FINAL EXAM REVIEW GUIDE

The nature of science

Scientific Method – organized set of investigative procedures necessary so that the results of an experiment are considered valid.

1. **State the problem**
2. **Gather Information**
3. **Hypothesis** – possible explanation, needs to be tested.
4. **Experiment** – tests the effect of one thing on another.

   Independent variable – changed by the experimenter

   Dependent variable – changed because of independent variable

   Constant – part of an experiment that does not change

   Control – set up that does not contain the variable; used to compare to the test results.

   Exclude **Bias** – avoid having expectations

5. **Observations** – gathered DATA from an experiment by using **senses** or tools.
6. **Conclusion** – using Data to make a statement of whether or not the **hypothesis was correct or supported**.

Theory – **explanation** of things or events based on many observations and investigations.

Scientific Law – statement or **rule** about what happens. Always seems to be true.

Length – distance between 2 points.

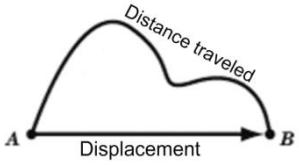
Mass – amount of matter. Measured in grams

Volume – amount of space an object takes up

Temperature – measure of the energy of motion of the molecules

SI units used to measure can be found on your reference table.

Motion

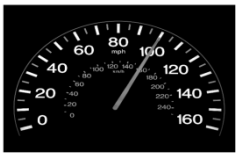


Motion – change in position as compared to a frame of reference.

Distance – how far something traveled, something is its actual path distance and direction

Displacement – how far from its starting point,

Speed – rate of change of position



Constant speed – speed that does not change

Instantaneous speed – speed at a moment in time.

(ex. A car speedometer tells instantaneous speed)

Average speed - $\frac{\text{total distance}}{\text{total time}}$

Velocity – speed in a direction. (ex. 10 meters/sec North)

Acceleration – rate of change of velocity. $\frac{Vf-Vi}{time}$ *Final velocity-Initial Velocity/Time*

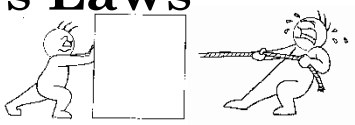
-Acceleration occurs when there is a **change speed OR change direction** Example: a racecar driving in a circle at a constant speed is still acceleration because the direction is changing

Positive acceleration – speeding up, going faster.

Negative acceleration – slowing down, going slower.

Friction opposes motion

Forces & Newton's Laws



Force is a push or a pull

Balanced forces - equal forces in opposite directions. Net force = zero

- no acceleration, motion maintained

Unbalanced Forces cause acceleration in the direction of the net force

Net Force – the total of all forces on an object. **Friction** - a force that opposes motion.

Balanced forces – forces that are equal and in the opposite direction

25N→←25N 15N↔15N

*****Net force = zero, no *change* in motion or no acceleration**

Unbalanced force – **causes acceleration** (change velocity), net force is in the direction of the acceleration.

25N→←12N Net force is 13N→ therefore, Acceleration is →

Momentum (p) – the force needed to stop an object in motion **p=mv**

Law of Conservation of Momentum – momentum can be transferred from one object to another but never lost.

Newton's 1st law:

Inertia - objects resistance to a change in motion

- An objects motion will remain the same unless acted on by an unbalanced force.

- Amount of inertia **depends on mass**

Acceleration is the rate of change of velocity

Newton's 2nd Law of Motion: Force = mass(acceleration) F = ma

Mass – the amount of matter in an object. **Weight**- the force on an object due to gravity

Force of gravity

- attractive force between objects with mass (mass = amount of matter in an object)

- all objects have gravity
- the amount of gravity **depends on the mass** of the objects and their **distance** apart
- causes **weight** which is measured in Newtons
- decreases with distance (weigh less the farther you are from the center of earth)

Acceleration of gravity (g)

- is **equal for all objects** regardless of mass
- **9.8 m/s²** on earth

Newton's 3rd Law: action/reaction

- for every action, there is an equal and opposite reaction
- Demonstrated when stepping forward off of a boat, causes the boat to push backwards

Energy

Energy is the ability to cause change (do work) and is measured in **Joules** (j).

Energy does not have to involve motion, work does.

Kinetic Energy (KE) – energy of motion.

KE = ½ (mass)(velocity²) More mass = more energy More velocity = more energy

Potential Energy (PE) – stored energy.

