* Math Review *

* PEMDAS :- Par., Expo., Multi., Divi., Add., Sub

* Per Centage % : Calculator (number (2nd) (قوص (enter) =)

جزء Rule

1) If % found → multiply and Div. / 100.
2) If No % → Divide and multiply × 100.

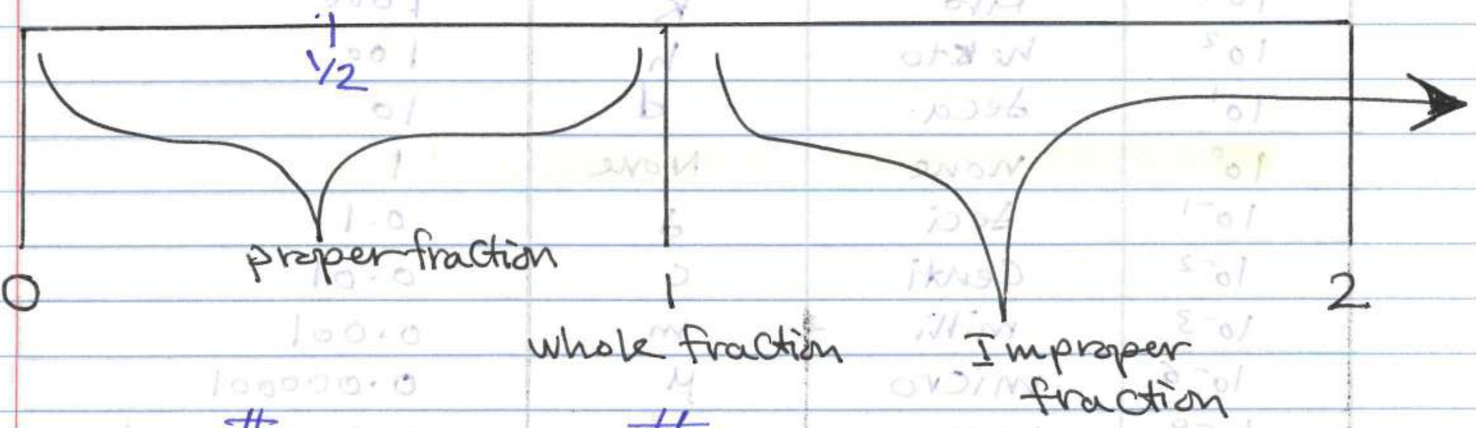
∴ $\frac{\text{Part}}{\text{total}} = \%$

- Part = 60, total = 80 so $\% = \frac{60}{80} \times 100 = 75\%$
- % = 40 and total = 15 so $\frac{40 \times 15}{100} = 6$.

* to Convert from % form to Decimal form:- Just move the point 2 places left.

35.0 % = 0.35

* fractions:-



$\frac{\#}{\#\#}$ $\frac{\#\#}{\#\#}$ $\frac{\#\#}{\#}$

proper < whole fraction < Improper

$1/5$ $2/2$ $5/4$

* Scientific and Engineering notation:-

- scientific conv.: move the point one by one.
- Engineering conv.: " " " in groups of 3.

number	sci. notation	Eng. not	syntax	
35760.0	3.576×10^4	35.76×10^3	35.76 K	35.76 E
0.35287	3.5287×10^{-1}	352.87×10^{-3}	352.87 mill	352 E
0.0000002	2×10^{-7}	200×10^{-9}	200 nano	200 E

10^n	prefix	symbol	Decimal
10^9	giga	G	1 000 000 000
10^6	mega	M	1 000 000
10^3	kilo	K	1000
10^2	hekto	h	100
10^1	deca	d	10
10^0	none	None	1
10^{-1}	deci	d	0.1
10^{-2}	centi	c	0.01
10^{-3}	milli	m	0.001
10^{-6}	micro	μ	0.000001
10^{-9}	nano	n	0.000000001
10^{-12}	pico	p	0.000000000001

* scientific not. on Calculator:

6.0221×10^{23}

$\Rightarrow$

$6.0221 \boxed{\times 10^n}\ 23 =$

* Unit Conv. <u>important</u>

Length	
1 inch = 2.54 Cm	1 mile = 1.609 Km = 1609 m
1 ft = 30.48 Cm	1 Km = 1,000 m
1 mile = 5280 ft	1 ft = 12 inch
1 yard = 3 ft	1 meter = 100 Cm

Volume	
1 L = 1000 mL	1 gallon = 3.78 L
1 m^3 = 1000 L	1 L = 1000 Cm^3
1 L = 1.06 qt	1 L = 1 dm^3
qt = 61.02 m^3 = 0.035 ft^3	1 L = 0.26 gallon

Mass	Pressure
1 Kg = 2.2 Lb	1 atm = 14.7 psi
1 Lb = 454 gm = 16 oz	1 psig + 14.7 = psia
1 Kg = 1000 gm	1 atm = 760 mmHg = 30 in.Hg = 760 torr
	1 atm = 101325 pa = 101 kpa
	1 atm = 1.01 bar

Density of water	Energy
1 gm/Cm^3 = 1.94 Slug/ft^3	1 Cal = 4 Joule

Temprature
$C = F - 32° / 1.8$
$K = C° + 237$
$R = F + 460$

* statistics : mean, median, mode
  - $\bar{x}$ • mean : average (إجمع وأقسم على العدد).
  - • median : middle value (لو العدد زوجي: الأتنين اللي في النص إجمعهم وأقسمهم على 2
  - • mode : most Repeated,

$\therefore$ 1, 8, 3, 2, 6 $\xrightarrow{\text{arrange}}$ 1 2 3 6 8

mean = 4

median = 3

mode = Zero (no mode).

