Scientific Inquiry

Measurement Tools

1 Mass
- *Triple beam balance* - grams
- *Digital Scale* - grams

2 Distance
- *Meter stick* - meter
- *ruler* - centimeter

3 Volume
- Regular shaped solid
  - *ruler* – cm^3
- Irregular shaped solid
  - *Water displacement* – cm^3
  - *Graduated cylinder*
  - *End – before volume*
- Liquids
  - *Graduated cylinder* - mL

4 Weather
- *anemometer* – wind speed
- *barometer* – air pressure
- *hydrometer* – relative humidity

5 Other Tools
- *Spring scale* – force
- *Microscope* – small objects
- *telescope* – far away objects
- *ammeter* –electrical current
- *thermometer* –temperature
- *voltmeter* –electricity voltage

Variables

6 Independent Variable: Changes for a reason
7 Dependent variable: measured during the experiment
8 Control: Used for comparison – nothing happened
9 Constant: stays the same for the whole experiment

EXAMPLE:
Buddy wants to know which laundry soap will get grass stains out of his shorts. He has 3 shorts that he has grass stains on. He tries 3 different laundry soaps one for each short. He thinks that the best at removing grass stains will be most expensive laundry soap.

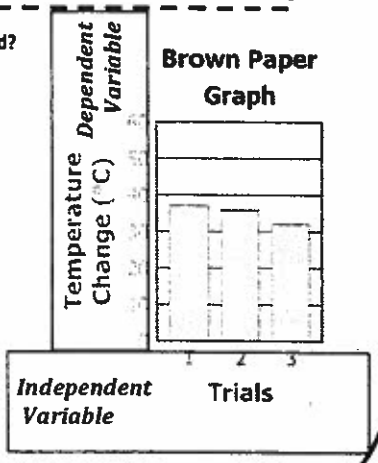
IV: *types of laundry soap*
DV: *amount of grass stains*
HO: *If the laundry detergent is the most expensive, then it will remove the grass stain.*

Charts and Graphs

How Long Does It Take Objects to Reach the Ground?

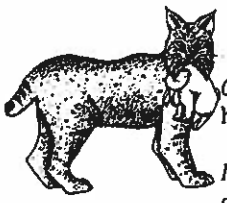
Object	Drop Height (m)	Time (sec)
ton Ball	10	
Marble	10	
pled Paper	10	
nis Ball	10	

Independent Variable — *Constant* — *Dependent Variable*



9 Observation and Inference

Observation: using your 5 senses
Inference: using clues to draw a conclusion



Observation: The bobcat is holding a rabbit in its mouth.

Inference: The bobcat is going to eat the rabbit.

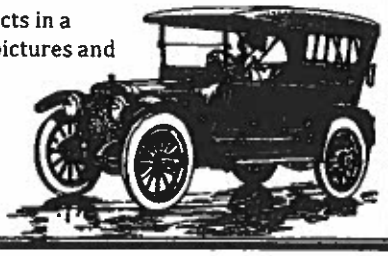
10 Nano Tech

•Nanotechnology is the study of materials at the molecular (atomic) scale. Items at this scale are so small they are no longer visible with the naked eye. Nanotechnology has shown that the behavior and properties of some substances at the Nano scale (a nanometer is one-billionth of a meter) contradict how they behave and what their properties are at the visible scale. New discoveries based on Nano science investigations have allowed the production of superior new materials with improved properties (e.g., computers, cell phones).

11 Qualitative – data **without** numbers
Loud, soft, red, blue
12. Quantities – data **with** numbers
55 kg, 13 students, 1.0 g/cm³

13 Scale models

Used to show larger objects in a smaller size. Easier for pictures and demos



Matter and the Atom

14 Elements
* Found on the periodic table
* The simplest form of matter.
* All the atoms are the same

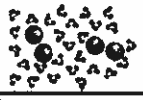
Na O Ag Au

15 Compounds
* Two or more atoms that are CHEMICALLY combined

NaCl H_2O

16 Mixture
* When two or more substances combine PHYSICALLY
* Can be easily separated

Pizza, Salt Water

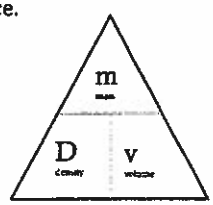


18 Matter
* Has mass and takes up space
* Matter is made of smaller particles called atoms
* Solid, Liquid, Gas, and Plasma

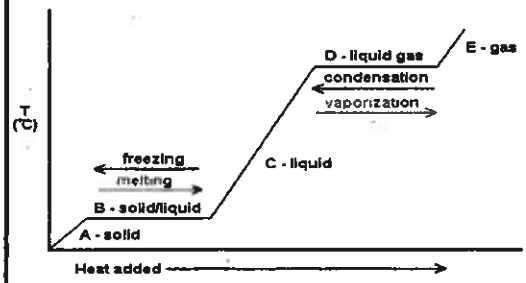
19 Density – the amount of matter in a give space.

g/mL
g/cm³

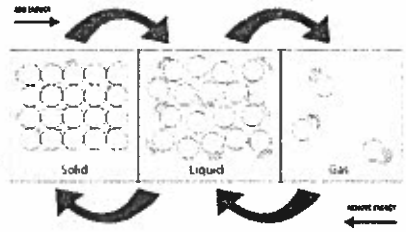
1cm³=1mL



Phases of Matter



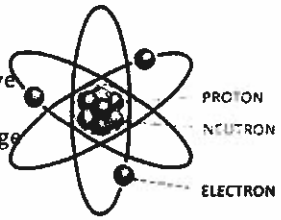
17 ***Theory of matter** all matter is made tiny particles that are in constant motion. These particles are constantly moving and bouncing off of each other.
* Solids have the lowest amount of energy, thus the lowest particle speed; gases have the highest amount of energy and fastest particle movement.



22 The Atom

The basic building block of all matter. Each element has a unique amount of **PROTONS**.

23 Protons: have a positive charge
24 Neutron: have no charge
* Move set energy levels around the nucleus



25 Electrons: have a negative charge * Orbit the nucleus of the atom * Responsible for chemical bonds to other atoms.

Chemical & Physical Properties and Change

20 Chemical Properties and Change

A chemical change that creates a new substance

** size*
** shape*
**density*
** color*
**phase of Matter*

**bubbling*
** rusting*
** burning*

Change in appearance without creating a new substance

21 Physical Properties and Change

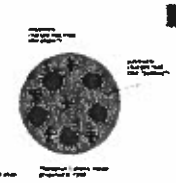
26 DALTON

*Smallest unit of matter
* All atoms of the same element are alike

Dalton
1803-1805

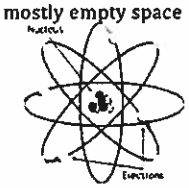
27 THOMSON

* The atoms is a positive mass with negatives particles
**Plumpudding



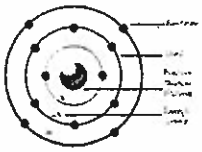
28 RUTHERFORD

* Gold Foil Experiment
* Found the nucleus contained the proton
* The atoms made of mostly empty space