PE= (Mass)(Gravity)(Height) P= mgh More mass = more energy More height = more energy

- **Elastic Potential** – stored in things that stretch or compress
- **Chemical Potential** – stored in chemical bonds in substances like **gasoline or food**
- **Gravitational Potential** (GPE) – energy of position, based on the objects height above the ground

Mechanical Energy = Kinetic Energy + Potential Energy

Law of Conservation of Energy – Energy *cannot* be created or destroyed.

Falling objects convert potential energy to kinetic energy

Friction – converts some kinetic energy into thermal energy

Combustion Engine – converts chemical potential energy into kinetic energy by burning a fuel, causing it to heat and expand, producing motion (KE).

Generator- Coverts chemical potential energy into electrical energy

Nuclear Energy – changes mass in to energy

Fission – atoms split**,** energy is released **Fusion** – atoms join, energy is released

Thermal Energy- Converting energy into heat

Electromagnetic Energy- Energy transferred in waves

Electricity

Static Electricity (not flowing) is due to an **accumulation of electric charge** on an object. Electric Charge is detected with an **electroscope**.

Law of conservation of charge states that electric charge cannot be created or destroyed but can only be transferred from one object to another.

Electric Force - surrounds every electric charge and exerts a force that either attracts or repels other electric charges

Opposite charges **attract**. **Like** charges **repel**.

Conductors allow the **passage** of electrons easily. Ex. **Metals** such as copper or silver or gold
Insulators are materials in which electrons are **not able to move** easily. Ex. Rubber or glass.

Charging methods: charge by **contact** or charge by **induction** (coming near a charge)

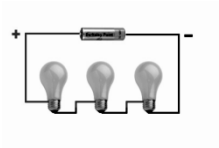
Voltage difference is the **force** that pushes electrons. **Measured in volts** (the energy behind an electron)
Current is the **flow** or net movement of electrons. **Measured in Amperes (amps)** (the number of electrons)
Resistance opposes the **flow** of electrons. **Measured in ohms.**
More resistance = Less current

Conductors have a low resistance. Insulators have a high resistance.

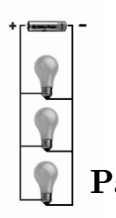
Ohms law relates voltage, current and resistance. **Volts = current x resistance**

Circuits

Closed circuit is a path for electric current to flow.
Open circuit is an incomplete path - does not allow current.



Series



Parallel

Series Circuit has only **one path** for the current.
Parallel circuit has **more than one path** for the current to flow.

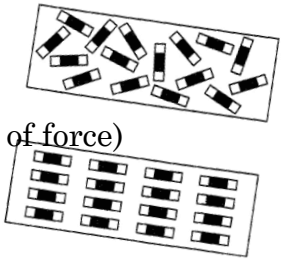
Sources of Electricity

Generators provide **alternating current (AC)** – the positive and negative poles switch. USA's power supply switches 60 times/sec. Measured in hertz. (60Hz)

Be sure to know the following units and the properties associated with each unit:
Volts, Amps, ohm, watt, kilowatt hours

Magnetism

Magnetic Field is the region around a magnet where the **force** acts.



- **Magnets have aligned magnetic domains**
- Iron, cobalt or nickel can be **magnetized by magnetic induction**.
- Magnets apply a **force** which is **strongest at the poles** (closer lines of force)
- **Like** poles **repel** **Opposite** poles **attract**

Types of Magnets

Natural magnets – lodestone and magnetite
Objects that keep their magnetic properties for a long time are **permanent magnets**

Current through a wire **produces a magnetic field** around the wire. Coil the wire to concentrate the field

An **Electromagnet** is a coil of wire wrapped around an iron core. A **solenoid** is missing the iron core ** Electromagnets can be turned on or off or have their poles reversed by reversing the current in the coil.**

More coils = greater field **More current in the wire = greater field**
Reverse the **current** = **Reverse** the **field** **No current = no magnetic field**
Electromagnets are temporary magnets

Galvanometer : an electromagnet surrounded by permanent magnets that **measures** the **current** in a wire.

Producing Electricity

Electromagnetic Induction – moving a coil of wire through a magnetic field produces a current in the wire.

More coils of wire = **more current** **Stronger** magnetic **field** = **more current**
Reverse the direction of the **movement** of the coil = **reverse** the **current**

A **generator** changes **mechanical energy into electrical energy**.
Generators spin a coil of wire therefore they produce **alternating current** (AC)

Transformers – change voltage.