---

* Geometric equations :-

		sq.ft or sq.in		
shape	perimeter	Area	Volume	Dim.
square rectangle	$2L + 2W$	$L \times H$	$L \times W \times H$	2D
Circle	$\pi d = 2\pi r$ Circumference	πr^2		2D
triangle	$a + b + c$	$\frac{1}{2}$ base $\times h$		2D
Cylender			$\pi r^2 h$	3D
Sphere			$\frac{4}{3}\pi r^3$	3D
cone			$\frac{1}{3}\pi r^2 h$	3D

---

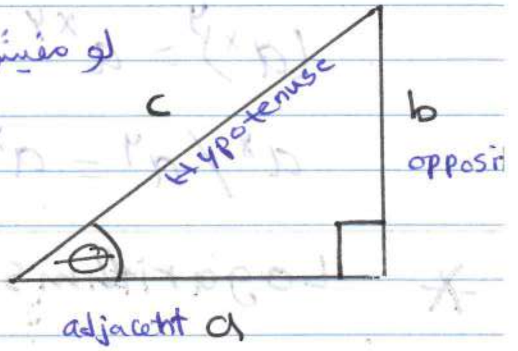
* Quadratic equation. $ax^2 + bx + c = 0$

$$x_1, x_2 = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

* Pythagorean equation :- مثلثات

* $a^2 + b^2 = c^2$ ← لو مفيش زوايا

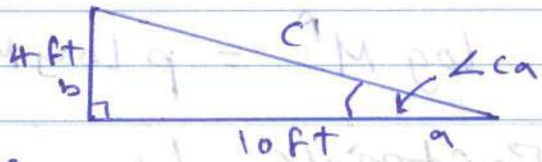
لو عندك زوايا
$$\begin{cases} \sin\theta = \frac{b}{c} = \frac{opp.}{Hyp.} \\ \cos\theta = \frac{a}{c} = \frac{adj.}{Hyp.} \\ \tan\theta = \frac{b}{a} = \frac{opp.}{adj.} \end{cases}$$



* Examples :- (applications)

1 Ramp angle

- Find the angle
- we have opp, adjacent
- So we use tan. of angle

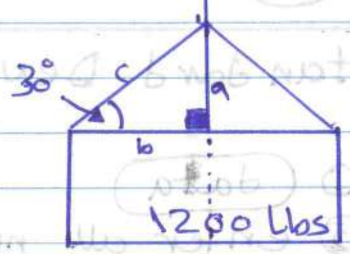


$\therefore \tan\angle ca = \frac{4}{10} = 0.4$

$\therefore \tan^{-1}(0.4) = 21.8^\circ$ The angle itself.
$\simeq 22^\circ$

2 tention on Slings

- weight = 1200 lbs.
- angle = 30°
- 2 Slings, find tention.



∴ Devide wt / number of Slings = 600 lbs
∴ wt @ side a = 600 lbs

$\sin 30^\circ = \frac{600}{c}$ ∴ $c = \frac{600}{\sin 30} = \frac{600}{0.5} = 1200$ Lb.

So, tention = 1200 Lb.
on each Sling

(F1)

* exponents: Laws of exponents

$a^x \times a^y = a^{x+y}$ $(a \times b)^x = a^x + b^x$

$(a^x)^y = a^{xy}$

$a^x / a^y = a^{x-y}$

Boolean algebra

---

* Logarithms:- laws of logarithms.

$\log (M \times N) = \log M + \log N$

$\log M/N = \log M - \log N$

$\log M^p = p \log M.$

---

* Factorials !:- on calculator.

(number !) (prob.), choose 3:! (enter.)

---

* euler no and neutral log:-

(e) —— عكس (ln)

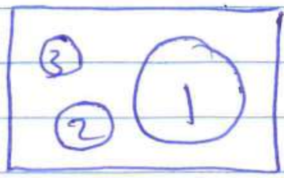
---

* Standard Deviation, mean, median on Calculator (for one var.)

① (data)
② enter all numbers needed.
③ (2nd) (data) stat
④ choose 1-Var stats + enter
⑤ move to CALC + enter
⑥ choose result. → Sx : sample deviation
⇒ σx : standard deviat

***notes:-**

* Calculating Dike height *



worst case scenario

Steps:-

1- only Biggest Tank to be calculated.
2- If no safety factor $\therefore V = V$
   If safety factor $\therefore V \times SF$ ض الرقم

3- Substract the ② ③ areas neglected from whole area.