29 BOHR

* Electrons orbit the nucleus in set energy levels, like planets around the sun

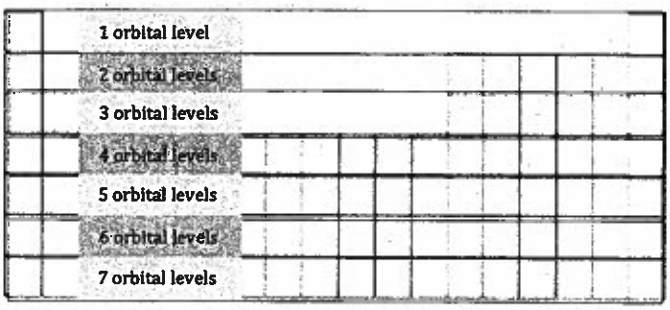


30 MODERN

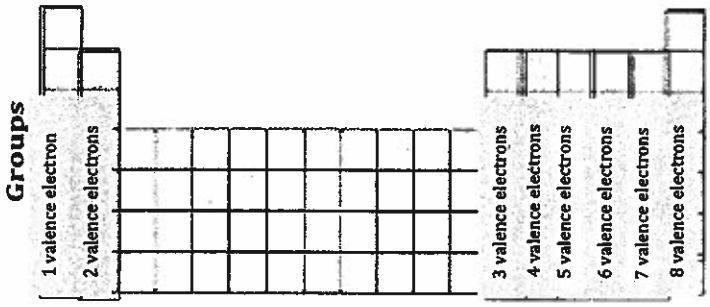
*Protons and Neutrons are made of smaller particles called Quarks
* 3D electron orbit

Periodic Table & Chemical Bonds

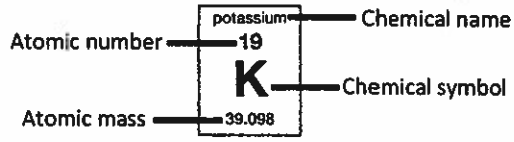
Periods



31. Periods are the horizontal rows. Every element in the same row has the same number of orbital levels.
Orbital levels are the location on the atom where the electron can be located.



32 Groups are the vertical columns. Every element in the same column has the same number of valence electrons.
Elements in the same group have the *same chemical reactivity*
Valance electrons are the electrons in the outer orbital level that are responsible for chemical bonding.



33. Atomic number – the number of protons and electrons
34 Atomic mass – the number of protons and neutrons combined

Subatomic Particles

M atomic MASS
A - atomic NUMBER
N neutrons

A atomic NUMBER
P = Protons
E = Electrons

35 Ion

When an atom gains or loses an electron.

Lose electron = positive ion

Gain electron = negative ion

36 Isotope

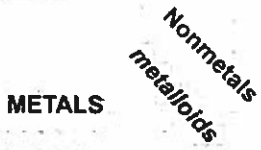
When an atom gains or loses a neutron.

Changing the number of neutrons changes the atomic mass of the atom.

37 Metalloids – elements that share properties of both metals & nonmetals - semiconductors

38 Nonmetals – elements on the right side of the periodic table tend to have a negative charge during chemical bonds since these atoms gain electrons.

39 METALS - Elements on the left side of the periodic tables that tend to lose electrons during chemical bonds thus having a positive charge.



40 Chemical bonds and Compounds

- Atoms react to form chemically stable substances that are held together by chemical bonds and are represented by chemical formulas. *To become chemically stable, atoms gain, lose, or share electrons.*
- Compounds are formed when elements react chemically.

41 Ionic compounds form when *metal* and *nonmetal* combine. The metal loses an electron and the nonmetals gains the electron. Fe_2O_3

42 Covalent compounds when two nonmetals combine to make a compound. NO_2

43 Organic compounds are compounds that contain carbon and hydrogen. These compounds are associated with living or once living organism. $C_7H_8N_4O_2$

44 Inorganic compounds are compounds that are NOT associated with life. MgCl

45 Lewis Dot Diagram

Shows the number of valence electrons for an element and which elements will mostly bond.

Cl has 7 dots. Cl has 7 valence electrons

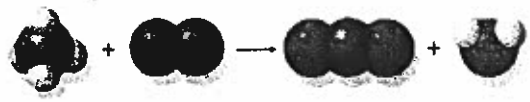
Reactions and Equations

46 Law of conservation of mass

Matter can be neither created nor destroyed it can only *change forms*. The total mass in a closed system will be the same at the end of the reaction as at the start of the reaction.

Parts of an equation

$CH_4 + O_2 \longrightarrow CO_2 + H_2O$



48 Reactant
* The left side of chemical equations
* The material that goes into the reaction

49 Product
* The right side of chemical equations
* The material that comes out of the reaction

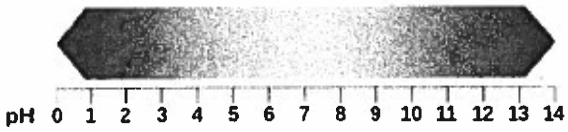
Types of Chemical Reactions

A + B -> AB + *energy*

50 Exothermic – a chemical reaction in which energy is released

CD + E + *energy* -> CDE

51 Endothermic – a chemical reaction in which energy is absorbed



53 Acids
* pH 0-7
* sour, electrolytes, corrosive
* **H+** ion in solution

54 Bases
* pH 7 - 14
* bitter, electrolytes, corrosive
* **OH-** ion in solution

Acids + Bases → Salt + water (pH7)

Atomic Reactions

55 Fusion an atomic reaction in an atom splits apart

Nuclear reactors

56 Fission an atomic reaction in which two smaller atoms form a new larger atom

The sun

47 Counting Atoms

Simple Equation

The subscript how many atoms you have for each.

$C_7H_8N_4O_2$

C = 7
H = 8
N = 4
O =2

Equations with parenthesis

Multiply the number to the right of the parenthesis by all the atoms inside the parenthesis.

$Ca(NO_3)_2$

Ca = 1
N = 1x2 =2
O = 3x2=6

Equations with coefficients

Multiply the number to the left of the compound by all the atoms.

$2\ Ca(NO_3)_2$

Ca = 1x2= 2
N = 1x2x2 =4
O = 3x2x2=12

52 Balancing Equations

Count the number of atoms for both the reactant & product

$Mg + O_2 \rightarrow MgO$

1 = Mg = 1
2 = O = 1

Do all elements have the same number for both sides?

No *Yes*

Pick the elements that is not the same and add a coefficient.

$Mg + O_2 \rightarrow 2\ MgO$

1 = Mg = 1x2 =2
2 = O = 1x2= 2

Do all elements have the same number for both sides?

No *Yes*

Repeat step 2 until both sides are the same.

$2\ Mg + O_2 \rightarrow 2\ MgO$

2=1x2 = Mg = 1x2 =2
2 = O = 1x2= 2

Do all elements have the same number for both sides?

No *Yes*

You are done. It is balanced

57 Energy – the ability to do work

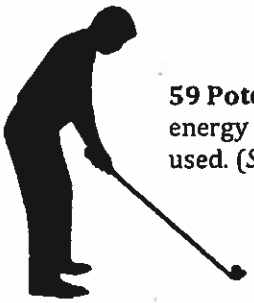
Energy

58 Law of conservation of energy

Energy can be neither created nor destroyed it can only *change forms*. The total energy in a closed system will be the same at the end as at the start.

The other half of the law of conservation of mass

Energy exists in two forms, potential energy and kinetic energy.



59 Potential energy is energy that has not been used. (*Stored*)

60 Kinetic energy is energy that is being used. (*In motion*)

Size of an object and how fast it is traveling impact how much energy the object has.