Step-up transformer **increases** the **voltage** (high voltage will travel farther in thinner wire)

Step-down transformer **decreases** the **voltage** (low voltage has less push – is safer)

Waves

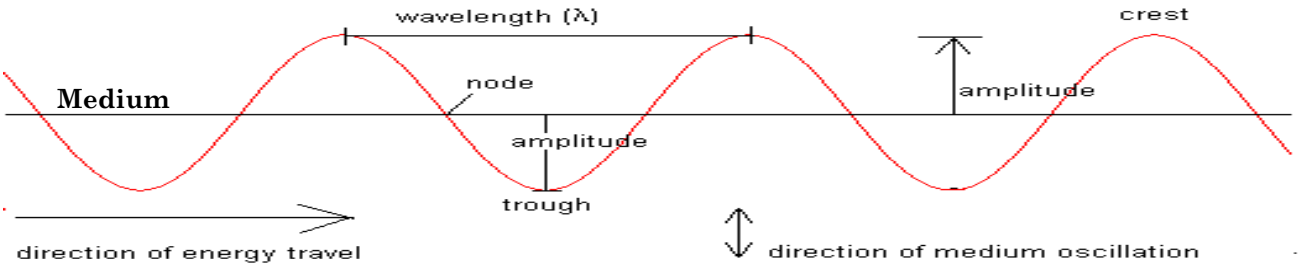
A **wave** is rhythmic disturbance that carries energy without carrying matter.

Mechanical waves only travel through a **medium** (matter through which it travels).
Mechanical waves travel faster through a more dense medium.

Properties of Waves

A **transverse wave** is a wave where the **medium moves perpendicular** to the direction of the wave. The **high point** of the wave is the **crest**, while the **low point** of the wave is the **trough**.

Ex. Ocean waves



The measurement of distance from one part of a wave to the next part of the same type is called the **wavelength**.

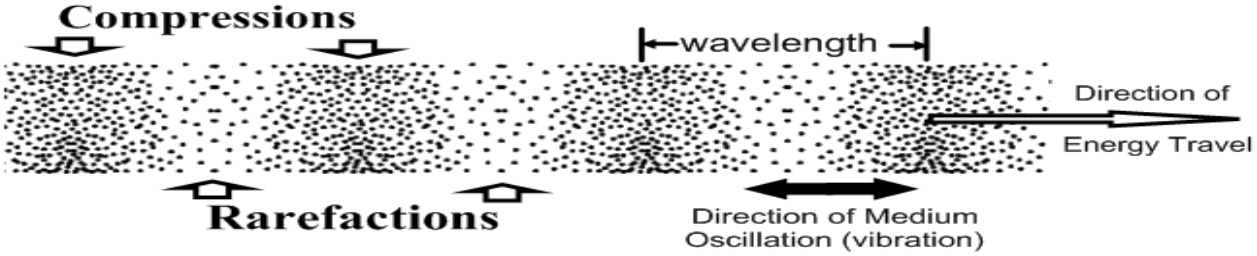
Ex. The distance from crest to crest OR trough to trough

Frequency is a measure of the number of wavelengths that pass a given point in a second. Frequency is **measured in hertz** (Hz). A high frequency wave has short wavelengths.

The **rest position** of transverse wave is the position halfway between the crest and trough; where the wave would rest or settle of it had no energy.

Compressional wave is a mechanical wave where the **medium moves parallel** to the direction of the wave.

Ex. Sound waves



Compressions are areas where the medium **particles are squeezed** close together (compressed)

Rarefactions are areas where the medium **particles are spread** farther apart than normal.

Amplitude - is the distance from the rest position to the crest or trough. (transverse waves)
- the difference between compressions and rarefactions. (compressional waves)
- measures the **amount of energy** carried by the wav

Wave Behavior

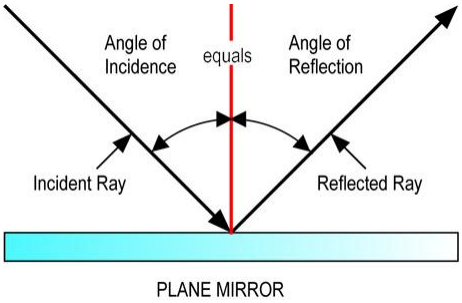
Reflection is when a wave bounces off of a surface.

Law of Reflection states that the angle of incidence of a wave = the angle of reflection.

