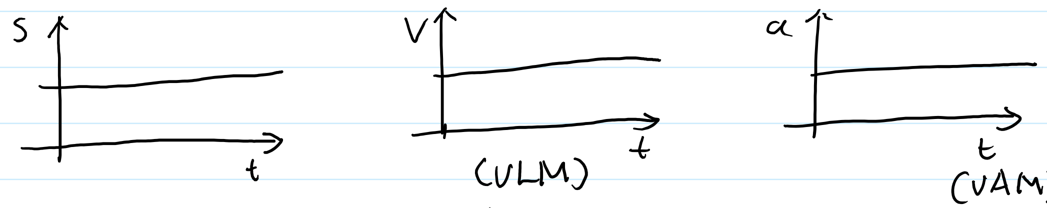
9/13: Motion by Graph

Wednesday, September 13, 2017 9:30 AM



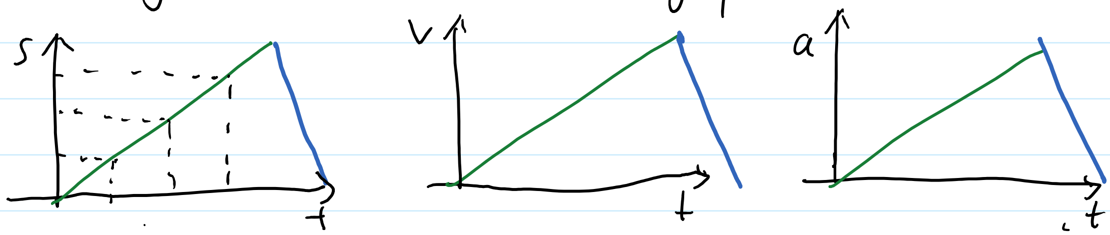
(ULM) (VAM)

stationary (not moving)

~~constant velocity motion~~
Uniform linear motion

uniform acceleration motion

• identify the axis label on the graph



ULM
Revert moving (ULM)
→ change direction

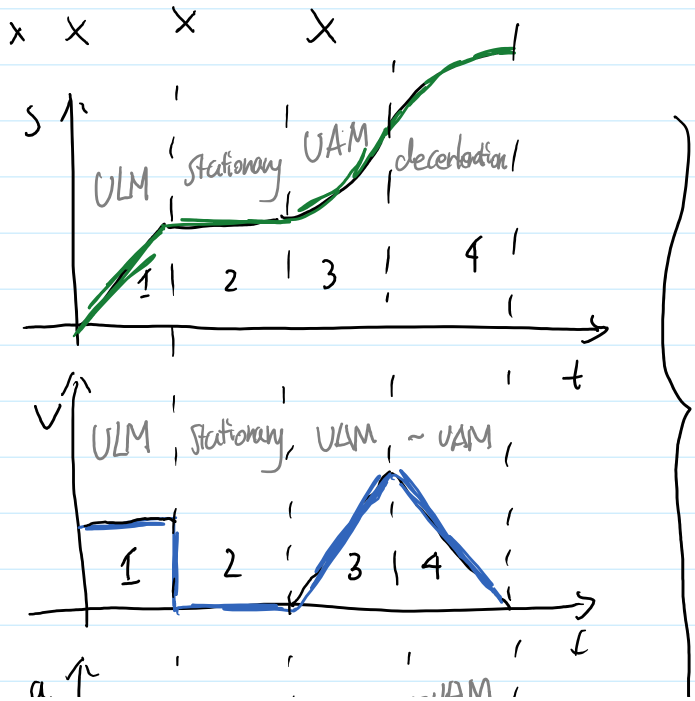
UAM
decelerating (UAM)
same direction

non-uniform acceleration
non-uniform deceleration

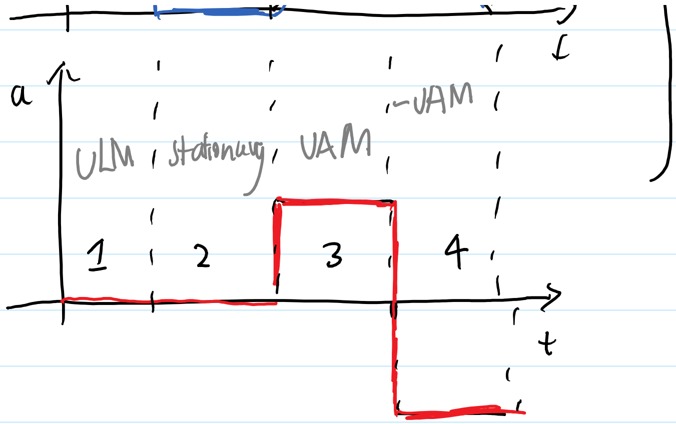
UAM t

non-uniform acceleration

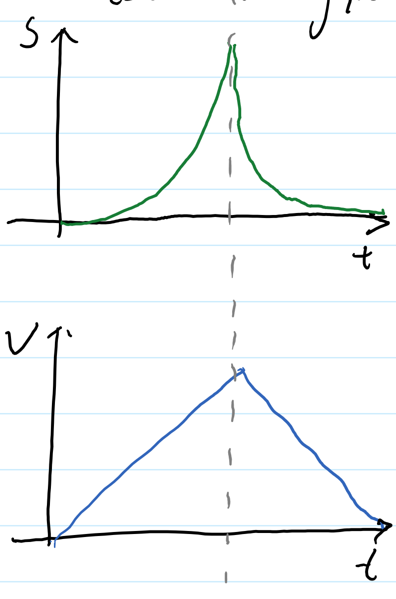
non-uniform acceleration



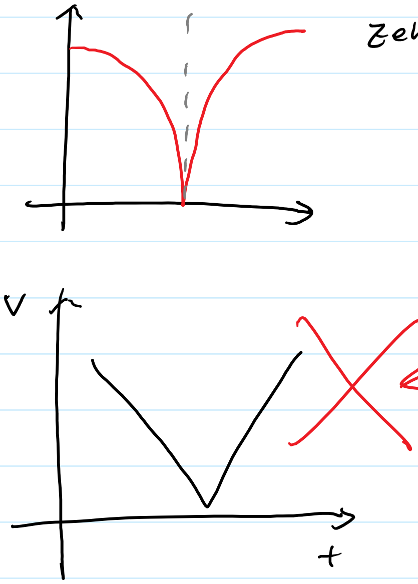
vertically aligned graph.



Zero as starting point

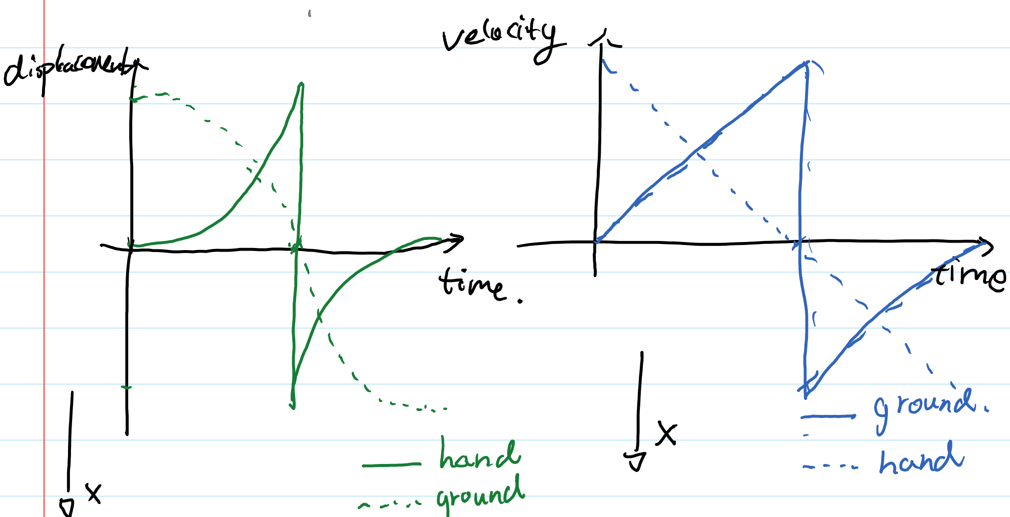


zero as ground.