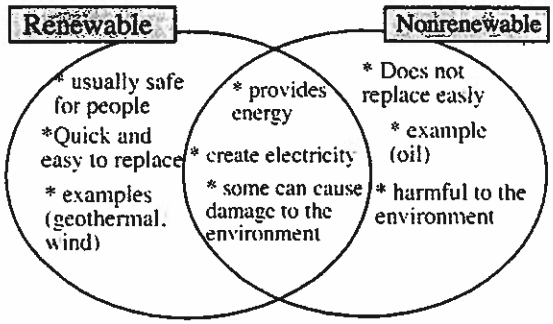
Chemical – light
Chemical - thermal

Energy transformation

Mc Snelt

61 Mechanical – movement
62 Chemical – from a chemical reaction
63 Sound – what you hear
64 Nuclear - the splitting of the atom
65 Electrical – moving of electrons
66 Light (radiant) – visible light
67 Thermal – heat energy

Renewable and Nonrenewable Energies



68 Nonrenewable Energy Sources

- Oil
- Natural gas
- Nuclear energy
- Coal

69 Renewable Energy Sources

- Biomass
- Geothermal
- Solar
- Wind

Motion

70 Motion – a change in position compared to another object

71 Force – push or pull on an object

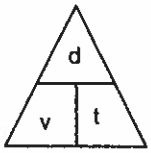
72 Friction is caused when two objects rub together creating heat and slowing down an object.

73 Gravity the force of attraction between to objects, larger objects attract smaller objects.

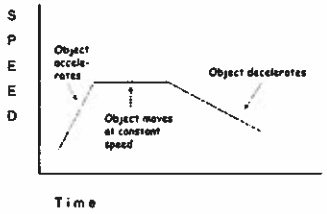
74 Traction the adhesive friction of a body on some surface, as a wheel on a rail or a tire on a road

75 Speed is how fast something is moving. It is calculated by dividing the distance travelled by the time travelled.

V=d/t



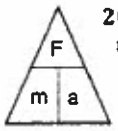
76 Velocity - the speed travelled with direction of movement.



77 Acceleration – is a change in speed over time. An increase in speed (speed up) is called acceleration. A decrease in speed (slow down) is called deceleration.

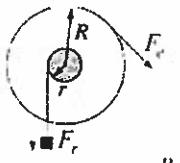
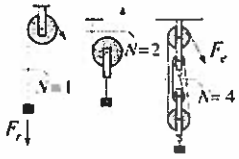
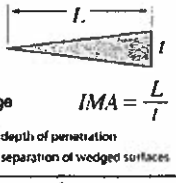
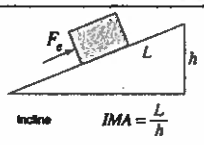
78 Newton's Laws of Motion

1st Law of motion – An object at rest will stay at rest; an object in motion will stay in motion unless an unbalanced force acts on it.



2nd Law of motion – when an unbalanced force is applied to a mass (object) it will accelerate in the direction of the force.

3rd Law of Motion – For every action there is an equal and opposite reaction.

Simple Machine		Mechanical Advantage
Lever		A/B
Wheel and axle		MA=R/r
Pulley		Number of ropes
screw		Closer the threads higher the MA
Wedge		Length of incline/height of wedge
Incline plaine		Length of incline/height of ramp

79 Work is when a force is applied to an object and the object changes location. *If the object does not change location, then no work is done.*

W=Fd

P=W/t

80 Power is how much work is done is a set amount of time.

W

F d

W

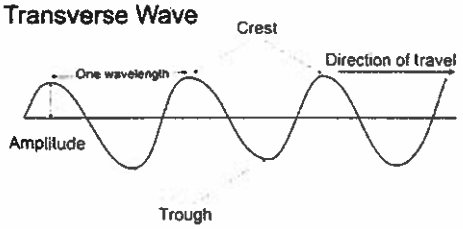
P t

Waves

81 Waves move energy without moving matter.

Electromagnetic wave

Transverse Wave

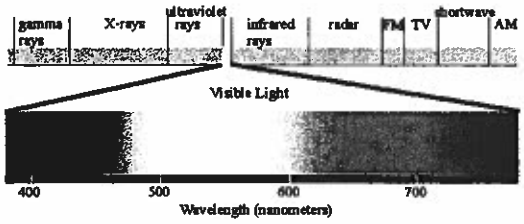


82 Wavelength – The distance between any two crests of compressions next to each other in a wave. Made up of frequency, speed and amplitude.
83 Frequency – The number of waves produced in a given amount of time. (Hertz) Higher frequency means more energy
84 Speed – The speed in which the wave travels
85 Amplitude – related to its height. The larger the amplitude the taller the wave is.
86 Crest – The peak of each wave
87 Trough – The bottom of each wave

90 Electromagnetic waves facts

- We can see
- Can travel in space
- Can travel in a vacuum
- Parts are invisible to the human eye

Electromagnetic spectrum

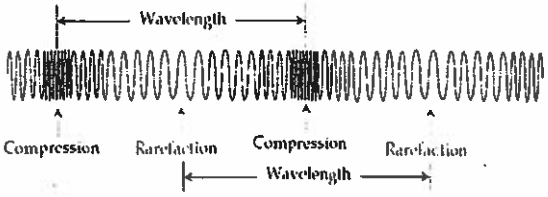


95 The **electromagnetic spectrum** is an arrangement of electromagnetic waves in order based on wavelength. Radio waves have the lowest energy, and gamma rays have the highest energy.
The only part we can see is visible light.

96 Applications of sound waves include
a. ultrasonic imaging (medical ultrasound)
b. sonar
c. Doppler radar (weather mapping)
d. fiber optics

Sound Wave

Compression wave or longitudinal wave



88 Rarefaction – When a wave spreads out the wavelength increases
89 Compression – When a wave compresses and wavelength decreases

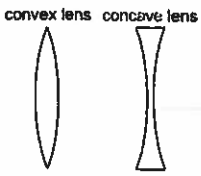
91 Sound waves facts

- Moves the fastest in solids
- Moves the slowest in gases
- Needs a medium (matter) to travel
- Is a type of mechanical wave
- Cannot travel in space
- Cannot travel in a vacuum

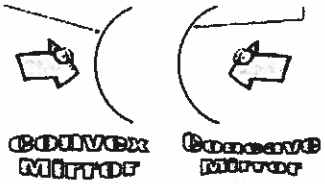
92 Resonance is when the movement of a wave matches the natural frequency. Example Tacoma narrows bridge.

93 Frequency of a wave is how many identical parts of a wave can pass one point in one second of time. The faster the wave travels the higher the frequency.

93 Lenses – A transparent object that forms an image by refracting or bending light.
Convex, concave



94 Mirrors – Reflective surfaces that bends lights
Convex, concave



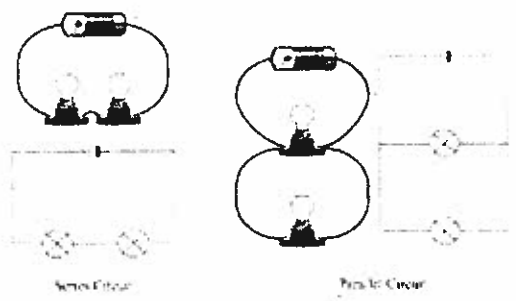
Created By Deb Hicks

Electricity and Magnetism

97 Static electricity – The electric charge at rest on an object. Created by friction

98 Current electricity – the rate at which charges pass a given point. The higher the current is, the greater the number of charges that pass the point each second.

102 Circuits – A complete, closed path through which electric charges flow. Needs 3 things, an energy source, wires and a load. (Load = the thing that is receiving the electricity) Two types- Parallel and Series

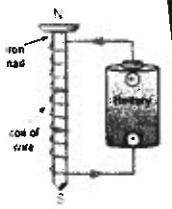


99 A **magnet** is a device that is made of iron and produces a magnetic field.

100 Magnetic field - magnets have specific magnetic fields. The Earth has a magnetic field (South and North poles). Opposites attract, Same repels.
Magnetic fields can create electrical current, and an electrical current can make a magnetic field.