4- area available $= \pi r^2 \to ①$
$\pi r^2 \to ②$ +

$\therefore$ total $-$ (①, ② area)

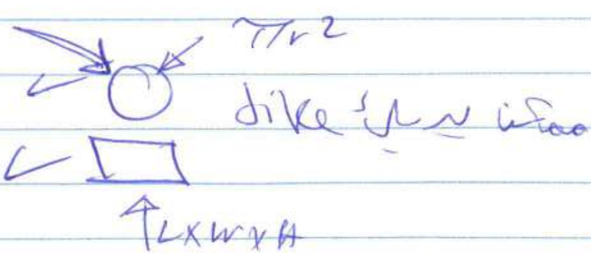
5- $V_1 = V_2$

$\underset{\text{Tank}}{\pi r^2 H} = \underbrace{L \times W}_{\text{area}} \times H$ dike

$(L \times W - 2 \text{ tanks area}) \times H$

$\therefore H = \dfrac{\pi r^2 H}{L \times W \text{ final after substract 2 Tanks.}}$

* ملاحظة :



* Chemistry *

* **Density, sp-gravity:-**

water density $= 62.4\ lb/ft^3$
$= 1\ gm/cm^3$

- Density $(\rho) = \frac{mass}{Volume} = \frac{m}{V}$
- Sp. Gravity $= \frac{\text{mass of solid or liquid}}{\text{mass of eq. volume of water}}$

  if sp > 1 Sink
  sp < 1 Float

- number of moles $= \frac{wt}{M.wt}$

  gm mole $= \frac{\text{mass in grams}}{M.WT}$

  Pound mole $= \frac{\text{mass in pound}}{M.wt}$

at.wt. of
Na = 23
C = 12
O = 16
H = 1
N = 14

∴ To find sp-Gravity, 1st find weight by no of moles, M.Wt
2nd, apply Sp. Gr. or Density equation.

- Calculate % by weight :-

$$\frac{gm}{m.wt} \times 100 = \%$$

- Molarity (M) $= \frac{\text{Moles of Solute}}{\text{Liter of solution}}$

- steps for solving Chemical Questions.
  1- Balance Chemical equation
  2- get M.wt
  3- get no of moles
  4- Continue with equations mentioned.

- gas laws :-

- BOYLE's law $P1V1 = P2V2$
- CHarles' law $V1/T1 = V2/T2$
- Gay lussac $P1/T1 = P2/T2$

Combined gas law

$\therefore \frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

or: $P_1V_1T_2 = P_2V_2T_1$

- Ideal gas law :-

$$PV = nRT$$

- Thermal units Conversion :-

$R = F° + 460$ $K = C° + 273$ $C = \frac{F° - 32}{1.8}$

* note : when mentioned STP, make sure to Convert T, P to K or R, 1atm.

- Psig + 14.7 = psia.

---

* Convert ppm to mg/m^3 :-

$$ppm = \frac{mg/m^3 \times 24.45}{m.wt}$$

$$mg/m^3 = \frac{ppm \times M.wt}{24.45}$$

---

* atomic No :- protons
* atomic mas :- protons + neutrons
* Isotopes : same atomic no, diff atomic mass. (protons equal, neutrons different).
* Mole : the avogadro's no = 6.023×10^{23}.

* Valence, Chemical Bonding :-
  * Ionic Bonds :- أيونية
    one or more valence elec transfered from 1 atom to another
    -> atom lost elec. become +ve Charged. (+ve ion)
    -> atom gained elec. become -ve Charged. (-ve ion)
    -> Strong elec force (Ionic Bond) is been developed
    Sodium, Chlorine -> sod. Chloride.

* Covalent Bond :- آصرة تساهمية
→ atoms (Share) valence electrons to complete in valence shell of each.
→ Type of Bonding is called Covalent.
ex :- $H_2, O_2 \rightarrow H_2O$
∴ Ionic : lose and gain electrons.
Covalent : Share electrons.

∴ Covalent bond weak than Ionic Bond.

* Isomer : substance that have same no of atoms of each element per molecule / but different in spiral arragemt of atoms.

* Oxidation : loss of electrons in chem. reaction
* Reduction : gain of electrons " " "
Redox Reactions :-
- $Fe \longrightarrow Fe^{+2} + 2$ electrons (oxidation)
- $Cl_2 \xrightarrow{+2e} 2Cl^-$ (reduction)

* Molarity :- no gram moles solute / Liter Solution
* Mole fraction : no moles solute / sum mole solute and solvent.
→ $Y_A = \dfrac{n_A}{n_t}$

y_A = mole fraction total
n_A = no component 1
n_t = total no of moles

* / ركز ع هاده mole fraction , partial pressure
طريقة الحل :- Cal. no of moles
Cal. mole fraction $y_A = \dfrac{n_A}{n_{t}}$
Cal. $P_A = Y_A \times P_T$

* vapor pressure:-
V. press. of liquid, pressure exerted by vapor when liquid and vapor phases reach equilibrium.
→ vp ↑ as temp ↑.

* Heat of vaporization; amount of heat req. to ~~melt~~ vaporize 1 unit mas of ~~solid~~ liquid to ~~melt~~ boiling pt. w/o change temp.

* Heat of fusion; amount heat req. to melt 1 unit mas of solid to melting. point w/o chge temp.

* Heat of Sublimation; solid to vapor w/o chge temp.

⇒ Heat sublimation = fusion + vaporization

* Compressible fluids:- volume changes significantly with chge in P or T (gases)

* incomp. fluids:- volume doesn't chage with P or T (liquids)

* Mixture density:-

$$\frac{1}{\rho} = \frac{x_1}{\rho_1} + \frac{x_2}{\rho_2}$$

x_1 = mass fraction
ρ = density

then ρ of mix = $1/\rho$ v. stao.
في آخر

* Partial pressure:-

$$P_A = y_A P_t$$

→ mole fraction
total press

$6.023 \times 10^{23} \times \frac{\cancel{gm}}{wt}$ ⟸ عدد ذرات الغاز *
avogadro

* Electrical Safety *

① Fundamentals of electricity.
- ohms law (current - volt. - Resistance). + power.
- current density.
- Heating.
- Arching
- Classification of electrical systems.
- circuits. (Resistors, capacitors.