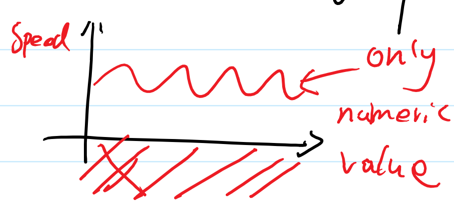


zero speed at begining

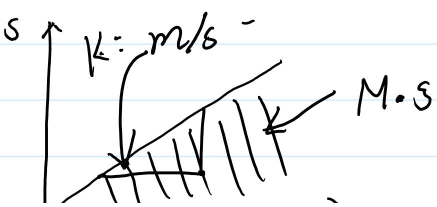
total displacement

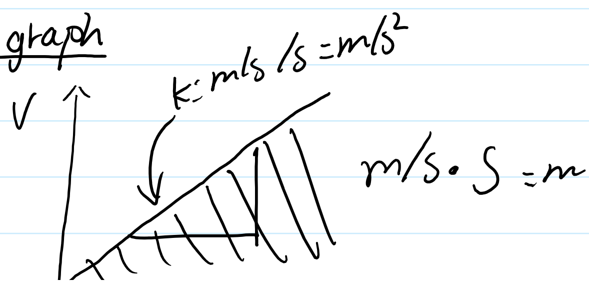


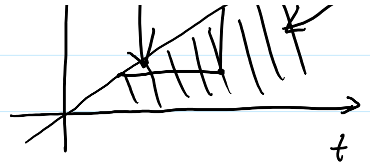
idealised graph.



areas and gradient of the graph

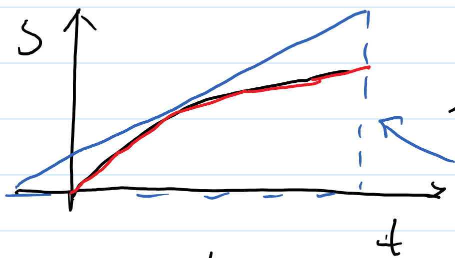






area under s-t graph does not have physical meaning
gradient represents speed

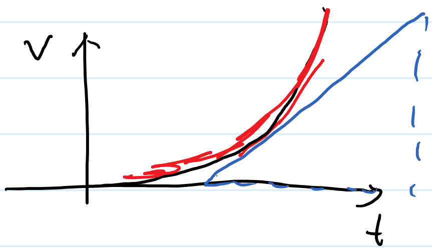
area under V vs t graph is the distance traveled,
gradient represents acceleration



how do I found the gradient?

draw the tangent line as big as possible.
then find the gradient of the large triangle

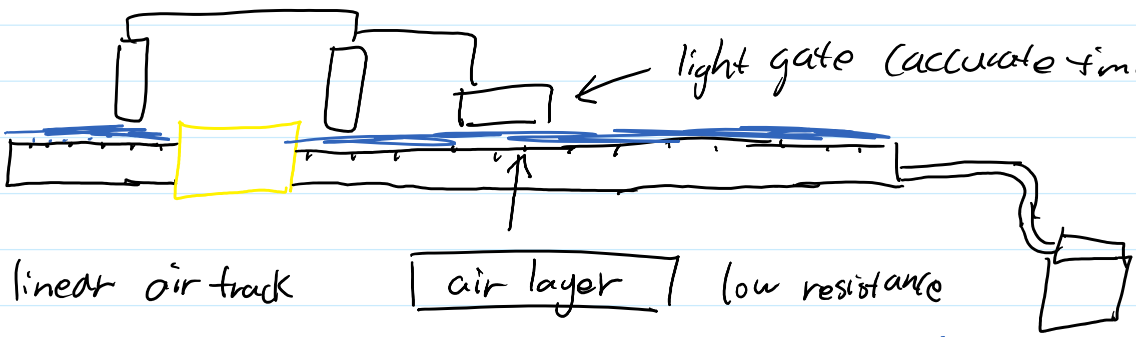
gradient ↓ → stop



same for graph on acceleration

gradient = slope = steepness

average velocity = total distance / total time.

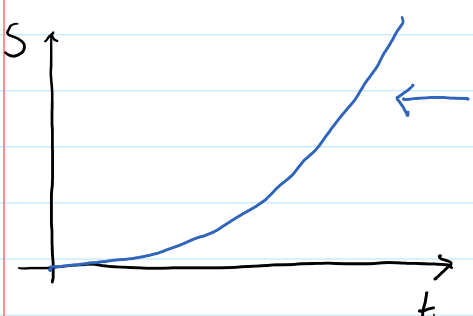


light gate (accurate timing)

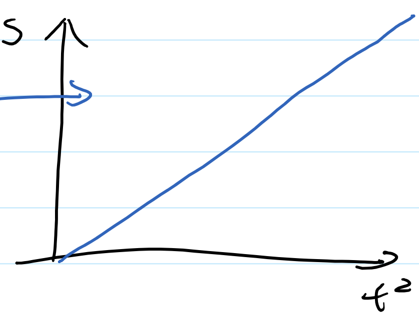
linear air track

air layer

low resistance



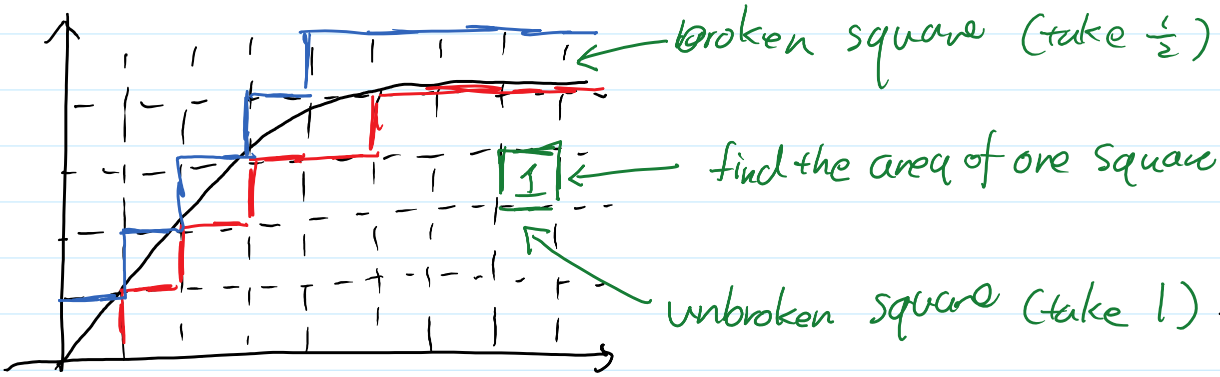
← UAM →



$s = \frac{1}{2}at^2$

$y = mx \rightarrow \text{grad} = \frac{1}{2}a$

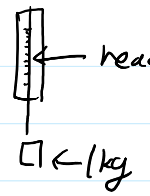
· if y intercepts lower than 0, then you <u>must</u> calculate it same for finding the x intercept.



add them together to give estimation.

9/20: Acceleration by gravity

Wednesday, September 20, 2017 9:32 AM



$g = 9.81$ { gravatational field strength $\frac{N}{kg}$; acceleration deul to gravity m/s^2

gravational field strength shows force of gravity acting onto 1kg on that planet

homogenius equation: $N/kg = kgm/s^2/kg = m/s^2$

$F = mg$ (a) → during free fall (i.e. no air resistance) F of gravity

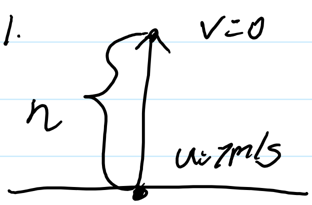
regardless of mass. → land at same time.

earth: $g = 9.81N/kg$

moon: $g = 1.6N/kg$

Work Example.

