measure change in climate: **TREE RINGS, FOSSILS, ICE CORES**

CO_2 Sampling: AIR or CORE sampling

AIR SAMPLING	CORE SAMPLING (from glaciers)
• More recent changes • Allow for Short Term Comparisons	• Long ago changes (up to 650,000 years) • Allow for Long Term Comparisons

Natural Green House Effect





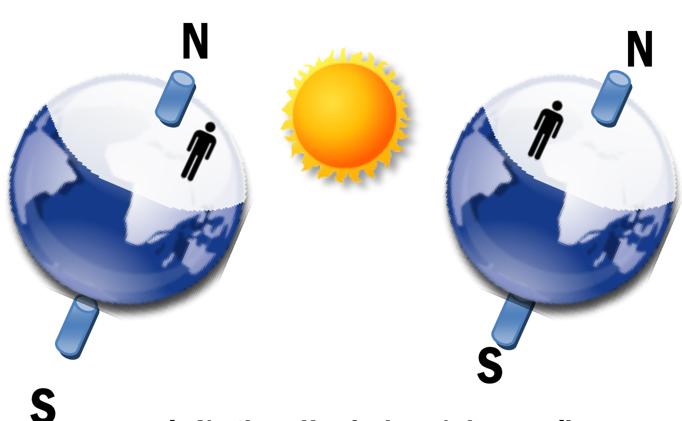
Atmosphere acts as glass in a greenhouse

Thermal Energy is trapped by greenhouse gases in atmosphere

WARMER SURFACE:
34°C warmer than if we had no greenhouse effect

Seasons

SUMMER in Northern Hemisphere



WINTER in Northern Hemisphere

In Northern Hemisphere (where we live:

NORTH POLE faces SUN = SUMMER **SOUTH POLE faces away from SUN = WINTER**

Wobble and Orbit of Earth

1. The earth has a slight wobble as it ROTATES on its axis: this wobble will eventually change the ANGLE of INCIDENCE
2. Earth's orbit is slightly elliptical and changes every 100 000 years which brings the earth CLOSER or FURTHER away from sun

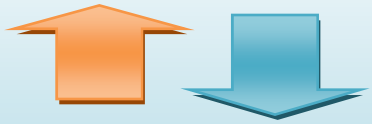
Ocean Currents

There are currents that naturally occur in the ocean. There are 2 types of currents:

1. Surface Currents (less than 500m)
2. Deep-Ocean Currents (500m and below)

Create GIANT CONVECTION CURRENTS that carry THERMAL ENERGY around the Earth

WARM, LESS SALTY WATER RISES



COLD, SALTY WATER SINKS

Cause water to RISE and SINK creating CONVECTION currents

The melting of the GLACIERS adds FRESH, LESS DENSE water to the OCEAN disrupting the CONVECTION currents that BRING thermal energy to certain regions of the world

El Nino and La Nina

El Nino: Strong WESTWARD winds push in WARM water towards North America:
Warm **WINTER IN NORTHWEST (ESPECIALLY BC)**

La Nina: Strong EASTWARD winds push out WARM water AWAY from North America
COLD **WINTER IN NORTHWEST**

The changes in the winds that control the El Nino and La Nina events are called **El-Nino Southern Oscillation (ENSO)**

Volcanoes and Meteor strikes

Volcanic Eruptions

Rock and ash block out sunlight
SO_2 released → reacts with water vapour to form H_2SO_4
H_2SO_4 reflect even more sunlight COOLING the atmosphere

Meteor impacts

Impact ejects dust and gases into the atmosphere, blocking out sunlight
May take years for the dust to return to the Earth's surface leading to drastic cooling

11.2 Human Activity and Climate Change

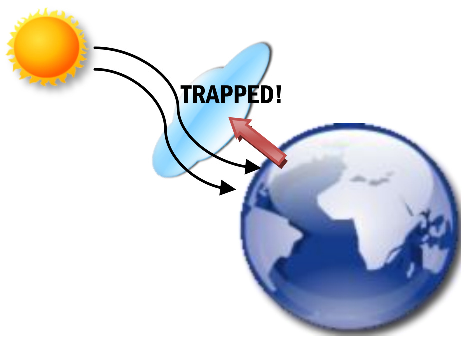
Global Warming

Climate change is sometimes a misunderstood term as some people think it refers to the entire planet's climate changing all at once.
Instead, it refers to changes to weather patterns in certain parts of the world NOT necessarily the WHOLE earth