2) Electrical ~~Power~~ Hazards:. BSAFE

③ Controls of electrical Hazards:
* physical controls
(wiring, location, conduits and covers, sealed eq. proper connections, isolation, Double insulations.).
* over current Devices. (fuses, CB).
* switching Devices (LO/TO, interlocks).
* Grounding and Bonding.
* GFCI.
* AFCI.
* Low voltage
* warnings.
* procedures.
* Smart integrated circuits.

④ power generation and Distribution.

⑤ static electricity.

⑥ Hospital patients.

⑦ lightning.

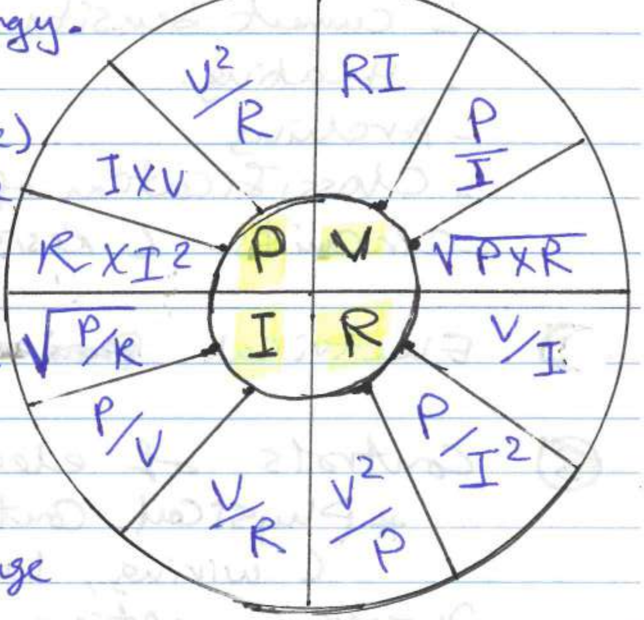
⑧ Batteries charging (Lead + others.).

* References.

* fundamentals of electricity *

* Ohm's Law *

- Defines the flow of electrical energy.
- The electron flow (current) is a function of elec. potential (voltage) between 2 points and the resistance between them.

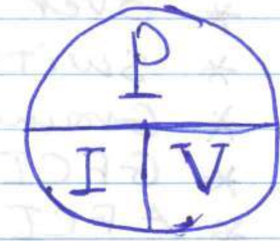


- I. amperes $\quad I = V/R$
- V. Voltage. $\quad \text{current} = \frac{\text{elec. potential}}{\text{Resistance}}$
- R. ohms.

- electrical power (P):- watts
  The rate of energy lost by a charge moving through a pot. difference.

- so,

and



- Electricity:- current flow, time determine the exten' of Injury from electrical shock:,
  1- Amount, magnitude.
  2- Route through the body.
  3- time of contact.

- Resistance:-
  - materials allow electrons to flow are conductors
  - Insulators, materials don't allow the flow

examples:-

Conductors	Insulators
copper	rubber
water	wood, plastics.
electrolytic fluids	glass
	air, gases

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

* electro-magnetic series:- Ag → Cu → Au → AL.

High current also heat up

* Heating (The relation between Resistance and power)

* Joule's law *

- a material creating resistance to electron to flow ~~...~~ Introduce heating (the amount of heating or temp. of conductor increases as current increases.)

watts $P = I^2 \times R$.

• note :- any metal in magnetic field, including jewelry worn by someone, will heat up.

* Arcing :-

- it occurs when current flow through air between two conductors. that in non-direct contact. arc produce light as electrons move across the gap between 2 conductors.
- Arching is function of voltage between conductors,

* Classification of electrical systems :-

based on voltage, current and hazard pot., electrical systems classified to $\boxed{DC, AC}$.

DC uniderctional flow of electron charge.

AC Reversible direction of electron charge.

• note :- AC is more safe than DC.

* Calc ohm's values in DC, AC :-

• voltage
- DC : $V = IR$
- AC : $V = \sqrt{\frac{PI}{\cos \phi}}$, ϕ is phase angle.

• power
- DC : $P = IV$
- AC : $P = \frac{V^2 \times \cos \phi}{R}$

• Resistance.
- DC : $R = \rho \, L/A$
- AC : $I = \frac{V}{A} = \frac{\text{Volts.}}{\text{Amp}} = I$ impedance Ω

Electrical HaZards
BSAFE

* **Burns:-** Shock Related - non Fatal Injury.
  - Three types:-
    Heats lowly → - electrical burns: elec current pass through tissue
    - Arc burns: not nec. direct contact
    - Thermal contact burns: skin touch hot surface of overheated elec. conductor energized eqp.

* **Electrical shock:-**
  - Current passing over or through human body or its members.
  - a body should be a part of an electrical circuit. (become a conductor between two points of potential difference).

  - electrical current on human body effect table.