1.



formula

$v^2 - u^2 = 2gh$ [1]

$h = \frac{u^2}{2g} = \frac{7^2}{2\times 9.81} = 2.5m$

rounded correctly 2 s.f. max.

working out [1] answer with unit [1]

1 and 3 s.f. → 2 s.f.

2 and 3 s.f. → 2/3 s.f.

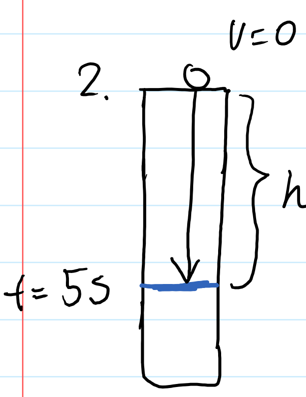
$v = u + gt$

$h = ut + \frac{1}{2}gt^2$

$v^2 - u^2 = 2gh$

no time involving.

2.



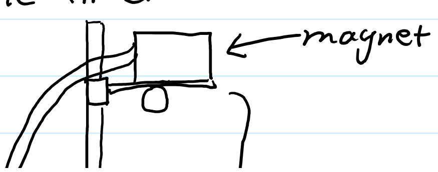
$\underbrace{h = \frac{1}{2}gt^2}_{[1]} = \underbrace{\frac{1}{2} \times 9.81 \times 5^2}_{[1]} = \cancel{122.6} = 120\ m$

round s.f. / add unit } [1]

3 methods on how to measure acceldation of free fall

- electric timer
- ticker timer
- light gate

electric timer



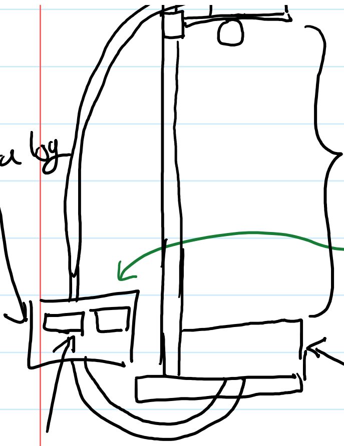
gradient $= \frac{1}{2}g$ physical meaning!

h

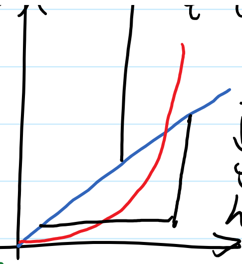
t (at x)

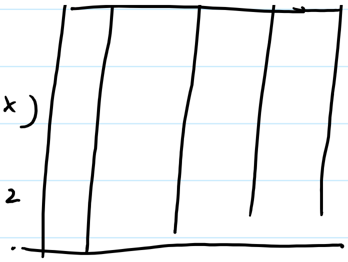
t^2 (at x)

h/m	t/s	t^2/s^2



you can also connect it to some old PC





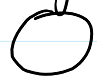
plot table

timer → precesion 6 decimal point

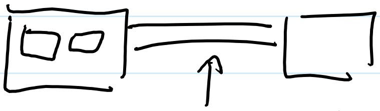
systematic error

why $g \neq 9.81\, m/s^2$ → limitation.

① air resistance → change the surface area



→ ◦ reduce air resistance.



② reaction time of machine

as short as possible

takes time for signal to travel to data log

> or use identical length → start and stop equally

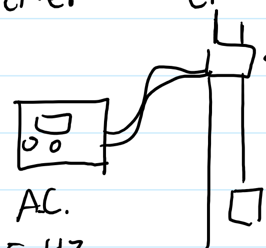
③ electric magnets may get slightly magnetize permanently.

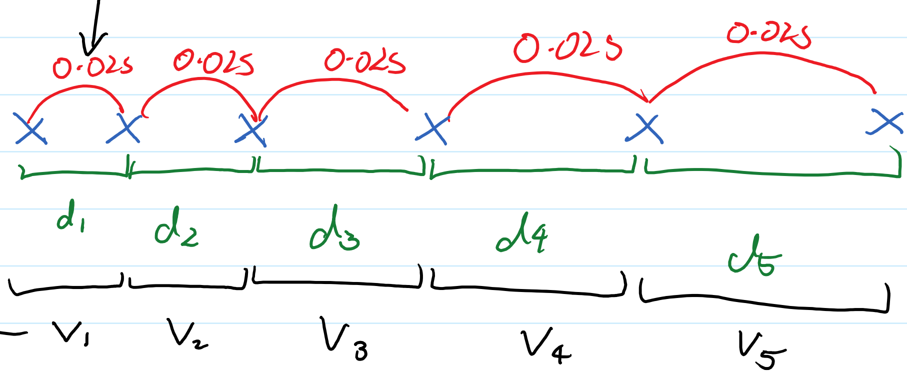
measure the height is autcaud and difficult.

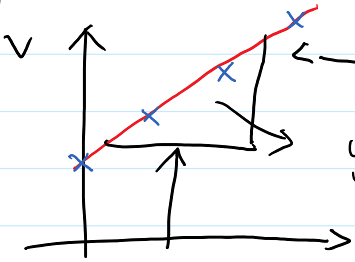
we the projection of light and reflecion

Ticker Timer

It's too fast, we usually use 0.1s.







$y = mx + c$ / $V = at + u$

gradient = a

It's very inaccurate! far away from true result

limitation

① air resistance → bell jar

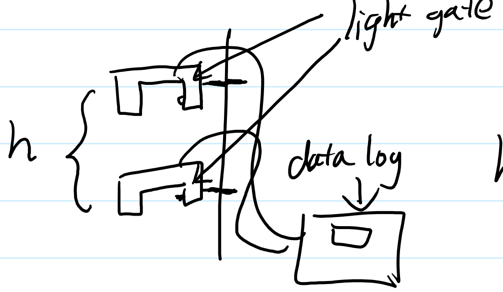
$V_{average} = \frac{s}{t}$ ← allow for non uniform motion

② friction between paper and ticker timer → unavoidable

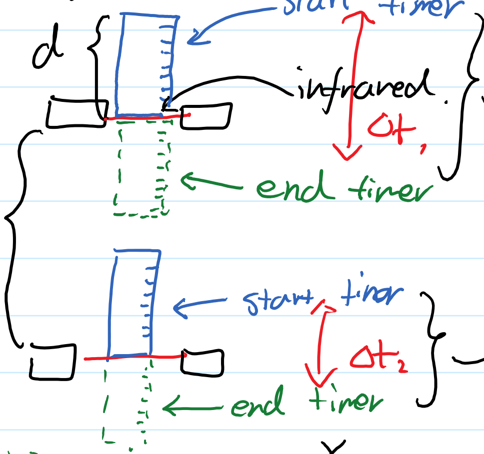
③ the formula is actually average speed → not the exact speed.

·X· It's not the instantenous speed → unavoidable

Light gate



2 light gate:



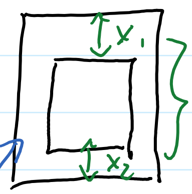
$u = \frac{d}{\Delta t_1}$

$V = \frac{d}{\Delta t_2}$

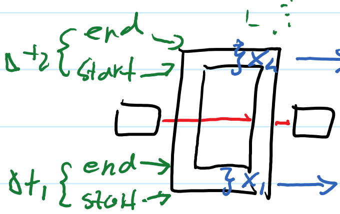
$V^2 - u^2 = 2gh$

$g = \frac{V^2 - u^2}{2h}$

1 light gate:



$x = x_1 = x_2$



$V = \frac{x_2}{\Delta t_2}$

$u = \frac{x_1}{\Delta t_1}$

$g = \frac{V^2 - u^2}{2h}$

○ shape Carboard

x should be as small as possible

limitation:

① it's difficult to cut a correct cardboard

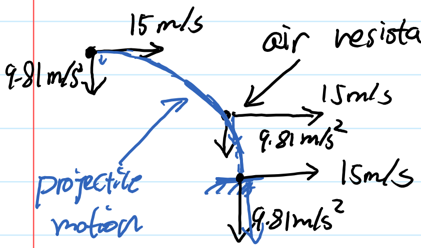
② it should be thicker and heavier
↳ to make sure it go straight.