Global Warming

-**WHOLE** planet average increases in temperature are referred to as **GLOBAL WARMING**
-Scientists do not know the FULL IMPACT that global warming has on climate change but the evidence is increasing

Enhanced Greenhouse Effect



Different from the NATURAL GREENHOUSE EFFECT:

The burning of fossil fuel into the atmosphere increase the amount of GREENHOUSE GASES that TRAP EVEN MORE THERMAL ENERGY than normal

CO_2	**Carbon Dioxide**	**1 GWP**
CH_4	**Methane**	**25 GWP**
N_2O	**Nitrous Oxide**	**298 GWP**
	CFCs	**4750-5310 GWP**

Worst greenhouse gas since it has the **highest GWP (Global Warming Potential).**
Are synthetic gases

Remember, not all gases are GREENHOUSE gases. Greenhouse gases have the ability to hold and trap thermal energy.

1. Burning of fossil fuels (coal, gas) INCREASES CO_2 production
2. Melting of permafrost regions releases methane gas
3. Livestock emit methane gas
4. Use of CFCs in refrigeration
5. Deforestation reduces the amount of plants (CARBON SINKS)

Albedo and Climate

ICE

HIGH ALBEDO
-reflects a large portion of sunlight

WATER

LOW ALBEDO
-DOES NOT reflect a large portion of sunlight

Global warming is melting glaciers meaning now that earth is not able to reflect as much sunlight leading to EVEN more GLOABAL WARMING

12.1 EVIDENCE FOR CONTINENTAL DRIFT

Continental Drift Theory:

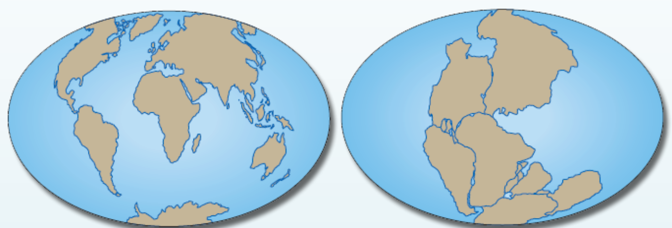
German scientist Wegener hypothesized that the continents were not always in their present location-they must have "drifted" over a long period of time

There are 4 supporting types of evidence supporting Wegener's theory:

1. Jigsaw Puzzle Fit

-S. America and Africa fit together as do other continents into one original "super-continent"

-Wegener termed this super-continent **Pangea**



2. Matching Geological Structures and Rocks

-when continents were connected mountain ranges that began on one continent seemed to continue to another

-multiple similarities between rock structures found on different continents

3. Matching Fossils

-fossils for an extinct small freshwater reptile were only found on both S. America and Africa. It is unlikely that the reptile could cross the Atlantic suggesting that the continents had once been connected

-fern fossils of an extinct plant were also found in multiple continents including Antarctica, again supporting the idea that the continents were in different locations than at present.

4. Climate Evidence involving glaciers

-glaciers leave marks on rock as they retreat and move; glacier evidence was found in regions that are now tropical (glaciers create U-shaped valleys, scratch rock, and create specific rock patterns)

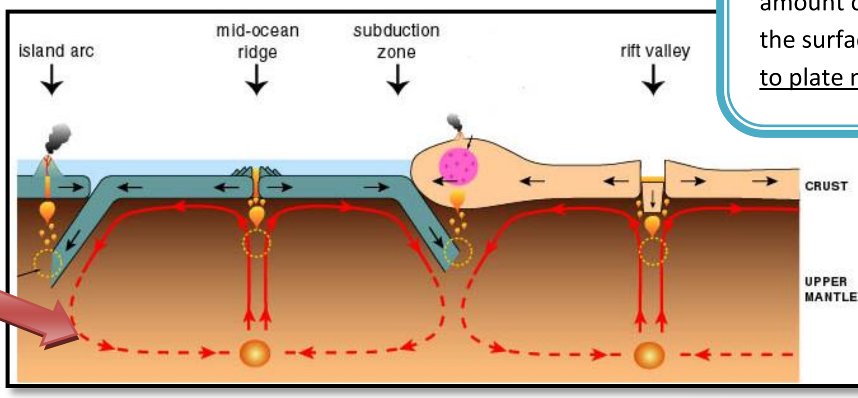
-**<u>Paleoglaciation</u>:** refers to BOTH to the pattern of where glaciers used to be and rock markings left behind

