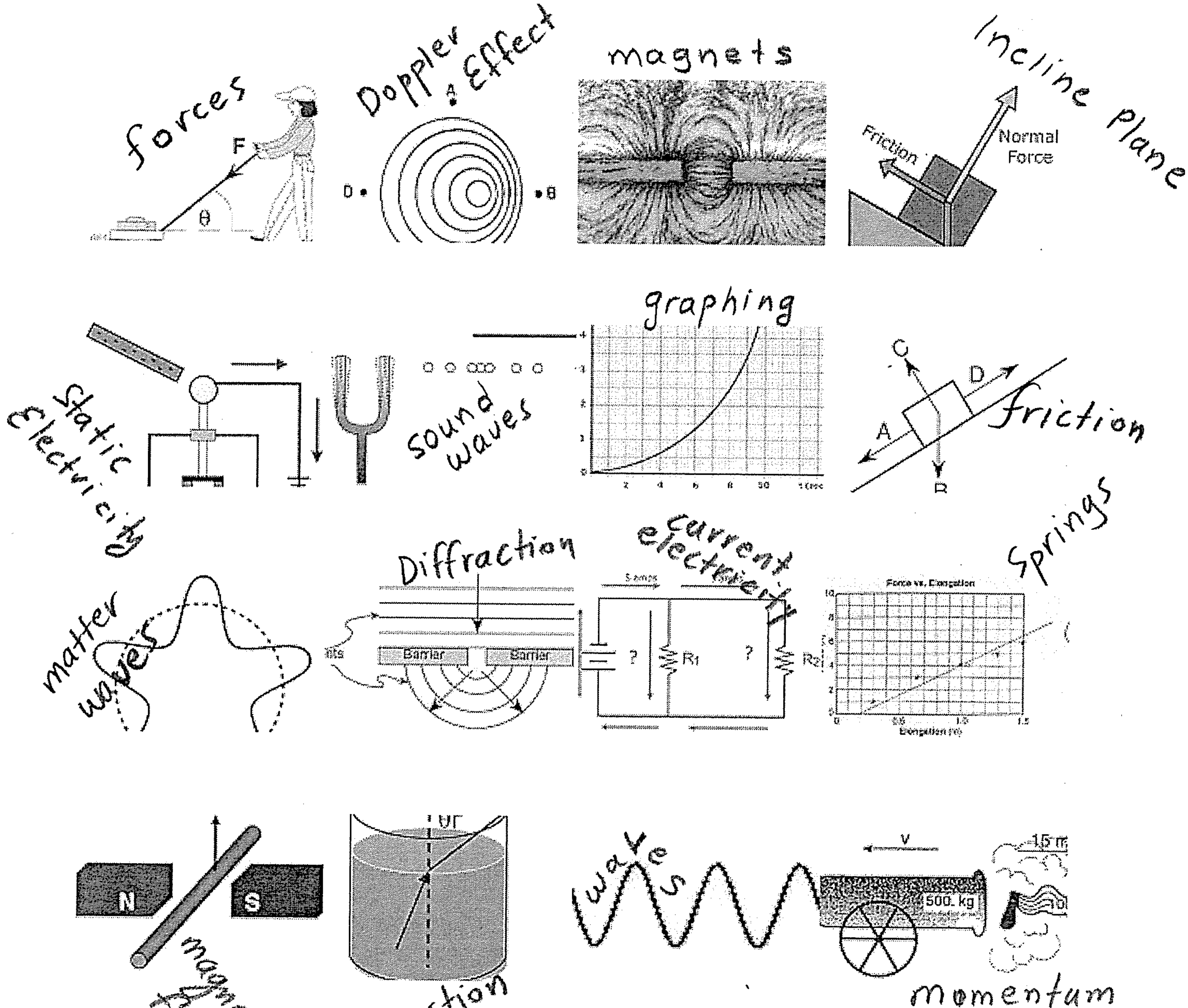
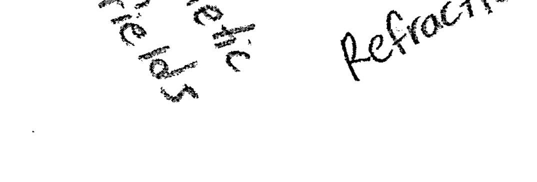
PHYSICS REVIEW FOR THE REGENTS





BY MRS. KOUNDI

Review : Kinematics

Uniform motion with constant velocity

$\bar{V} = \frac{d}{t}$

average speed $= \frac{\text{total distance}}{\text{total time}}$

average velocity $= \frac{\text{total displacement}}{\text{total time}}$

Uniform motion with constant acceleration

$a = \frac{V_f - V_i}{t}$

$V_f = V_i + at$

$\bar{V} = \frac{V_i + V_f}{2}$

$d = V_i t + \frac{1}{2} a t^2$

$V_f^2 = V_i^2 + 2da$

a is (+) when object accelerates in positive direction
or " " decelerates in negative direction

a is (−) when object accelerates in negative direction
or " " decelerates in positive direction

Free Fall ($a = g = -9.8\ m/s^2$)

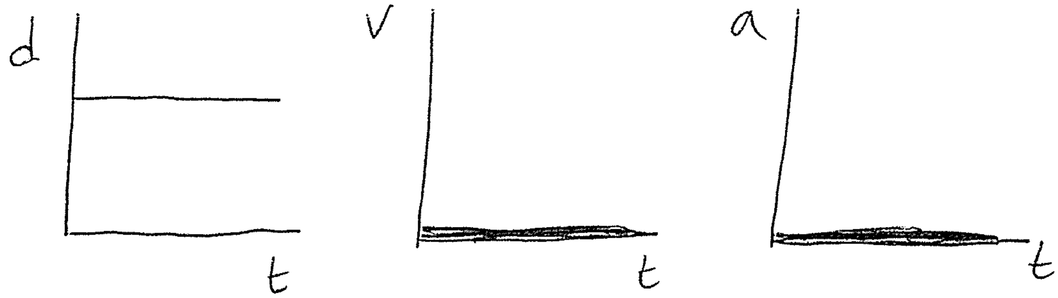
$V_i = 0$ d is negative V_f is negative

Upward Motion ($a = g = -9.8\ m/s^2$)

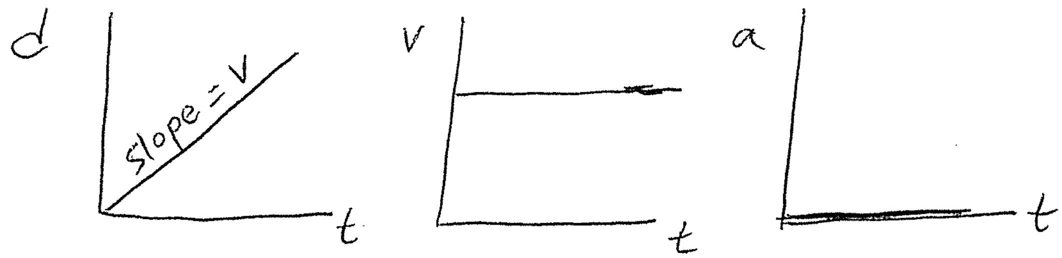
$V_f = 0$ d is positive V_i is positive

Review: Graphing Motion (d, v and a graphs)

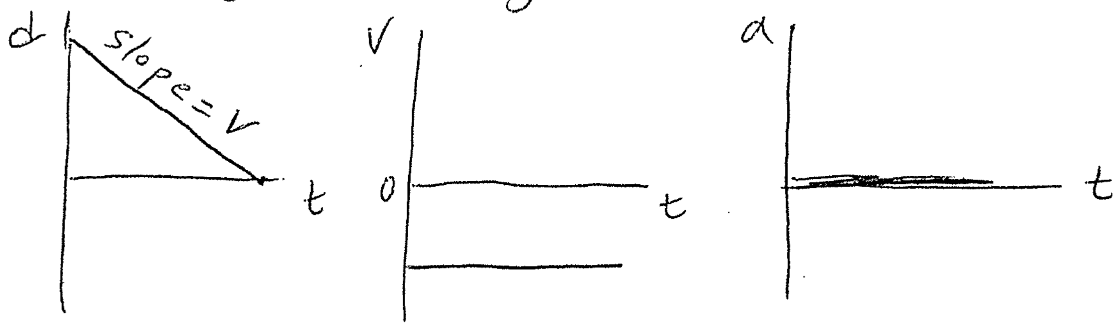
A: Rest



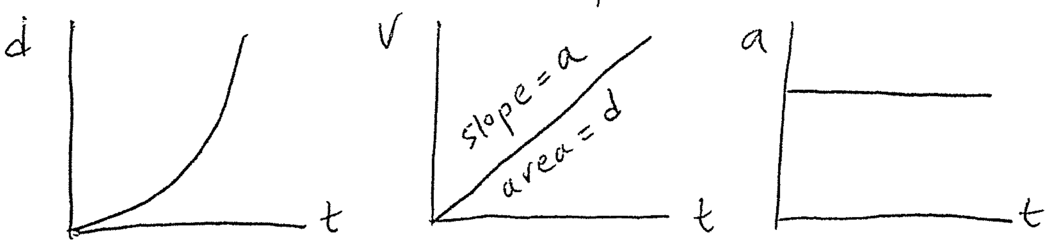
B: Constant velocity in a positive direction



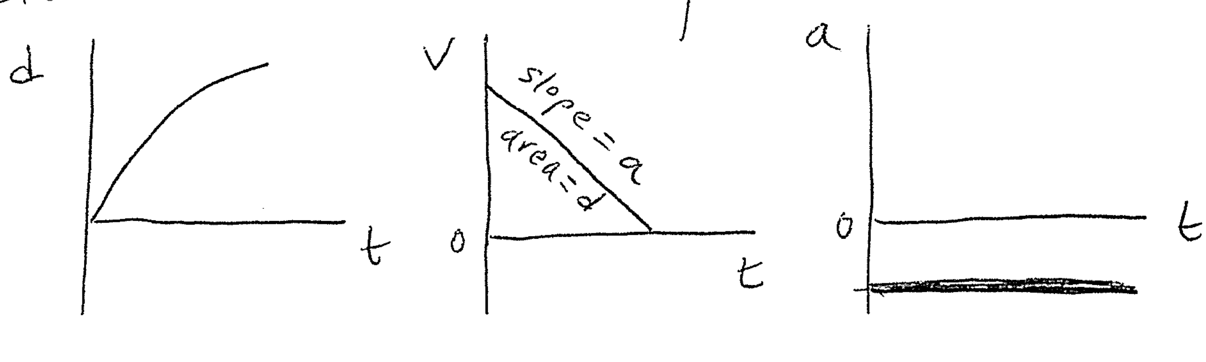
C: Constant velocity in a negative direction



D: Accelerated Motion in a positive direction

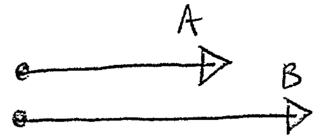


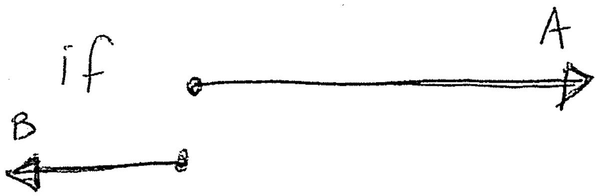
E: Decelerated Motion in a positive direction

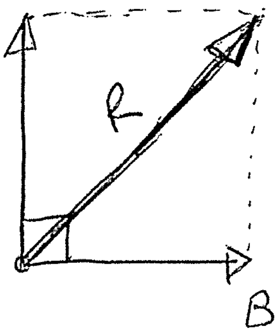


Review: Statics

Vectors (adding and resolving vectors)

if  are parallel and <u>0</u>° apart $R = A + B$ R is (max)

if  are parallel and <u>180</u>° apart $R = A - B$ R is (min)

if  are perpendicular or <u>90</u>° apart $R = \sqrt{A^2 + B^2}$

* R: Resultant: the result of two or more vectors combining

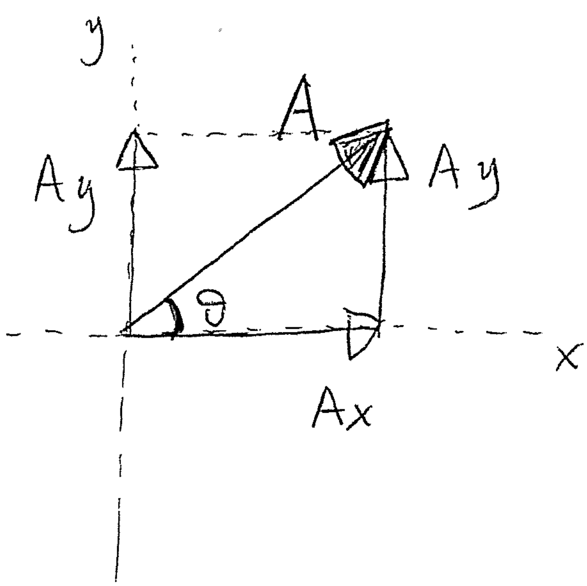
Resultant Range $|A| - |B| \leq R \leq |A| + |B|$

or

$R_{min} \leq R \leq R_{max}$

example
two vectors
<u>A = 5m</u>, <u>B = 7m</u>

<u>$2m \leq R \leq 12m$</u>



<u>Components</u>

$A_x = A \cos\theta$

$A_y = A \sin\theta$

$\theta = \tan^{-1}\left(\frac{A_y}{A_x}\right)$ horizontal angle

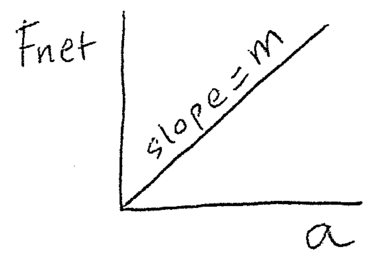
$A = \sqrt{A_x^2 + A_y^2}$

Newton's Laws

1. $m \sim$ Inertia (the more the mass, the greater the inertia)