9/25: Projectile Motion

Monday, September 25, 2017 3:05 PM

Projectile motion:

2D motion



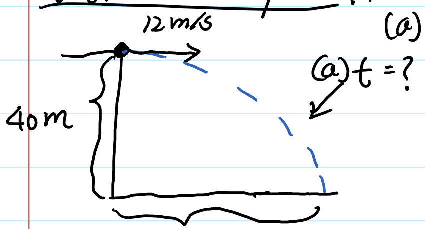
air resistance neglected

$a = g = 9.81\ m/s^2$

horizontally: ULM

vertically: UAM (free fall due to gravity)

Work Example 1:



(b) S = ?

(a) horizontal: $V = \frac{s}{t}$ unknown × useless

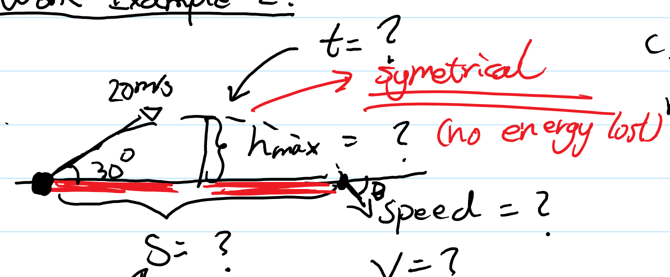
vertically: $s = ut + \frac{1}{2}at^2$

$h = \frac{1}{2}gt^2$

$t = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2\times 40}{9.81}} = 2.86s$

(b) $S = ut = 12 \times 2.86 = 3.43\ m$

Work Example 2:



range (horizontal distance)

a) $t = 2t_1$ (time to go up)

$v = u + at_1$

$0 = 20 \cdot \sin 30^\circ - gt_1$

$t_1 = \frac{20 \sin 30^\circ}{g} = \frac{20 \sin 30^\circ}{9.81} = 1.02\ s$

$t = 2.04s$

b) $S = ut$

$S = 20 \cos 30^\circ \times 2.04 = 35.3\ m$

c) $h_{max} = ?$

must use vertical component

$V^2 = u^2 + 2as$

$0^2 - (20 \cdot \sin 30^\circ)^2 = -2 \times 9.81 \times h$

$100 = 2gh$

$h = \frac{100}{\underbrace{2\times 9.81}_{2}} = 5.1m$

1 3

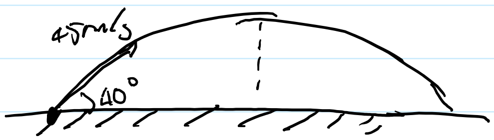
d) $\vec{V} = \sqrt{V_x^2 + V_y^2} = 20\ m/s$

$V_y^2 = 100$

$V_x^2 = 300$

→ no energy change happened here.

e) $\sin\theta = \frac{V_t}{V} = \frac{10}{20} = \frac{1}{2} \Rightarrow \theta = 30^\circ$



(a) $V_x = 45 m/s \times \cos 40^\circ = 34.5 m/s$

(b) $V_y = 45 m/s \times \sin 40^\circ = 28.9 m/s$

(c) $V = u + at$

$0 = 28.9 + 9.81t$

$t = 2.95 s$

(d) $V = ut = 34.5 m/s \times 2.95 s = 101.8 m$

24 a. $V = \frac{S}{t} = \frac{12}{4.0} = 3.0 m/s$

b. $S = ut + \frac{1}{2}at^2$ $\quad h = \frac{1}{2}gt^2 = \frac{1}{2} \times 9.81 \times 4.0^2 = 78.5 m$

25 a. $V_y = 8 \sin 40^\circ = 5.14 m/s$

b. $0 m/s$

c. $V = u + at$

$0 = 5.14 - gt$

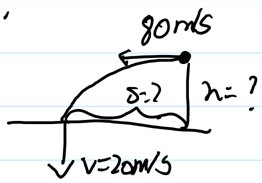
$t = \frac{5.14}{9.81} = 0.52 s$

d. $V_x = 8 \cos 40^\circ = 6.13 m/s$

e. $t = 2t_1 = 2 \times 0.52 = 1.04 s$

$S = Vt = 6.13 \times 1.04 = 6.38 m$

extra,



$V^2 - u^2 = 2as$

$20^2 - 0^2 = 2gh$

$h = \frac{20^2}{2 \times 9.81} = 20 m$

$V = u + at$

$\frac{20 - 0}{g} = t$ $\quad t = \frac{20}{9.81} = 2.0 s$ $\quad S = Vt = 80 \times 2.0 = 160 m$

9/26: Dynamics

Wednesday, September 27, 2017 10:01 AM

Dynamics

Forces

- fundamental (we don't know origin; i.e. can't explain why they exist)
  - gravitational Force
  - electromagnetic Force
  - strong force
  - weak force
- Non-fundamental

motion is the relative thanian

Frame of reference

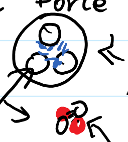
they are the problame

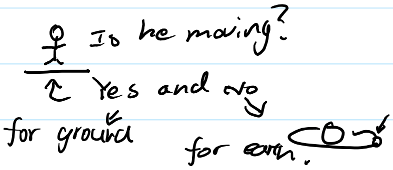
Is he moving?

Yes and no

for ground

for earth

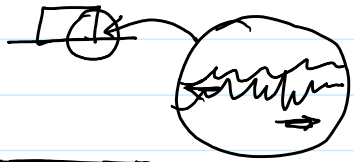




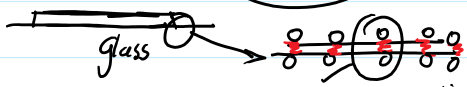
holding quarks together

another force holding nucleus together

Name	Its Origin
Friction	• roughnesses rub each other • molecular attraction if they are smooth
Air Resistance	• air particles colliding against the moving objects
Tensile Force	• particels interaction (electromagnetic nature)
Upthrust	• pressure difference on top and bottom



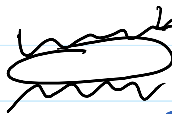
rough surface



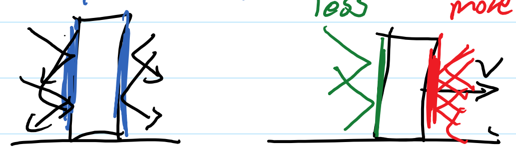
electrostatic attraction

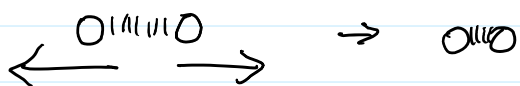
molecules attraction

they rub on

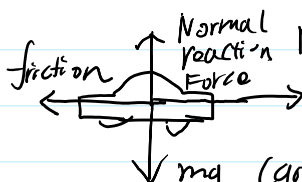


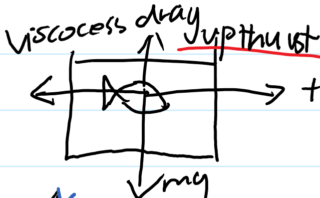
lubricant

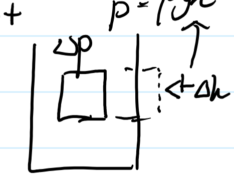


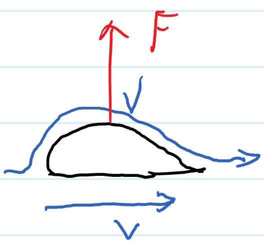


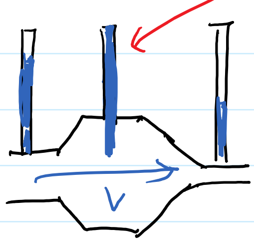
stays same distance









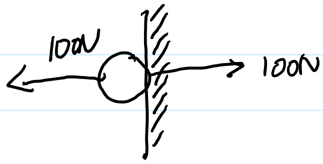


$V_2 > V_1$

Newton's Law

Newton's Law

- 1st $\sum \vec{F} = 0$ (forces are balanced) →
  - ULM
  - $v = 0$
- 2nd $\sum \vec{F} = m\vec{a}$ →
  - speed up
  - slow down
  - change in direction at constant speed
- 3rd Every action has an equal and opposite reaction