There is no pattern for **paleoglaciation,** until you fit the continents together

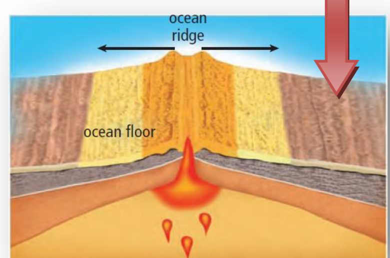
Tectonic Plate Theory: involves the theory that the earth's crust is broken up into separate slabs called **tectonic plates.** These rigid plates move over a partially molten rock layer due to convection currents that occur in the molten layer below which pull and push plates

Earthquakes are the result of the release of massive amount of energy at or near the surface of the earth; <u>due to plate movement</u>

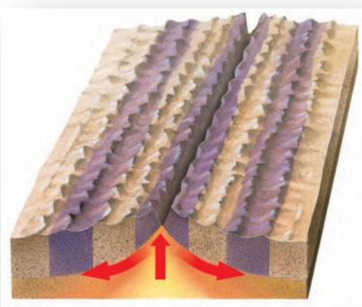
Convection currents in molten rock cause plates to push into one another or push apart



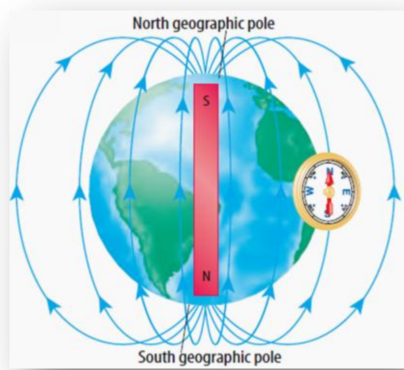
OLDEST rock is FURTHEST away from ridge



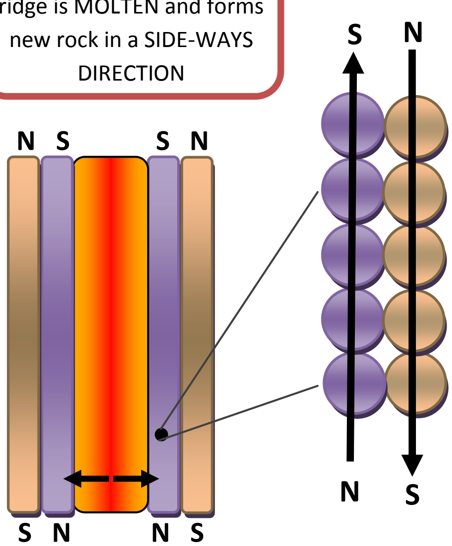
Mid-Atlantic Ridge is a massive ridge found in the middle of the Atlantic Ocean where two plates are moving away from one another



There is **Magnetic Striping** found at Mid-Atlantic Ridge; shows that the Earth's Magnetic field has reversed multiple times over time



Lava coming out of the ridge is MOLTEN and forms new rock in a SIDE-WAYS DIRECTION



Iron atoms in rock are ferromagnetic; align in direction of Earth's Magnetic field