101 Electromagnets – A solenoid wrapped around an iron core. Can be turned on an off with an electric current. (Ex. Doorbell)

An electromagnet is a device that has an iron center wrapped in a coil of wires. When an electrical current is added to the wire, a magnetic force is produced. Once the electrical currents ends, the magnet will not work



Creating Electricity

103 Turbine – A machine that converts kinetic energy of moving liquid, or air to mechanical energy. (Think windmills and water dams)
104 Electric Generators – Uses electromagnetic induction to change mechanical energy into electrical energy.

105 LED Light Emitting Diodes
- a low energy, high efficient light bulb
- Electricity can only flow one direction through the light.

Moving Electricity

106 Conductors – A material in which charges can move easily. Most metals are conductors, the electrons can move freely
107 Semiconductors – A substance that conducts electric current better than an insulator, but not as well as a conductor
108 Insulators – A material in which charges cannot move easily. The electrons can NOT move freely (Ex. rubber, glass, wood, air.

Famous Scientist

109. **Charles Darwin** – Came up with the theory of evolution. Species gradually change over time

110. **Watson & Crick** – Discovered the structure of DNA (A,T,C,G nitrogen base pairs)

111. **Mendel** – The Monk that had a pea plant garden. He tracked the traits of the plants and realized that they were dependent on the previous generation and probability. Punnett squares.

112. **Rosalind Franklin** – used an x-ray to figure out DNA is a Double Helix

113. **Louis Pasteur** – Scientist who figured out boiling kills bacteria using nutrient broth. Pasteurization is named for him.

114. **Francesco Redi** – Disproved Spontaneous Generation

115. **Aristotle** – The first Scientist to create a classification system (run, fly, swim)

116. **Robert Hooke** – The first person to observe cells, looked at cork under a microscope

117. **Linnaeus** – Came up with the classification system we use today

118. **Dalton** – came up with original atomic theory – 1. All substances are made up of atoms, atoms **cannot** be created, divided or destroyed. 2. Atoms of the same element are exactly alike. 3. Atoms join with other atoms to make new (different) substances.

119. **Thomson** – Discovered that there are small particles INSIDE the atom. He called it the Plum Pudding Model because he thought the atom was a big blob of positive with negatives all through it. Those negative were electrons. The atom could be divided even smaller.

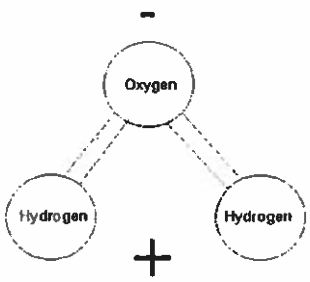
120. **Rutherford** – Used his gold foil experiment to show a new model of the atom – mostly empty space – small positive nucleus

121. **Bohr** – Realized that electrons moved around the nucleus in certain paths or energy levels (think about planets around the sun) Created the Bohr Model of the Atom – the one we draw in class

122. Sir Isaac Newton – created the laws of motion and law of gravity.

123. Water is a polar molecule with a chemical formula of H_2O. A polar molecule has one side of the molecule or compound has a positive charge, and the other side has a negative charge. The hydrogen side of the molecule has a positive charge, and the oxygen side has a negative charge. Being a polar molecule allows water to react with many different element and compounds.

124. Charged molecules tend to stick to the item. Positively charged items will stick to negatively charged items and vise versa. When water sticks to another water molecules it is called cohesion. Cohesion forms water droplets. When water molecules stick to other surfaces it is called adhesion.



125. Capillary action is when water climbs up tubes using the cohesion and adhesion to move the water molecules. Capillary action is how trees move water from the roots to the leaves.

126. Surface tension is when the surface of the water sticks together. If an object is light enough not to break surface tension, the object will appear to rest on top of the water. Water striders are bugs that do not break the water surface tension.

127. Water reacts with many different compounds and elements. One way is to dissolve many different substances. This is why water can make sugar and salt disappear in a cup of water. Because water can dissolve almost everything it is known as universal solvent.

128. Water has several unique properties that contribute to life on Earth. Water is the only compound on Earth to be found in three states of matter (solid, liquid, and gas). Water can exist as a solid when the temperature is below 0°C (32°F). Liquid water has a temperature range of 0°C to 100°C. (32°F to 212°F). Water as a gas can exist in both of there temperature ranges as humidity (water vapor in the air).

129. Another unique property of water is that when water freezes it expands. As water freezes the polar molecules become more aligned into a block like structure called a crystal. These ice crystals have positive hydrogens near negative oxygen. The gaps between the individual water molecules become pockets of trapped air. This arrangement allows for the ice to be less dense than liquid water. This is why ice floats on water.

130. Coastal cities have more moderate temperatures than land locked cities. Large bodies of water such as large lakes, bays, and oceans absorb and retain (hold) thermal energy. The cities near the water have a more moderate climate at the water slowly releases the thermal energy. This is why in the winter coastal cities get less snow than inland cities.

131. Water is very slow at change its temperature while absorbing thermal energy. The ability to store thermal energy is known as heat capacity. Different objects have different heat capacities. This is why in the summer time the beach sand can burn your feet, while the water feel comforting.

132. Water (rain, ice, snow) has shaped our environment by physically and chemically weathering rock and soil and transporting sediments. Freezing water can break rock without any change in the minerals that form the rock (physical weathering). This usually produces small particles and sand.

133. Water with dissolved gases and other chemicals causes the minerals in rocks to be changed, leading to the deterioration of the rock (chemical weathering). The faces of statues are no longer as detailed due to chemical weathering.

134. The oceans make up 97% of all the water on the surface of the Earth. That leaves only 3% of the water as fresh or drinkable water. Less than 1% of the fresh water is not frozen. Think of all the things in your life that you use water for (drinking, cleaning, watering your pets, gardens, etc.) has to come from that less than 1%.

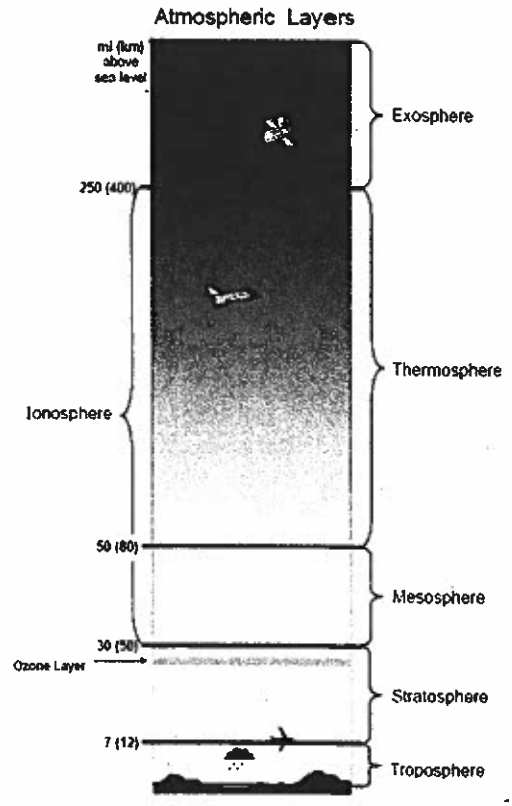
135. Water is essential for agriculture. Crops watered by reliable irrigation systems are more productive, and harvests more dependable.