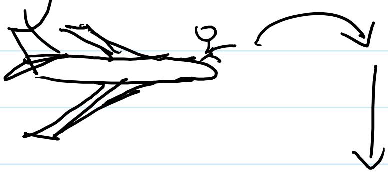
They are not balanced because they act on different object

9/26 Terminal Velocity

Monday, October 9, 2017 3:36 PM

Mass	Weight	Force of gravity
measure of inertia	$W = mg$	$F = mg$
the reluctance of object to change the speed	force of gravity act on the object	
Unit: kg	acceleration due to gravity $9.8 m/s^2$	
	g → $9.8 m/s^2$, $9.8 N/kg$	
	gravatitional field strength → the force due to gravity of 1kg of mass	
	for understanding: exerted by object (me) acting onto Support	for understanding: exerted by planet acting on to object (me)

During free fall:



jump in air → no support → weight = 0

$W = 0$ → apparent weightlessness

Force of gravity → still on

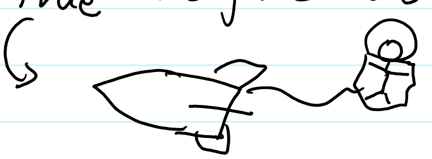
$F = mg$

$a = g$

$W = m(g \pm a)$

$w = 0$

True weightlessness



← you are in space → $F = mg$

$g = 0$

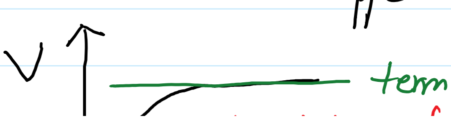
a → g forces

Terminal Velocity

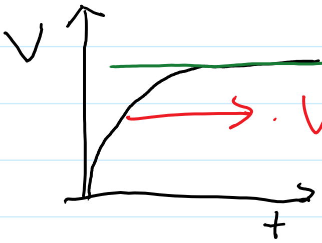
$a = 9.81 m/s^2$ assuming 10km

$V = \sqrt{2gh} \approx 396 m/s$ → >>10 Mach

but that's happening → they reach terminal velocity



terminal velocity



terminal velocity

→ $V\uparrow$ $f\uparrow$ → $\Sigma F\downarrow$ → $a\downarrow$ until 0

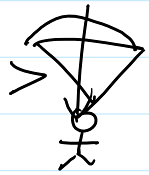
for human ≈ 55 m/s

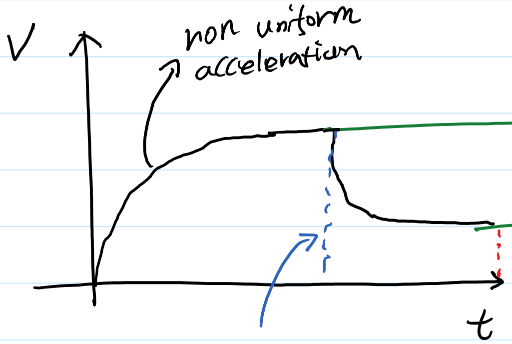
Terminal velocity is the constant speed during falling when air resistance balanced the force of gravity

→ not nessecary → for all fluid

inertia kills

the time to reduce

terminal V without parachute >  terminal V with parachute



terminal V with parachute

terminal V without parachute

This will kill you

This will not

Momentum

as v changed, m same, effect change

$\vec{P} = mv$ → it also depends on where it moves

$(kgms^{-1})$

as m changed, v same, effect change

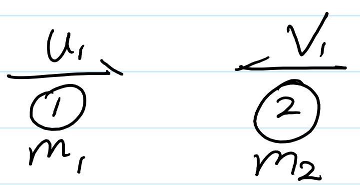
⚠ It should be operate as a vector

$\Delta p = \Delta mv = m\vec{v} - m\vec{u}$ the change in momentum is conserved [1]

> when there is no exernal force → the system is closed [1]

always add this

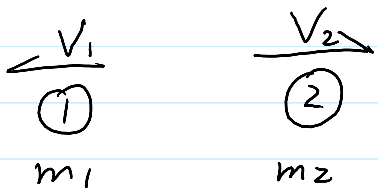
If no external force acts on a system, the total momentum of the system remains constant, or is conserved



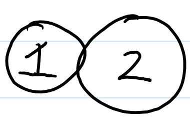
$m_1\vec{u_1} + m_2\vec{v_2}$ or $m_1u_1 - m_2v_2$

because vector sign

choose axes



$m_1\vec{v_1} + m_2\vec{v_2}$ or $m_2v_2 - m_1v_1$



$F = ma = m\left(\frac{\vec{v}-\vec{u}}{t}\right)$

$Ft = m(\vec{v}-\vec{u}) = m\vec{v} - m\vec{u}$

$F_1 = m\vec{v_1} - m\vec{u}$ $\quad F_2 = m\vec{v_2} - m\vec{u_2}$

$F_1 = -F_2$ (third Newton's law)

$m_1\vec{v_1} - m\vec{u_1} = -m_2\vec{v_2} + m\vec{u_2}$

$m_1\vec{u_1} + m_2\vec{u_2} = m_1\vec{v_1} + m_1\vec{v_2}$

Impulse

Impulse

$$Ft = \Delta mv = m_1\vec{v_1} - m_1\vec{u_1} \Rightarrow \text{impulse} = Ft = \Delta mv = [Ns]$$
$$= [kgms^{-1}]$$

Second Newton's Law:

$$\underbrace{\sum F}_{\text{unbalanced resultant force}} = \underbrace{\frac{mv - mu}{t}}_{\text{rate of change of momentum}}$$

$\boxed{\text{The resultant force acting on a body = rate of change of its momentum}}$

This is what you write

First Newton's Law:

The momentum of a particles remain constant unless an external Force act on it

$p =$ constant

Third Newton's Law:

when two body exert action and reaction forces on each other, the change of momentum is equal and opposite

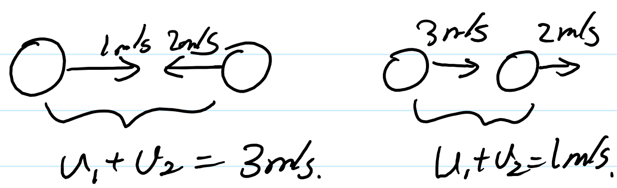
$$m_1\overline{v_1} - m_1\overline{u_1} = -(m_1\overline{v_2} - m_2\overline{u_2})$$

Elastic and Inelastic collision

elastic → no mechanical energy loss

$$\sum k.e.b. = \sum k.e.a. \Rightarrow \frac{1}{2}mv_1^2 + \frac{1}{2}mu_2^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$$

$$\Rightarrow \underbrace{\vec{u_1} + \vec{u_2}}_{\text{relative speed of approach}} = \underbrace{\vec{v_1} + \vec{v_2}}_{\text{relative speed of seperation}}$$



If mass is identical ⇒ exchange speed

If mass is not identical ⇒ $\vec{u_1} + \vec{u_2} = \vec{v_1} + \vec{v_2}$ need to be used

10/18 Densities and Pressure

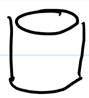
Wednesday, October 18, 2017 9:31 AM

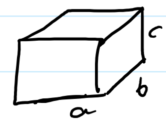
Densities

$\rho = 7800\ kg/m^3$ → mass of unit volume of given substance

$= 7.8\ g/cm^3$

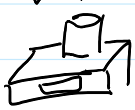
regular shape : V calculated :





$V = Ah$ $V = \frac{4}{3}\pi r^3$ $V = abc$

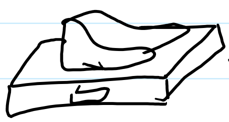
mass : balance



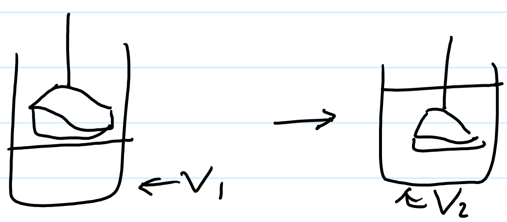
liquid: mass = cylinder + liquid − cylinder (empty).

