

MATTER, ENERGY, and the ENVIRONMENT Unit Notes

Name: _____

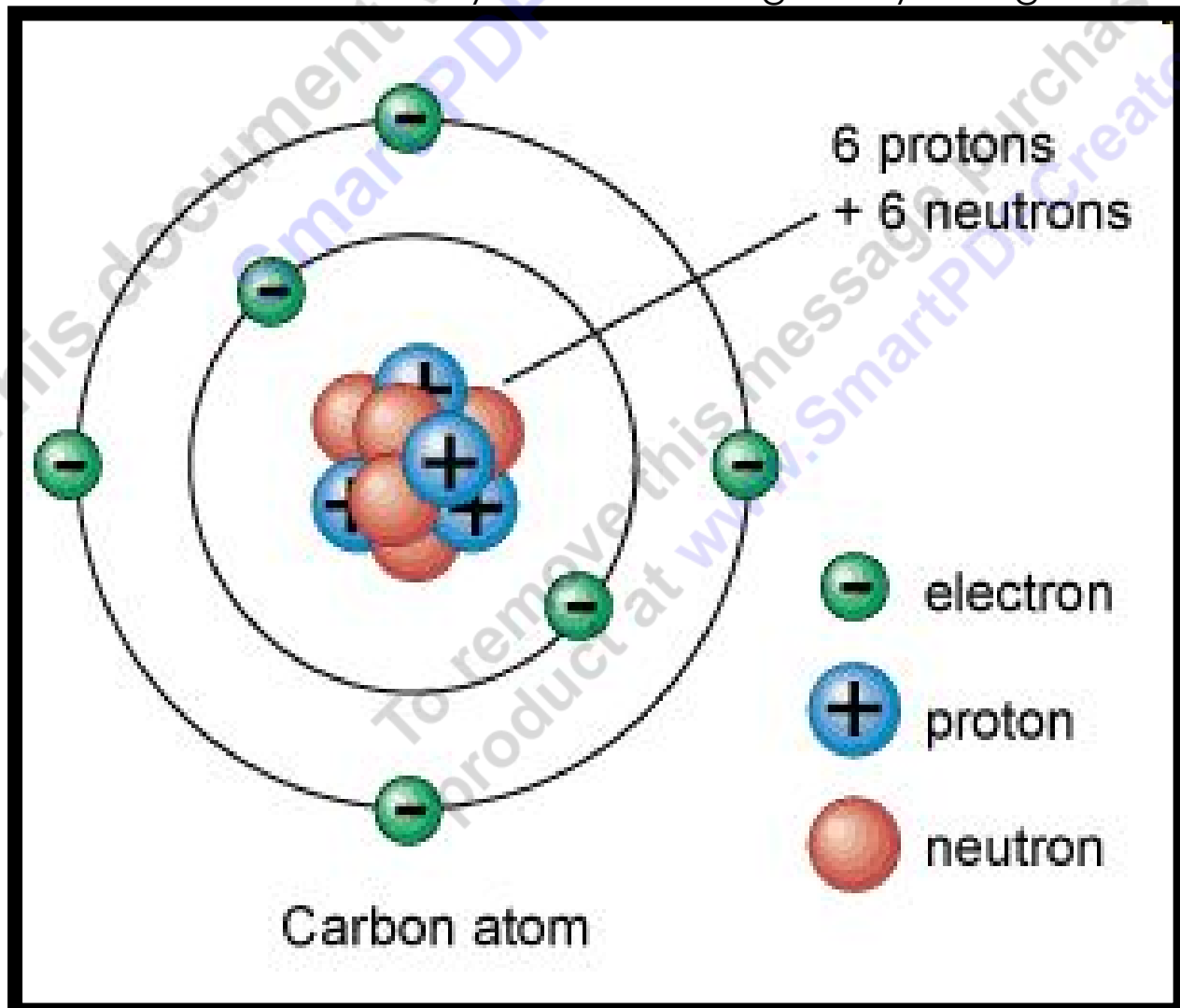
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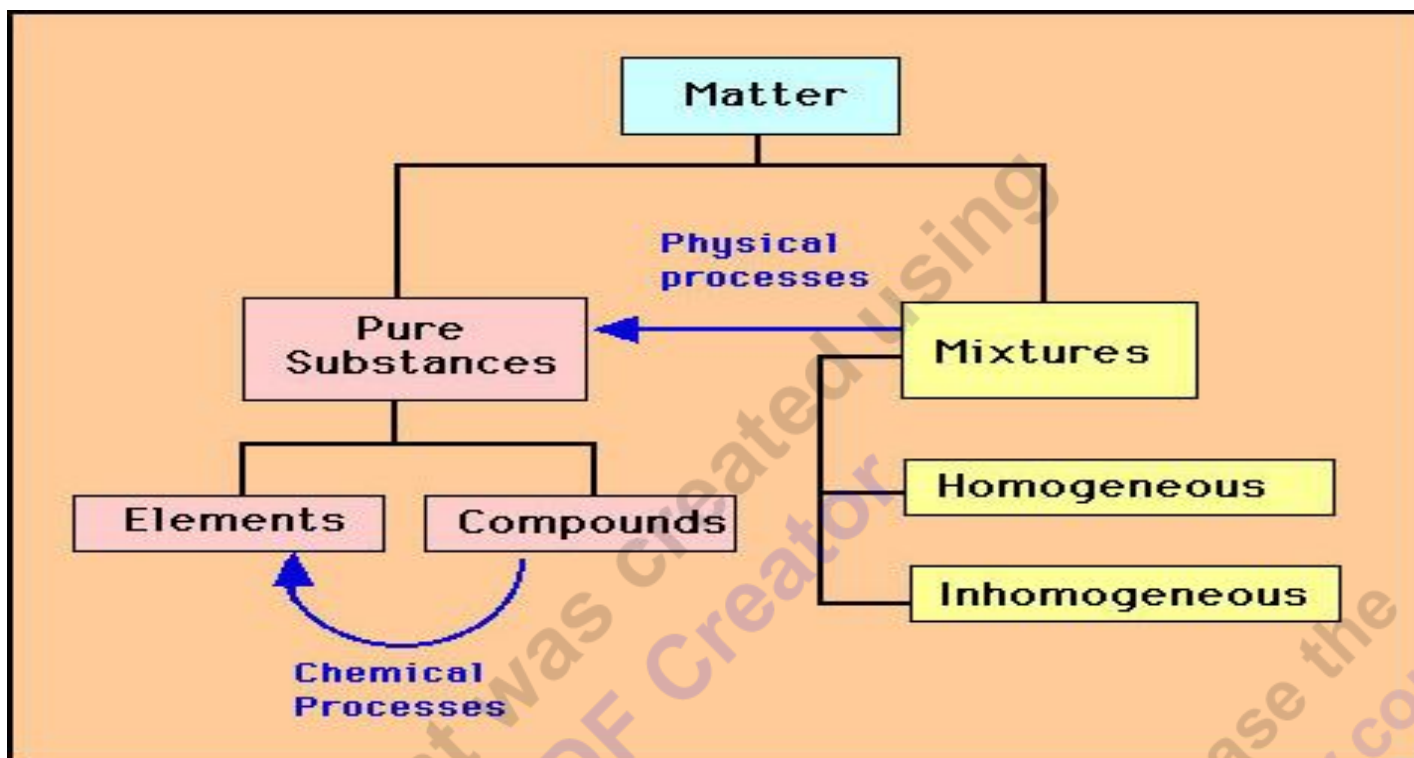
First Area of Focus: Matter

Matter: Anything that has mass and takes up space.



■ **Atom:** A basic unit of matter consisting of a dense, central nucleus surrounded by a cloud of negatively charged electrons.





Element – A substance that is made entirely from one type of atom

Compound – Made up of two or more elements bonded together.

Universal Solvent: Liquid water is able to dissolve a large number of different chemical compounds.

Homogeneous mixture – Same throughout.

Heterogeneous – A mixture of two or more compounds. The mixture is not uniform throughout (Ex. Chicken Noodle Soup)

Solvent – The substance that does the dissolving (usually larger amount) –Water is the universal solvent.