136. Water is important for both human health, but also our way of life. Since water is so improrrtant, there are many regulations about how water can and can not be used. These regulations are designed to protect our water resources. Prior to the start of water regulation in the mid 1800s human waste and open sewers were common. This allow for diseease outbreaks and contaminations of public drinking supplies. Ranchers would also damn rivers to prevent commpetions down stream from having access to water. Since then regulations have been put into place stating what can and can not go into the water supply and that you can not redirect the flow of rivers and streams.

137. Water is also very important for generation of electricity. Majority of the power plants created steam from to turn a turbine that then generates electricity. The creation of the steam can from nuclear fission, coal burning, and many other methods of creating heat. Water itself can create electricity by falling over the turnbine to generate electricity. Power plants that use water falling over the turbine is known as hydroelectric power plants. Example of this is the Hoover Dam in Nevada.

Earth's Atmosphere

138. Earth's atmosphere is 78% nitrogen, 21% oxygen, 09% argon, and 01% other. Carbon dioxide and water vapor are part of the 0.1% other. Carbon dioxide levels impact the greenhouse effect, and water vapor levels impact weather.
139. At sea level (elevation 0 feet) the air pressure is the greatest. There are more molecules pushing down at this location. The air pressure is at 14.7 psi. When you increase altitude the air pressure is less. At the top of the Shenandoah Mountains (elevation 3000 ft) the air pressure is 13.1 psi. As the altitude increases the air pressure will continue to decrease.
140. In the lowest layer of the atmosphere (troposphere), the temperature also decreases as you increase altitude. It is always warmer at sea level and colder at the stop of a mountain.
141. The atmosphere is made of several layers. Troposphere, Stratosphere, Mesosphere, Thermosphere, and exosphere. Each layer has its own unique set of properties. As you increase altitude from troposphere to exosphere the number of molecules decreases. As the number of molecules decreases so does the air pressure.
142. The troposphere is the lowest layer of the atmosphere. This is layer has the largest amount of molecules, and the overall highest air pressure. You will find life, mountains, birds, and even weather in the troposphere. Most airplanes fly in the troposphere.
143. The stratosphere is the next layer; it has lower air pressure than the troposphere. The temperature in the stratosphere is cold. The stratosphere contains the ozone layer, which protects the Earth from Ultraviolet radiation.
144. Mesosphere is the 3rd layer of the atmosphere. This is the coldest layer of the atmosphere. The mesosphere is responsible for destroying any foreign objects entering the Earth's atmosphere.
145. The Thermosphere is the thickest and hottest layer of the atmosphere. This layer protects the Earth from the Sun's rays and gamma (x rays). This layer is the layer with the northern lights (aura borealis). The space shuttle and low-level satellites fly in this layer.
146. The last layer, exosphere is where the atmosphere blends with outer space. High-level satellites orbit in this layer.

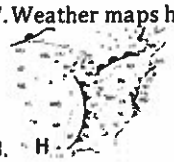


147. The atmosphere can be affected by natural causes such as forest fires and volcanic eruptions. Humans also affect the atmosphere. One such way is burning of fossil fuels, which releases carbons into the atmosphere. The long-term effects are still unknown.

148. Weather is impacted by the air pressure, humidity, and thermal energy (temperature). When one or more of these things changes, we experience a change in weather conditions.
149. Air quality impacts also impacts humans quality of life. Ozone is on such item that can lower air quality. Ozone in the stratosphere is useful, however in the troposphere it can be dangerous since the human body cannot use ozone. Higher amounts of air pollution increase the amount of ozone in the troposphere.
150. When water vapor is added to the air in increases the moisture level this is known as humidity. The higher the humidity the more uncomfortable or sticky the air feels.
151. Clouds are indicator of weather conditions. Status clouds are usually with rainy weather and cirrus clouds fair weather. Cumulus clouds can be both fair weather and severe weather. When a cumulus clouds is associated with rainy weather it is called cumulonimbus.
152. Local weather conditions can associated with where the weather originally started. If the air mass comes from the north over the Great Plains, we can expect cold, dry weather. If the air mass comes from south over the ocean, we can expect hot, wet weather.
153. When the weather conditions are sunny it is called High pressure. This is shown as an **H** on the weather map. Usually with there d here is no to low changes of rain.

154. When the weather conditions are rainy, and storm weather with a decrease in atmospheric pressure, it is called a lov ressure. This is shown as an **L** on the weather map. Usually these days are cloudy and raining.
155. Cold front is boundar tween air masses that have colder air behind the front.

156. Warm front is bou ary between air masses that have warmer air behind the front.
157. Weather maps help predict the weather by showing patterns that our occurring.

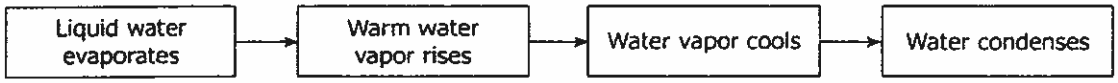


158.
159. Locations near water can have high pressure and still get after rain and storm. This occurs when the cooler air from the ocean travels over the warmer air of the land creating the storm. This popup variety of storms is common in coastal Virginia in the summer time.

Solar Energy on Weather

160. The Earth does not like having uneven heating. The Earth wants all locations to have the same temperature. Convection will be used to share the thermal energy. When the atmosphere moves thermal energy it is called wind. The ocean moves thermal energy is it known as ocean currents. The Earth also uses radiation when it reflects energy back. This is way some surfaces feel warmer than others.
161. As more thermal energy is added to water the amount of water evaporating will increase. As more water is added to the atmosphere the humidity in the air increase. In the summer time there is more moisture in the air, thus why it feels sticker in the summer than in the winter.
162. Warm humid air is less dense than cold dry air. Since the warm humid air is less dense it will rise up. Once the warm humid pocket of air reaches the dew point, the pocket of air will condense and become a cloud.
163. There are several steps in the cloud formation process.

Cloud Formation

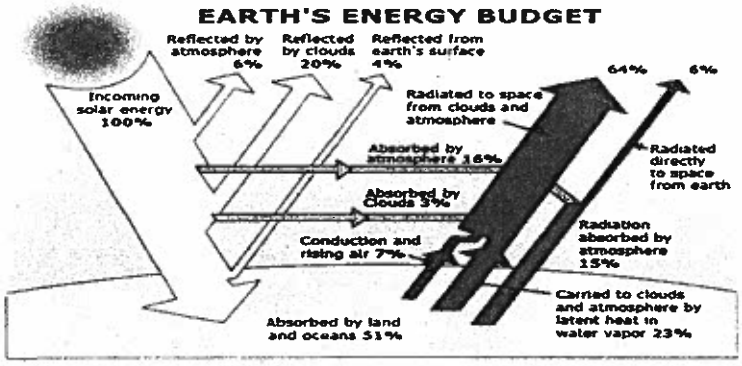


164. Severe weather occurs when there is a great amount of atmosphere difference or instability. The larger the difference between two different air mass, the strong the storm.
165. Hurricanes are a form of severe weather that occurs over the ocean. During the heating of the ocean waters in the summer storms can form. When the storm gets enough energy it can become a hurricane. Once a hurricane or tropical storm interacts or comes across land it loses some of its energy. The formation process from a hurricane is;

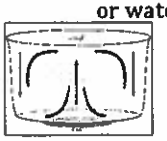
Low Pressure → Tropical Depression → Tropical Storm → Hurricane

Impact of Solar Energy

166. [illegible] the energy from the sun powers the atmosphere, oceans, photosynthesis, and other processes on Earth.
167. The sun emits solar radiation to the Earth called electromagnetic spectrum. Infrared radiation, which is observed as heat, is why it feels warm to sun in the sunlight. Visible light, the only part of the spectrum that we can see. Ultraviolet radiation (UV radiation), which caused sun tans.
168. When the balance between the energy coming to the Earth and the amount of energy already on the Earth is unequal we notice climate changes. Currently the amount of energy leaving the Earth is less than the amount we are getting from the sun, created the greenhouse effect. Excessive amounts of carbon dioxide and other gases are the cause for the greenhouse effect.
169. Energy from the sun can be reflected back into space or absorbed by the earth. This is what is known as the Earth's Energy Budget.