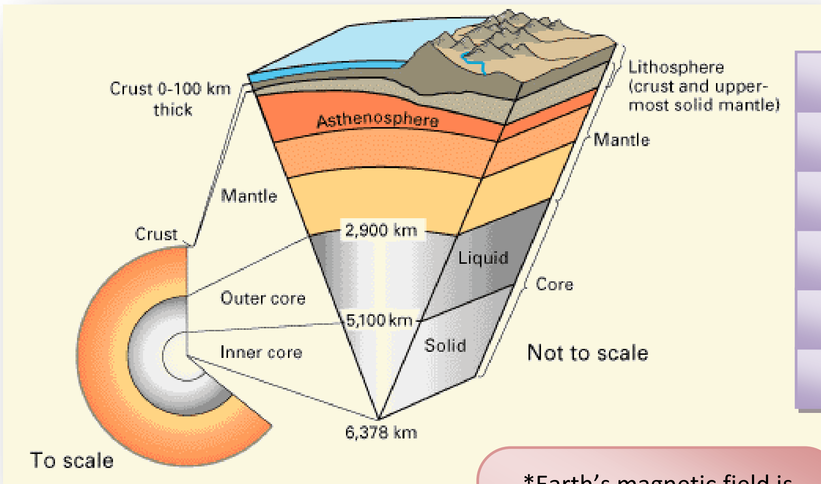
*When rock is molten, Fe atoms align with magnetic field and then "freeze in that direction" once they are a solid

Magnetic field "pushes" towards the SOUTH end of a magnetic (our NORTH POLE)
*These Magnetic Poles reverse every few hundred thousand years

Newest rock

12.2 FEATURES OF PLATE TECTONICS

Layers of the Earth & Plate Motion



- Crust
- Asthenosphere
- Upper Mantle
- Lower Mantle
- Outer Core
- Inner Core

Mantle

*Earth's magnetic field is thought to be caused by inner and outer cores rotating at different speeds

Crust: thinnest layer, made of solid rock.
Crust is made up of 2 parts:

OCEANIC (BASALT) DENSE
CONTINENTAL (GRANITE) LIGHT

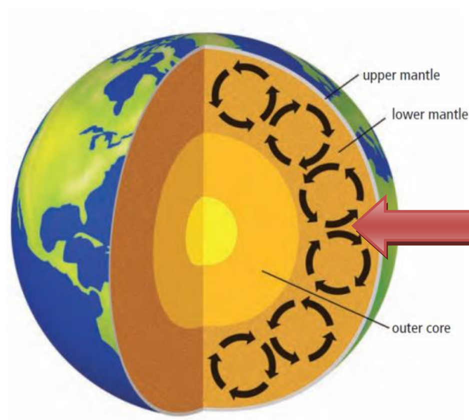
Mantle: thickest layer, divided into 2 major sections:

LOWER: solid rock
UPPER: partly molten rock (asthenosphere is part of upper mantle)
<u>* convection currents occur in the asthenosphere</u>

Outer Core: completely liquid layer
-due to pressure of the other layers above it

Inner Core: SOLID layer made mainly of IRON, pressure is so extreme that the Iron stays as a solid even though should be a liquid

Convection Currents in upper mantle allow the CRUST + UPPERMOST MANTLE (together make a solid lithosphere) to move
<u>*CURRENTS ARE THOUGHT TO BE RESULT OF POCKETS OF RADIOACTIVE ELEMENTS THAT HEAT ROCK</u>