Solute – The substance that gets dissolved (usually lesser amount)

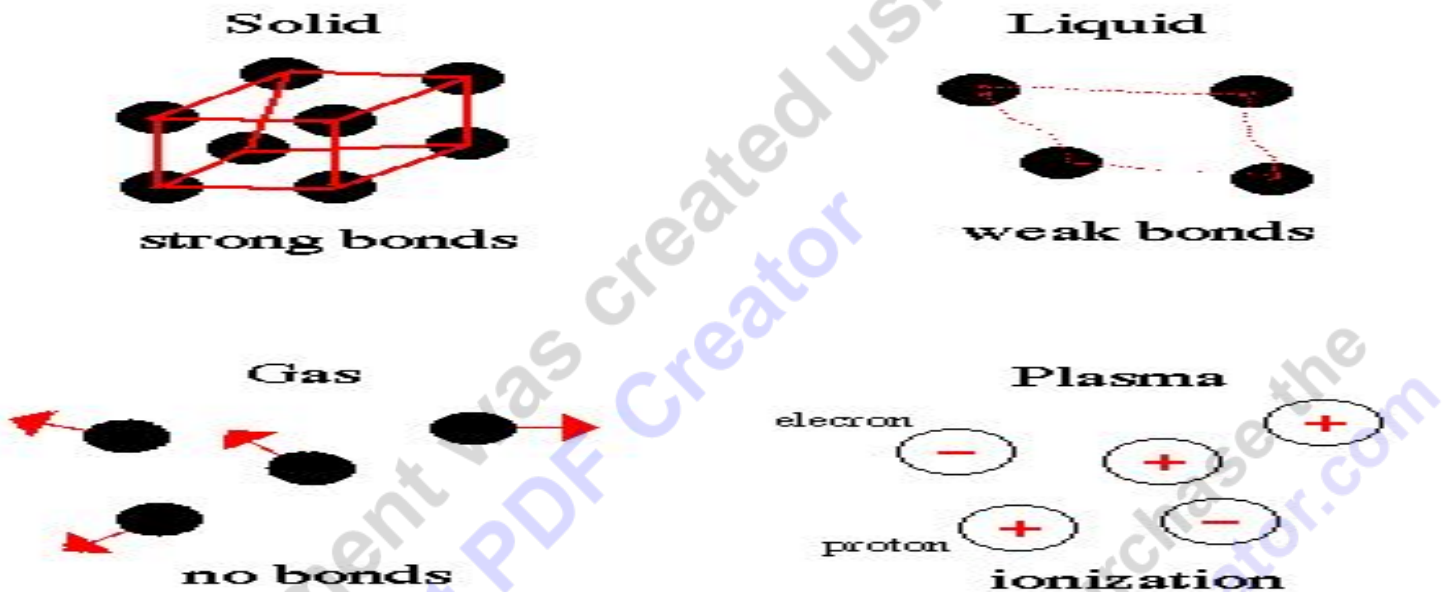
Solubility - How much solute can dissolve in a substance before it becomes saturated.

Supersaturated: When no more solute will dissolve. (crystals visible)

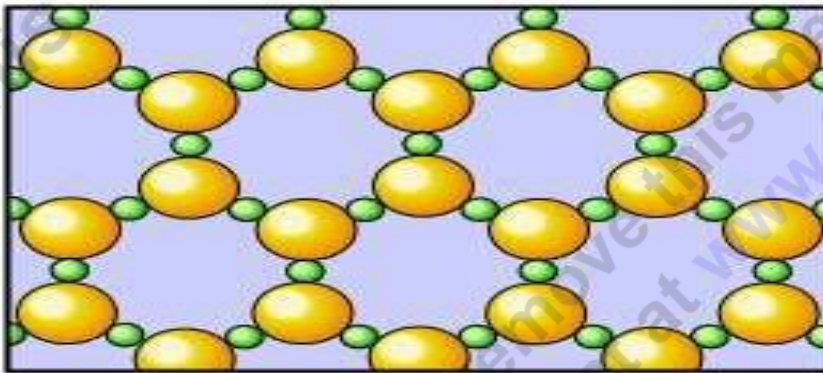
Kinetic Molecular Theory:

- The molecules are in constant motion.
- This motion is different for the 3 states of matter.

States of Matter -

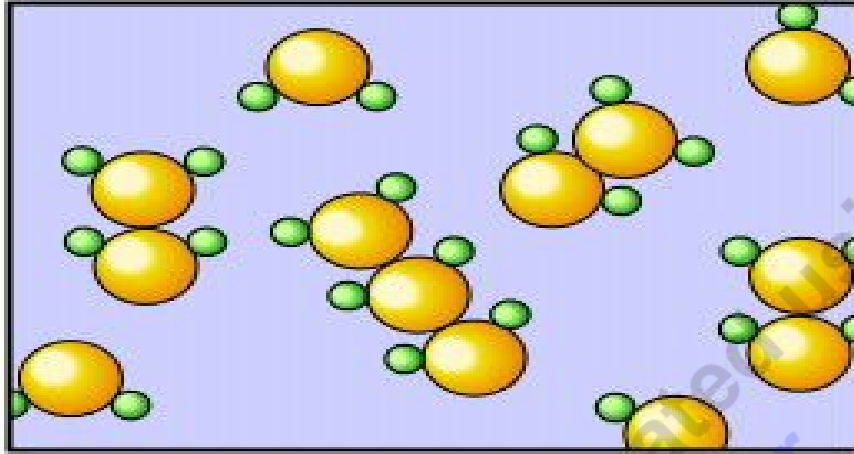


Solid (s) has a definite shape and volume



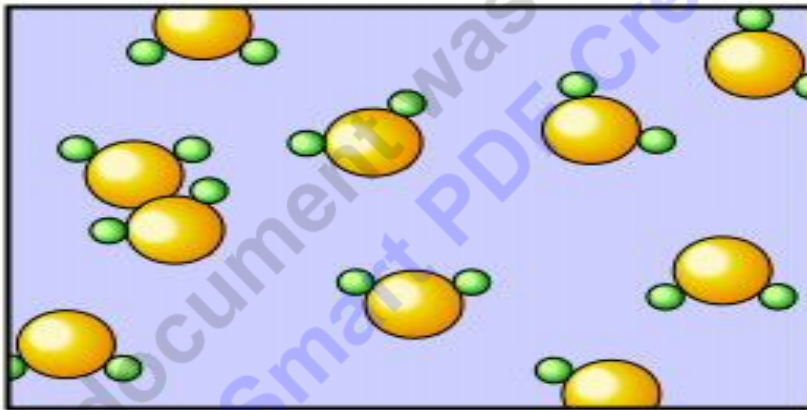
**Ordered
Molecular
Structure of
Frozen Water**

Liquid (l) Definite volume but not shape



**Semi-Ordered
Molecular
Structure of
Liquid Water**

Gas (g) No definite shape or volume



**Random
Molecular
Structure of
Vaporized Water**

Plasma (p) Ionized gas that emits electrons.