170. [illegible] land absorbed heat at different rates. Grassy yards absorb heat slower than black roadways.
171. When the air or water heats up, the molecules get more energy. The more energy the molecules have, the warmer the temperature. As temperature increase the density decreases. Less dense items will rise (float) to the top. The cooler air or water will sink to the bottom. This is called **convection**.



172. Watersheds are ecosystems that include both the local body of water, and all of the contributing bodies of water that add to it. All the land that allows water to flow into a river, stream, lake or other body of water is also apart of the watershed. Areas of high elevation such as mountains can create boundaries in watersheds. This is commonly found at continental divides.
173. River systems are made up of smaller rivers and streams. These river systems flow into larger bodies of water forming the watershed. Streams and rivers that flow into another body of water such as a larger river, lake, bay, and ocean are called tributaries.
174. When high amounts of water enter a river system flooding occurs. The area of land where the excess water goes is called the flood plain. When this area is not flooded, the floodplains are a great location for farming due to addition of soil and nutrients left behind from the receded waters.
175. The speed of the water or water flow can determine what types of materials and sediment can be transported down stream. When the water flow in fast it can carry larger objects such as rocks and trees. As the water flow decreases the larger objects will be left behind as deposits.
176. Abiotic (nonliving) factors determine the type of ecosystem. It also determines the type of plants and animals live in the ecosystem. Dryer ecosystems are going to have fewer plants and animals than wetter ecosystems. Abiotic factors that impact an ecosystem include water supply, topography, landforms, geology, soil, sunlight, and air quality.
177. Biotic (living) factors are the living organisms in the ecosystem. Biotic communities include plants, animals, fish, birds, microorganisms, and people. The ecosystems biotic communities can be greatly impact by each other and impact the abiotic factors of the ecosystem.
178. As mankind needs increase, our impact on the abiotic factors of an ecosystem increase. Deforestation, soil erosion from agriculture, changes in nutrient levels in the watersheds via fertilizers, increase in thermal pollution from parking lots, and other changes to the local environment.
179. There are three major watersheds in Virginia: Chesapeake Bay, North Carolina Sounds, and Gulf of Mexico. Each of these watersheds can be broken down even more based on the major rivers that add to that watershed. The Chesapeake Bay for example has the James, Potomac-Shenandoah, Rappahannock, and York Rivers.
180. Wetlands are the boundaries or transition zones between the water and the dry land. Swamps, beaches, and marshes are examples of wetlands.
181. There are two types of wetlands, tidal and nontidal wetlands. Tidal wetlands are located near bays and oceans where the tide cycle has the greatest impact. Tidal wetlands tend to have brackish water (salt water). Nontidal wetlands are not associated with tides and have fresh water.
182. Wetlands improve water quality by slowing down the flow of water. This slowing of the water allows the wetland to filter the water from pollutions and excess nutrients and recharge the ground water supplies. This creates a habitat from many different types of wildlife and fish. Many migratory birds nets and rest in wetlands during their travels.
183. Estuaries are a special type of wetland/watershed that has brackish water. Brackish water is water that is a mixture of both salt water and fresh water. Depend on the location in the estuary will determine salinity (salt) levels.
184. An estuary can be the home to both freshwater and saltwater organisms. Many salt-water organisms w00ill enter an estuary to have their young. Estuaries provide a safe place for the young to grown and to be away from predators in the open ocean that might feed on the young.
185. The Chesapeake Bay is the largest and most productive estuary in the United States.

- **1. Western Virginia** flows down to the **Gulf of Mexico.**

- **2. Southern Virginia** flows down to the **North Carolina Sounds.**
- **3. Northern Virginia** flows to the **Chesapeake Bay.**
- Most of the United States water ends up flowing to the Gulf of Mexico.

Energy Sources and the environment

186. Energy sources are ways that human can get energy to make our lives easier. Energy sources can be separated into two sources, renewable and nonrenewable.
187. Renewable resources are substantial energy sources, which can be a replaces in less than 100 years or had an endless supply. Examples of renewable energy sources are geothermal, biomass, solar, water (tidal, waves, and hydropower) and wind.
188. Nonrenewable resources are not sustainable energy sources, which cannot be replaced. Examples of nonrenewable energy sources are fossil fuels including coal, natural gas, petroleum, and nuclear energy from uranium. Fossil fuels are rich in carbons and hydrogens, which make then wonderful source of energy.
189. The energy resources are used for many things including creating electricity and provide transportation. There are many advantages and disadvantage to using each of the energy sources. (See section 6.9 conservation for more information)

190. **Cell Theory** – States that all organisms are made up of one or more cells, Cells are the basic unit of life, and cells come from cells that already exist.
191. **Biogenesis** – The theory that living things come only from other living things (Correct Theory)
192. **Spontaneous Generation** - The theory that living things come from non-living things (Incorrect Theory)
193. **Compound Light Microscope** – The fancy words for the microscopes you use in class
194. **Eukaryotic Cells** – Cells that have a Nuclear Membrane
195. **Prokaryotic Cells** – Cells that do NOT have a nuclear membrane

196. **Mitosis** – The process in which the cell divides into two exact copies

Prophase – "P repare"– The genetic material bundles up and forms chromosomes and the nuclear membrane break down. The centrioles move to the poles of the cell.

Metaphase - "M iddle"– The chromosomes line up in the middle of the cell. The centrioles attach to the chromosomes

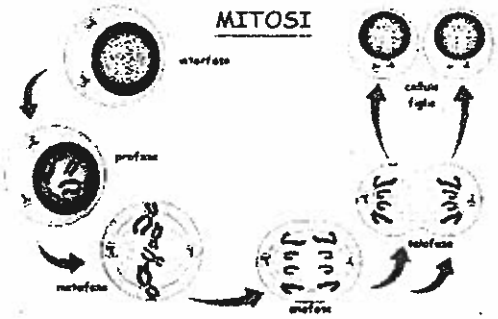
Anaphase – "A part" - The chromosomes are ripped apart and 1 set of each chromosomes move to each side

Telophase – "T wo"– The cell begins to split into two and the nuclear membranes start to reform

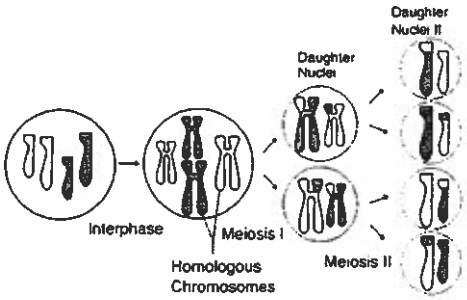
Cytokinesis – The cell finally splits apart. This results in two exact copies of the original cell

"M itosismakesmytocsesM ciosismademe"

Interphase – The cell remains in interphase for most (99%) of the time it is alive. Only when it gets the signal does it start Mitosis