volume → read out

irregular shape :

mass:  → balance.

volume



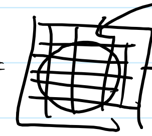
$V = V_2 - V_1$

Pressure

pressure

solid $\left(p = \frac{F}{A} \right.$ → the force per unit Area

$Pa = \frac{N}{m^2}$

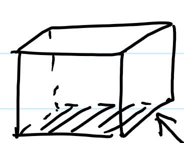
$F = mg$ → use balance $A =$ 

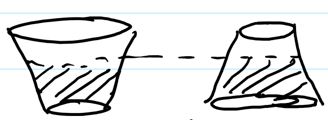
→ line paper

count break & unbreak

liquid

$p = \frac{F}{A} = \frac{mg}{A} = \frac{\rho V g}{A} = \rho g h$





P the same → $\rho g h$ (Area cancel)

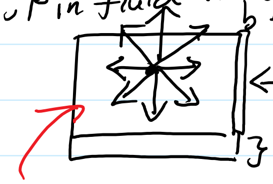
Pascal Law

at h, P in fluid transfer to every direction equally

Pascal Law

p the same $\rightarrow$ $\rho g h$ (Area cancel)

at h, P in fluid transfer to every direction equally

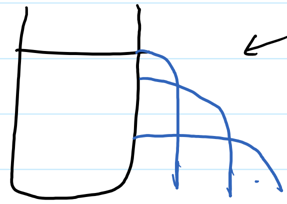


what will be the direction thick? $\rightarrow$ still b

a thick to stan the pressure

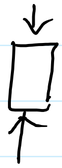
pressure is acting everywhere $\rightarrow$ not a vector

Upthrust



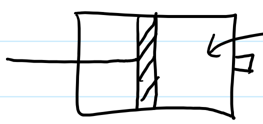
Pressure increase as depth increase

UpThrust $\rightarrow$



P_a, P_b $\}$ P_d cause upthrust

gas ~~$P = FA$~~ ~~$P = \rho g h$~~ $\rightarrow$ give smaller answer



gas trapped in

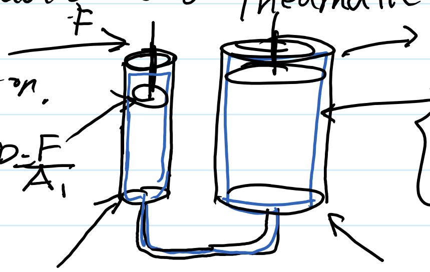
can not use this to calculate

the force not original from it

Particles collision $\rightarrow$ change in p $\rightarrow$ force exists $\rightarrow$ P exists

Atmospherical P = 101300 Pa $= 10^5$ Pa

Hydraulics and Pneumatics

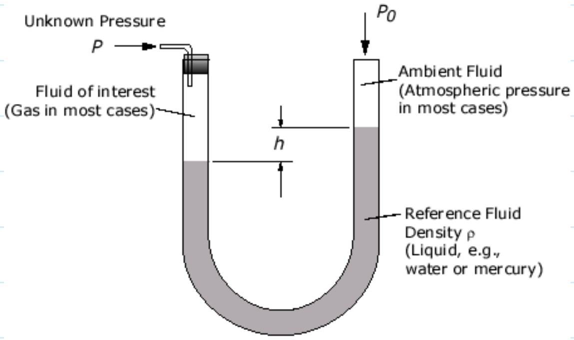


{ Gas : pneumatics
liquid = Hydraulics

P the same, but $P = \frac{F}{A}$

Area $\uparrow$, F must $\uparrow$

Manometers:



Gage Pressure $\Delta P = P - P_0 = \rho g h$

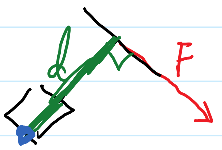
10/23: moment

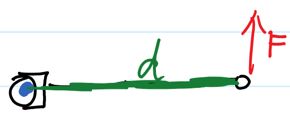
Monday, October 23, 2017 3:34 PM

Moment

effect of force { acceleration / rotate

moment (M) = $F \cdot d$ (shortest distance between line of force acting and pivot)





$W = F \cdot S = [Nm] = [J]$

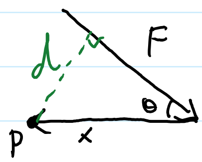
$M = F \cdot d = [NM] \neq [J]$

→ this is not made by the force directly

Definition of Unit $1Pa = \frac{1N}{1M^2}$ Compose a sentence

1pa is 1N act on $1m^2$

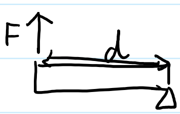
Definition of variables $Pa = \frac{N}{M^2}$ force act on unit Area



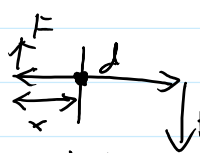
shortest distance between line of force & pivot! must be 90°

$d = x\sin\theta$

Torque (τ) : it's the moment of a couple



$M = Fd \Rightarrow$



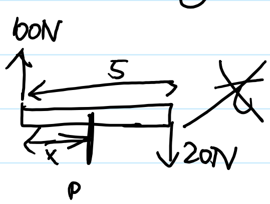
total moment = $Fx + F(d-x) = Fd$

so the torque is always the same

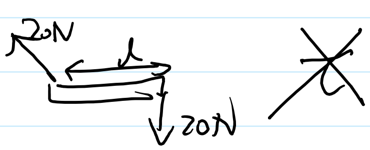
torque of a couple = force × perpendicular distance between lines of action of forces

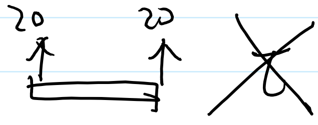
$\tau = Fd$ (not allowed when $F_1 \neq F_2$)

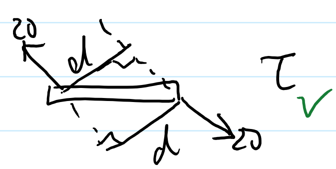
(not allowed when $F_1 \cancel{\parallel} F_2$) (not parallel)



$100x = 20(5-x)$





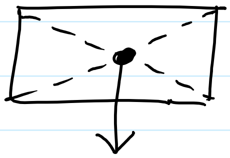


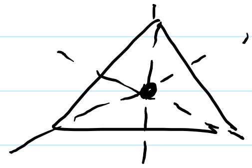
Center of gravity

{ Center of mass is the point that the mass of the whole object seems act on

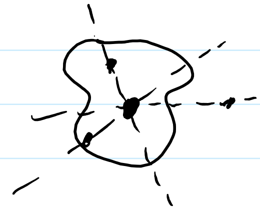
center of mass is the point that the mass of the whole object seems act on
center of gravity is the point that the weight of the whole object seems to act on

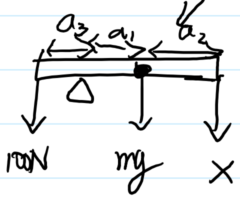
If it's a uniform shape, then center of mass = center of gravity = center of geometry





irregular: using palm line



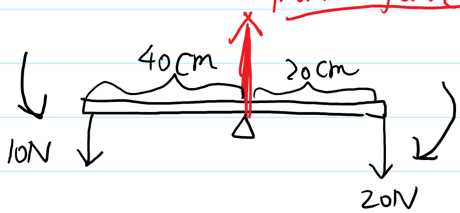


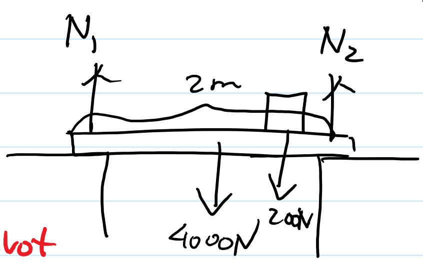
$$Fa_3 = mg\,a_1 + F_2(a_1+a_2)$$

the moment of centre of gravity is always zero

Equillibrium

- No resultant force / $\Sigma F = 0$ at any direction
- No resultant moment / $\Sigma M = 0$ about any pivot