Dark Matter – A hypothetical form of matter that is believed to make up 90% of the universe; it is invisible (does not absorb or emit light)

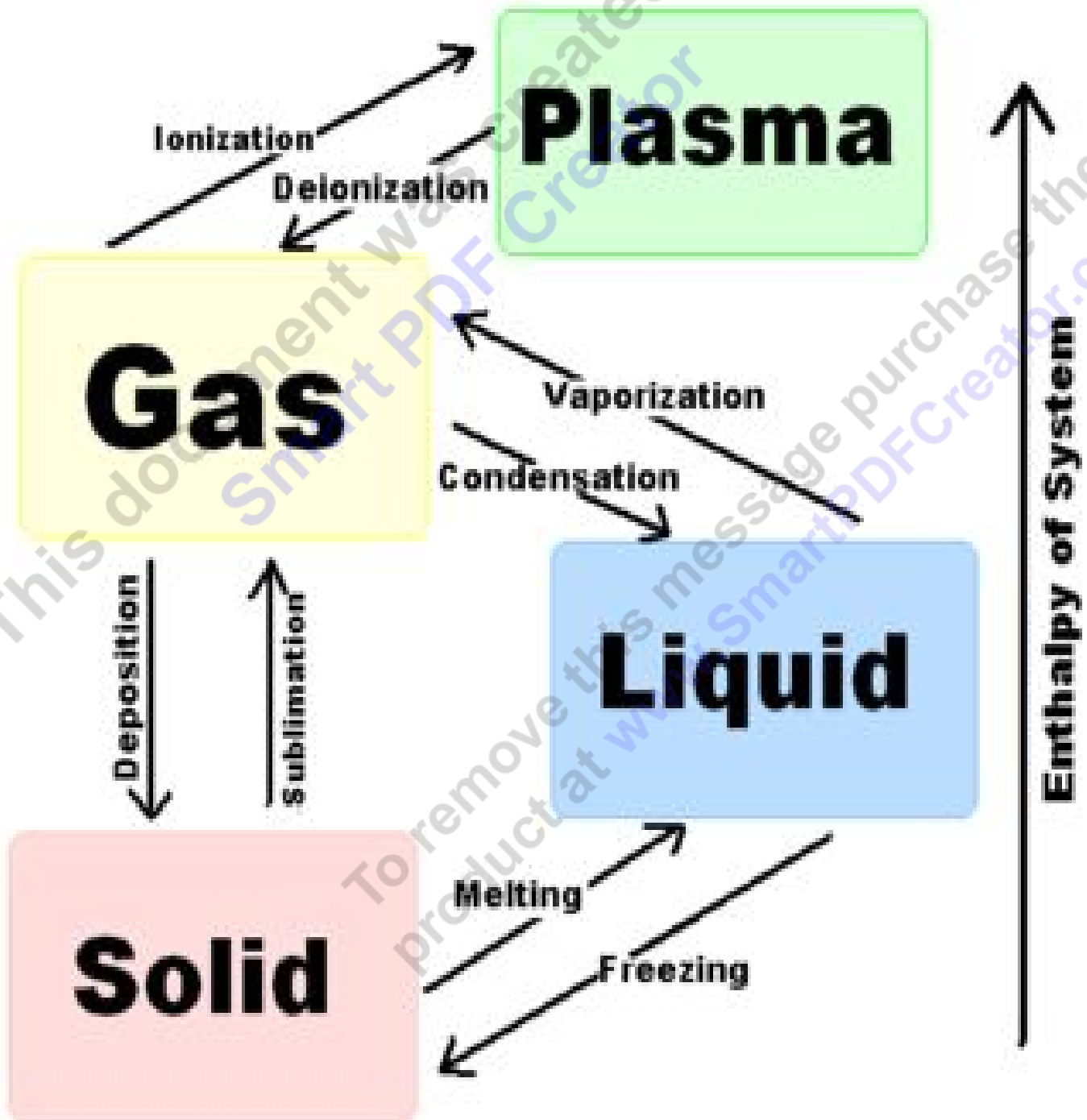
Dark Energy – A hypothetical form of energy that permeates space and exerts a negative pressure, which would have gravitational effects to account for the differences between the theoretical and observational results of gravitational effects on visible matter.

Law Conservation of Matter

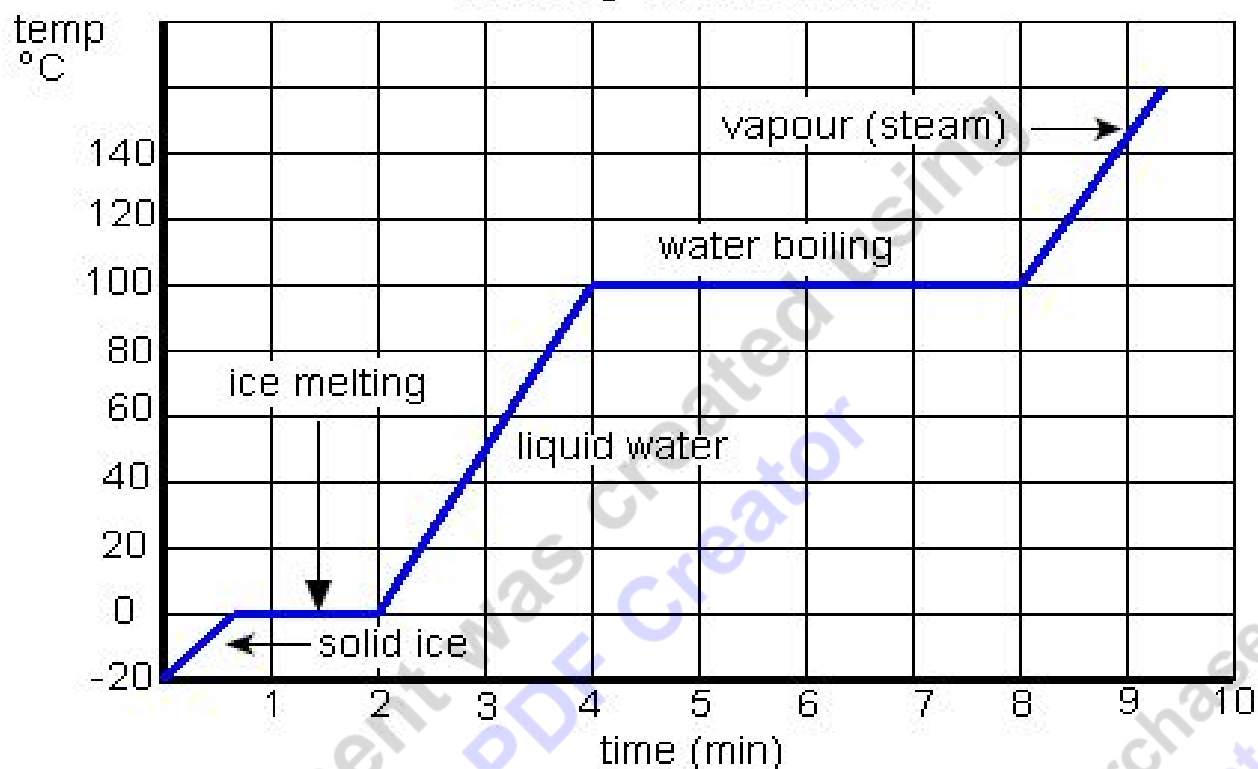
- In any physical or chemical change, matter is neither created nor destroyed but merely changed from one form to another.

Physical Change

- Changes form solid > liquid > gas > plasma
- Doesn't change identity



Heating curve for water



- The effort needed to compress a substance decreases from a S->L->G.

Chemical Change: The change of substances into other substances through a reorganization of the atoms.

The Six Types of Chemical Reactions

- Combustion: When oxygen combines with another compound to form water and carbon dioxide.
 - $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$
- Synthesis Reaction: When two or more simple compounds combine to form a more complicated one. $\text{A} + \text{B} = \text{AB}$
 - $\text{Zn} + 2\text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2(\text{g})$
- Decomposition Reaction: A complex molecule breaks down to make simpler ones.
 - Opposite of Synthesis Reaction. $\text{AB} \rightarrow \text{A} + \text{B}$
 - $2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$ (Electrolysis of Water)

- Single Displacement: When one element trades places with another element in a compound. $BC + A \rightarrow AC + B$
- Double Displacement: When the anions and cations of two different molecules switch places, forming two entirely different compounds.
 - $AB + CD \rightarrow AD + CB$
 - $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$
- Acid / Base: When an acid and base react with each other.

Gases

Charles Law - Volume of a gas increases with temperature.

Avogadro's Law - Equal volumes of gases, at the same temperature and pressure, contain the same number of particles, or molecules.

The ideal gas Law: $PV = nRT$ (pressure times volume equals the number of molecules times the gas constant times temperature).

- P=Pressure
- V=Volume
- n=number of molecules
- R=gas constant
- T=temperature

Pascal's Law states that if you apply pressure to fluids that are *confined* (or *can't flow to anywhere*), the fluids will then *transmit* (or *send out*) that same pressure in all directions at the *same rate*.

■ **Viscosity:** Resistance of liquid to flow.