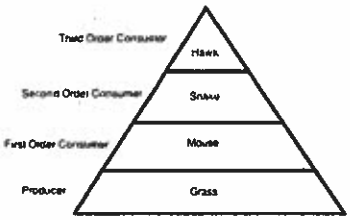
197. **Meiosis** – Is slightly different than Mitosis – PMATs twice & makes four sex cells (sperm, eggs)



Biomes and Environment

198. **Biome** – A group of ecosystems with similar climates and organisms
199. **Desert** – A biome in which the annual evaporation is greater than the amount of precipitation (very dry)
200. **Rainforest** – A biome that is tropical woodland with annual rainfall of at least 100 inches and has large leaved evergreen trees that form a continuous canopy
201. **Taiga** – A biome that is a cold region of cone-bearing, evergreen trees, including pine, hemlock and others. Also called a **Boreal** forest
202. **Temperate deciduous Forest** – A Biome containing deciduous trees, which lose their leaves in the fall. This is Virginia.
203. **Grassland** – A biome that typically gets 25 to 75 cm of rain annually and dominant vegetation is grasses (Prairie, savannah)
204. **Tundra** – A biome that is Cold, dry, treeless region where winters are 6-9 months long
205. **Marine** – Salt water
206. **Estuary** – Where freshwater mixes with salt water *(brackish water)* (Where the James river flows into the Chesapeake Bay)
207. **Terrestrial** – Living or growing on land; not aquatic
208. **Symbiosis** – A close relationship between two organisms that live together
209. **Commensalism** – A symbiotic relationship that benefits one partner, but does not harm nor benefit the other (Sharks and Remoras)
210. **Mutualism** – A symbiotic relationship in which both organisms benefit (Clown Fish & Sea Anemone)
211. **Parasitism** – [illegible] Dog)
212. **Host** – The animal or plant in or on another organism lives
213. **Parasite** – An organism that grows, feeds, and is sheltered on or in a different organism while contributing nothing to the survival of its host.
214. **Predator** – An organism that lives by preying on other organisms
215. **Prey** – An organism hunted or caught for food
216. **Carnivore** – Animal that eats ONLY other animals or the remains of other animals
217. **Herbivore** – Animal that eats ONLY plants
218. **Omnivore** – Animal that eats plants AND animals

Energy pyramid – The model that demonstrates relationships among producers and consumer
→→→



Evaporation – When water changes from liquid to gas (water vapor)
219. **Condensation** – When water changes from gas (water vapor) to liquid
220. **Precipitation** – Any water that falls from the sky (snow, rain, sleet, hail)

221. **Behavior** – The way an organism acts towards its environment
222. **Habitat** – Where an organism lives and provides food, shelter, moisture and the correct temperature
223. **Dormancy** – The condition of biological rest or inactivity where growth and development slow way down
224. **Hibernation** - Slowing activity during the winter; especially the slowing of metabolism
225. **Migration** – Instinctive seasonal movement of animals to find food or reproduce
226. **Energy Pyramid** – Diagram that shows the amount of energy available at each feeding level in an ecosystem
227. **Nitrogen Fixation** – Process of changing free nitrogen in the air to a form of nitrogen that plants can use. *Bacteria* live in *nodules* on the roots of legume plants fix the nitrogen
228. **Phototropism** – The tendency of plants (especially seedlings) to grow towards the sun
229. **Tropism** – A plants response to stimulus
230. Phototropism – Plant grows towards the sun
231. Thigmotropism – Plants response to touch
232. Gravitropism – Roots grow towards gravity
233. **Eutrophication** –
    1. Algae grows like crazy due to an excess of needed nutrients. (Animal waste run off, fertilizer, etc.)
    2. Algae bloom blocks out the sun and the plants at the bottom of the lake that need sun die.
    3. Decomposers then multiple like crazy because there is so many dead organisms, they use up all the oxygen in the water.
    4. All of the fish and other water organisms die. (no oxygen in the water for respiration)

234. **Acid Rain** – Rain or snow with a pH below 5.6 that washes valuable nutrients from the soil, leading to the acidification of lakes and ponds and the death of organisms
235. **Air Quality** – A measurement of pollutants in the air
236. **Biodiversity** – The number of different species in an area
237. **Global Warming** – A [illegible] gases in the atmosphere
238. **Ozone Depletion** - The thinning of the Earth's ozone layer due to chlorofluorocarbon (C F C 's)
239. **Soil depletion** – overuse of soil by farming, causing desertification (non-renewable resource)
240. **Producer** – An organism that is able to create its own energy
241. **Consumer** – An organism that consumes nutrients and has to actively seek out its food
242. **Decomposer** – Breaks down anything that is dead or dying
243. **Heterotrophic** – [illegible]
244. **Autotrophic** - Can create its own food (producers)
245. **Abiotic**- Not Alive (*Inorganic*) **Biotic** – Alive *(organic)*
246. **Competition** – The demand by two or more organisms for limited environmental resources, such as nutrients, living space, or light
247. **Cooperation** – Joint operation or action (wolves hunting as a pack)
248. **Niche** – The role of organisms in an ecosystem
249. **Community** – All the populations of different species that live in the same place at the same time and interact with each other.
250. **Population** – A group of the same species living in the same area at the same time.
251. **Ecosystem** – All the living organisms that live in an area and the nonliving features of their environment

Organisms

LEAST SPECIFIC

254. Dear - Domain – The largest categories of organisms base on cell type (Includes Archae, Bacteria, Eukaryota).
255. King – Kingdom – Largest category in each Domain (Includes Animal, Plant, Protista, Fungi)
256. Phillip – Phylum - Animal Kingdom Phyla

Annelids – Segments (Worms)
Arthropods – Exoskeleton (Bugs, Lobsters)
Chordates – Anything with a backbone (Humans, Tigers, Whales)
Cnidarians – Radial Symmetry and Stingers (Jellyfish, Sea Anemone)
Echinoderms – Spikey Skin (Sea Star, Sea Cucumber, Sea Urchin)
Mollusks – Soft Body (Squid, Snails, Clams)

Plant Kingdom includes 4 Divisions:
Mosses – Seedless, Non-vascular (Moss)
Ferns – Seedless, Vascular (Ferns)
Conifers – Gymnosperms - Cones and Needles (Pine Tree)
Flowering Plants – Angiosperms – Flowers (Rose, lily)

257. Came – Class – Phylum is broken down into Classes
254. Over – Order – Classes are broken down into Orders
255. For – Family – Orders are broken down into Families
256. Good – Genus – A group of Similar Organisms. Broken down into species
257. Spaghetti – Species – Organisms that are of the same species can reproduce and make viable offspring

MOST SPECIFIC

→Organisms are named with their Genus and species (Example *Homo sapien*) and it's always in italics. Only the first letter is cap.
← This is called **Binomial Nomenclature**. Also Latin is the language used.

258. **Species Diversity** – Variety of plants, animals, and other organisms

259. **Photosynthesis** – The process that allows plants to turn light energy (Sun) into chemical energy (Glucose). (Endothermic) Think about what you know plants use and what they put out. It is the opposite (chemically speaking) of Respiration.