Summary NIOSH

- < 1 mA : Generally not perceptible.
- 1 mA : faint Tingle
- 5 mA : slight shock (can let go).
- 6-25 mA : painful shock / paralysis
- 9-30 mA : Can't let go
- 50-150 mA : Can cause heart fibrillation

* **Arc-Blast:-** Can Result in:-
  1. Thermal Radiation (Heat) Can Cause burns.
  2. High voltage arc produce pressure wave blast
  3. " " " cause copper and Al metals to melt

* **Electrical Fires:-**
  Defective or misused elec. equipment is major cause of electrical fires.

* Circuits (series + parallel) *

Resistors Ω	elements to resist the flow of current at known measurement	Series circuits	$R_s = R_1 + R_2 + \dots + R_n$
		parallell circuits	$1/R_p = 1/R_1 + 1/R_2 \dots + 1/R_n$
Capacitors or condensers (Farads)	store energy and produce mech. force bet. conductors	Series	$1/C_s = 1/C_1 + 1/C_2 \dots$
		parallel	$C_p = C_1 + C_2 + \dots$
Inductors or reactor (Henry)	create, store magnetic field inside coil.	Series	$L_s = L_1 + L_2 \dots$
		parallel	$1/L_p = 1/L_1 + 1/L_2 \dots$

* notes from Daniel's :-
  - voltage: elec. force (Energy), push current bet. two points (current move from High volt to low volt.
  - current :- flow of electrons between 2 points
  - Resistance: opposite to flow of elec.
* power inverter :- device or circuitry change direct current (DC) to (AC)
* Rectifier :- opposite (AC -> DC)
* wheatstone bridge :-
  circuit to accurate measure unknown elec. Resistance by balancing two legs of bridge circuit. (one leg to compustible gas that unbalance circuit. (temp, of sensor).
* sneak circuit analysis :- (SCA)
  used to ID sneak path within circuits, electromech systems, that may allow unsafe condition to develop

* Control of Electrical Hazard *

[I] physical controls:-

depend on materials used, Design of parts, placement or location of electical equipment.

- **wire size and Length:-**

- Resistance increase with the length of wire of a given size or cross section
- the higher the resistance, the more heat generated.
- each gauge and type of wire has recommended maximu length to limit its temp and safe use.

- **Locations:-**

- keep elect. eq. where people can't contact. (poles keep dist. lines above over head), (Buried power lines reduce the contact.).
- Cranes, equipment must be kept at least 10 ft away from powe lines when voltage < 50kV, add 4" inch. for every 10kV above 50kV.
- Shielding need protection when lines pass through or near people. (power lines covers, locked gates, fenses.).

- **Conduit and protective covering:-**
- to prevent physical damage to lines.
- reduce the chance of people contact.
- **proper connections materials:-**
- **Sealed equipments:-** EX
- when using electrical eq. in classified Hazardous area (HAC), occurre in atmosphere containing flammable mixture of air, gas, dust.
- **Isolation and Double insulation.**

[2] over Current Devices :-

- fuses :-

If Current exceeds the limit, the material in the fuse (lead) heat above its melting point and separates.

- Circuit breakers:-

It is a form of switch that opens when current exceeds the limit

*Braker types :- ① Thermal, surrounding env. affect respon
② magnetic, " " " don't affect

[3] Switching devices :-

- lock-outs :-

- lockout procedures involve placing a lock on swich to prevent switching or energizing the equipment.
- each person work on eq. should put a pad lock.
- over come human error.

- Tag outs :-

- If a machine mal function, a Tag to be placed to inform and identify the hazard. to people.

- Inter locks :-

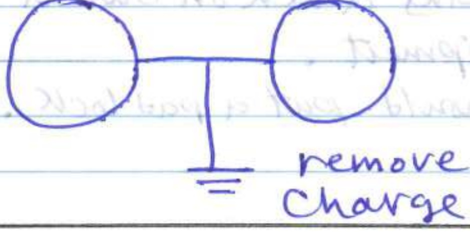
- switch prevent access to energized eq. or dangerous location
- access doors, panels, gates have interlocks.
- when activated, it interrupts power to the equipmet.

- thermal and overspeed cutouts :-

- Thermal ! a temp sensitive switch with a preset temp limit : Can interrupt power.
- overspeed: sense when motor operates too fast.
when eq. exceed speed, the switch interrupt power

4 Grounding and Bonding :-

- They control electrical potential between two bodies.
- if there is difference, a conductor betwen them will allow Charge to flow, This flow is dangerous particularly source of igni

Grounding	Bonding
• Connecting eq. to ground (earth). • Remove Charges to ground. • driving conductive rod (Cu) to ground.	• Connecting two or more pieces together • prevent static Charge buildup between pieces. • equalize but not remove Charge between bodies.
• it may protect from shock.  remove Charge	• it is not protection from shock.  equalize Charge between Two Bodies

5 and 6 GFCI and AFCI

GFCI Ground fault. C. interp.	AFCI Arc fault C. intrupter
• fast acting circut Breaker. current → • sense (2 mA) in 0.03 Sec. • Compare Current between power dist. and grounded neutral. • if not equal, GFCI Shut off. • protect 110/120 V circuits, ✓ • It Can't works on Line to Line connection in 220 V distribution and higher.	• The difference: - GFCI: protect people when There is ground fault in The eq. - AFCI:- protect Branch circuit wiring from Arc faults that could cause electric fire.