High viscosity = Travels slow because of high resistance.

Low viscosity = Travels fast because low resistance.

Archimedes Principle: A body that is submerged in a fluid is buoyed up by a force equal in magnitude to the weight of the fluid that is displaced.

Buoyancy: Buoyancy force is equal to the weight of fluid displaced by the body.

New Area of Focus: Energy

THINK TINSTAAFL

- There
- Is
- No
- Such
- Thing
- As
- A
- Free
- Lunch

Energy comes from somewhere – nothing is free.

Law Conservation of Energy:

Energy cannot be created or destroyed but can diminish in quality from useful to less useful.

The seven forms of energy

- Mechanical (PE+KE)
- Sound
- Chemical
- Electrical
- Light / Radiant
 - o Convection: Vertical circulation in which warm rises and cool sinks. Flow of heat by this circulation.
 - o Conduction: The movement of heat from one molecule to another.
 - o Radiation: Energy that is radiated or transmitted in the form of rays, waves, or particles.
- Heat / Thermal

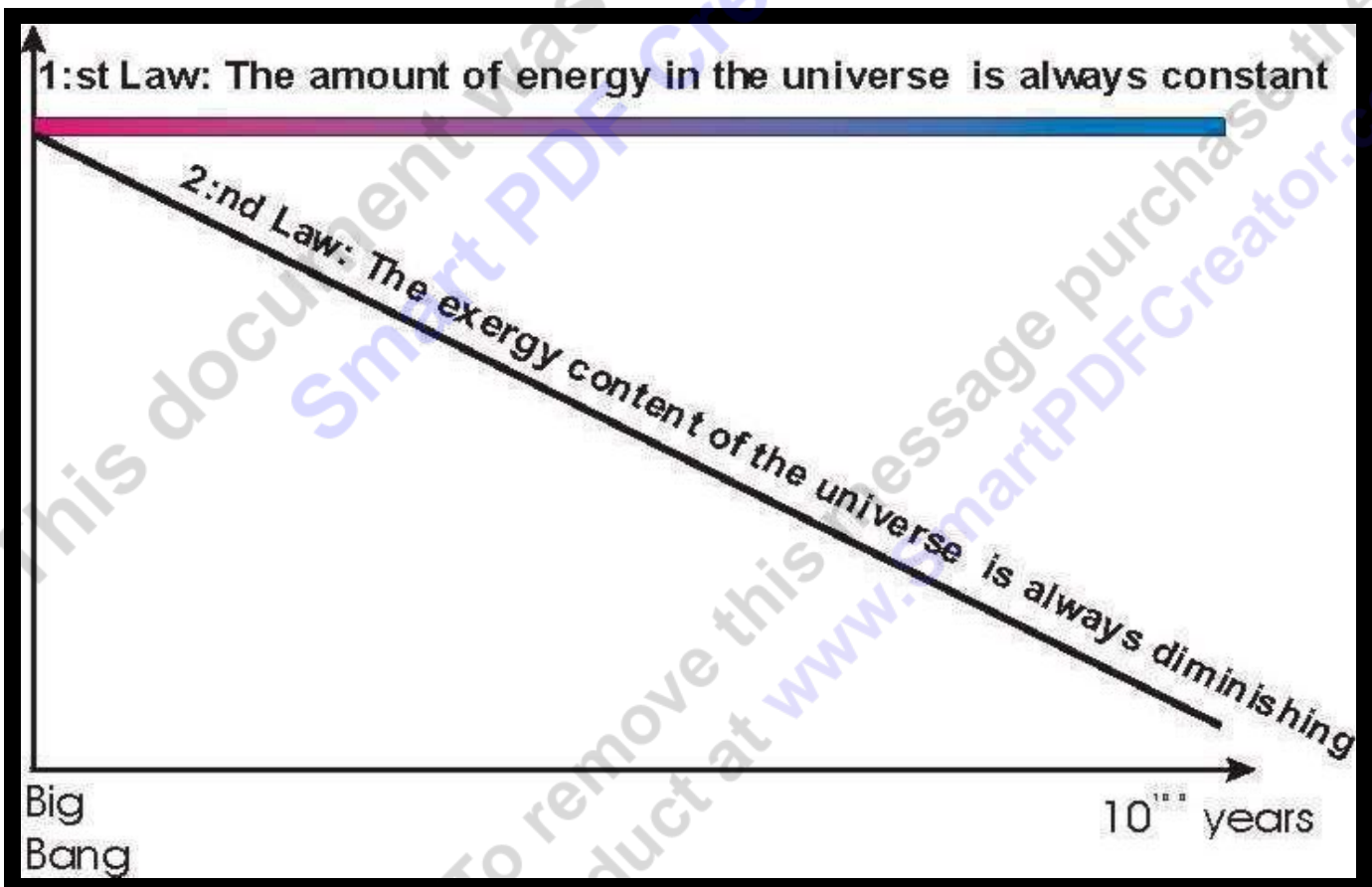
● 1st Law of Thermodynamics

- Change in energy of a system is equal to the heat added to the system minus the work done.
- You can't get something for nothing.

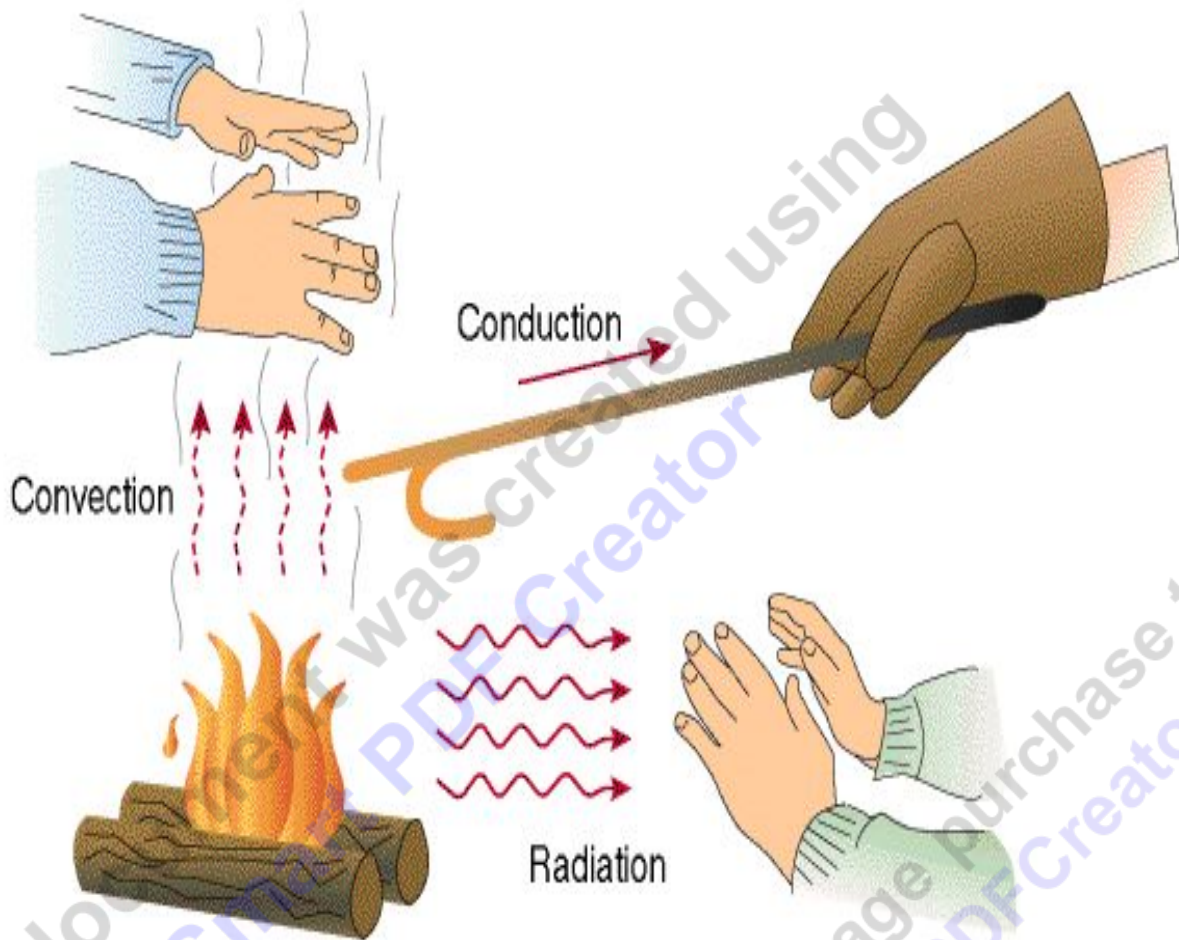
$$\Delta U = Q - W$$

Change in Energy = Heat Added - Work Done

- 2nd Law: The energy content of the universe is always diminishing in quality.
 - Heat Flow -> Warm to cold.