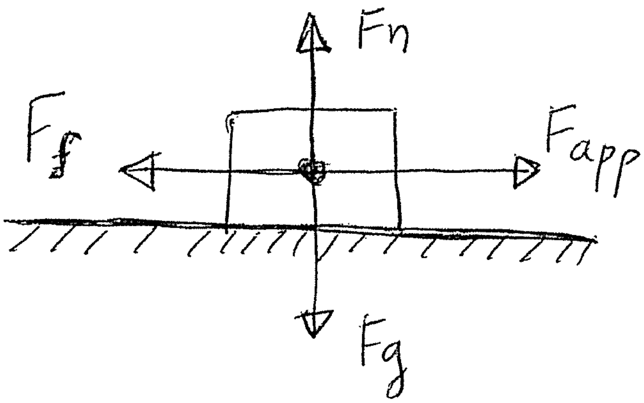
2. $$F_{net} = ma$$

3. $F_{action} = F_{reaction}$

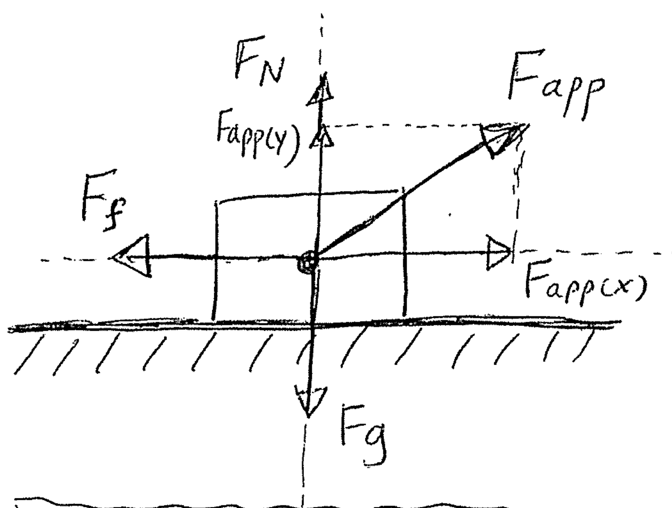


Friction ($F_{static} > F_{kinetic}$) and Free Body Diagrams

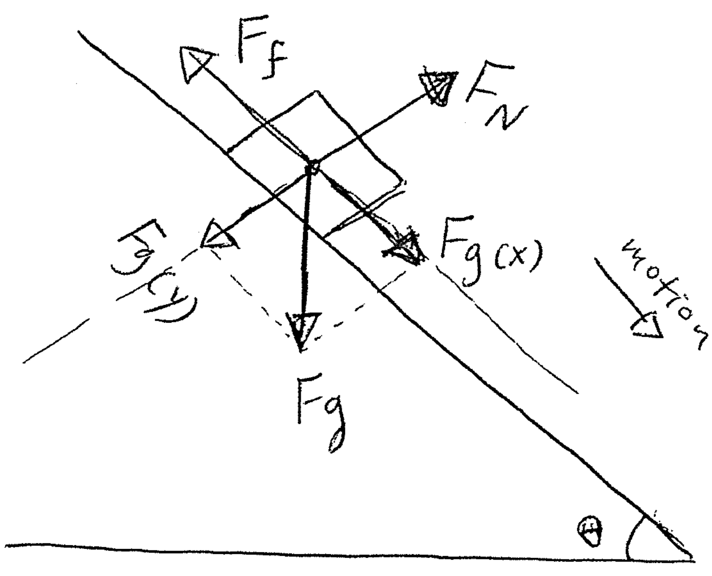
$$F_f = \mu F_N$$



$$F_{net} = F_{app} - F_f$$



$$F_{net} = F_{app(x)} - F_f$$



Incline Plane (downward motion)

$F_{gx} = F_g \sin\theta$

$F_{gy} = F_g \cos\theta$

if motion is constant

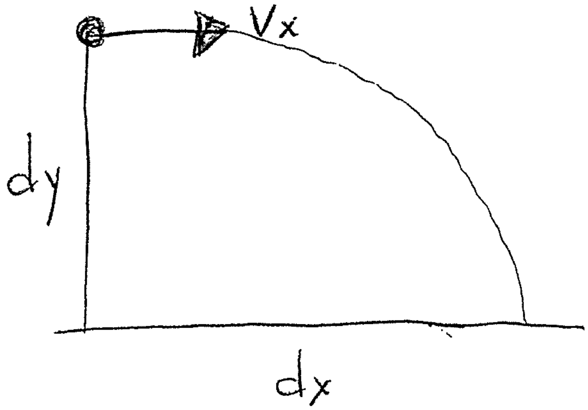
$F_f = F_{g(x)}$ and

$F_N = F_{g(y)}$

Review

Projectile Motion

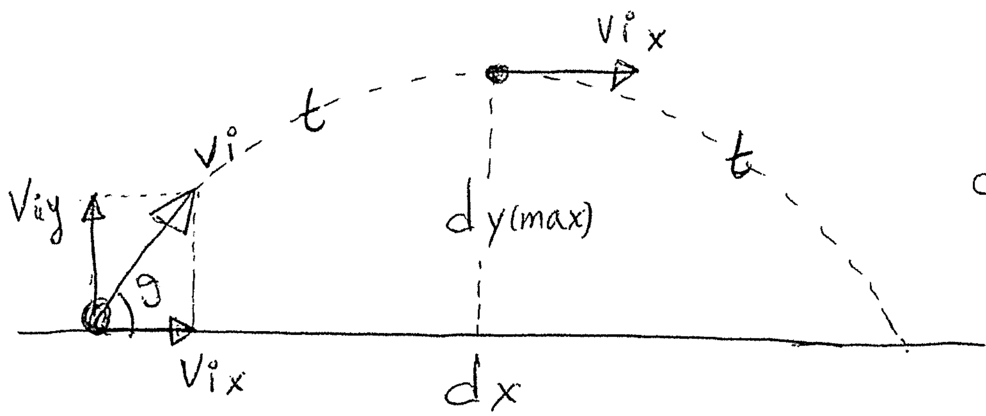
A) Horizontal



$V_x = \frac{d_x}{t}$

$d_y = \frac{1}{2} g t^2$

B) Fired at an angle θ



$V_{ix} = V_i \cos\theta$

$V_{iy} = V_i \sin\theta$

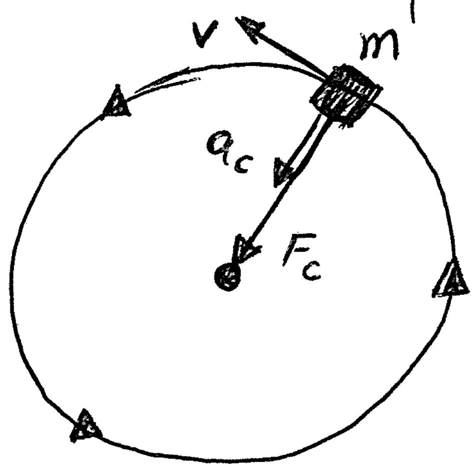
$d_x = V_{ix} \cdot 2t$

$d_{y(max)} = \frac{1}{2} g t^2$

$V_{iy} = g t \quad g = -9.8 \frac{m}{s^2}$

- As angle θ increases dy increases and dx decreases
  max range (dx) occurs at θ = 45°
- Complementary angles produce the same range (dx).
  (sum of 90°)
- Max altitude (dy) occurs at θ = 90°
- Mass of the object does not affect the dy or dx
- Air Resistance decreases dy and dx and time
- As dy increases, time increases (dy ~ t)

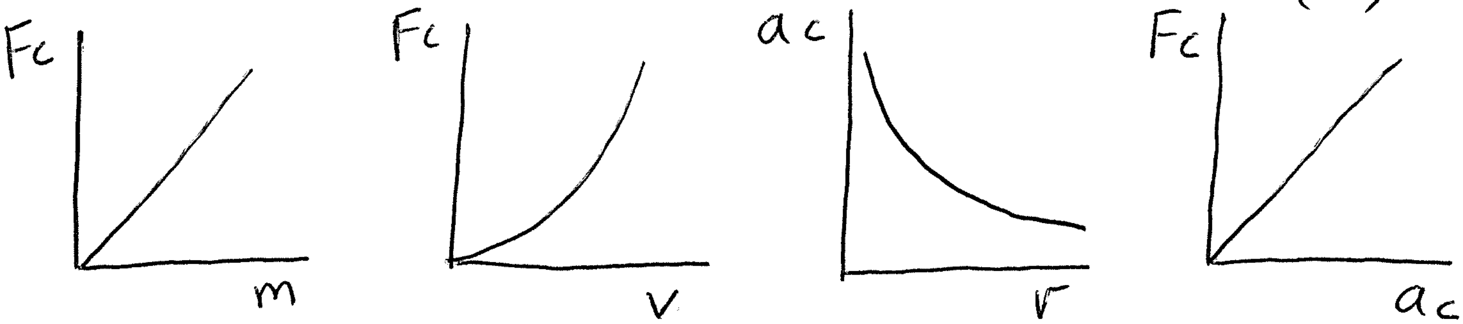
Review : Centripetal Force



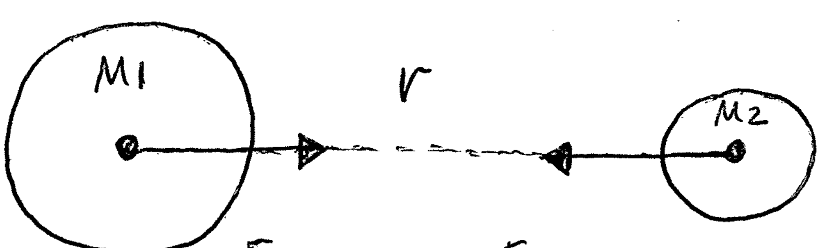
$$V = \frac{2\pi r}{T}$$ T: period of Revolution (time to complete one circle)

$$a_c = \frac{v^2}{r} \qquad F_c = m a_c$$

$$F_c = \frac{m v^2}{r} \qquad F_c = \frac{(\ )(\ )^2}{(\ )}$$



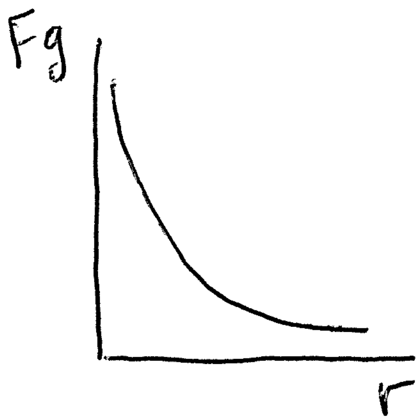
Review : Law of Universal Gravity



$$F_g(1,2) = F_g(2,1)$$

$$F_g = \frac{G M_1 M_2}{r^2}$$

$$F_g = \frac{(\ )(\ )}{(\ )^2}$$



r	2	3	4	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{4}$
Fg	$\frac{1}{4}$	$\frac{1}{9}$	$\frac{1}{16}$	4	9	16

Review: Impulse - Momentum - Conservation of Momentum

$F_{net} = m a$

$F_{net} = m \frac{\Delta v}{t}$

$F_{net} = m \frac{(v_f - v_i)}{t}$

$F_{net} \cdot t = m v_f - m v_i$

$J = p_f - p_i$

$J = \Delta p$

* $p = m v$

$p_i = m v_i$

$p_f = m v_f$

* $J = \Delta p$

$J = F_{net} \cdot t$

* $F_{net}\, t = F_{net}\, t$

extending the time of a collision minimizes the force

Collisions

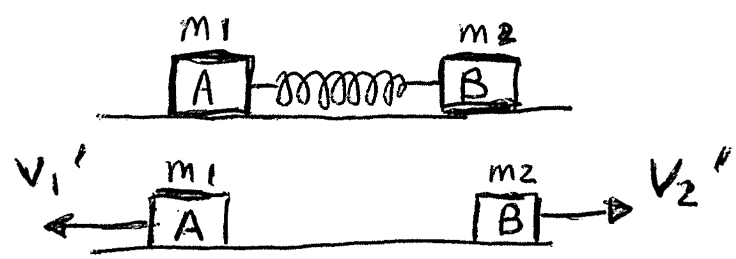
1) Elastic $m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$

2) Inelastic $m_1 v_1 + m_2 v_2 = (m_1 + m_2) v'$

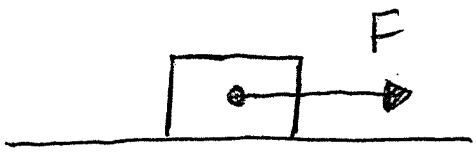
3) Explosion $0 = m_1 v_1' - m_2 v_2'$

4) Compination (some times) $(m_1 + m_2) v = m_1 v_1' + m_2 v_2'$

explosion pic

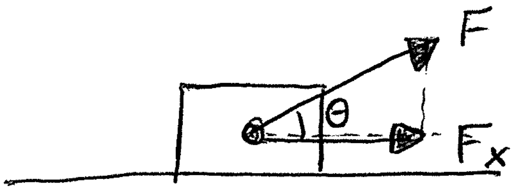


Energy - Work - Power - Conservation of Energy



$W = F \cdot d$ ($N \cdot m$ = Joule)

* Joule = $N \cdot m = kg \frac{m}{s^2} \cdot m = kg \frac{m^2}{s^2}$



only F_x does work

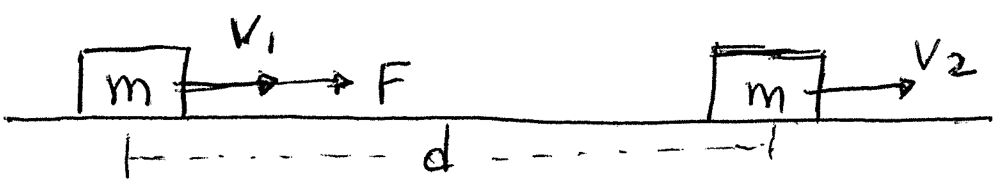
$W = F_x \cdot d = F \cos\theta \cdot d$

* Work can be done only when F and d are having the same direction and neither one is zero.

Power: Rate of doing work $P = \frac{W}{t} = \frac{F \cdot d}{t} = F \cdot \bar{V}$

* unit: $\text{Watt} = \frac{\text{Joule}}{\text{sec}} = \frac{N \cdot m}{s} = \frac{kg \frac{m}{s^2} \cdot m}{s} = kg \frac{m^2}{s^3}$

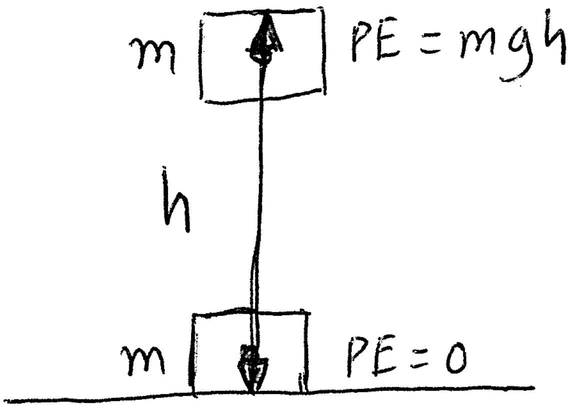
Work / Kinetic Energy Theorem



$\text{Work} = F \cdot d = \frac{1}{2} m v_2^2 - \frac{1}{2} m v_1^2$

* the work done by the Force to accelerate the mass is equal to the change of the kinetic energy of the object

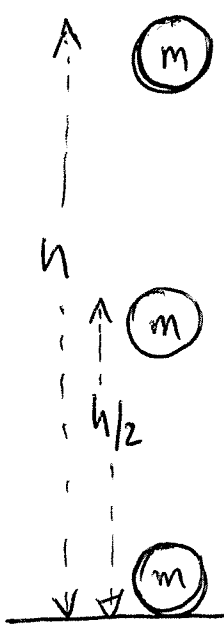
Work done during <u>lifting</u> is



$$W = F_g \cdot h = \Delta PE$$
$$mg\,h = mgh - 0$$

the work done by the Force of Gravity

Free Fall.