A power outlet → GFCI → Cord → power tool
التركيب الكلي

7 lightning :-

- It's The sudden release of Static build up in Clouds. during Thunder Storms. Can produce very Large Current
- lightning Can Cause external damge., people kills 150Y
- lightning rods or air terminals placed along roof lines or protective Grid., to interrupt and transfer current generated to ground.
- providing gromding points for all systems in building can protect from demige.

8 Battery Charging, Shipping, storge:-

* lead acid Batteries:-

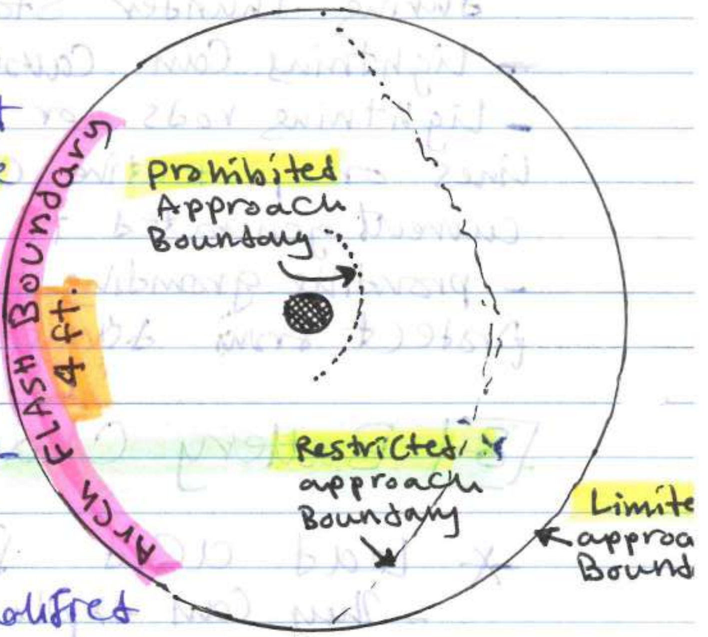
- They Can explode during charging causing battery acid and particles to injure eyes or skin.
- two types of explositons:-
  1. one related to flammability of Hydrogen gas.
  2. electrical.
- During charging, lead acid batt., produce Hydrogen.
- if The gas reaches a flammable conc. (4-75% by vol.) a spark or flame can ignite and explode.
- The spark can come from attaching or removing cables.

- To reduce the hazard:-
  * dilute the air around the battery.
  * enclosed battery charging room need exhaust sys.
  * Charging racks.
  * emergency eye wash station., shower.
  * wear PPE eye, clothing.
  * ensure two Batteries have same Voltage before connecting.
  * Connect ⊖ terminals to ground last, disconnect them first.

NFPA 70E
p: 61

AFPB * Arc flash protection boundary * and Categories.

* Arc flash Boundary:-
  - Linear distance to prevent any more than secondry degree Burns, from arc flash pot.
  - Distance @ which Incident energy is 1.2 Cal / cm^2.
    5.0 Joule / cm^2



* Shock protection Boundaries:- (shock layer Hazard).
  - Limited approach Boundary:- entered only by qualified or non qualified persons, That have been advised and escorted by qualified.
  - Restricted approach Boundary:- enterd by only qualified person, required shock protection techniques and PPE.
  - prohibited approach Boundary:- entered by only qualified persons, req. same protection as if direct contact with live part.

* Arc flash Hazard catigories (4) of incident En

	HAZ. CAT.	Incident energy	min Arc PPE	Cloth. Description	Cloth. req.
·ow	1	1.2 to 4 Cal / Cm^2	4 Cal / Cm^2	arc rated + min 4 cal / cm^2	FR shirts, pants or FR Coverall
·IM	2	4 to 8 Cal / cm^2	8 Cal / Cm^2	arc rated + min 8 cal / cm^2	Cotton under clothing + FR shirt, pants
ed.	3	8 to 25 Cal / cm^2	25 Cal / cm^2	arc rated + min 25 Cal / cm^2	Cotton under cloth + FR coverall
righ	4	>25 to 40 Cal / cm^2	40 Cal / cm^2	arc rated + min 40 Cal / cm^2	Cotton under, FR coverall, + multi layer flash suit.

*note:- no PPE specialized for Incident Inj. greater than 40.

Physics * Mechanics *

[1] Energy:-

* potential energy.

$P.E = mgh$

* Kinetic Energy.

$K.E = \frac{1}{2} mv^2$

* Elastic potential Energy:-

$P.E_{elastic} = \frac{1}{2} K x^2$ النابض spring

[2] Mass and weight:-

$\underset{weight}{W} = \underset{mass}{m}\,\overset{9.8\ m/s^2}{g}$ acceleration due to gravity.

Mass	weight
• Matter Contained in object	• force of gravity
• measured in Kilograms	• measured in newton.
• Same no matter where it's (Constant).	• Vary according to location

[3] Forces:-

* Contact forces.
  - fractional
  - Tension
  - Normal
  - Air resistance
  - Applied
  - Spring

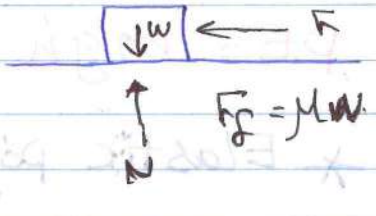
* Action - at distance forces.
  - gravitational
  - electrical
  - Magnetic.