- The third law of thermodynamics: All molecular movement stops at absolute zero.
 - Temperature: The degree of hotness or coldness of a body or environment.
 - Corresponds to its molecular activity.

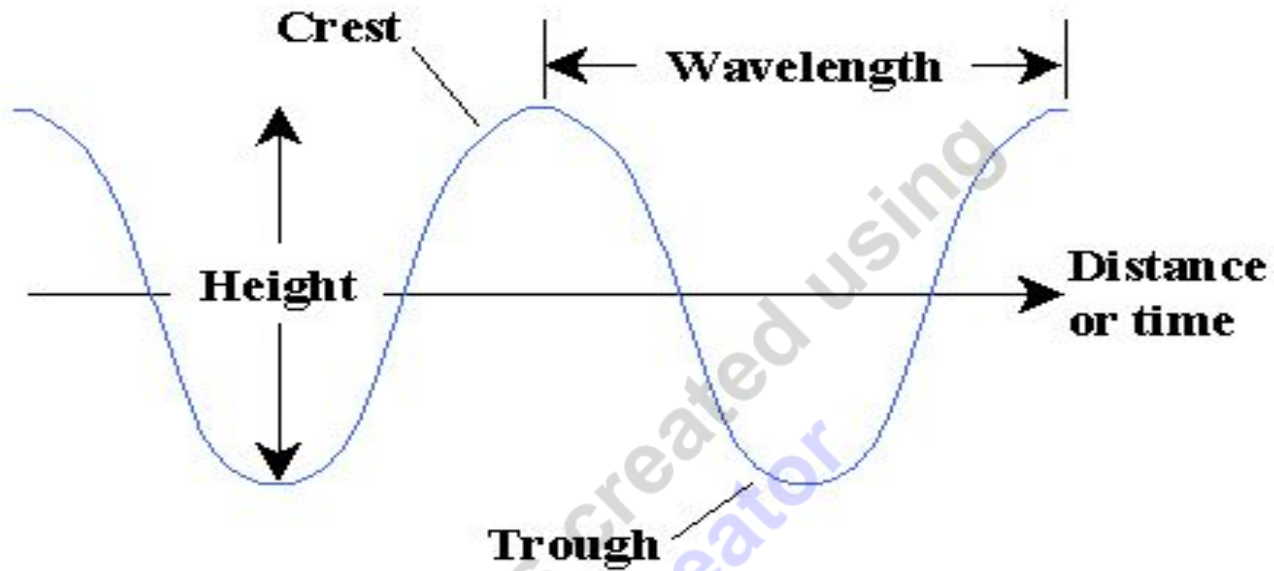


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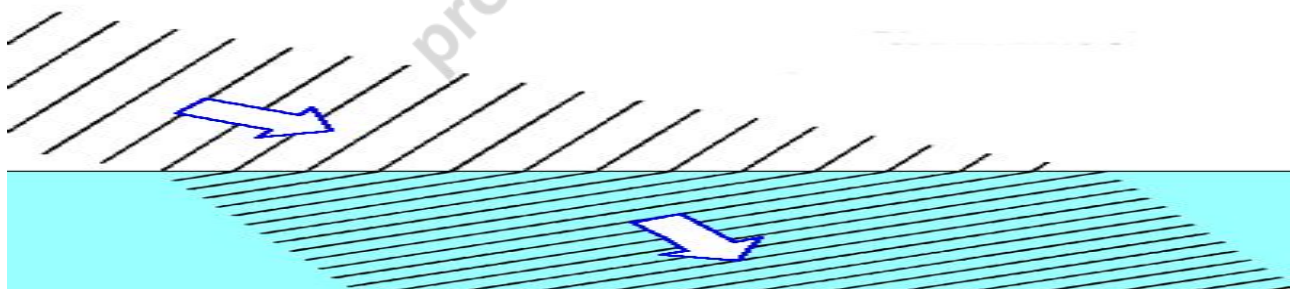
- Nuclear (Another form of Energy)

Nuclear Energy- The energy that deals with the changes in the nucleus of an atom. Nuclear energy is produced when the nuclei of two atoms join together (fusion) or when the nucleus of an atom splits apart (fission).

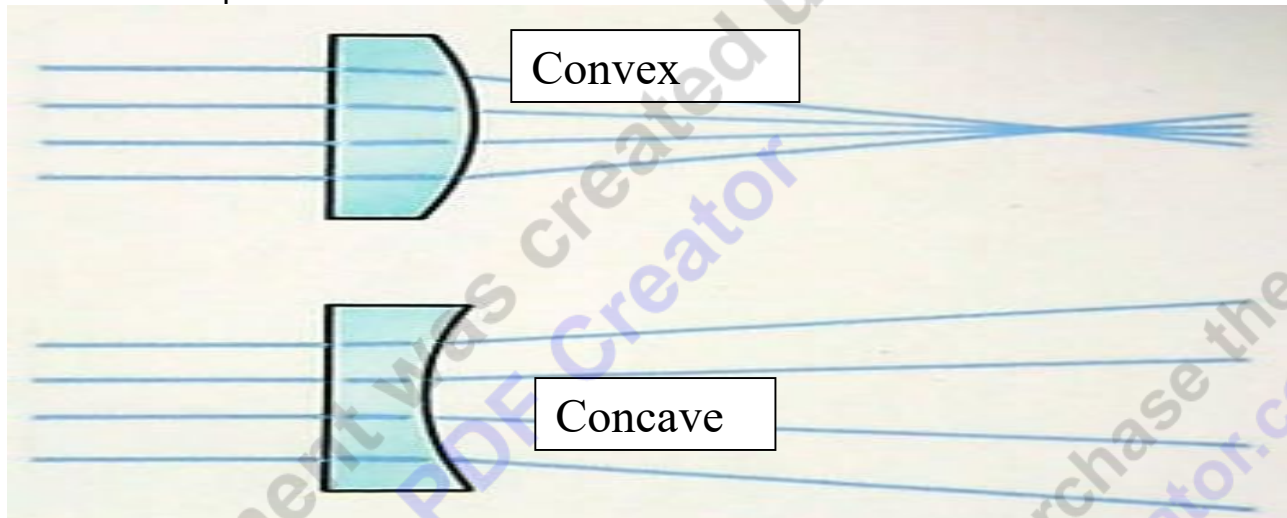
Area of Focus: Waves



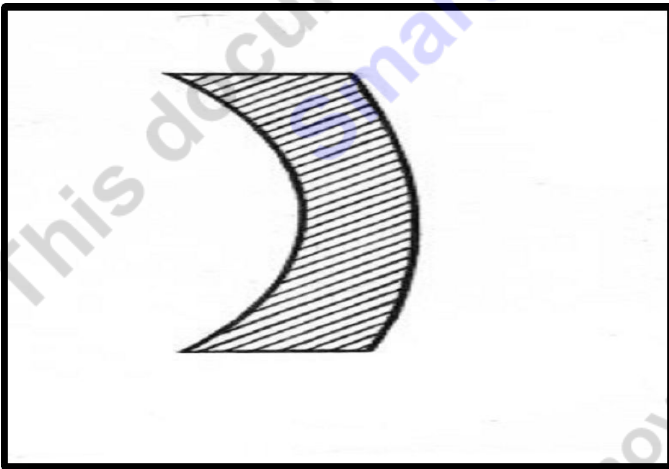
- **A wave:** In physics – A wave is the movement up and down or back and forth.
- The three types of waves:
 - Mechanical Wave: Moves through a medium.
 - Water, Solid, Gas,
 - Electromagnetic Waves: Do not require a medium to move through.
 - Matter Waves: Electrons and Particles.
- Light is a particle and a wave and goes out in a straight line unless it bumps something.
- **Refraction:** The bending of a wave when it enters a medium where it's speed is different.