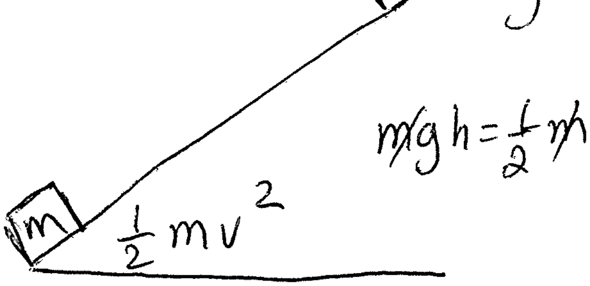
$ME = PE + KE = mgh + 0 = 100\,J$

$ME = PE + KE = mg\frac{h}{2} + \frac{1}{2}m\left(\frac{v}{2}\right)^2 = 50J + 50J$

$ME = PE + KE = 0 + \frac{1}{2}mv^2 = 100\,J$

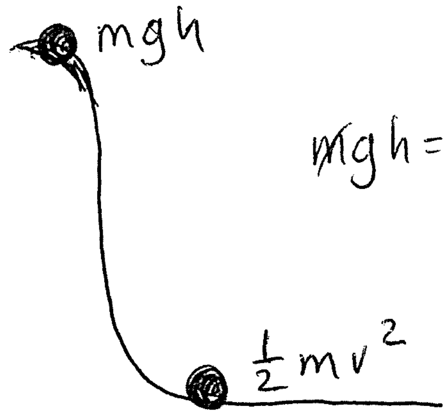
$$\cancel{m}gh = \frac{1}{2}\cancel{m}v^2$$
$$2gh = v^2$$
$$v = \sqrt{2gh}$$

Incline Planes



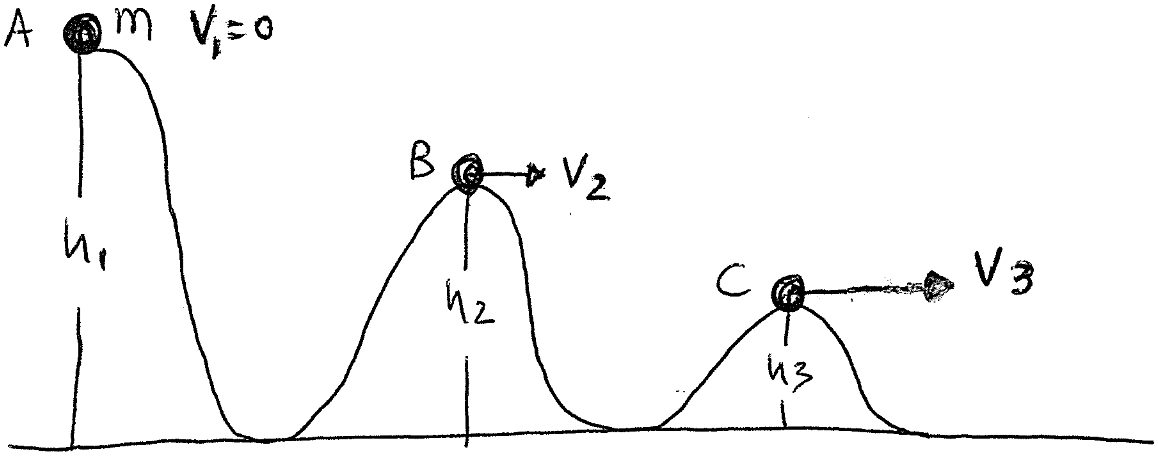
$$\cancel{m}gh = \frac{1}{2}\cancel{m}v^2$$

Roller Coasters



$$\cancel{m}gh = \frac{1}{2}\cancel{m}v^2$$

More Roller Coasters....



A: $ME = mgh_1 + 0$

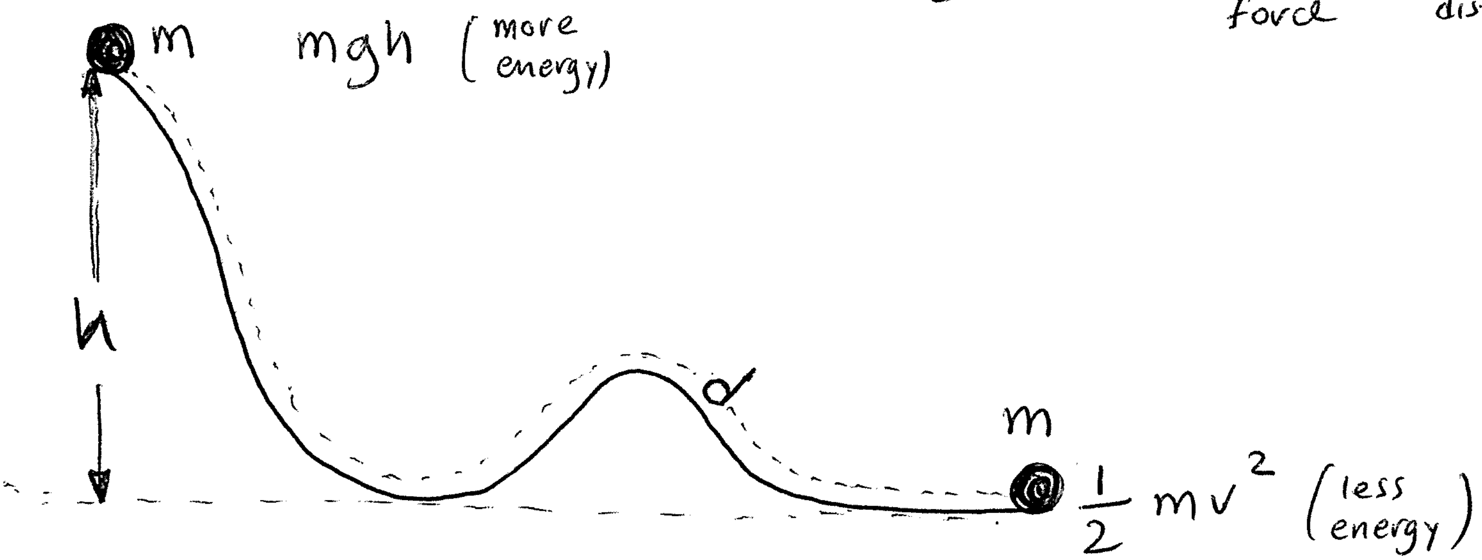
B: $ME = mgh_2 + \frac{1}{2}mV_2^2$

C: $ME = mgh_3 + \frac{1}{2}mV_3^2$

* As height decreases PE decreases and KE increases
($V_3 > V_2 > V_1$)
($h_3 < h_2 < h_1$)

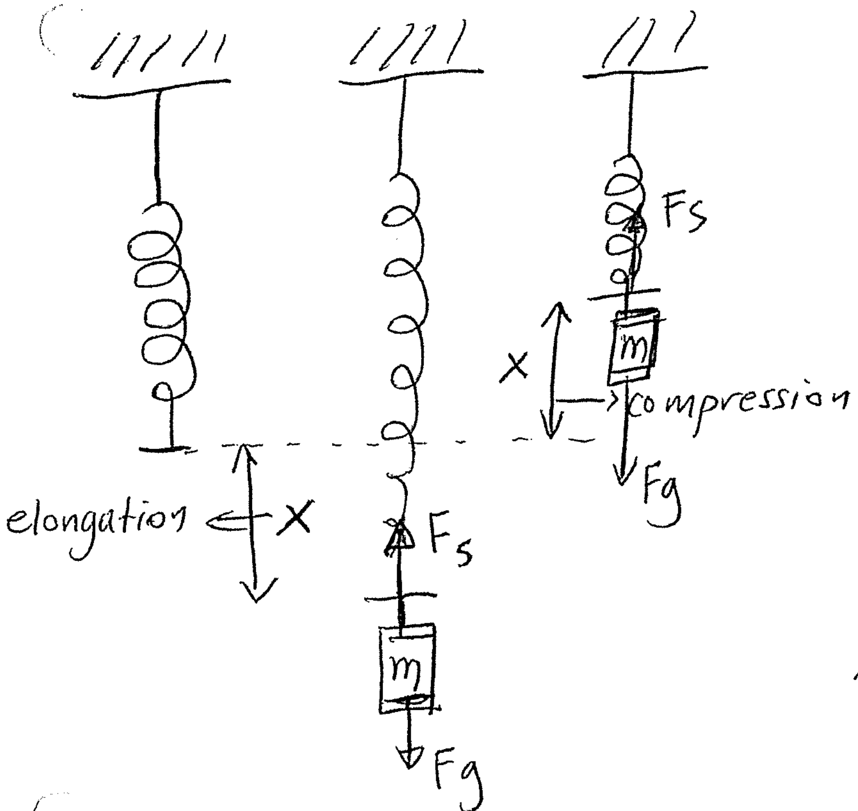
In Non-Ideal systems (where friction exists)

Work of friction = heat = $f \cdot d$ = friction force · total distance



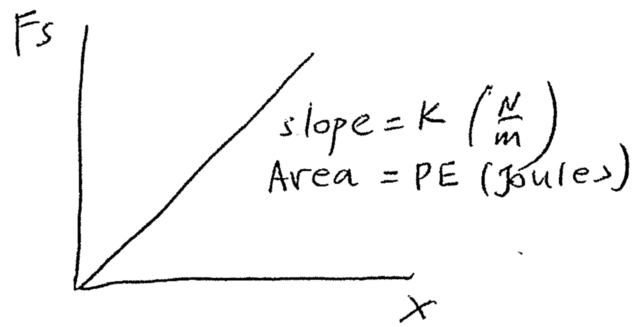
$$W_f = f \cdot d = mgh - \frac{1}{2}mv^2$$

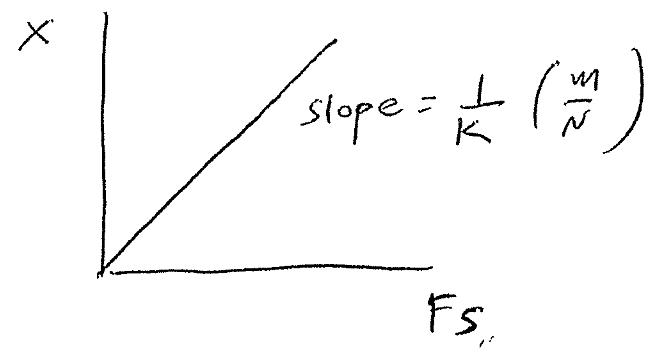
Springs



$F_s = kx$ (N)

$PE_s = \frac{1}{2}kx^2$ (Joules)

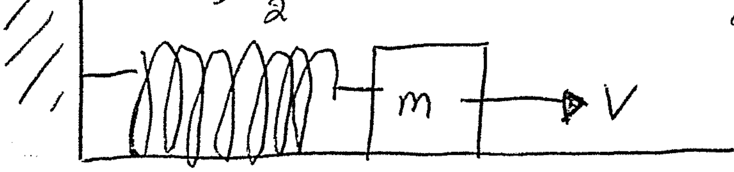




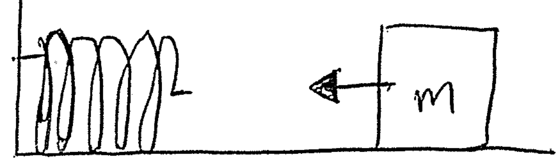
$PE_s = \frac{1}{2}kx^2$ or

$\frac{1}{2}F_s \cdot x$ (in Joules)

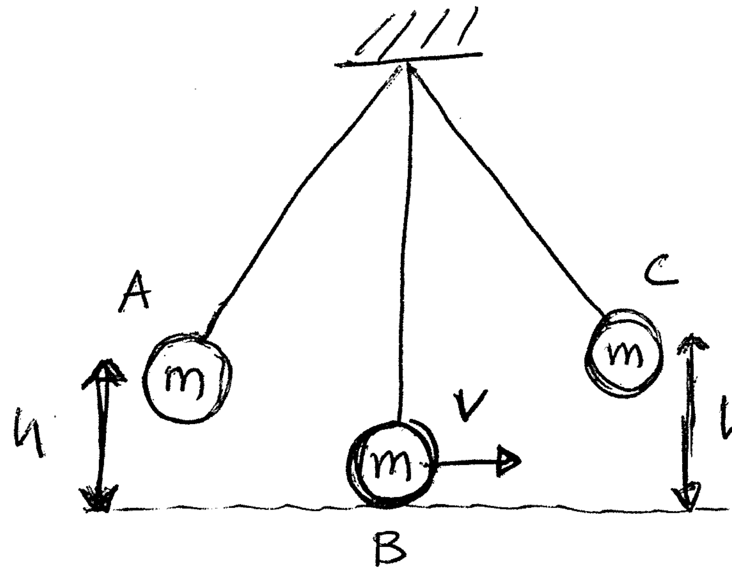
$PE_s = \frac{1}{2}kx^2 = KE = \frac{1}{2}mv^2$



or



Energy Conservation in the pendulum



A: ME = KE + PE = $0 + mgh$

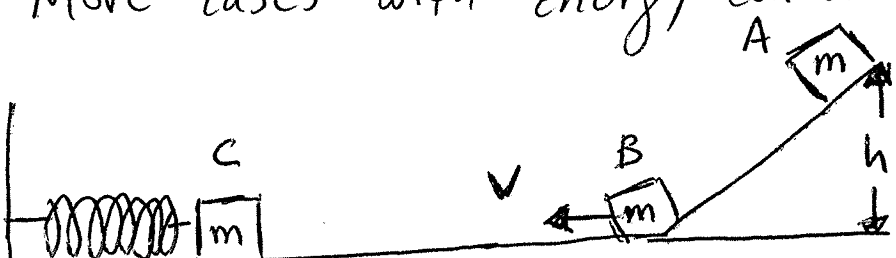
B: ME = KE + PE = $\frac{1}{2}mv^2 + 0$

C: ME = KE + PE = $0 + mgh$

ME(A) = ME(B) = ME(C)

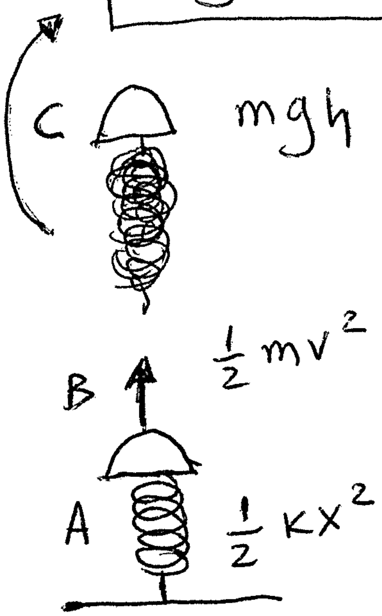
$$\frac{1}{2}\cancel{m}v^2 = \cancel{m}gh$$

More cases with Energy Conservation and spring.