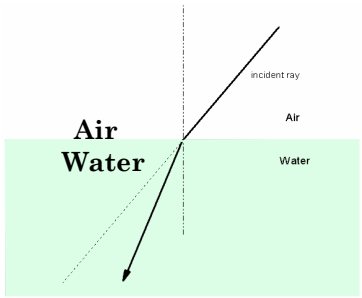
Refraction – when a **wave bends** because its speed changed while **traveling through** one medium into another. Ex. A lens causes light to refract.

Diffraction – when a **wave bends around** a barrier.

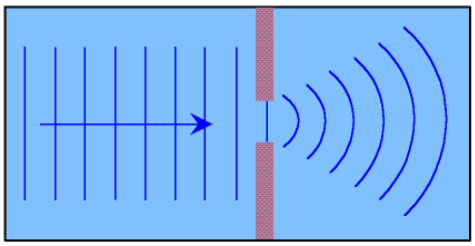
Ex. Sound can be heard from around a wall in another room.



Reflection



Refraction



Diffraction

Sound Waves

Properties of Sound

Sound is a **compressional wave**. Sound waves **require a medium** through which to travel.
Sound waves will travel **faster through a denser medium**
More **Energy** = more **Amplitude** = greater **Intensity**. Intensity is measured in **decibels** (dB)
Human perception of sound intensity is called **Loudness**

Sound Frequency - pitch

Shorter wavelength = Higher frequency = Higher pitch

Longer wavelength = Lower frequency = Lower pitch

The **Doppler Effect** is the apparent change in frequency due to the movement of the source of the sound

- Objects **moving closer** have an apparent **higher frequency** than they are actually emitting
- Objects **moving away** have an apparent **lower frequency** than they are actually emitting

Normal human hearing range is 20 to 20,000 Hz

Below 20 Hz is **infrasonic** (subsonic) Above 20,000 Hz is **ultrasonic**

Uses of Sound

Echolocation uses reflected sound waves to locate objects

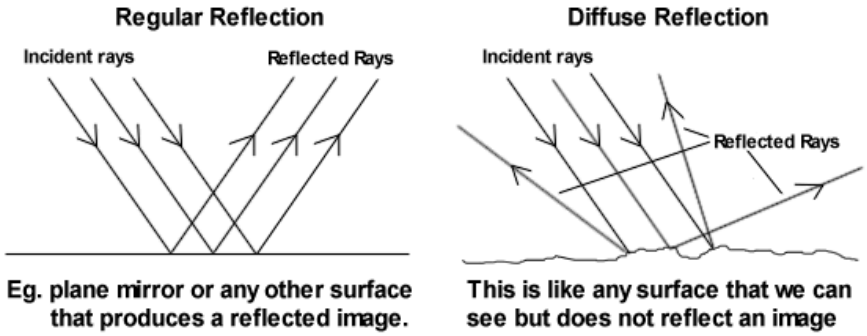
Sonar – a type of echolocation that uses the reflection of human created underwater sound waves to detect objects

Acoustics is the study of sound

Light Waves

Behavior of Light

Refraction- Bending of light due to differences in densities
Reflection – light bounces off of the material's surface



Regular Reflection- occurs when the surface light is reflecting off is smooth
Diffuse Reflection- occurs when the surface the light is reflecting off is rough

Opaque Materials – no light is transmitted, all light is absorbed or reflected
Translucent – some light is transmitted, some is either reflected or absorbed, cannot see through clearly
Transparent – all light is transmitted, can see through clearly

Visible Spectrum – all wavelengths of light that can be seen by the normal human eye
Each wavelength is seen as a different color
These colors seen in a rainbow ROYGBIV

Rainbows– caused by the refraction of light and light reflecting off of the rain drops

Light and Color

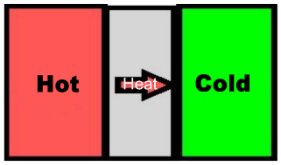
White materials reflect all colors of the visible spectrum
Black materials absorb all colors of the visible spectrum
Colored materials reflect the color which they appear and absorb all other colors

Thermal Energy

Temperature – the measure of the average kinetic energy of all the particles in an object.

Internal Potential Energy – when the particles are forced to expand

Thermal energy – total kinetic energy and the **internal** potential energy
Measured with a **thermometer**

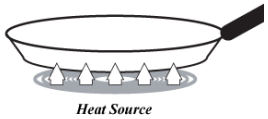


Heat – the flow of thermal energy <u>from high</u> temperature <u>to low</u> temperature.