260. $6\ CO_2 + 6\ H_20 + \text{Light Energy} \rightarrow C_6H_{12}O_6 + 6\ O_2$

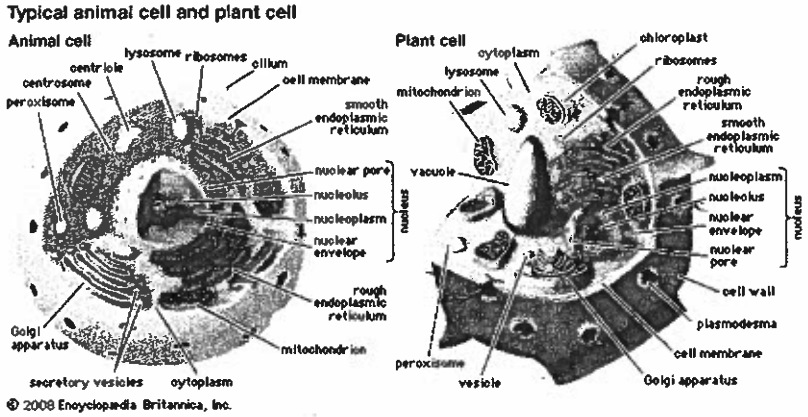
261. **Respiration** – The process that every organisms uses to change Chemical Energy (Glucose) into Energy organisms can use to think, move and live. (Exothermic) It is the opposite (chemically speaking) of Photosynthesis

262. $C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O + \text{Energy}$

263. **Raw Materials – (also know as reactants)** The materials that go into the processes
264. **Products** – The materials that come out of the processes.
265. Think about a cake. **Raw** Eggs, **Raw** milk, and other ingredients (**raw materials**) go into pan. They are baked (**light energy**) and out comes a finished cake (product) that you could potentially sell.
266. **Angiosperm** – A plant that produces flowers and seeds in fruits (apple trees, squash, roses, grasses)
267. **Gymnosperm** – Vascular Plants that do not have protective coverings. (pine tree)
268. **Vascular** – Long, tube like cells in which water and nutrients are transported through
269. **Non-Vascular** – plant group containing mosses. Plants lack vascular tissue and can't transport water and nutrients

CELL ORGANELLES (*Only in plants)

270. **Cell Membrane** – Outer Boundary of the cell that allows only certain materials to pass into and out of the cell
271. **Cytoplasm** – Gel-Like material inside the cell membrane and outside the nucleus
272. **Endoplasmic Reticulum** – Folded membrane that moves materials around in the cell (Transportation)
273. **Mitochondria** or Mitochondrion – Breaks down food and releases energy (Cell Powerhouse)
274. **Nucleus** – Directs all cell activities (the brain of the cell)
275. **Vacuoles** – Storage tanks for the cell (much bigger in plants, but still present in animals)
276. **Lysosome** – Contain chemicals that digest wastes and worn-out cell parts as well as break down food
277. **Ribosomes** – Where all the protein is made
278. ***Cell Wall** – Rigid Structure made of cellulose that supports and protects the plant cell; Found outside cell membrane
279. ***Chloroplast** – Organelles in plant cells that change light energy into chemical energy in the form of sugar (glucose) **- also in some protists like the Euglena**
280. ***Chlorophyll** – Green pigment in plant cells that traps light energy, which is then used to produce food for
    i. the plant cell



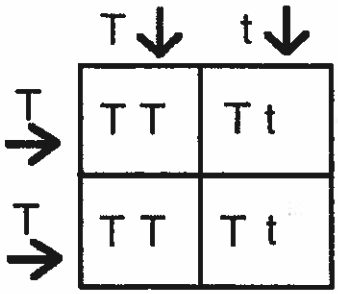
Movement of materials across a membrane

281. **Active Transport** – E[illegible]
282. **Passive Transport** – Movement of a material across a cell without the use of energy (Water does this)
283. **Diffusion** – Movement of molecules from an area where there is a HIGH concentration to LOW concentration (think about water behind a dam and what happens if the dam is taken away).
284. **Osmosis** – Diffusion of WATER into and out of the cell (moves through the cell membrane). Water is moving constantly
285. **Equilibrium** – The state where molecules of a substance are spread out **EVENLY** throughout a space. Equal
286. **Selective Permeability** – The property of a cell membrane that allows some materials to pass through while keeping other materials out. Like the Security guy at the club that only lets the pretty ladies in.
287. **Digestion** – Mechanical and chemical breakdown of food into small molecules that cells can absorb and use
288. **Irritability** – The property of living organisms that permits them to react to stimuli
289. **Metabolism** – Total of all chemical activities of an organism that enable it to stay alive, grow and replicate.
290. **Atom** – the basic unit of **ALL** things
291. **Cell** – The smallest unit of an organism (**living thing**) that can perform life functions
292. **Tissue** – Group of similar cells that work together to do a job. They form Organs
293. **Organ** – Structure, such as the heart, made of up different types of tissues that work together to form systems
294. **System** – Organs work together to form a system such as the digestive system – requires several organs like the stomach, small intestines, brain, etc. Systems form a fully developed Organism.

295. **Endocytosis** – Process by which the cells transport stuff **INTO** the cell
296. **Exocytosis** – Process by which the cells transport stuff **OUT** of the cell

297. **Gene** – Section of DNA one a chromosome that contains instructions for making specific proteins
298. **Genetics** – The study of how traits are inherited through the actions of alleles
299. **Genome** – The entire DNA in one cell of an organism
300. **Genotype** – The genetic makeup of an organism or allele combinations (Ex. Tt, TT, tt)
301. **Phenotype** – The physical trait of an organism that you actually see (Ex. Blue Eyes, Brown Hair)
302. **Heredity** – Passing of traits from parents to offspring
303. **Clone** – an organism that is genetically identical to the organism from which it was produced
304. **Selective Breeding** – Process of selecting a few organisms with desired traits to serve as parents of the next generation (This is why we have tiny dogs or those gross cats)
305. **Mutation** – A [illegible]
306. **Allele** – Each form of a gene; a different form a gene may have for a trait. Two forms are Dominant and Recessive
307. **Dominant** – A trait that always shows up in the organism or covers up another trait
308. **Recessive** – A trait that only shows up in an organism when it is paired with another Recessive trait. Gets overruled by Dominant traits
309. **Heterozygous** – Traits that are opposite (Tt) Think Heterosexual, one girl, one boy
310. **Homozygous** – Traits are the same (TT, tt) Think Homosexual, two boys or two girls
311. **Chromatin** – Heredity material made up of proteins and DNA
312. **Chromosome** – rod-shaped structures made up of condensed DNA that are located in the nucleus of every cell in an organism
    i. **Nucleus** (Inside the cell) → **Cell** → **Chromosome** → **DNA Molecule** → **Nitrogen bases**

313. Punnett Squares



314. [illegible] letters are at the top, put them in the 2 boxes underneath
315. If the letters are on the side, put them in the 2 boxes on the right

316. Remember, each box with a capital letter = 25% chance that the trait will be dominant. Add up the boxes with a capital letter (all of them in this example) and then you will know the % of dominant and % recessive.
317. DOMINANT [illegible] .. DOMINANTALWAYSWI NS.

318. **Adaptation** – Any variation that makes an organism better suited to its environment
319. **Evolution** – Change in inherited characteristics over time
320. **Extinction** – No more Organisms of that species
321. **Fossil** – Remains of once living organisms. This is the main evidence of Evolution
322. **Natural Selection** – Organisms with traits best suited to their environment are more likely to survive and reproduce; includes concepts of variation, overproduction, and competition
323. **Population** – a group of organisms of the same species living in the same area at the same time
324. **Species** – similar organisms that can successfully make babies
325. **Trait** – A genetically determined characteristic or condition
326. **Variation** – Inherited trait that makes an individual different from other members of the same species and results from a mutation in the organism's genes