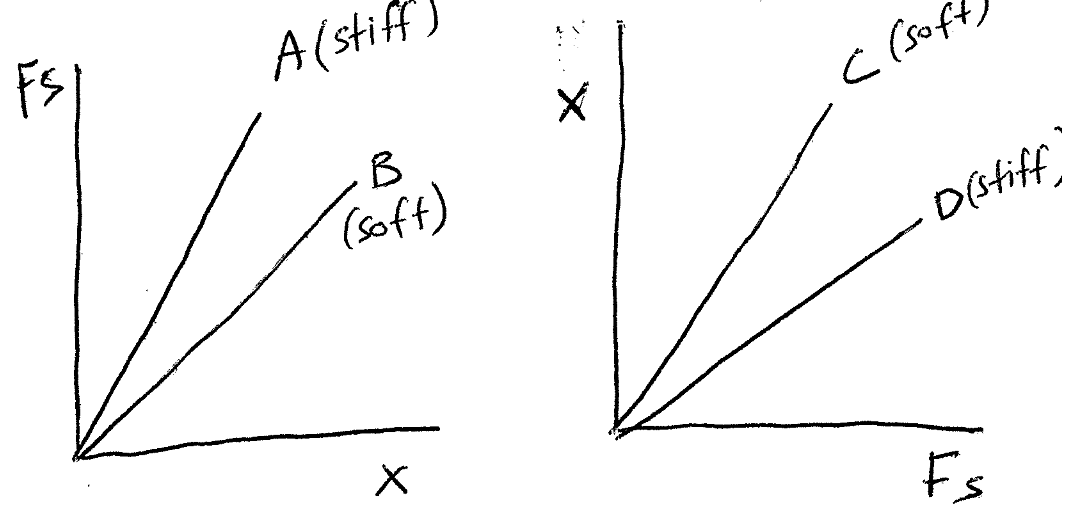


C: $\frac{1}{2}kx^2$ B: $\frac{1}{2}mv^2$ A: mgh

$$mgh = \frac{1}{2}mv^2 = \frac{1}{2}kx^2$$



Multiple springs (compare spring constants)



Static Electricity (Notes)

charge of an electron $(e) = -1.6 \times 10^{-19}$ C
charge of a proton $(p) = +1.6 \times 10^{-19}$ C
elementary charge = charge of the e or p $= 1.6 \times 10^{-19}$ C
1 Coulomb (C) - unit of charge $= 6.25 \times 10^{18}$ e
* 1 $\mu C = 10^{-6}$ C
A positive charge - lost electrons (e)
A negative charge - gained electrons (e)
Only electrons move

Transfer of electrons

Rubber + fur (Rubber gains e and becomes −)
(fur loses e and becomes +)

Glass + Silk (Glass loses e and becomes +)
(silk gains e and becomes −)

Elementary Charge

Every charge is a multiple integer of the elementary charge $Q = ne$ $n = 1, 2, 3, 4 \ldots$

ex. Could 3.2×10^{-19} C be a real charge

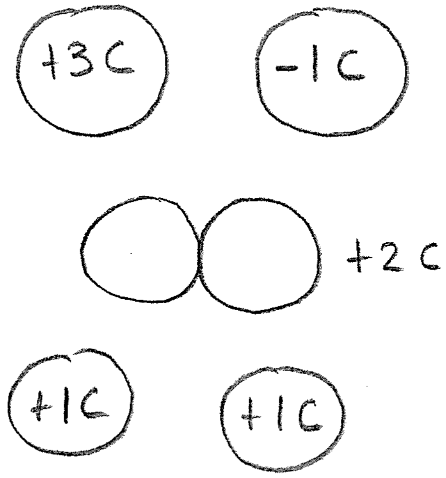
$$\frac{3.2 \times 10^{-19} C}{1.6 \times 10^{-19} C} = 2e \quad \text{Yes}$$

ex could 5×10^{-19} C be a real charge

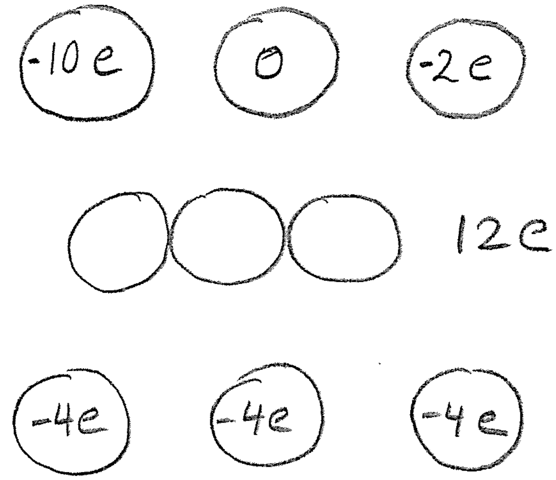
$$\frac{5 \times 10^{-19} C}{1.6 \times 10^{-19} C} = 3.125e \quad \text{Not possible}$$

Conservation of charge: when two or more charged objects come in contact and then get separated, the total charge gets evenly distributed between them.

ex

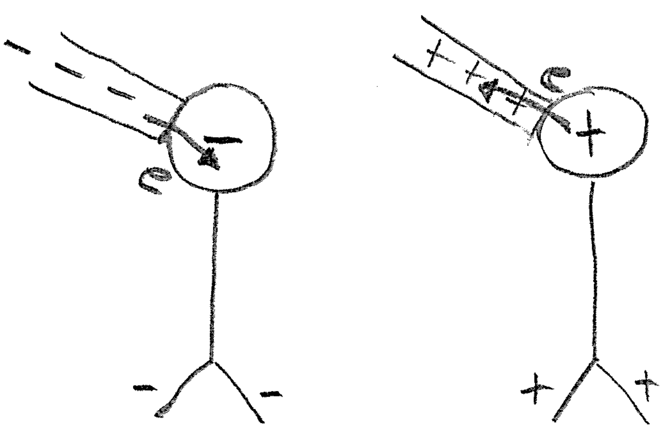


ex

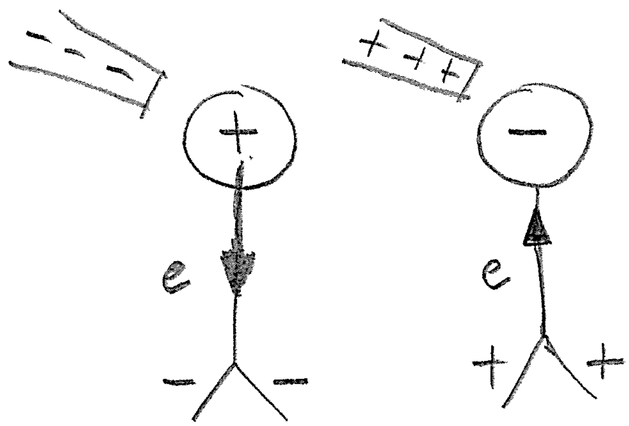


Electroscope

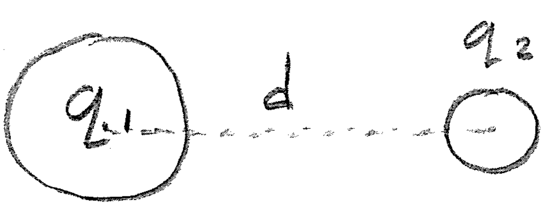
Conduction



Induction



Coulomb's Law



$$F_e = \frac{K q_1 q_2}{d^2}$$

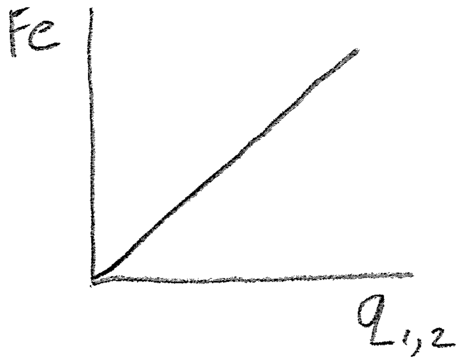
$$K = 9 \times 10^9 \frac{Nm^2}{C^2}$$

if $q_1(\pm)$ and $q_2(\pm)$ then F_e (+) repulsive force

if $q_1(+)$ and $q_2(-)$ then F_e (−) attractive force

Coulomb's Law → cont

find patterns

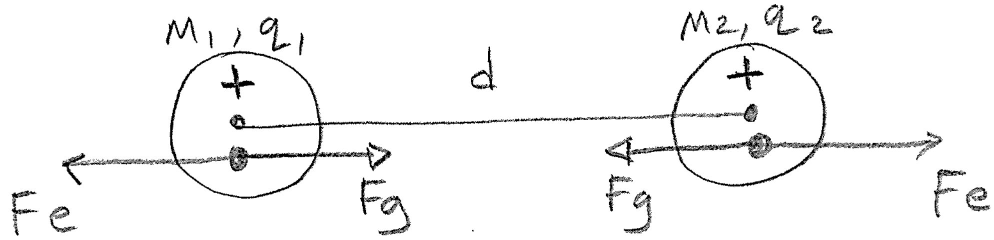


ex.

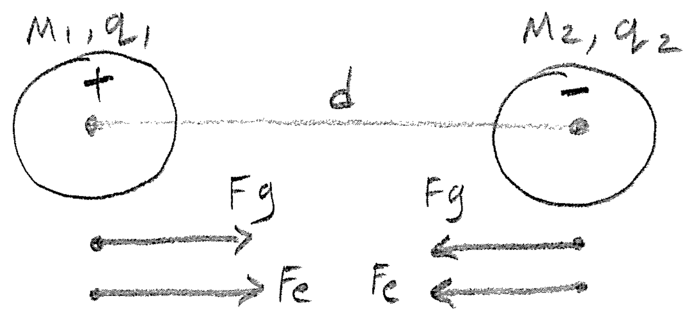
$$F_e = \frac{(\ \ )(\ \ )}{(\ \ )^2}$$

Compare Electric with Gravitational forces

if



if



* Vectors are not drawn to scale

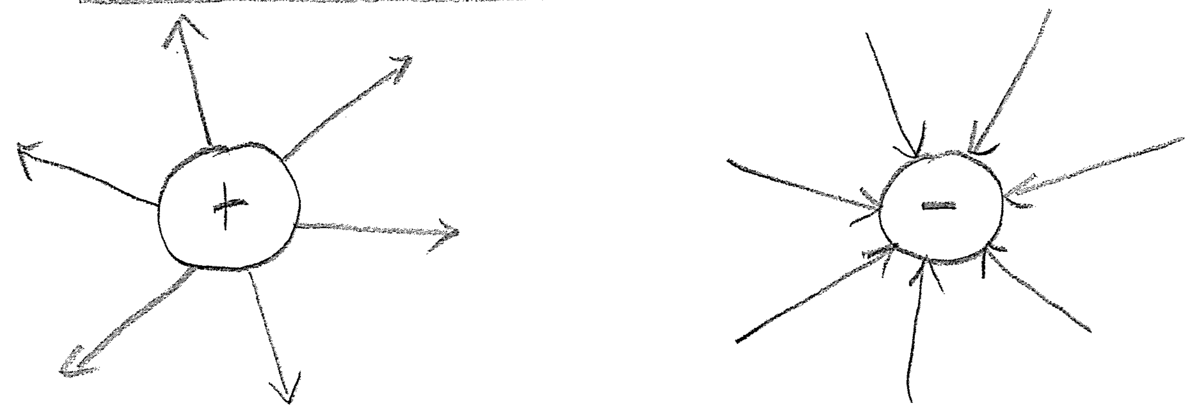
Fg is much less than (Fe) stronger force

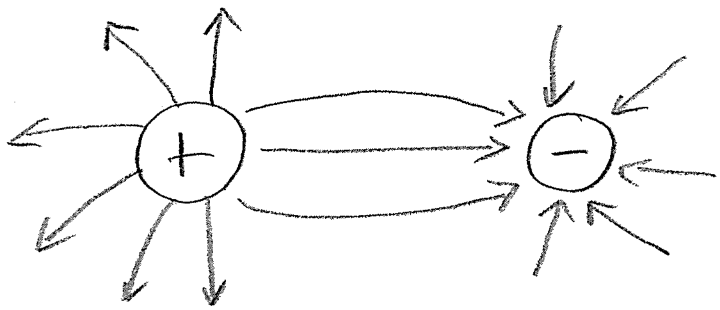
Fg : always an attractive force

Fe : can be attractive or repulsive

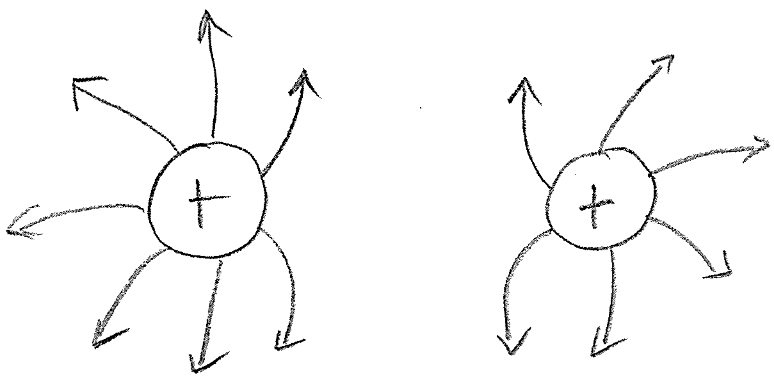
but Fe is Stronger than Fg

Electric Field Lines → * (never intersect)