Specific Heat – the amount of heat needed to raise the temperature of 1 kg of a substance one degree Celsius.

- the specific heat of **water** is very high!!

Thermal Energy Transfer



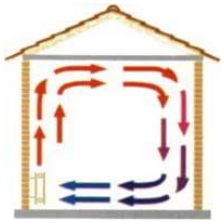
COOKING BY CONDUCTION

Conduction – transfer of energy by contact, the **collision of the particles**.

Conductors transfer heat easily (**Metals** are the best) ex. A metal pot on the stove.

Insulators reduce the flow of heat.(**air is an excellent insulator**) ex. A fluffy blanket.

Convection – transfer of thermal energy by the **bulk movement** (current) of a fluid (liquid or gas).



ex. A radiator in a house heats the room by convection.
ex. 2. Convection currents on earth **cause winds**!

Radiation – transfer of energy by electromagnetic waves (ex. light, ultraviolet, radio waves, etc.).

- the **suns energy** is transmitted to earth by radiation. (**does not require matter**)
- **Dark** materials **absorb** radiation better.
- **Shiny** materials **reflect** radiant energy.

Solids, Liquids & Gases

The ***KINETIC THEORY OF MATTER*** states that all matter is made up of small particles that are in constant motion. The particles collide with each other and the walls of their container.

The more kinetic energy = more motion = **higher** temperature = matter expands
Thermal Expansion is the increase in size due to the rise in temperature

State of Matter	***Volume & Shape***	***Kinetic Energy of the Particles***	***Particle behavior***
Solid	Definite Shape & Volume	Low kinetic Energy	Vibrate in a fixed place
Liquid	Definite Volume & No definite Shape	More kinetic energy than a solid	Move freely within the liquid
Gas	No definite Volume & No definite Shape	More kinetic energy than a liquid	Move freely in any direction
Plasma ***	No definite Volume & No definite Shape	Highest Kinetic Energy	Electrically Charged ions

*****Plasma is the most common state of matter in the universe**

Phase Change	***Term for Phase Change***	***Heat movement during phase change***
Solid → Liquid	Melting ***Melting Point:*** is the temperature when the solid liquefies	Heat energy is ***added*** to reach the solids melting point causing it to liquefy
Liquid → Solid	Freezing or Solidification	Heat energy is ***removed*** to cause the liquid to solidify
Liquid → Gas	Evaporation or Vaporization ***Boiling Point***: Temperature when bubbles start	Hat energy is ***added*** to the liquid to reach its boiling point and cause evaporation
Gas → Liquid	Condensation	Heat energy is ***removed*** from the gas causing it to turn back into a liquid
Solid → Gas	Sublimation	Heat energy is ***added*** so quickly the liquid phase is skipped

Phase change requires the addition or removal of thermal energy or pressure. A phase change is a physical change. ***There is no temperature change*** during a phase change.

Heat of Fusion**:** The amount of energy needed to cause the solid to liquefy
Heat of Vaporization**:** The amount of heat energy required to cause the liquid to evaporate

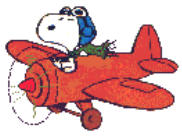
Fluid Principles

Archimedes' Principle - the **buoyant force** on an object in a fluid is **equal to the weight of the fluid displaced** by the object.

Ex. This principle allows a **ship to float**.
Whether an object will sink or float is based on Archimedes' principle

Buoyancy is the ability of the fluid to apply an upward force on an object (buoys float)

Bernoulli's Principle - as the **velocity** of a fluid **increases**, the **pressure** exerted by the fluid **decreases**.



- Faster moving fluid has less pressure.
Ex. This principle is used to make a **plane fly**.

Pascal's principle – the **pressure** in a fluid is equal throughout the fluid. The pressure in a fluid is measured in a unit called ***Pascal***.

Gas Laws

Boyle's Law - As the **volume** of a gas **decreases** the **pressure increases** as long as the temperature remains the same.

Charles' Law - As the **temperature** of a gas **increases** the **volume** of the gas also **increases**
Charles' Law is thermal expansion of a gas

Properties of Matter

Element- a substance made up of only one type of atom
Ex. Sodium; Na – an explosive metal has only atoms made with 11 protons
Chlorine; Cl – a poisonous gas, has only atoms made with 17 protons

Compound- a substance made up of two or more elements **chemically combined**

- **properties** of individual elements are **not retained** (properties are lost)
- Sodium and Chlorine chemically joined in a compound forms Sodium Chloride; NaCl – table salt!
- Can be **separated by chemical means**.