* forces (Cont.) :-

* Normal . $\underset{\text{force}}{F} = \underset{\text{mass}}{m}\ a$ acceleration

. F = N
. m = kg or slug
. a = m/s^2

* frictional . $\underset{\text{fric.}}{F_f} = \mu\ N$ Normal
friction Coe.



$F_f = \mu W$

* Boyuant . $\underset{\text{buoyat}}{F_b} = \underset{\text{Den.}}{\rho}\ g\ V$ volume
acc. due to gravity

* force and Distance :-
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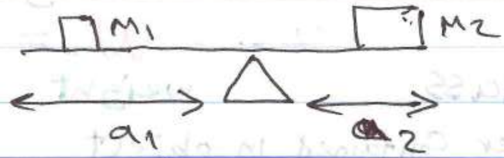
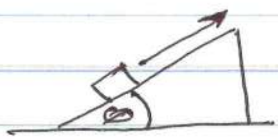
$M_1 \times a_1 = M_2 \times a_2$



* Momentum and Work :-

. Momentum

moment $P = \underset{\text{mass}}{m}V$ velocity



. work

. $W = F\ S$ مسطح
Cos 0 = 1
صفر
. $W = F\ S\ \cos\theta$ ب

* Velocity (Motion) :- Traffic accident applications

. velocity

tion ① . $V = V_0 + at$
acc. m/s^2 — time s
e have velocity / time only

. final velocity

$V^2 = V_0^2 + 2aS$
. when we have acc, displacement ~~distance~~ and velocity initial
displacement meter

. $S = V_0 t + \frac{1}{2} a t^2$
Stopping distance
* when we want to find position

* Check examples Nouh, khalaf.

* Hydraulics *
and Hydro Statics.

- pressure: force / unit area.
- Hydrostatic p: Pressure exerted by water.
- PSI: US system press. / sq. inch

- $\underset{PSI}{P} = F/A_{inch^2}$ (lb/ft³)

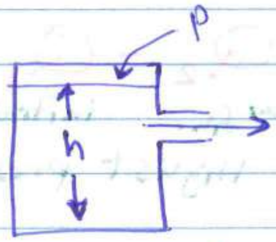
* example: leaking in fi.fi piping sys.:
How to solve: ① $V_{cyl.} = \pi r^2 h$
② $A = \pi r^2$
③ $P = F/A$

- $P = \rho g h$ press. of Liquid.
(density) (acc. due to grav.) (depth)

---

* Torricelli's Law:- application: dumping fluids.

velocity $V = \sqrt{2gh}$ ← head
ft/s
↑ acc. due to grav
9.8 m/s
32 ft/s



note:- Speed of fluid flowing out of opening increase as height of head.
$\therefore$ h↑ → V↑ and vice versa.

$P = 0.433 \times h$.

* Head pressure:- $\underset{ft}{h_p} = P/\omega$ (P: gauge press.; ω: weight of water)

* Velocity head:- $h_v = V^2/2g$ (V: velocity; g: acc. due to grav)

---

* Bernoulli's principle:- §8
Check Noah, Yates
P↑ → Speed↓

* Laminar, turbulent velocity *

* Reynold's number * Re

- Lam. flow : $Re < 2000$
- transitional flow : $2000 < Re < 4000$
- turbulent flow : $Re > 4000$

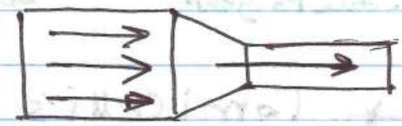
press. @ Lam. Flow psi $P_v = \dfrac{Q^2}{891\, d^4}$ flow rate gpm; pipe diameter in or ft or m

* Flow Rates and pressure drops. :-

- Rule of thumbs:-

flow Rate ↑ → pres. ↓

flow rate ∝ 1/pressure.



$$Q_2 = Q_1 \left[\frac{(S - R_2)^{0.54}}{(S - R_1)^{0.54}} \right]$$

Q_2: flow fin. Q_1: initial; S: Higlist press.; R_1: pressure drop

. note:- (S) Higlist press. in the system
ضالع في المسائل

$$P = \left(\frac{Q}{K} \right)^2$$

Q: flow rate. K: distance Coe.

* Application: press. drop in fire piping sys.

$$\frac{Q_1}{Q_2} = \frac{\sqrt{P_1}}{\sqrt{P_2}}$$

* pressure due to friction *

$$P_d = \frac{4.52\, Q^{1.85}}{C^{1.85}\, d^{4.87}}$$

P_d: psi; Q: flow rate; C: friction. Coe.; d: diameter

* $\underset{\text{force normal}}{F} = \underset{\text{mass} \times \text{acceleration}}{ma} = \dfrac{\Delta P \text{ momentum}}{\Delta t \text{ time}}$

* $\underset{\text{weight newton}}{W} = \underset{\text{mass}}{m}\ \underset{\text{acc. due to gravity}}{g}$

accelerati

$a = \dfrac{\Delta V}{\Delta t} = m/s^2$

* $F_{buoyant} = \underset{\text{Density}}{\rho}\ \underset{\text{acc. grav}}{g}\ V_{(volume)}$

$\underset{\text{distance}}{S} = \underset{\text{velo}}{V}\ t$

* $F_{friction} = \underset{\text{c.f}}{\mu}\ N_{\text{normal force}}$

$V_{elocity} = \dfrac{\Delta S}{\Delta t}$

* $\underset{\text{work horizontal}}{W} = \underset{\text{force}}{F} \times \underset{\text{distance}}{s}\ \overset{1}{(\cos\theta)}$

* $W_{\text{vertical against gravity}} = mg\Delta h$

* $\underset{\text{momentum}}{P} = \underset{\text{mass}}{m}\ V$ velocity.