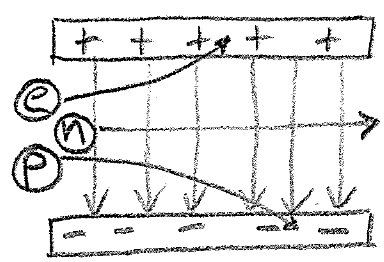


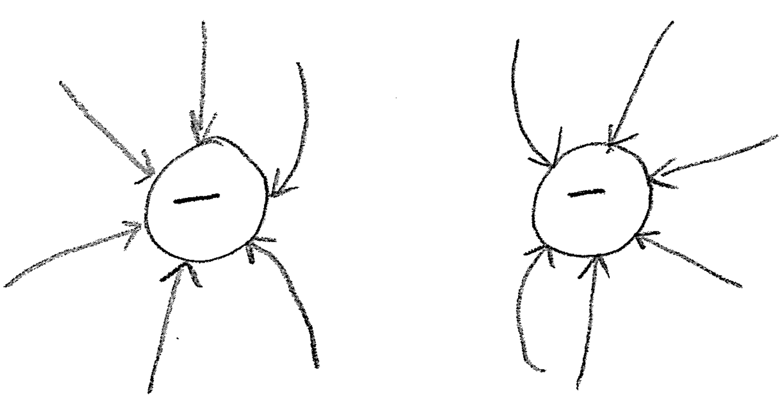


attractive field



Uniform Electric Field between two parallel plates oppositely charged

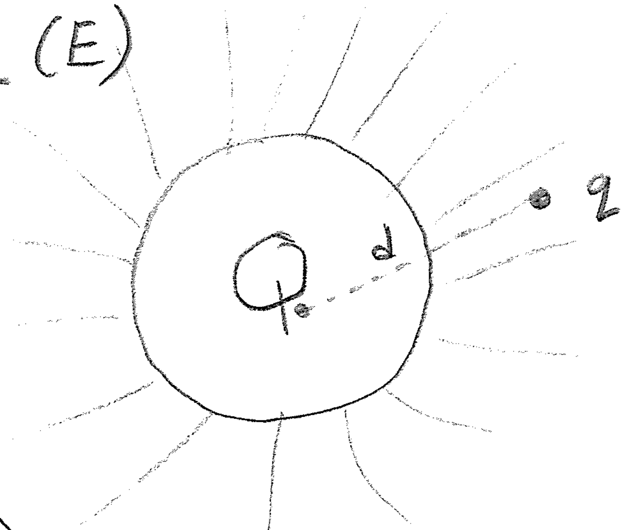




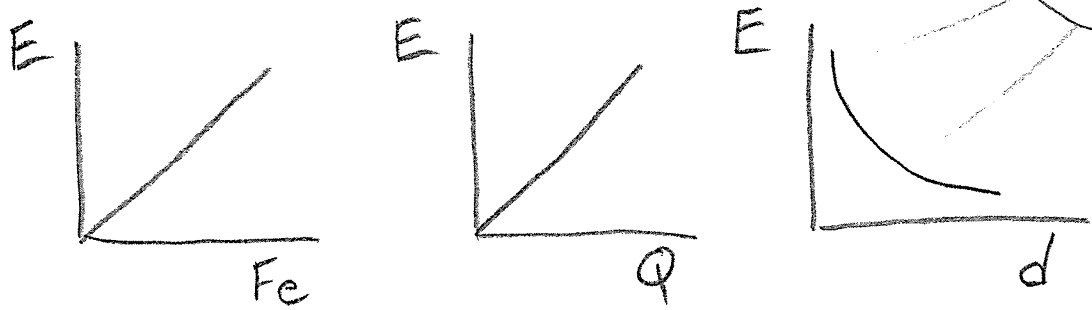
* every where in the field the intensity or strength is the same

Electric Field Strength (E)

$$E = \frac{F_e}{q} = \frac{\frac{KQq}{d^2}}{q} = \frac{KQ}{d^2}$$



Unit: $\frac{N}{C}$



Electric Potential Difference (V or Voltage)

$$V = \frac{W}{q}$$

W: work done on a charge q to either keep it in the electric field or move it away

Unit: Volt = $\frac{\text{Joule}}{\text{Coulomb}}$ $1\,V = 1\,\frac{J}{C}$

Review Conversions on Units

Charge: Q

$$e \xrightarrow{\times 1.6\times10^{-19}} C$$
$$C \xrightarrow{\div(1.6\times10^{-19})} e$$

*when you divide with a number in scientific notat remember to op parenthesis

Electric Work or Energy (W):

$$eV \xrightarrow{\times 1.6\times10^{-19}} \text{Joule}$$
$$\text{Joule} \xrightarrow{\div(1.6\times10^{-19})} eV$$

Current Electricity Notes

V: Potential Difference (Voltage)

$V = \frac{W}{q}$ unit: Volt $= \frac{\text{Joule}}{\text{Coulomb}}$ or (V)

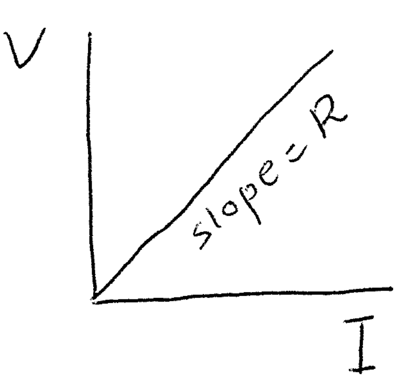
I: Electric Current

$I = \frac{q}{t}$ unit: Ampere $= \frac{\text{Coulomb}}{\text{sec}}$ or (Amp)

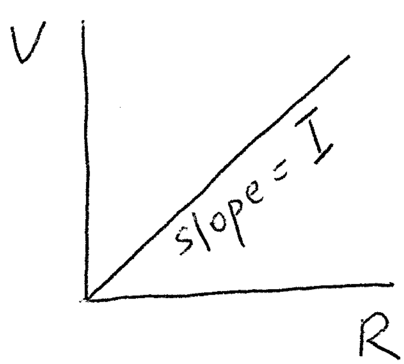
R: Electric Resistance

$R = \frac{V}{I}$ unit: Ohm $= \frac{\text{Volt}}{\text{Ampere}}$ or (Ω) or ($\underline{o}$)

Graphs (Ohm's Law)



$V = \boxed{R}\, I$



$V = \boxed{I}\, R$

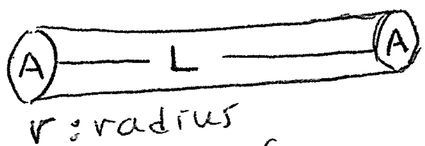
$I = \frac{V}{R}$ or $R = \frac{V}{I}$

Electric Resistance

$$R = \frac{\rho L}{A}$$

R depends on
- ρ : resistivity
- L : length
- A : Cross Sectional Area
- : Temperature

pic :



$A = \pi r^2$

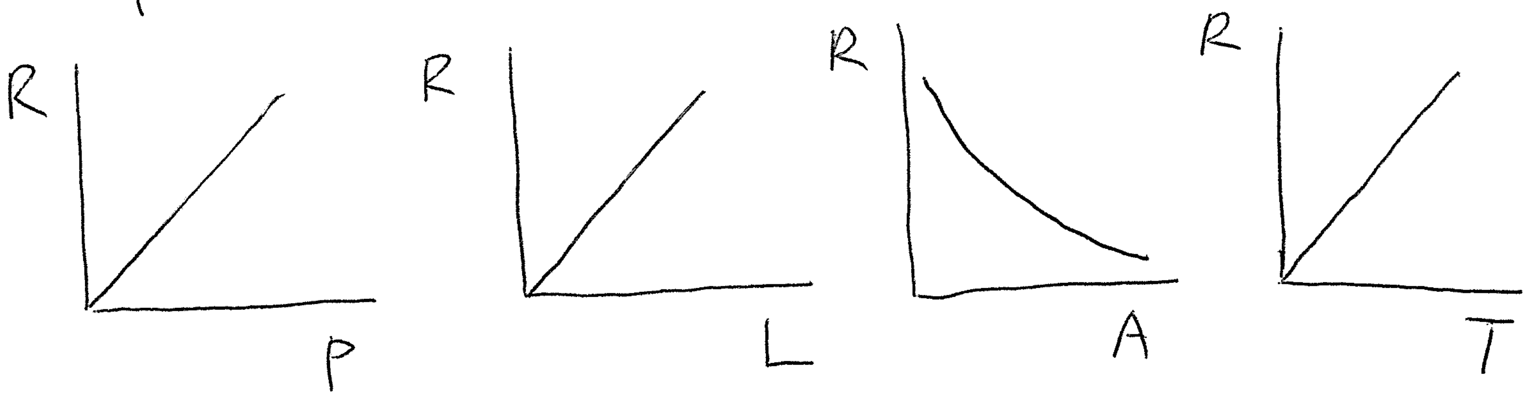
ρ : resistivity (unit: $\Omega \cdot m$)
check your Ref. Tables for values of resistivity. Relationship with R : direct

L : length (unit : m) Relationship with R : direct

A : Cross Sectional Area (unit: m^2) Relationship with R : inverse
(thickness)

T : Temperature. Relationship with R : direct
* (only for conductors)

Graphs



Power and Energy

$$P = \frac{W}{t} \text{ or } \frac{E}{t} \rightarrow \frac{Vq}{t} = VI$$

unit : $\text{Watt} = \frac{\text{Joule}}{\text{sec}} = \frac{\text{Volt} \cdot \text{Coulomb}}{\text{sec}} = \text{Volt} \cdot \text{Amp}$

$P = VI$ (when R is not given) or $\frac{V^2}{R}$ (when I is not given) or $I^2 R$ (when V is not given)

$$W = P \cdot t \text{ or } VIt \text{ or } \frac{V^2}{R} t \text{ or } I^2 R t$$

unit : Joule = Watt · sec

unit of work (or Electric Energy) = KWh

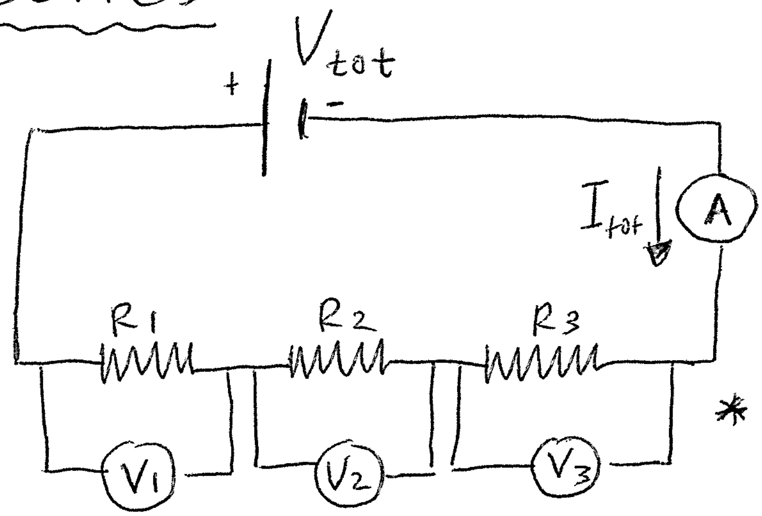
1 KWh = 1,000 Watt · 3,600 sec =

= 3,600,000 Watt · sec

= 3,600,000 Joules

Circuits

Series



$I_{tot} = I_1 = I_2 = I_3$

$V_{tot} = V_1 + V_2 + V_3$

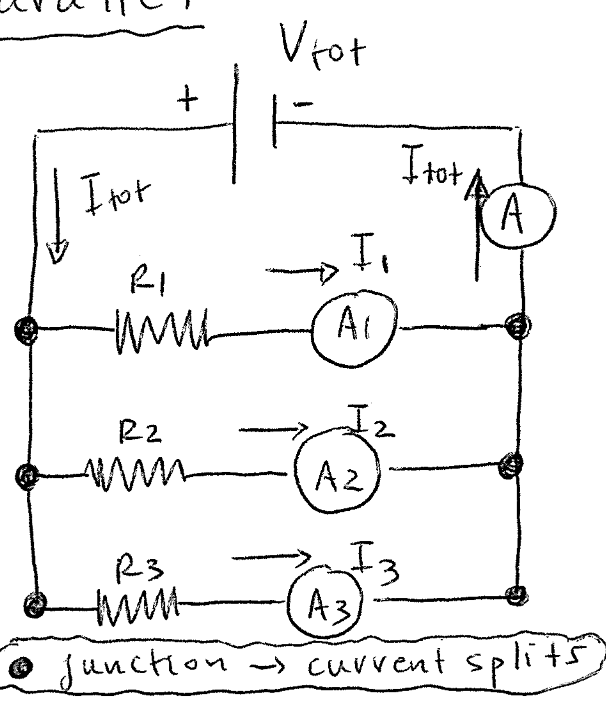
$R_{tot} = R_1 + R_2 + R_3$

* $R_{tot} > R_{(max)}$

* the greater the R_{tot} the lower the I_{tot}

Adding more resistors in series will result in the significant drop of the I_{tot} (circuit doesn't function)

Parallel



$I_{tot} = I_1 + I_2 + I_3$

$V_{tot} = V_1 = V_2 = V_3$

$$\frac{1}{R_{tot}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

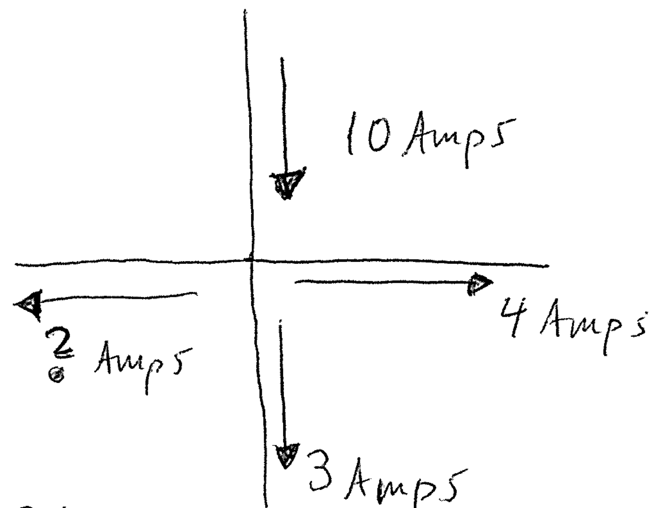
* $R_{tot} < R_{(min)}$

* the more resistors we add in parallel, the lower the R_{tot} and higher the I_{tot}. That can cause overloading (FIRE)

Conservation of Current

* the total current (I) that arrives at a junction, is equal to the total current (I) that leaves from the junction

ex.