Pure Substance- a material made up of only one type of matter, matter with a fixed composition

- can be an element or compound.

Mixture

- two or more elements **combined physically**
- each substance **maintains its own properties**
- can be **separated by physical means. Distillation** uses boiling point to separate substances

Homogeneous Mixtures are evenly mixed, are the **same throughout,** and remain mixed.

Solution- type of homogeneous mixture where one substance is dissolved in another substance the particles are too small to be seen with a microscope and will not settle out.
Ex. Salt water, iced tea,

Colloid- type of homogeneous mixture like a solution with larger particles that do not settle out.
- *Ex. Fog, smoke*

Tyndall effect – the scattering of light by colloids. Used to detect colloids.

Heterogeneous Mixtures are not evenly mixed. They are not **the same throughout.**
- *Ex. Italian salad dressing, rice Pudding, chocolate chip cookie, concrete*

Suspension- heterogeneous mixture like a solution with visible particles that settle out
- *Ex. muddy water, ketchup, mustard*

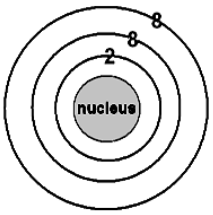
Physical Properties - characteristics that can be determined without changing the substance in to something new.
- *Ex. Mass, Magnetism, Volume, Density, Color, Size, Odor, Viscosity, Phase .*

Chemical Properties - describe how a substance will react or change when it reacts with another substance.
- *Ex. Flammability (tells that it can burn not that it is burning)*

Physical Change – change in a physical property, still the same substance.
- *Ex. Phase change, change in shape*

Chemical Change – involves a chemical reaction to **produce a new substance**. (may be indicated by bubbles)
- *Ex. Rusting, Corrosion, Burning*

The Law of Conservation of Mass
The total mass of all substances before chemical change is equal to the total mass of the substances before the chemical change



Periodic Table

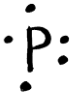
All matter is made up of **atoms**
An atom is the smallest piece of an element that still has the properties of the element

Sub atomic particles

Atoms are made up of **Protons (+), Neutrons (0), and Electrons (-)**

Protons and Neutrons each have a **mass of 1amu**, are **in the nucleus** & each contain 3 quarks **+**

Electrons are found at different levels around the nucleus in the **electron cloud**.
Electron energy levels: Level 1 holds 2 electrons Levels 2 & 3 hold 8 electrons (for now)
Electrons have such a small mass, it is almost zero.
Valence electrons are the outer most electrons **Dot diagram** – shows the valence electrons



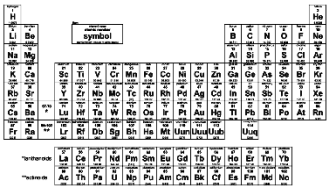
Special atoms

Isotopes – are varieties of the same atom with **different #'s of neutrons**
Ion – is an atom with an electrical **charge (+ or -)** because the # of protons does not match the # of electrons

Periodic Table

List of elements organized by atomic number

Atomic # and symbol is unique to each type of atom. **Atomic #** tells the **# of protons.**
Mass # is the **sum of the protons and neutrons**
Atomic Mass – average mass of all the isotopes of an element
Most elements are solids at room temperature



Periodic Table Arrangement

Elements are arranged by their atomic number

Columns (or groups) – vertical, elements have similar properties
Rows (or periods) – horizontal, elements have similar size, properties repeat in each row
Most elements are **metals** – need to lose electron(s) Most active on left
Nonmetals – need to gain electrons Most active **towards** right
Metalloids – will gain or lose electrons, have properties of both metals and nonmetals
Noble Gases – (far right column) stable, have just the right outer electrons, do not react, **far right**

Bonding

Bond - a force that holds atoms in a compound together due to the behavior of their electrons

Ionic Bond – **transfer of electrons** from metal to the nonmetal creating opposite ions

- bond between a metal and a nonmetal.
- the **metal needs to lose** electrons while the **nonmetal needs to gain** electrons
- the atoms stay **attracted because opposite charges attract**

Covalent Bond – **share electrons** in outer most electron cloud.

- Bond between two nonmetals (both want to gain electrons)
- Ex. H_2O each hydrogen atom shares one electron with the oxygen atom.

Metallic Bond – valence **electrons flow freely** among the positive nuclei

- bond between metals
- metals are **good conductors** of electricity