* $P_{pressure}$ (general) $= \dfrac{F \text{ force}}{A \text{ Area}}$ N/m^2 lb/ft^2

* $P_{\text{liquid pressure}} = \rho g h$ height.

* KE $\dfrac{mv^2}{2}$

mechanical Eng
ME
= KE + PE
Conserved
not chnge

PE
mgh

* Mechanical power $P = \dfrac{\Delta W \text{ (work)}}{\Delta t \text{ (time)}} = \dfrac{\text{work}}{\text{time}} = \dfrac{\text{Joules}}{\text{sec}}$

$\therefore 1\,W = \dfrac{1\,J}{1\,sec} \Rightarrow 100\,W = 100\,J/S.$

* motion *

③ equations :-

S	V	a	t
distance	velocity	acceleration	time
ft, meter mile	ft/sec m/sec miles	ft/sec^2	sec, min, hr

Keys

- Motion ① :- $V = V_0 + at$ ← final velocity + time

final initial

- Motion ② :- $S = V_0 t + \frac{at^2}{2}$ ← distance

- Motion ③ :- $V^2 = V_0^2 + 2aS$ ← no time

$$\overset{\text{pressure}}{P} \times \cancel{A} \qquad \frac{\Delta P}{\Delta T} \qquad W$$

$$\| \qquad \| \qquad //$$

$$\cancel{W} \qquad w \qquad p$$

$$\| \qquad \| \qquad \|$$

$$F_{\text{friction}} = \mu \times (F_{\text{normal}}) = m \times a$$

$$\times \qquad\qquad \cancel{\times} \quad \times \quad \times$$

$$S \qquad\qquad \cancel{S} \quad g \quad v$$

$$F_b = \rho g V_{\text{volume}}$$

$$P = \rho g h_{\text{height}}$$

* Noise *

Hearing Conservation program

OSHA 29 CFR 1910:95

* Definations:.

- Noise: continous and Intermittent noise
- Sound: pressure waves
- freqency: No of cycles of pressure waves / sec.

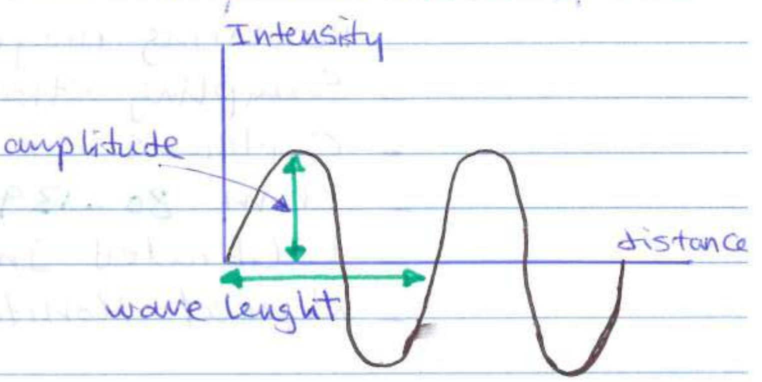
* Humans hear from 20 - 20K HZ.
* speech range 500 - 3K Hz.
* velocity of sound (C) in air : 332 m/s

 " water : 1500 m/s

 " Steel : 6100 m/s

Speed → $C = \lambda F$ m/s

λ = wave length (m), F = frequency (s^{-1})



requency generated by fan. $f = \frac{(N)\,RPM}{60}$, $T = \frac{1}{F}$ period

N = nu. of Blades on the fan.

RPM = rotational speed

* Physiology of The EAR:-

Sound vibration → ear Canal to ear drum → Middle-ear (3 Bones ossicles) → Transmit sound waves to Inner-ear

. The hearing part of Inner ear is Cochlea

* noise Category:-

1. White noise: increase (3) db / octave.
2. pink noise: equal energy of octave
3. Red noise: power density dec. by (6) dB/ octave

* OSHA Hearing Conservation Programme *
OSHA 29 CFR 1910.95

* applys to any employee exposed to Sound >= 85 dB for 8h (TWA) on A-Scale.

* Sound Level Meters (Scales) SLM:-

- A-Scale: max 2500 HZ $\xrightarrow{\text{drop to}}$ 1000 HZ
- B-Scale: max 1000 HZ $\xrightarrow{\text{drop to}}$ 500 HZ
- C-Scale: 30 - 8000 HZ.

* OSHA requrements:-
  - Monitoring program.
  - Sampling Strategy.
  - Continous or Intermittent or Impulse sound wav
  - from 80-139 dB.
  - Calibrated Instruments.
  - Repeat Monitoring.

* Sound-Measuring devices:-

Type 1 SLM	Type 2 SLM
✓ - precision measurements	- General Measurements
- accuracy ± 1dB	- accuracy ± 2dB
49 - 50 - 51	48 - 50 - 52

* Sound level Meter use:-
  - spot check employee exposure.
  - Identify potential noise source reading for further
  - assist in feasibility of engineering Controls.

* Sound level meter types:-
  Octave band analyzer, Noise dosimeter, and ~~personal~~ Hand held.