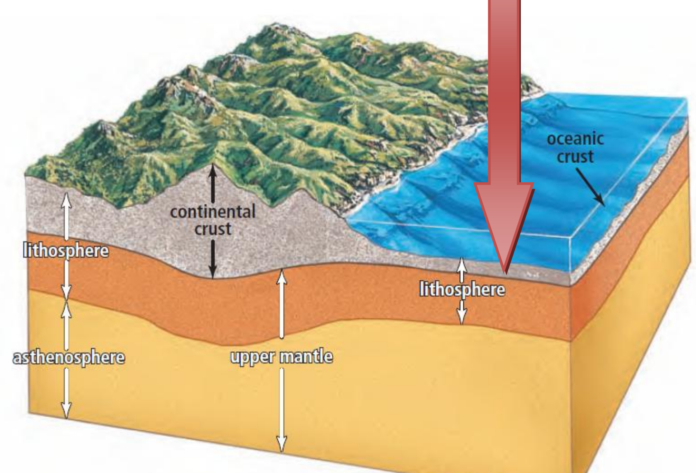


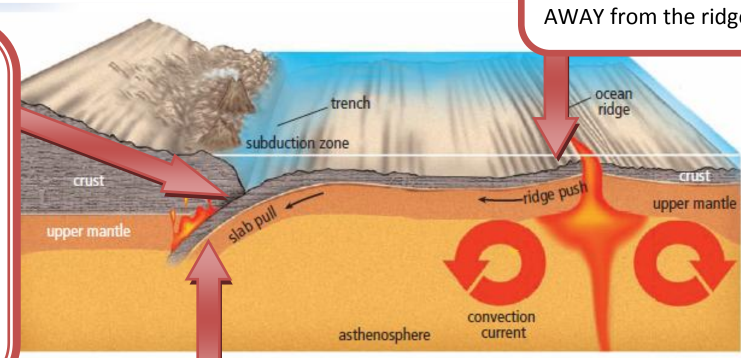
Figure 12.14 A cross-section through Earth's surface

Push and Pull

SUBDUCTION ZONE:
Where one plate slides under the other

OCEANIC (DENSE) SLIDES UNDER CONTINENTAL PLATE (LIGHTER)

Ridge Push: as magma cools into rock it adds new rock at each side of the rift. This pushes the plate AWAY from the ridge.



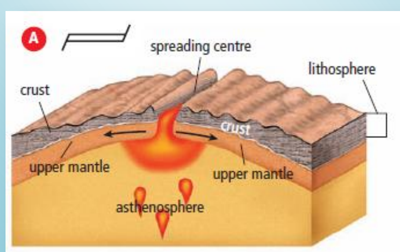
Slab Pull: as plate slides under another plate it begins to sink and its weight pulls the rest of the plate with it.

Plate Boundaries

DIVERGENT

-TWO TECHTONIC PLATES SPREAD APART

-Mid-Atlantic Ridge is an example



CONVERGENT

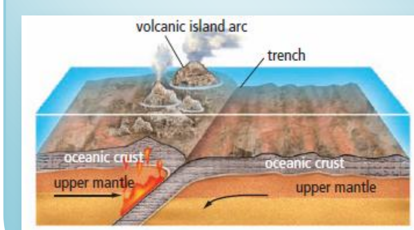
-TWO TECHTONIC PLATES COLLIDE.

There are 3 types:

I. Oceanic-continental

II. Oceanic-oceanic

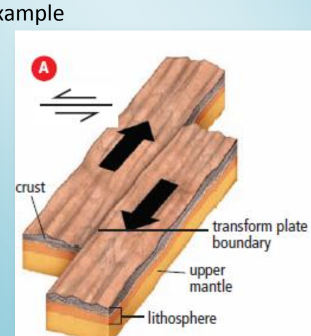
III. Continental-continental



TRANSFORM

-TECTONIC PLATES THAT SLIDE PAST ONE ANOTHER

-San Andreas Fault in California is an example

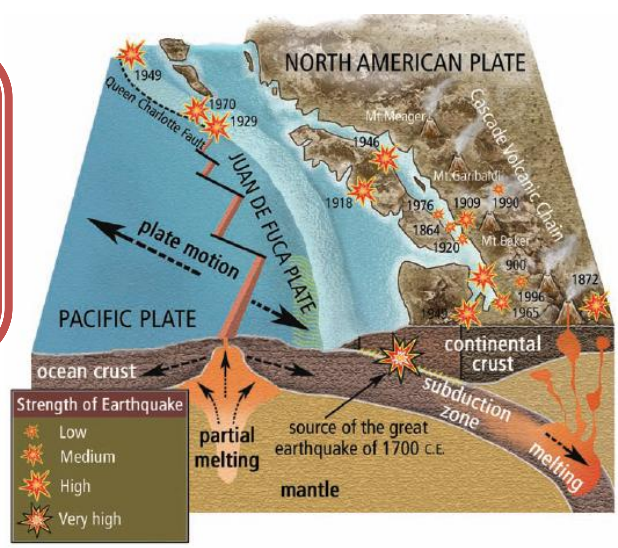


Earthquakes

There is a tremendous amount of energy needed to move tectonic plates. FRICTION works against CONVECTION CURRENTS. This creates STRESS. When this build up of energy reaches a critical point, an earthquake happens which is a massive shaking of the crust