- **Diffraction:** Bending of waves.
- **Lens:** A transparent optical device used to converge or diverge transmitted light and to form images.
- Convex top / Concave bottom



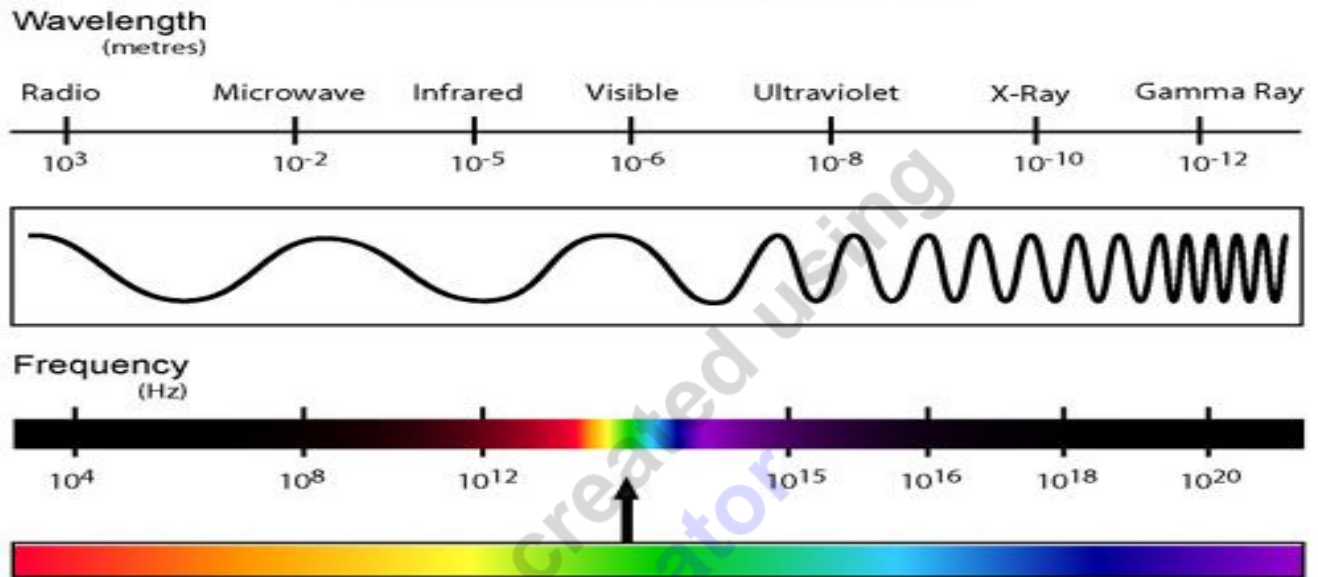
■ Concavo-convex



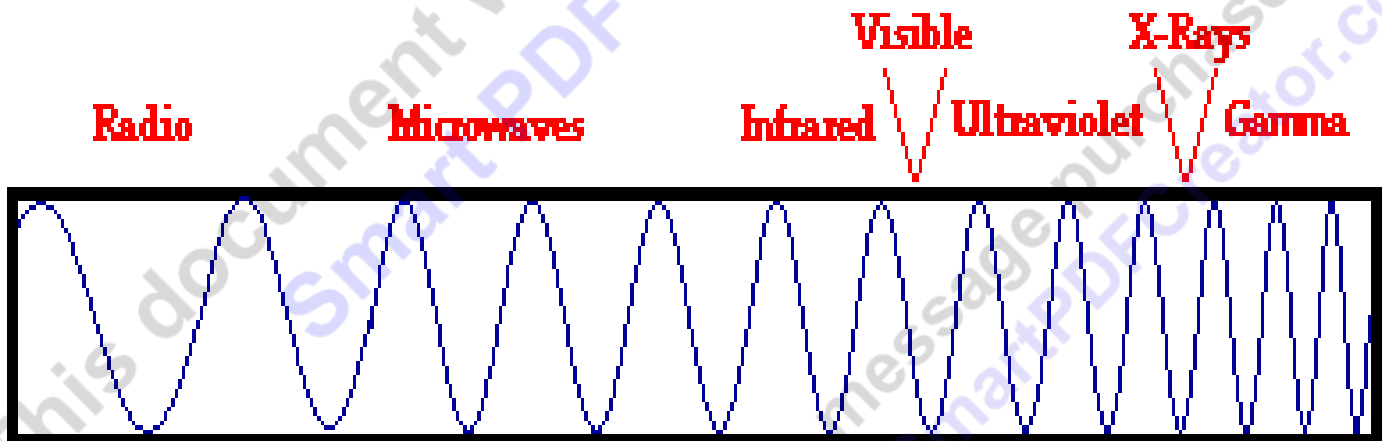
New Area of Focus: The electromagnetic spectrum

- **The Electromagnetic spectrum:** The entire frequency range of electromagnetic waves.

THE ELECTRO MAGNETIC SPECTRUM



- Long waves are less powerful, short are more powerful.



Long λ

Low f

Short λ

High f

- Waves of the electromagnetic spectrum travel at the speed of light. 186,000 miles per second or 300,000 kilometers per second in a vacuum.
 - Visible light measured in lumens.
 - All others are measured in radiation.
- Radiation when it hits something can be...
 - Absorbed
 - Reflected

- Scattered (Diffraction, Refraction)
- Transmitted
- Nothing, it missed.
- Temperature of an object relates to the amount of radiation released.
- The hotter, the more radiation released.
- **Radiowaves**: Longest wave in the spectrum, size of a football field. Not very powerful.
- **Microwaves**: Waves with wavelengths ranging from 1 m down to 1 mm.
- **Infrared Radiation**: Wavelengths between microwaves and visible light. (heat)
- Visible light consists of...

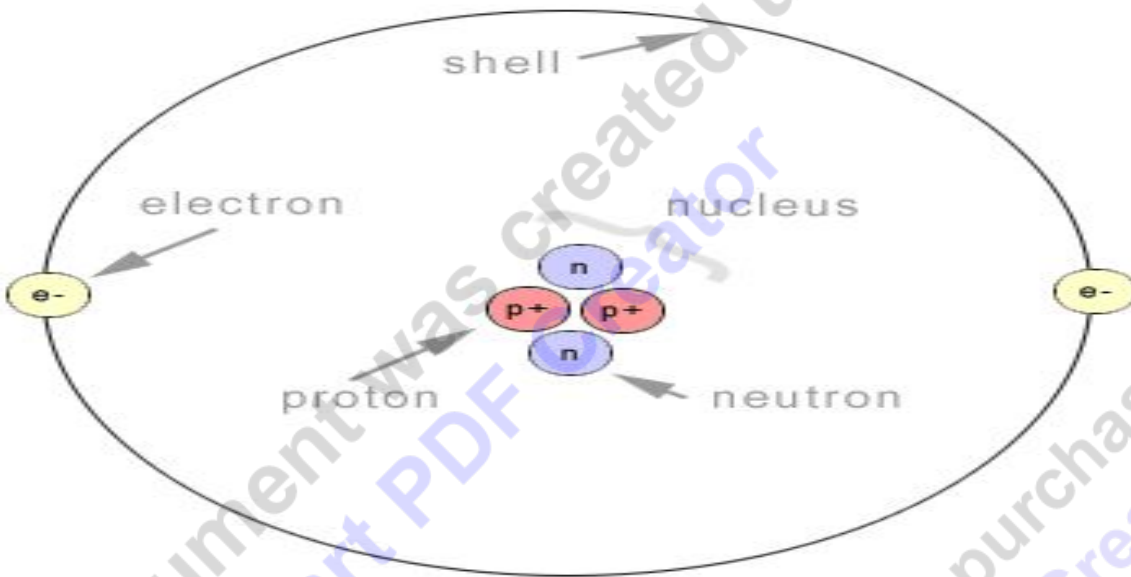


- **Ultraviolet (UV)** - Has shorter wavelengths than visible light. – thus it more powerful than visible light.
- **Ultraviolet (UV)** has many wave lengths as well. All of which can cause cancer.
 - UVA
 - UVB
 - UVC
- **X-Rays**: They have smaller wavelengths and therefore higher energy than ultraviolet waves.
- **Gamma ray**: Highest energy, shortest wavelength. Emitted during radioactive decay of a fission product.
- **Laser** - Light Amplification by Stimulated Emission of Radiation.