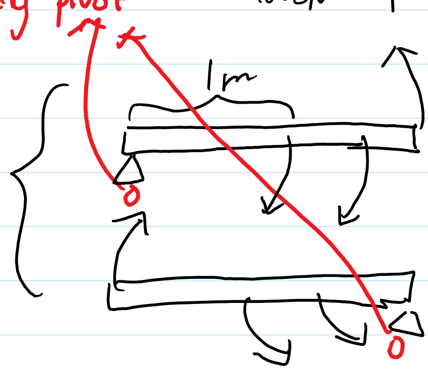


$N_1 \neq N_2$!

mentally pivot

Equillibrium

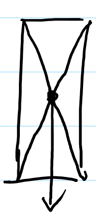
$$\begin{cases} N_1 = \\ N_2 = \end{cases} \Leftarrow$$



$4000 \times 1 + 200 \times (1.5) = N_2 \times 2$

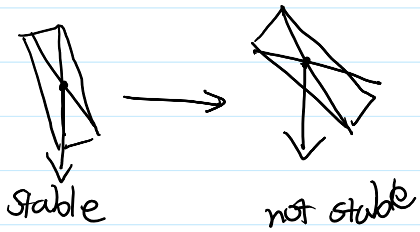
$4000 \times 1 + 200 \times 0.5 = N_1 \times 2$

Stability

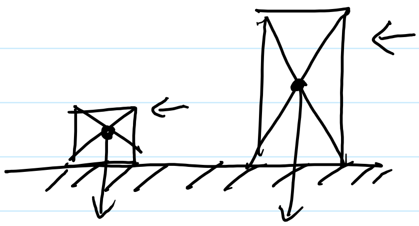


if weight crosses base → it's stable

a line



if not → it's not stable (fall)



the lower the centre of mass, the more stable it is

11/6: Work

Monday, November 6, 2017 3:50 PM

$W = F d$

Both need to be changed correspond to have work

have force

distance moved in by the force

$F \neq 0,\ s = 0 \Rightarrow W = 0$: pushing the wall

$F = 0,\ s \neq 0 \Rightarrow \cos\theta = 0 \Rightarrow$ ~~object~~ is floating in space

$F \neq 0,\ s \neq 0 \Rightarrow w = 0$ ... ~~moon orbiting earth~~

$W \propto d$ given F constant $\Rightarrow -400\,J$ ← doing work against friction

$W \propto F$ given d constant

$\boxed{\text{Unit: J (N m)}}$

$W = F \cdot d \Rightarrow 400\,J$ doing work against force

Definition: $1J = 1N\,1m$

$W_g = mg \cdot d \Rightarrow -400\,J$ of gravit

1 joule is such a energy that a force of 1N apply to an object to move 1m

Notice: work done and energy are related

if 100% efficient $\frac{P}{}$ energy $\cdot \frac{N}{m^2} \cdot m^3 = \text{work} \Rightarrow \frac{N}{m^2} \cdot m^3 = Nm = F \cdot S$

but this is not the work Done! Volume?

no energy lost i.e. no friction no resistance, no heat loss

piston move ⇒ work is done ⇒ $W = P \Delta V$

Notice: Work done by a expanding gas

Notice: W is a scalar

$W = \vec{F} \cdot \vec{S}$ → distance in direction of force

Power:

power output for given F & d is the same

~~Power~~ $= \frac{\text{work done}}{t} = \frac{E\ \text{energy transfer}}{t}$ rate of

$F = 200\,N$, $W \neq 200 \times 10$

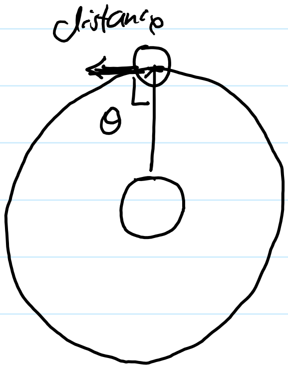
rate of $W = F\cos\theta\, d$ → projected to the axis

$= \frac{F \cdot S}{t}$, $d = F \cdot S$

$= F \cdot V$ Both of them are projection, therefore, it is scalar

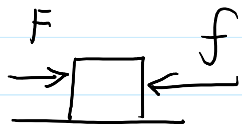
Complete Version: $W = F \cdot S \cdot \cos\theta$ → angle between them this is dot product → lead to a scalar

a cross product lead to a vector

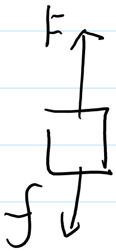


Earth doesn't do the work to hold the moon.

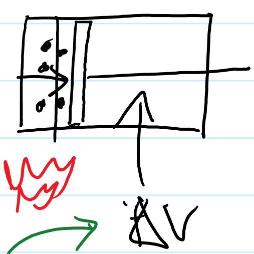
$\theta = 90^\circ$



$$\left.\begin{aligned} W &= Fd = 400J \\ W_f &= fd = -400J \end{aligned}\right\} \rightarrow \text{work done against friction}$$



$$\left.\begin{aligned} W &= Fd = 400J \\ W_g &= mgd = -400J \end{aligned}\right\} \rightarrow \text{work done against gravity}$$



heat to expansion $\Rightarrow \Delta V$

force next the wall

$PV = Pa \cdot m^3 = \frac{N}{\cancel{m^2}} \cdot \cancel{m^3}$ → This is

$= Nm = J$

only change in

$W = P\Delta V$

work done due to expansion of gas

Definition Unit $W = \frac{J}{t} = \frac{1J}{1t}$

$P = \frac{W}{t} = \frac{F d}{t} = FV$

force exceed, but uniform linear motion?

resultant force should be 0

it's the power of driving force.

11/8 :energy

Wednesday, November 8, 2017 9:30 AM

Energy

- Mechanical Energy (been done)
  - kinetic Energy: $E_K = \frac{1}{2}mv^2$ — energy of the moving object
  - gravitational potential energy (not done yet): $E_p = mgh$ — energy due to position on earth
  - elastic potential energy (Deforming solid; interaction): $E_p = \frac{1}{2}kx^2$ — energy due to attraction and repulsion of particles in an elastic object
- • ✗ chemical
- • ✓ electrical/magnetic
- • ✓ nuclear
- • ✗ Sound
- • ✓ light
- • ✓ thermal
- Internal Energy: Sum of all particles' kinetic energy due to random motion + Sum of all potential energy due to particle interaction (electric potential)

energy: Something needed to do work

potential: will be done under certain condition

$u = 0$, $V = V_t$

$v^2 - u^2 = 2as$ ($u^2 = 0$)

$v^2 = 2as$

$$\frac{mv^2}{2} = \frac{2as \cdot m}{2} = ma \cdot s = F \cdot d = W$$

Deviation

$E_p = mgh$

$= wh$

$W = F \cdot d$

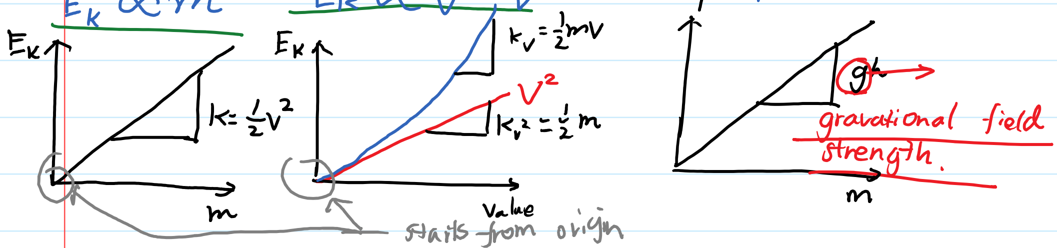
(100% efficiency → potential)