Answer: 3 Amps

why?: (3 + 4 + 3) Amps = 10 Amps

Meters

(A) : Ammeter : connected in series
possesses zero or very low resistance

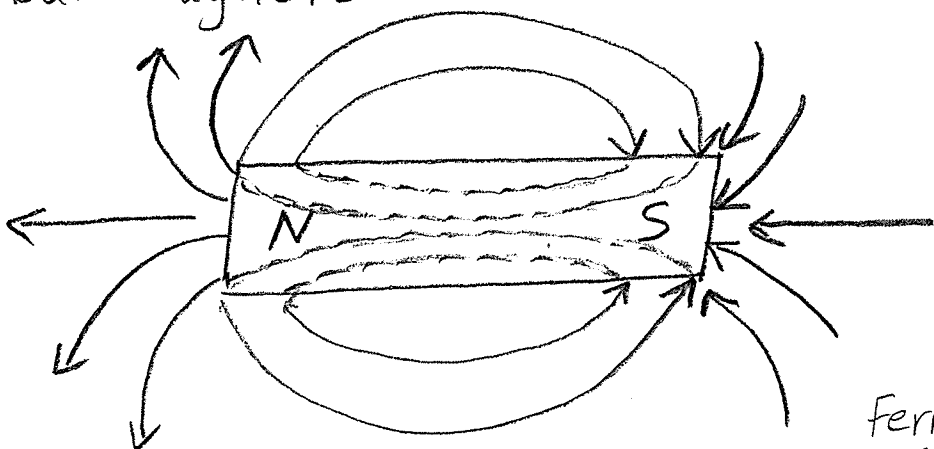
(V) : Voltmeter : connected in parallel
possesses infinite or very high resistance

Magnetism Review Notes

* Moving charges create Magnetism
* Natural Magnetism comes from spinning electrons in atoms
* Moving magnets create electric current

Magnetic Fields : regions where magnetic forces may be detected

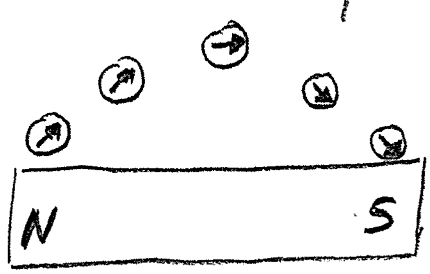
* Bar Magnets



Magnetic flux Lines : lines of magnetism in a magnetic field

Ferromagnetic Elements : Co (COBALT), Fe (IRON), Ni (NICKEL)

* the needles of a compass line up perfectly with the flux lines
* the arrows on a flux line show where the North Pole of a compass would point in the field

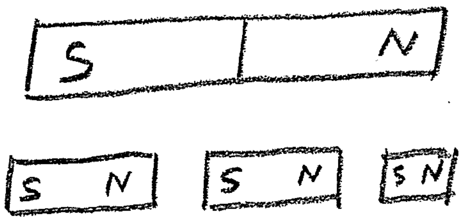


Flux arrows point "OUT OF NORTH INTO SOUTH"

Magnetic force is strongest at the POLES where flux lines are closest.

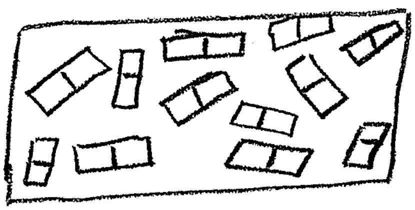
* Magnetic flux lines <u>never</u> cross and are closed loops that start from the NP to the SP and pass through,

Cutting Magnets → each piece is a brand new magnet



Magnets attract non-magnets

* Certain metals contain magnetic regions called domains. They are randomly orientated



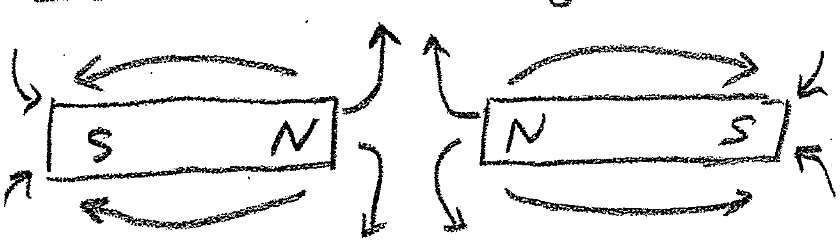
Domains are spinning electrons that create small magnetic fields and act like small magnets
The fields cancel eachother

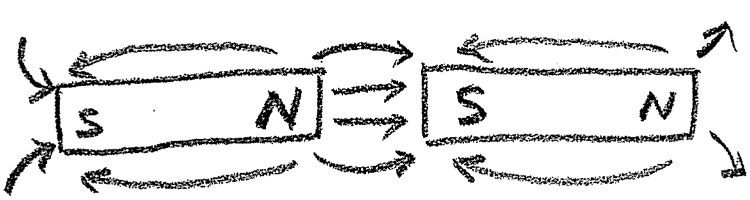
but when a bar magnet comes closer then →

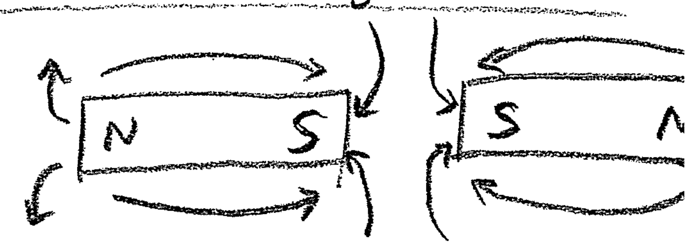
the magnetic domains line up with the magnet. The metal is magnetized

ex: paper clips attracted to a bar magnet.

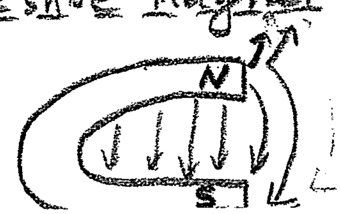
Magnetic Flux Lines between two magnets



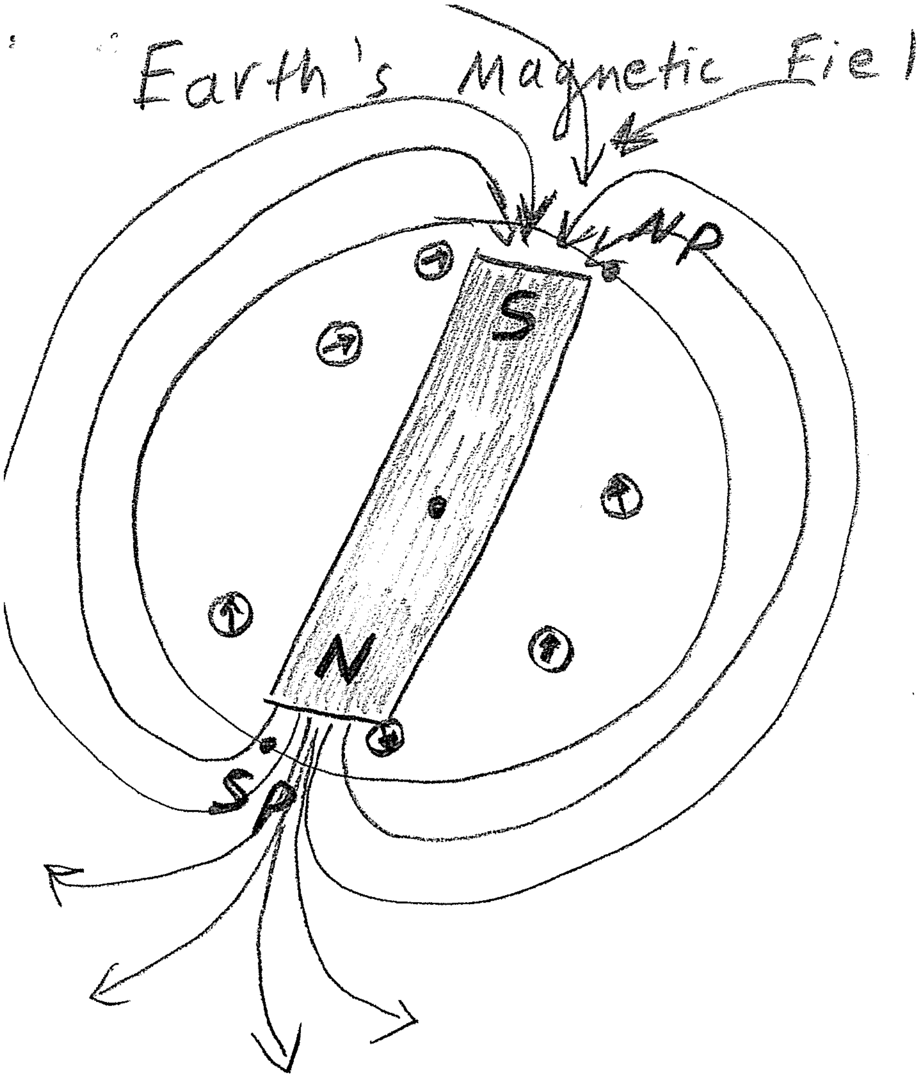




Horseshoe Magnet



Earth's Magnetic Field



A compass points to the North Geographic Pole which is close to the South Magnetic Pole.

Earth's Magnetic Field : Reversed Polarity

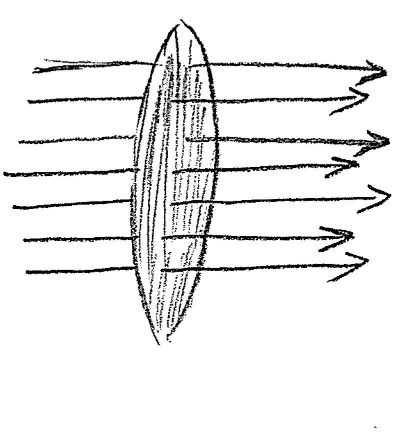
<u>Magnetic Fild strength</u> (B) is the number of magnetic flux lines per unit area passing through a plane perpendicular to the direction of the Lines

Unit : Teslas Type of Quantity : Vector

<u>Number of lines of flux</u>

Unit: Weber (Wb)

$$1 \text{ Tesla} = 1 \frac{\text{Weber}}{m^2}$$



<u>Electromagnetic Radiation</u> :

accelerating electric charges produce changing electric and magnetic fields

Waves: Disturbances that move through space or through a medium (material) and transfer Energy, **no** mass

Wave Classification:

Transverse: particles move perpendicular to the direction of the wave (up and down) ex light, ocean waves

Longitudinal: particles move parallel to the direction of the wave (side to side) ex sound,

Mechanical: Require medium (sound waves can not be transmitted in emply space)

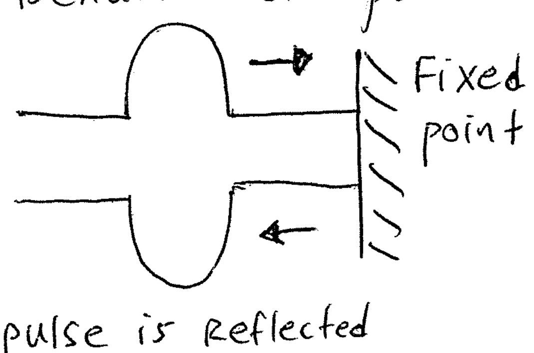
Electromagnetic: Do not require medium (light waves can travel through empty space)

| light waves | are transverse and electromagnetic

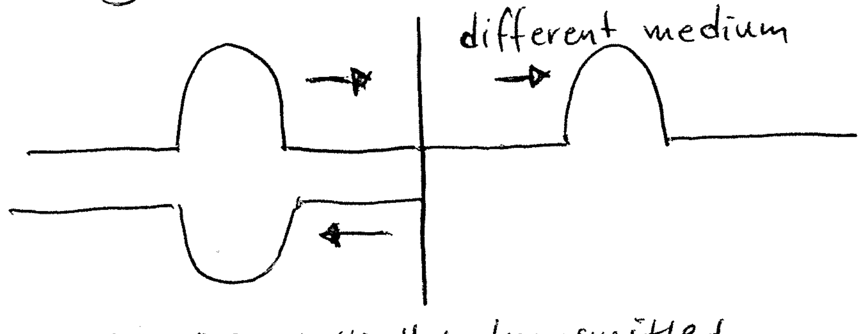
| Sound waves | are longitudinal and mechanical

Wave Pulses: single vibratory disturbances

Behavior of pulses



pulse is Reflected and inverted

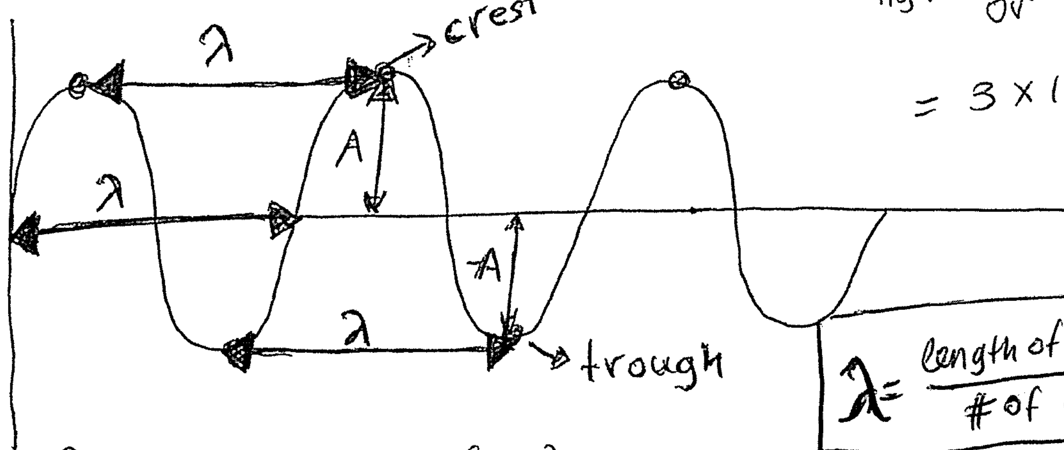


pulse is partially transmitted and partially reflected and partially absorbed

Waves / Characteristics

Types: A) Transverse (ex light)

V_{light} (in vacuum or air) $= 3 \times 10^8 \frac{m}{s}$



$\lambda = \frac{\text{length of wave train}}{\text{\# of cycles}}$

λ = wavelength (m)

f = frequency (Hz)

T = Period (T)

$f = \frac{\text{\# of cycles}}{\text{time}}$

$T = \frac{\text{time}}{\text{\# of cycles}}$

$T = \frac{1}{f}$ $\quad f = \frac{1}{T}$

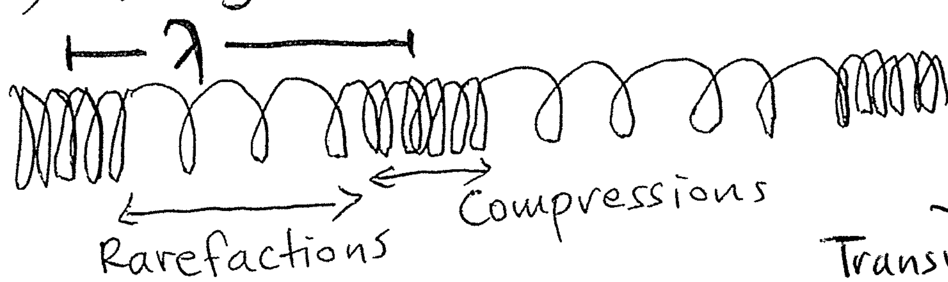
V = velocity of a wave ($\frac{m}{s}$)

$V = \lambda \cdot f$

$V = \frac{\lambda}{T}$

$V = \frac{d}{t}$

B) Longitudinal (ex sound)