95% of earthquakes occur at tectonic plate boundaries

80% occur in a ring bordering the Pacific Ocean (we live on this ring)



We live right along a SUBDUCTION ZONE:

JUAN DE FUCA PLATE IS SLIDING UNDER THE N. AMERICAN PLATE

Subduction Zone earthquakes are the strongest

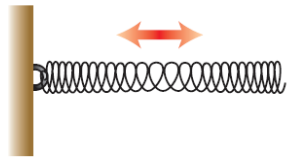
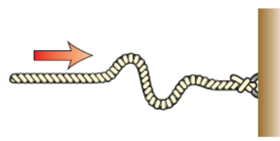
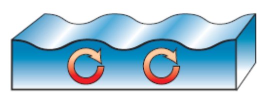
Focus: location inside the Earth where an earthquake starts

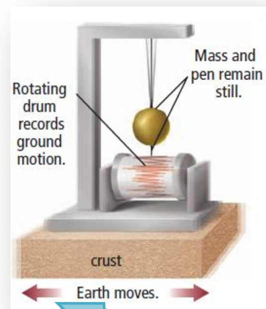
Epicentre: is the point on Earth's surface directly above the focus

Earthquakes with FOCUS points near the surface are more destructive

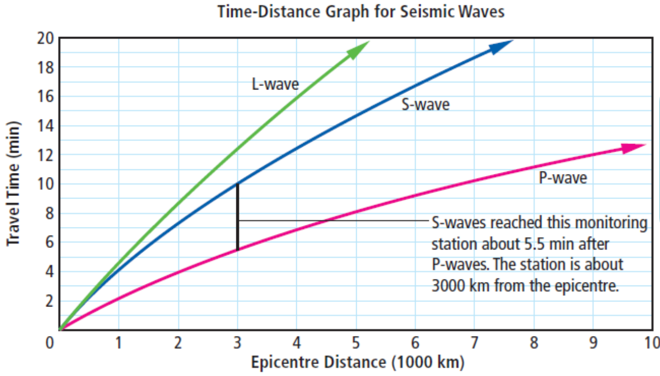
Seismic Waves

Table 12.3 Types of Seismic Waves

Seismic Wave	Abbreviation	Description	Ground Motion
Primary wave	P	• Type of body wave • First to arrive (fastest) • Ground squeezes and stretches in direction of wave travel. • Travels through solids, liquids, and gases	
Secondary wave	S	• Type of body wave • Second to arrive (slower) • Ground motion is perpendicular to direction of wave travel. • Travels through solids but not liquids	
Surface wave	L	• Travels along Earth's surface • Last to arrive (slowest) • Ground motion is a rolling action, like ripples on a pond.	



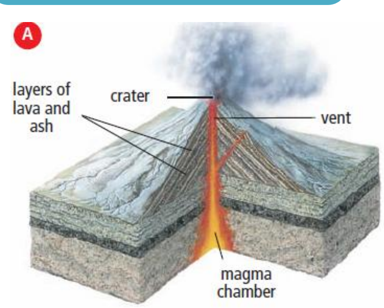
Time-Distance Graph for Seismic Waves



P-WAVES arrive the fastest at monitoring stations

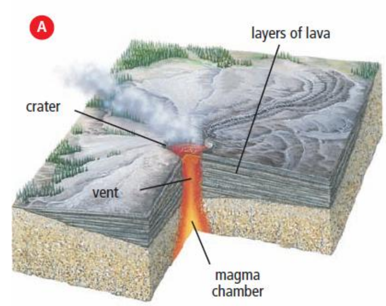
* Measured by **seismometer**

Volcanoes



RIFT ERUPTIONS:

Occur at Ridges where plates are separating; not very explosive but a tremendous amount of magma is released



Composite Volcano:
-cone shaped
-found near Subduction zones
-explosive eruptions, thicker lava

Shield Volcano:
-flat shield shaped
-found near hot spots (thin part of crust)
-less explosive eruptions, thinner fast lava