- Lasers cross over many parts of the EM scale.

Electricity: Electricity is related to charges, and both electrons and protons carry a charge.

The Atom



Lightning is a big spark that occurs when lots of electrons move from one place to another very quickly. Unequal distribution of electrons.

Static Electricity: The imbalance of positive and negative charges.

Magnetism

Electric Fields: The funky area near any electrically-charged object

- replace electrostatic for funky.

Coulombs Law:

- The greater the charges, the greater the force.
- The greater the distance between them, the smaller the force.

Current is a flow of electrons, or individual negative charges

Conductors, Insulators, Semi-conductors: How easily energy is transferred through the object by moving charge.

Conductor: Electrons flow easily, semi flows in the middle.

Semi-conductor: Conductivity between conductor and insulator (electronics use)

Insulator: Electrons do not flow easily

There are two main kinds of electric current, direct current (DC) and alternating current (AC).

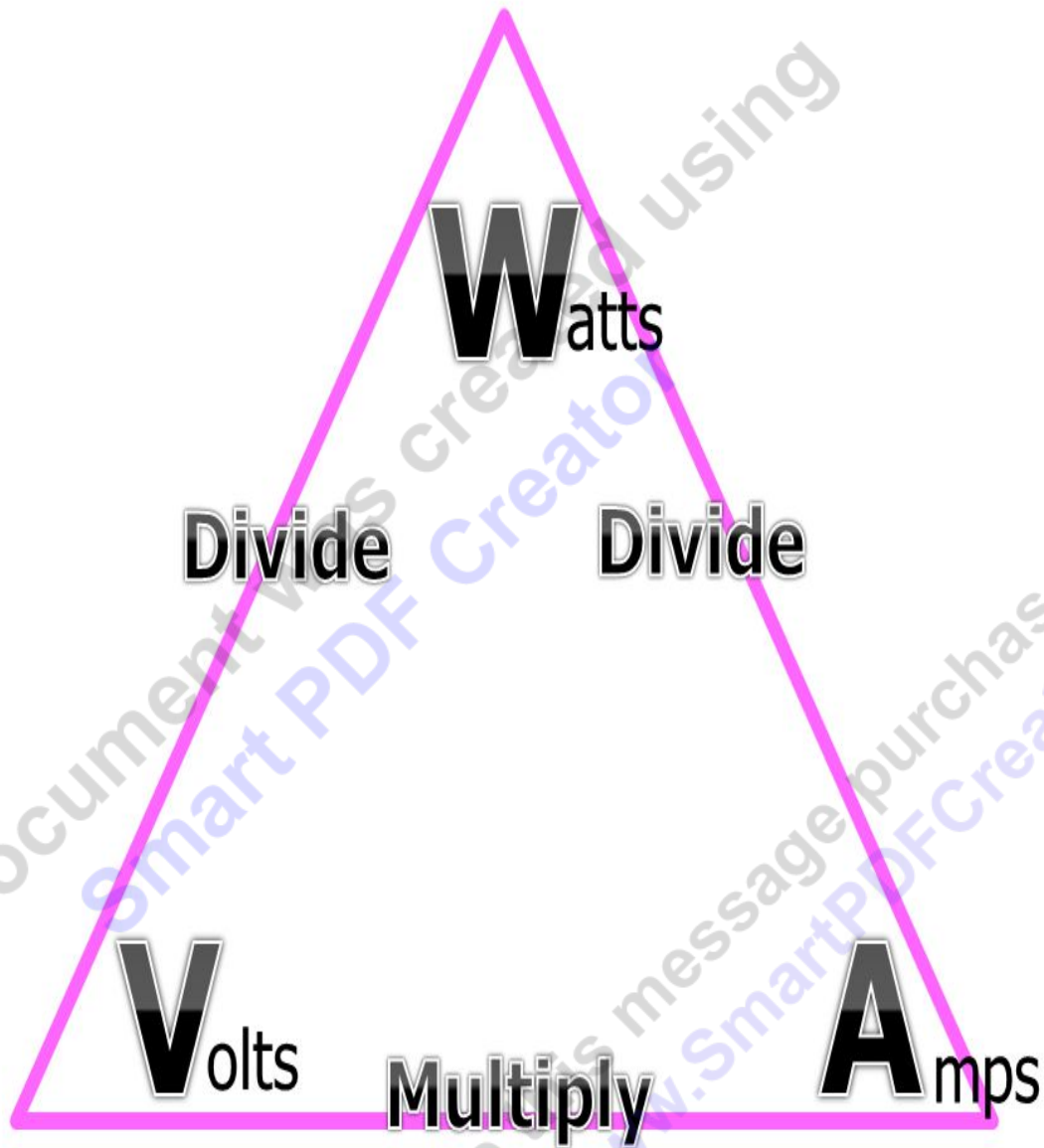
- (DC) Direct current is a flow of charge always in one direction. (Batteries)
 - (AC) -Alternating current is a flow of charge back and forth, changing its direction many times in one second. (Plugs and outlets / household)
- Volts are a measure of the force or pressure under which electricity flows.
 - Amps are a measurement of the current flow rate of electrons
 - Watts is a measurement of electrical power created.
 - 1 watt is equal to one joule of energy per second.

Volt: A measure of the force or pressure under which electricity flows.

Ampere: How much current moves through a wire in one second is measured in amperes. Basically, the larger the size of wire, the greater the ampere capacity.

Watt: The amount of electricity consumed per second is measured by what are called watts, calculated by multiplying volts times amps. Most household electrical usage is billed in kilowatt hours, or the amount of hours times 1,000 watts.

Electrical Current Conversion Triad

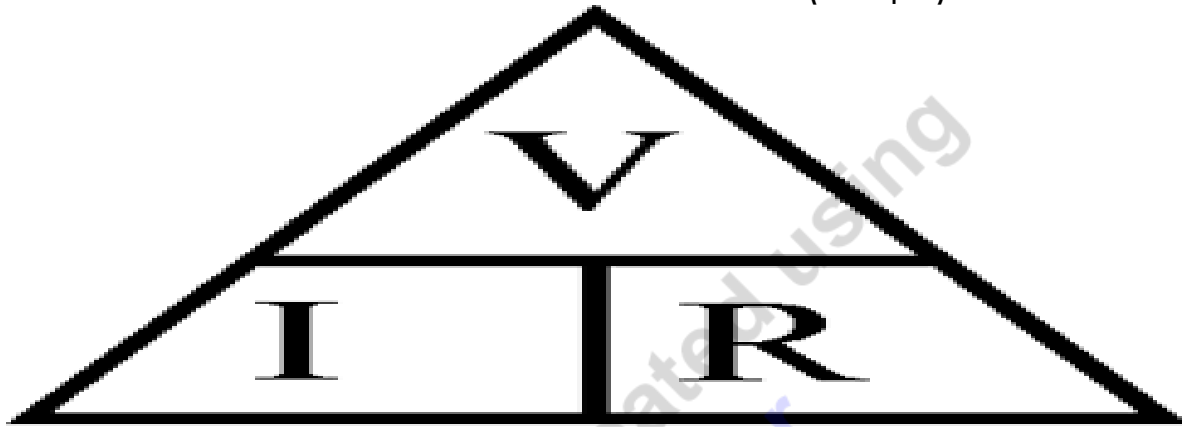


Resistance: Anything in an electrical circuit that impedes the flow of current is referred to as resistance. (ohms) Ω

Ohms Law

$$I \text{ (amps)} = \frac{V}{R \Omega}$$

V = Volts, R = Resistance Ω , I = Current (amps)



Magnetism

A **magnet** is an object or a device that gives off an external magnetic field.