V_{sound} (in air) $= 331 \frac{m}{s}$

Definitions of

Transverse waves: up and down

Longitudinal waves: side to side

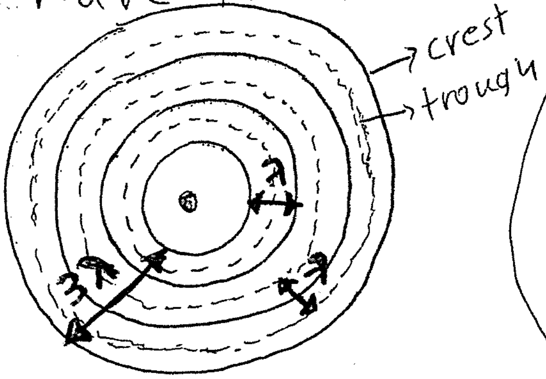
Mechanical waves: need medium

Electromagnetic waves: do not need medium

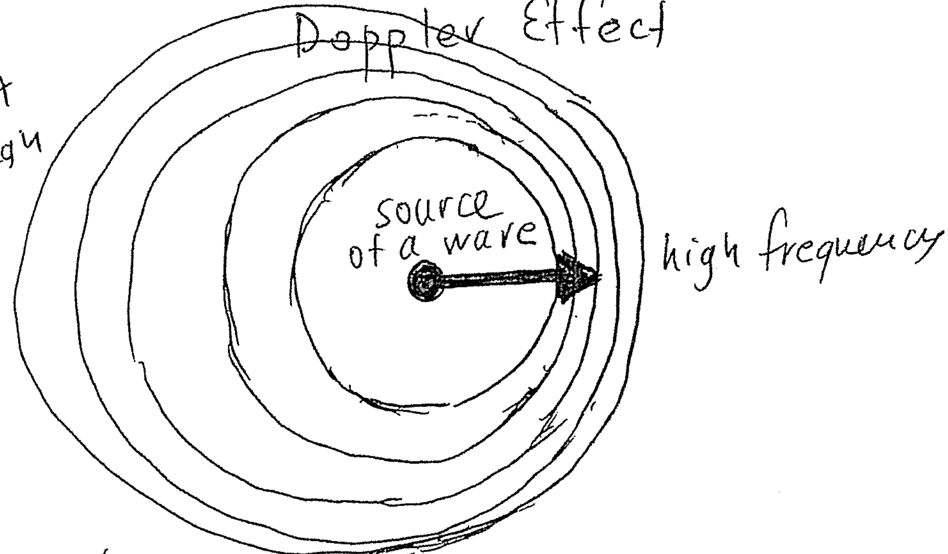
17

Wave Phenomena

Wave fronts

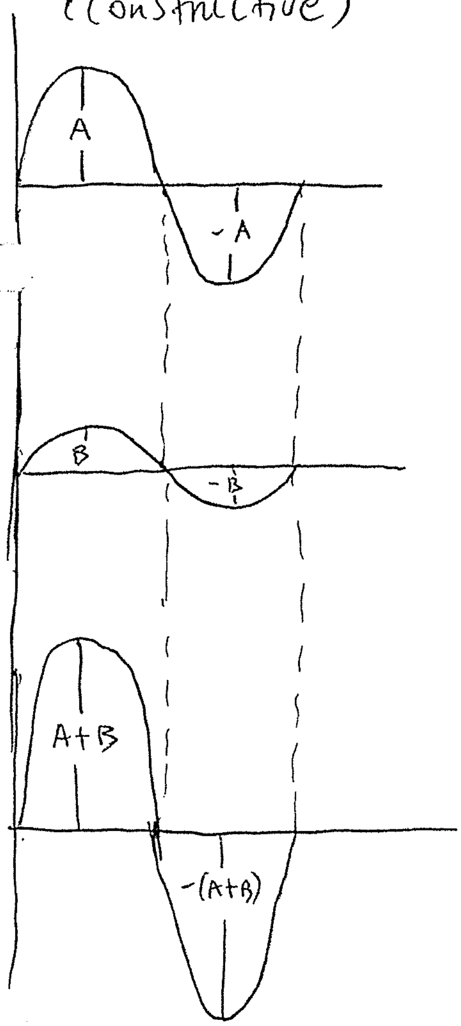


Doppler Effect

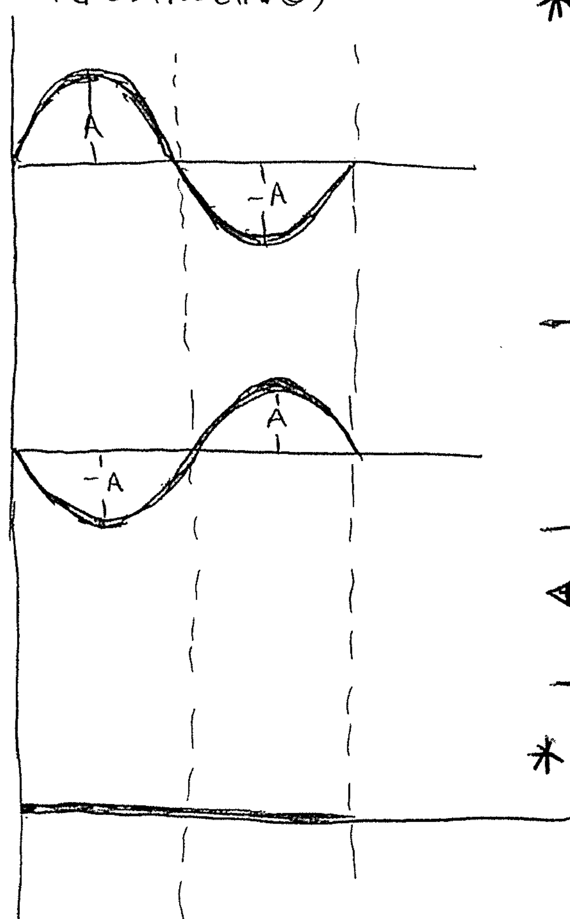


Interference

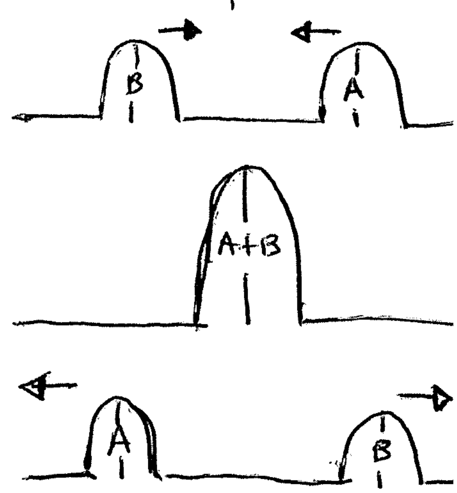
(constructive)



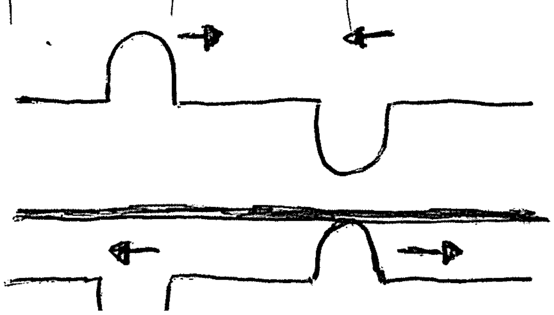
(destructive)



* more pictures on Interference with pulses



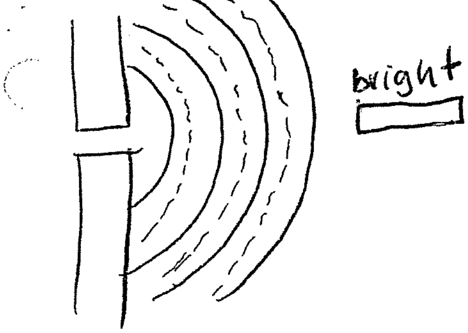
* Constructive



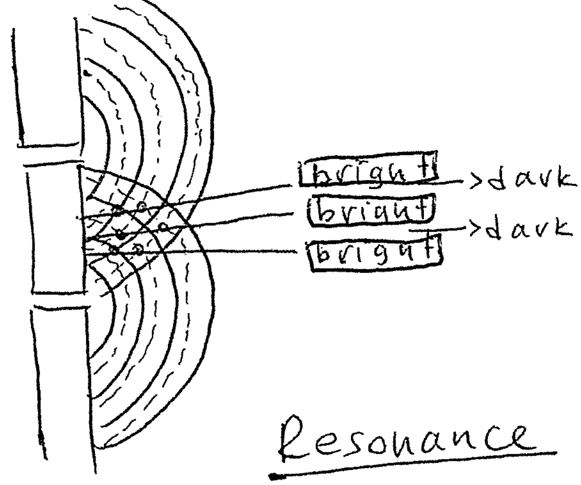
Destructive

↑ Principle of Superposition

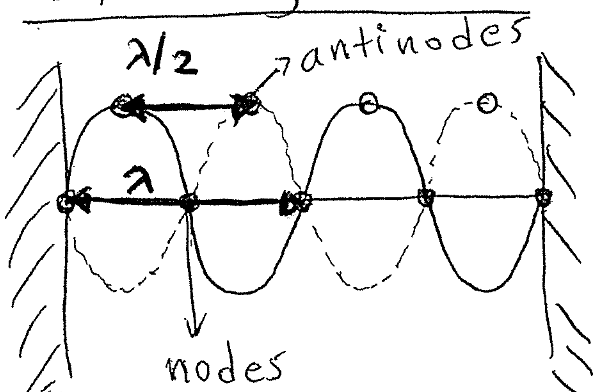
Diffraction



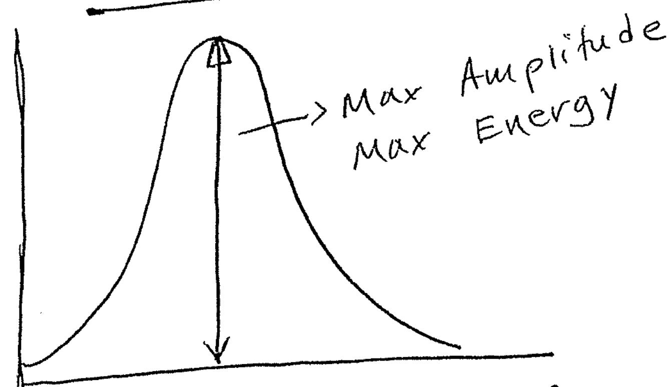
Double slit Diffraction



Standing waves



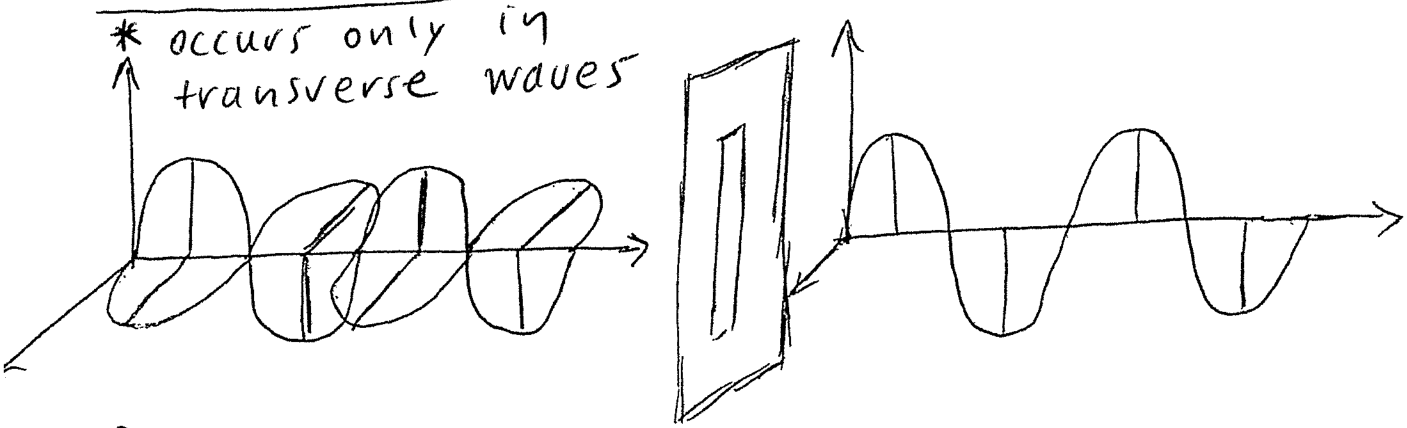
Resonance



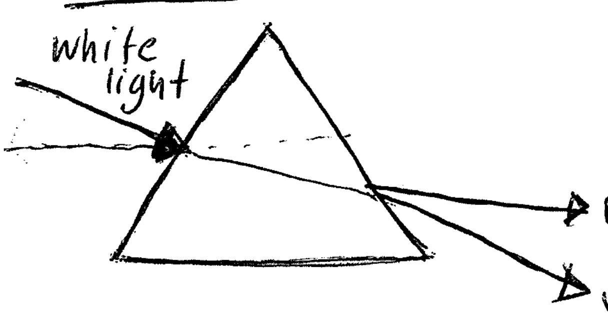
frequency of vibration = Natural frequency of the object

Polarization

* occurs only in transverse waves



Disspersion



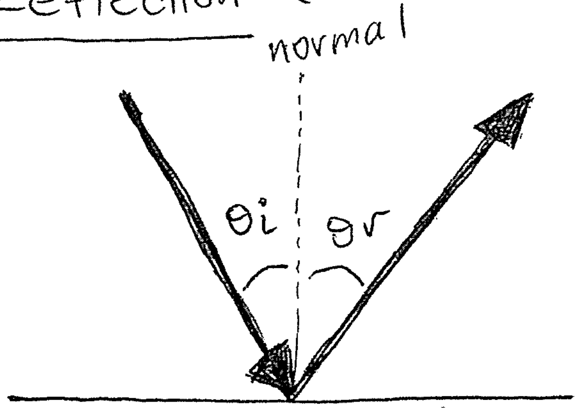
red (fastest color – bends the least)

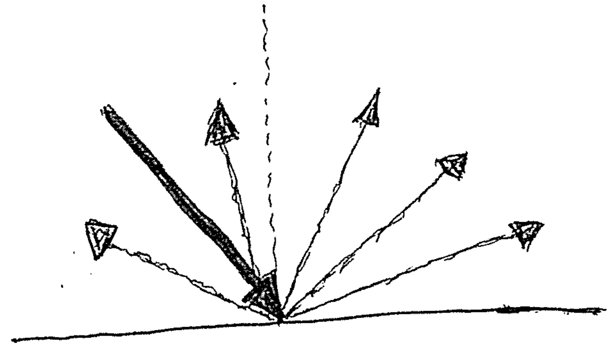
violet (slowest color – bends the most)

red → big λ → big V

violet → small λ → small V

Reflection (makes a V)





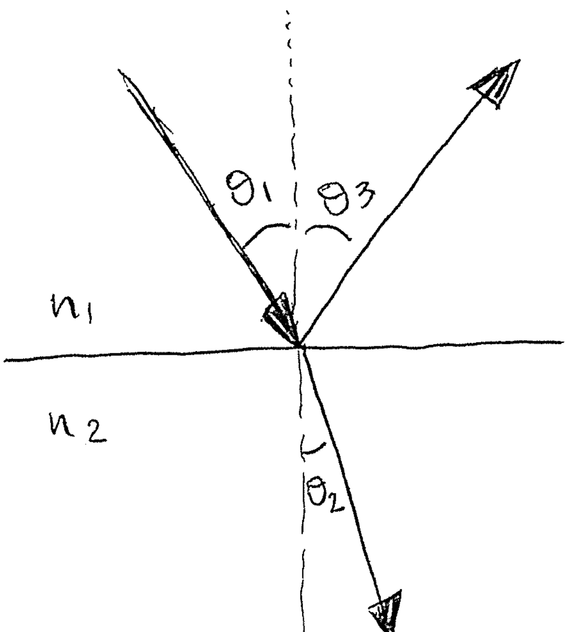
Random or Diffuse Reflection

θi = angle of incidence

θr = angle of reflection

$\theta i = \theta r$: Law of Reflection

Refraction



θ_1 = angle of incidence

θ_3 = angle of reflection

θ_2 = angle of refraction

n : index of Refraction (see R.T.)

$n = \frac{c}{v}$ c: speed of light in vacuum or air ($3 \times 10^8 \frac{m}{s}$)

v: speed of light in a different medium

$\theta_1 = \theta_3$ (θ_3: Reflected Ray)

Snell's Law

$n_1 \sin\theta_1 = n_2 \sin\theta_2$

if $n_2 > n_1$ medium 2: slow, medium 1: fast

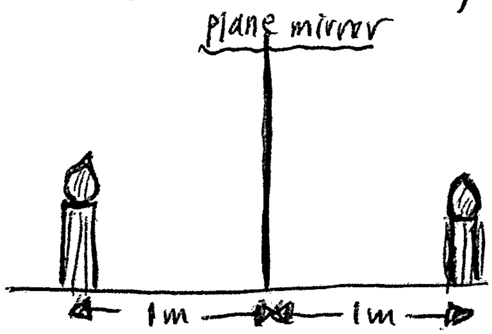
$\theta_2 < \theta_1$ Refracted Ray bends towards the normal

if $n_2 < n_1$ medium 2: fast, medium 1: slow

$\theta_2 > \theta_1$ Refracted Ray bends away from the normal.

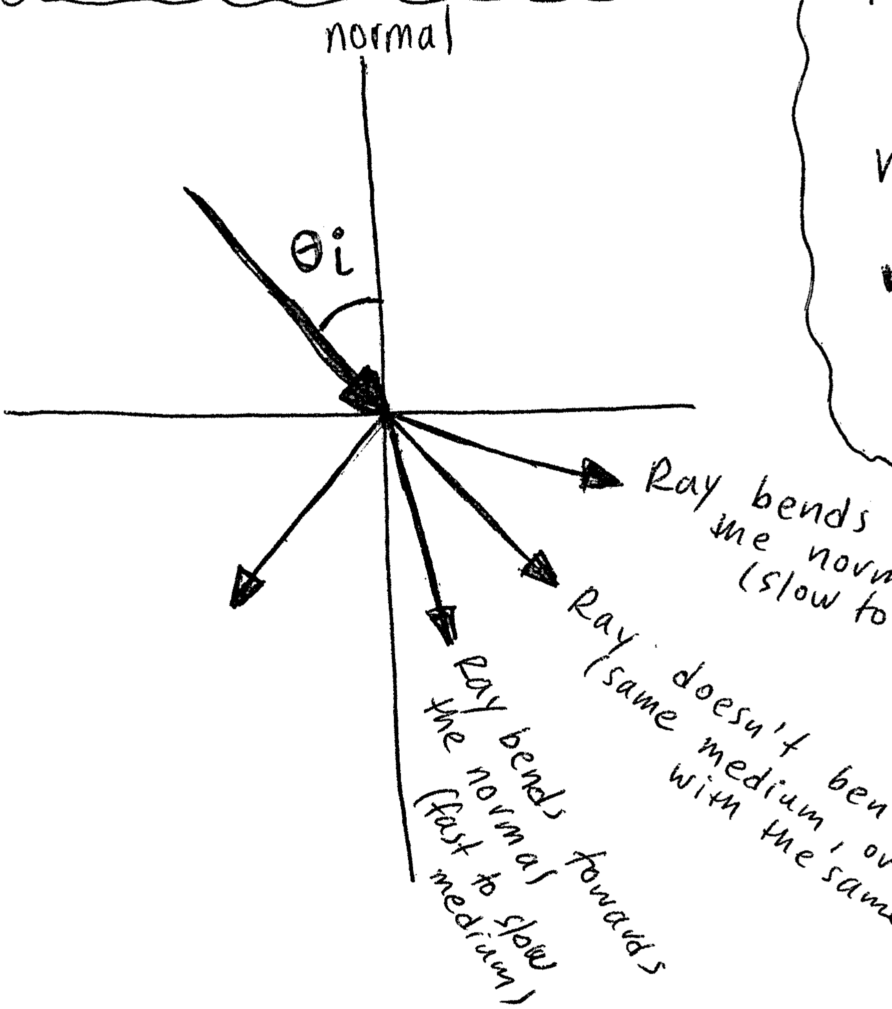
More on Reflection

* Plane mirrors do not produce a real image. Image is virtual, upright, same size as object and is found behind the mirror, equal distance as the object from the mirror



* A person with a certain height h needs a mirror **half** his size to see his whole body reflection in the mirror

More on Refraction



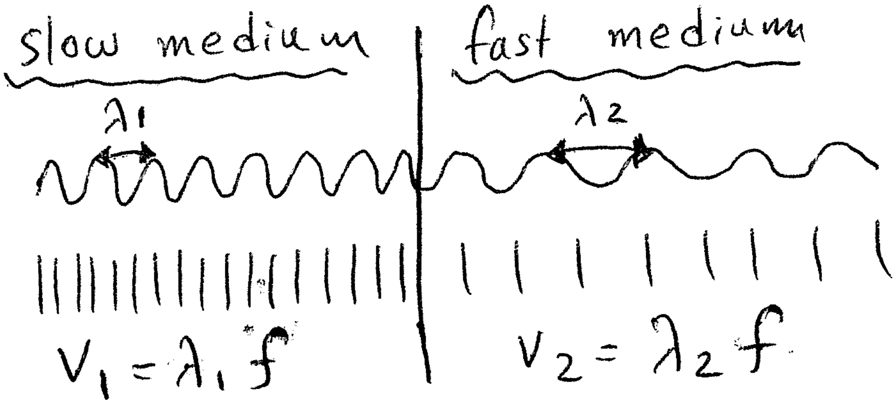
Relationship between n and V

$n = \frac{c}{V}$ $V = \frac{c}{n}$

* During Refraction → frequency doesn't change

* color doesn't change

if V increases then ($V = \lambda f$) λ increases as well



if $V_2 > V_1$ then $\lambda_2 > \lambda_1$

$$\frac{n_2}{n_1} = \frac{\frac{c}{V_2}}{\frac{c}{V_1}} = \frac{V_1}{V_2} = \frac{\lambda_1}{\lambda_2}$$

*equations used when n's and V's are given or n's and λ's

More on Wave Phenomena (Definitions)

Doppler Effect: variation in the observed frequency of a wave when there is relative motion between the source of the wave and the receiver

Interference: effect produced by two waves passing simultaneously through a region

Diffraction: the spreading out of a wave into the region behind an obstacle

Standing waves: waves produced when two waves of the same frequency and amplitude travels in opposite directions in the same medium

Resonance: The building up of energy by adding small amounts of energy in time with the natural frequency of an object

Modern Physics

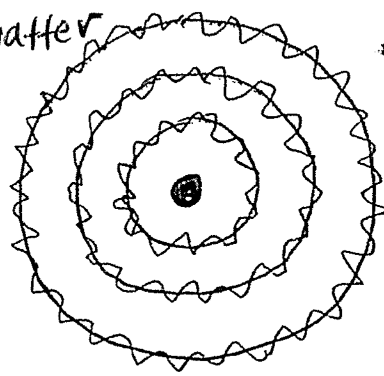
light

→ wave ↓
- Diffraction
- Doppler Effect
- Standing waves
- Resonance
- Interference

→ particle ↓
- Photoelectric Effect
- Compton scattering.

DeBroglie Waves

* (electron waves)
or matter



$$\lambda = \frac{h}{P}$$

or

$$\lambda = \frac{h}{mv}$$

Bohr's Model

$$E_{(electron)} = hf \text{ (eV)}$$

(eV) $\xrightarrow{\times 1.6\times10^{-19}}$ Joules

(eV) $\xleftarrow{\div 1.6\times10^{-19}}$ Joules

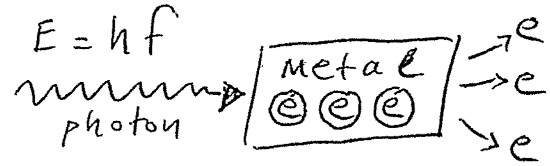
$$f = \frac{E \text{ (Joules)}}{h \text{ (J·s)}} \Rightarrow \text{(Hz)}$$

Energy of a photon

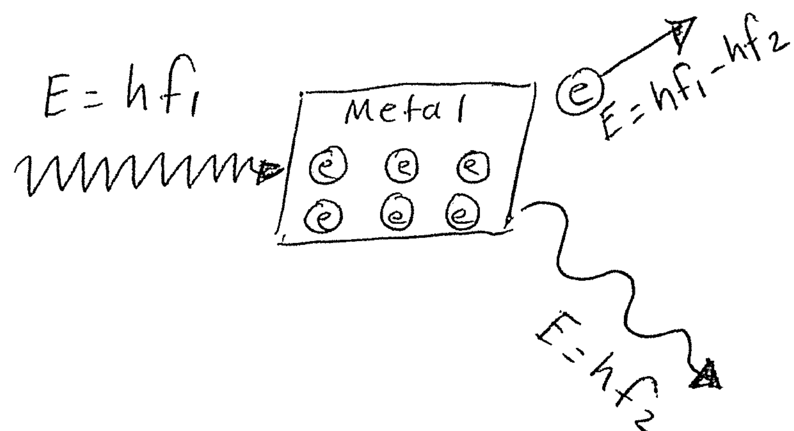
$$E = hf = \frac{hc}{\lambda}$$

h: Plank's Constant
6.63×10^{-34} J·s.

Photoelectric Effect



Compton Scattering



$$E = mc^2$$

$m \rightarrow kg \quad c^2 = 9\times10^{16}\ \frac{m^2}{s^2}$

$E \rightarrow$ Joules

$1 \text{ amu} = \frac{1}{12} \text{ of } {}^{12}_{6}C = 9.31\times10^{2} \text{ MeV}$

Binding Energy = Mass Defect * c^2

Strong (Nuclear Force) → strong (short range) force that holds the nucleons together (protons and neutrons)

* strong Force is 100 x stronger than Electrostatic Force and 10^{38} x stronger than Gravitational Force.

Standard Model (Classification of Particles) (see R. T)

Hadrons → Baryons (ex proton (uud), neutron (ddu) 3 quarks in each baryon
→ Meson (ex $u\bar{d}$, $s\bar{c}$ 1 quark and 1 anti-quark)

Leptons → electron (e), positron ($\bar{e}$)

All hadrons or leptons have a charge that is a multiple integer of the elementary charge (e)

* $e = 1.6 \times 10^{-19}$ C

Only quarks have a charge that is a portion of the elementary charge (ex $+\frac{1}{3}e$ or $-\frac{2}{3}e$) but quarks can not be found free in nature. They always come in a packet of three or two.

a packet of 3 quarks is a baryon

a packet of 2 quarks (quark + antiquark) is a meson

Neutrons and neutrinos are neutral. Their antiparticl have an opposite spin.

Antiparticles have the same symbol as the corresponding particles, they take a bar (–) on top ex p and $\bar{p}$ (proton and antiproton)

UNITS

U : velocity – ($\frac{m}{s}$)
a : acceleration – ($\frac{m}{s^2}$)
d : dispacement – (m)
F : force – Newton = (kg · $\frac{m}{s^2}$)
m : mass – (kg)
μ : coefficient of friction (no unit)
g : gravitational acceleration or gravitational field strength – (9.8 $\frac{m}{s^2}$)
p : momentum – (kg · $\frac{m}{s}$ or N · s)
J : impulse – (N · s or kg · $\frac{m}{s}$)
K : spring constant – ($\frac{N}{m}$)
KE : Kinetic Energy (J) – Joule
PE : Potential Energy (J) – Joule
W : Work (J) – Joule
P : Power (Watt)
E_T = total energy (J) – Joule
Q = Internal energy (J) – Joule
F_e = Electrostatic force (N)
E = Electric Field strength ($\frac{N}{C}$)
V : Potential Difference (V) – Volt
I : Electric Current (A) – Ampere
R : Resistance (Ω – Ohms)
ρ : resistivity (Ω · m)

Q : charge (C) Coulomb
f : frequency (Hz)
λ : wavelength (m)
T : period (sec)
n : index of Refraction (no unit)
C : 3×10^8 m/s

* **Vector Quantities**

velocity
displacement
acceleration
force / weight
Impulse
momentum
Electric field strength

* **Scalar Quantities**

Speed
distance
mass
frequency
period
energy / work
power

$1 \text{ Joule} = 1 \text{ N} \cdot \text{m} = 1 \text{ kg} \frac{\text{m}}{\text{s}^2} \text{m} = 1 \text{ kg} \frac{\text{m}}{\text{s}^2}$

$1 \text{ kg} \frac{\text{m}}{\text{s}} = 1 \text{ N} \cdot \text{s}$

$1 \text{ Watt} = 1 \frac{\text{Joule}}{\text{sec}} = 1 \frac{\text{N} \cdot \text{m}}{\text{sec}} = 1 \text{ kg} \frac{\text{m}}{\text{s}^2} \frac{\text{m}}{\text{s}} =$

$= 1 \text{ kg} \frac{\text{m}^2}{\text{s}^3}$

Inertia (no units) ~ Mass (kg)

$1 \text{ Amp} = 1 \frac{\text{Coulomb}}{\text{sec}}$

$1 \text{ Volt} = 1 \text{ Amp} \cdot \text{ohm}$

$1 \text{ Volt} = 1 \frac{\text{Joule}}{\text{Coulomb}}$

$1 \text{ Watt} = 1 \text{ Volt} \cdot \text{Amp}$

$1 \text{ Hz} = \frac{1}{\text{sec}}$ $\quad 1 \text{ sec} = \frac{1}{\text{Hz}}$

$\frac{\text{m}}{\text{s}} = \text{m} \cdot \text{Hz}$

$1 \text{ Joule} = 1 \text{ kg} \frac{\text{m}^2}{\text{s}^2}$

$1 \text{ Joule} = 6.25 \times 10^{18} \text{ eV}$ $\quad 1 \text{ C} = 6.25 \times 10^{18} \text{ e}$

$1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$ $\quad 1 \text{ e} = 1.6 \times 10^{-19} \text{ C}$

$1 \text{ u} = 9.31 \times 10^{2} \text{ MeV}$