Faraday's Law: The changing of a magnetic field can create voltage.

Electromagnets: By running electric current through a wire, you can create a magnetic field.

Compass: A navigational instrument for determining direction relative to the Earth's magnetic poles.

- New Area of Focus: Relativity, Einstein, and $E=MC^2$

General Relativity is a theory of the structure of spacetime.

- Time slows down with increased velocity.

Special Relativity:

- The laws of physics are equally valid in all frames of reference moving at a uniform velocity.
- The speed of light from a uniformly moving source is always the same, regardless of how fast or slow the source or its observer is moving.

E=MC²

- E = Energy (Joules)
- M = Mass
- C = Speed of Light in vacuum
 - 300,000,000 meters per second (really 299, 792,458)

Almost all of the energy on earth comes from our sun.

Energy

- The ability to work
- To cause something to move/change
- Energy is transferred but not destroyed
- Energy is lost in quality due to friction/force/heat

First Law of Thermodynamics: Energy can be transformed (changed from one form to another), but it can neither be created nor destroyed.

2nd Law of Thermodynamics: The energy content of the universe is always diminishing in quality. Heat Flow -> Warm to cold.

3rd Law of Thermodynamics: All molecular movement stops at absolute zero.

New Area of Focus: The Environment

Environmental Science / Studies

Environmental science is the study of interactions among physical, chemical, and biological components of the environment.

Environmental studies is the systematic study of human interaction with their environment.

Ecocentrism: Believing the ecosphere, rather than any individual organism, is the source and support of all life.

The 4 R's

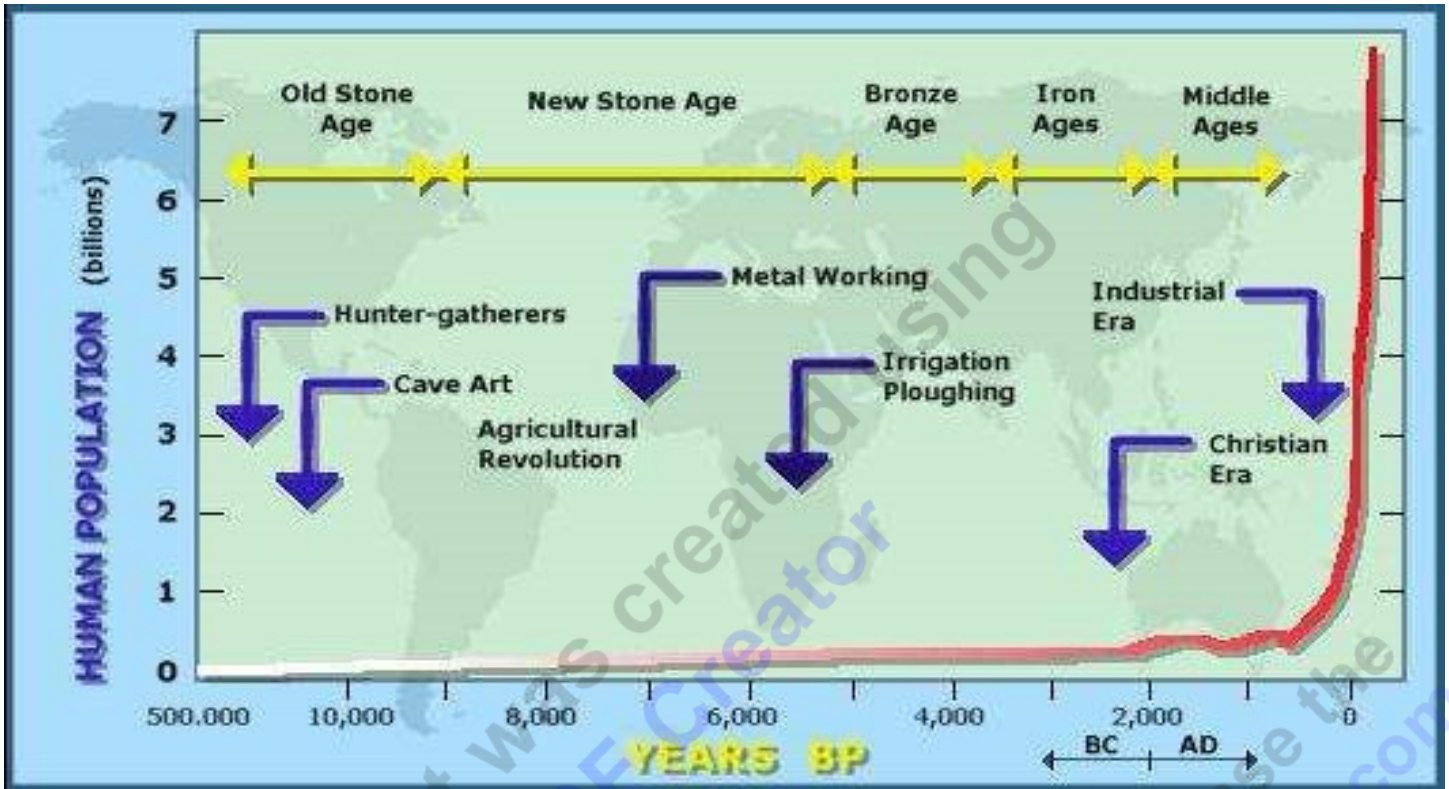
- Reduce
 - Our stuff becomes harmful waste
- Reuse
 - So we can reduce
- Recycle
- Last because it uses energy and TINSTAAFL
- Rethink: Reinvent everything with the R's in mind.

Frugality: is about getting the maximum value for your dollar while living.

- Strategies of frugality: reduce waste, curb expensive habits, be happy with less, don't be materialistic.*

Sustainability: Meeting the needs of the present without compromising the ability of future generations to meet their own needs.

Human Population Growth



Anthropogenesis: humans shaping their environment.

Fossil fuels are borrowed light: The energy rich organic matter from millions of years ago.

Carrying Capacity: the amount of food that an area of land will yield and, therefore, the number of people that an area of land will support.

Megalopolis: A very large urban complex usually involving several major cities and towns.

Forms of renewable energy

- Hydropower.
- Damless Hydropower.
- Ocean thermal energy conversion.
- Wave Energy.
- Tidal Energy.
- Wind.
- Solar Chimney.
- Solar Thermal.

- Liquid Biofuels.
 - Vegetable oils
 - Ethanol
 - Biobutanol
 - Sweet Sorghum (food and fuel)
- Solid Biofuels.
 - Wood
 - Manure
 - Crop waste
 - Biogasification
- Biogas.
 - Digesters that produce flammable gas.
 - Algae as a fuel source.
- Nuclear (kind of clean / renewable)
 - Nuclear waste needs to be stored away forever.
 - Nuclear material is not an abundant resource.

ECOFRIENDLY CONSTRUCTION

With 32 "green" buildings, Seattle has become a leader in environmentally sensitive building and design. Green construction aims to reduce pollution and reduce dependence on power plants and logging.

► GREEN ROOFS:

A thin layer of plants and soil on rooftops provides insulation, reduces stormwater runoff, absorbs carbon dioxide and creates oxygen.

► ALTERNATIVE ENERGY:

Roof-mounted wind turbines and solar panels reduce need for outside energy sources.



► WINDOWS

Windows and skylights provide natural lighting and heat. Glazed or double-paned windows provide insulation.

► WATER EFFICIENCY

Cisterns collect rainwater to use for landscaping irrigation. Low-flow, waterless or composting toilets help reduce water use.

► **VENTILATION:** Vents and operable windows assist in heating and cooling by circulating air better.

► **BUILDING MATERIALS:** Recycled building materials reduce waste. Building with certified lumber helps protect forests and using non-toxic paints and carpets creates a healthier interior space.

Source: P-I reporting

SEATTLE POST-INTELLIGENCER

Five Elements of Passive Solar Design



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