Graph and relationship:

direct relationship $E_K \propto m$

direct square relationship $E_K \propto v^2$, v

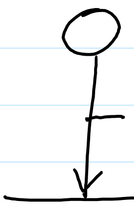
E_p $E_p \propto m$



Conservation of energy

Principle of conservation of energy:

- energy can not be created or destroyed [1]
- energy can be only change from one type to another type [1]
- [• or transfer from one object to another] [1]



p.e. = 4J . k.e. = 0J

p.e. = 2J . k.e. = 2J

p.e. = 0J. k.e. = 4J

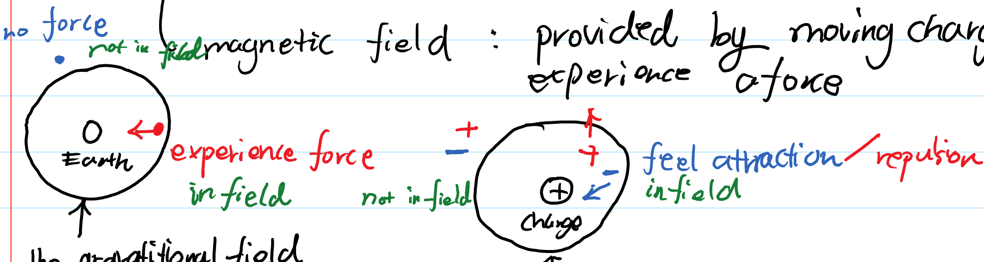
p.e. = 0J, k.e. = 4J

During Nucelar reaction, mass is not conserved, so total energy is not conserved

11/22 Electric Field

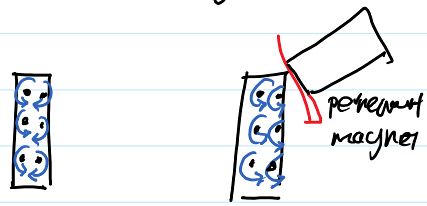
Wednesday, November 22, 2017 10:07 AM

field
- gravatitional field : An area which another mass is put in and experience a force
- electric field : An area which another charge experiences force
- magnetic field : provided by moving charge, another moving charge experience a force



the gravitational field

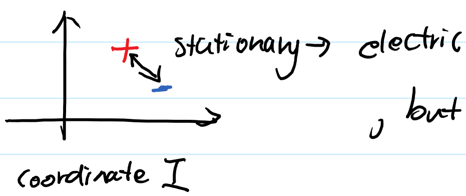
the electric field



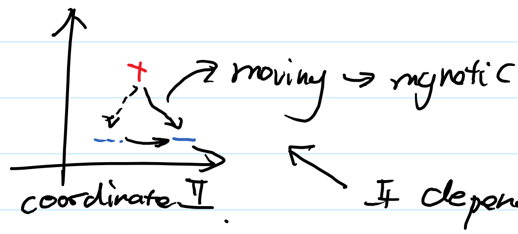
natural (cancil eachother)

Sycronised (magnitized)

electric field
magnetic field } split by artifical selection because of relativity



, but at same time



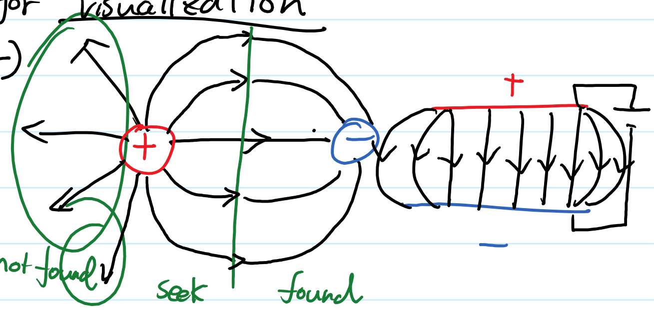
It depends on coordinate

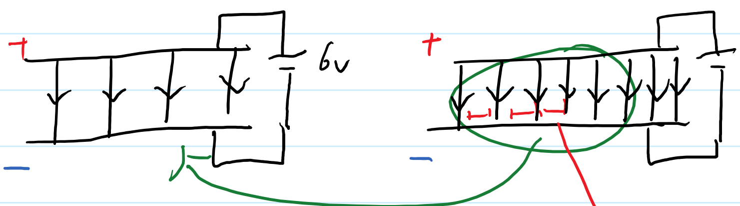
Elecric Field lines

Field line don't exist in realistic, just for visualization

- direction (start at +, seeking for -)
- density of line show strength of field

how line close to each other — how strong the field is





2x number

distance are the same (uniform field)

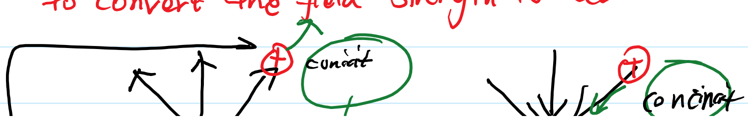
Electric field strength

$$E = \frac{F}{Q}$$ ← postive

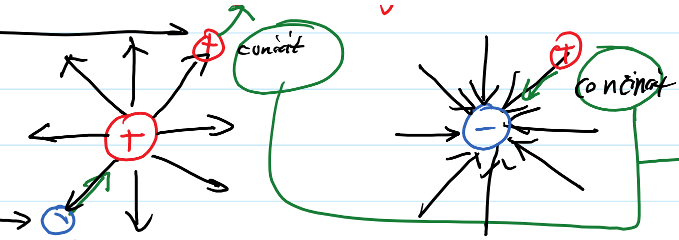
force acting on a unit postive charge

$g = \frac{F}{m}$

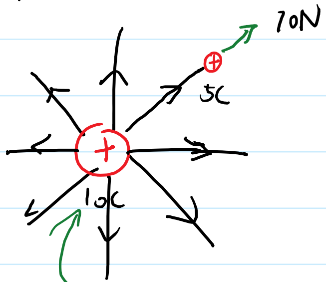
to convert the field strength to scalar



different direction



now they are a scalar



$E = \frac{F}{Q} = \frac{10N}{5C} = 2\ N/C$

placed in the field!

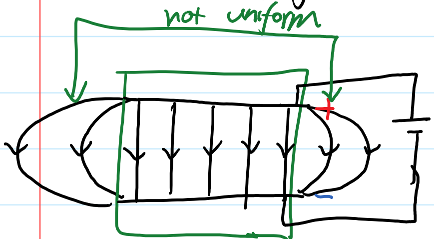
not the one that created

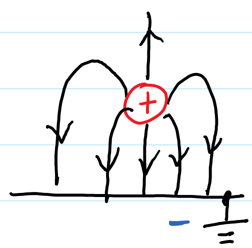
Type of Fields

Uniform : Electric field strength (E) is the same everywhere in this field (lines are parallel)

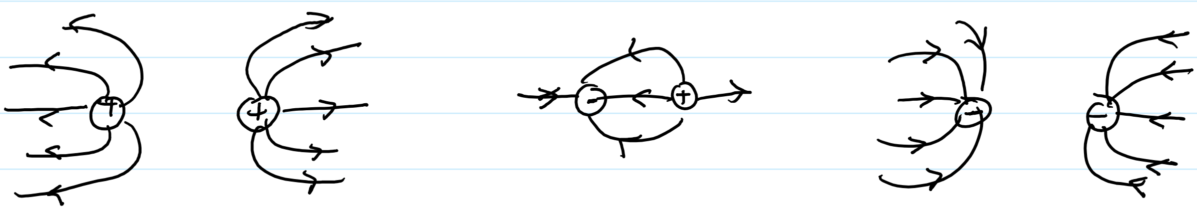
non-uniform not the same : e.g. • radials field

not uniform





earth also conduct electricity (a source of negative charge)



like repal like , like attract dislike

lightning strikes here (strongest field strength)

definition

from common sense

assume to

from common sense

definition

assume to be 0

non-uniform $\Leftarrow \boxed{E = \frac{F}{Q}} \Rightarrow$ uniform $\Leftarrow E \propto V$, $E \propto \frac{1}{d}$

for uniform field only

$E = k_1 V = k_2 \frac{1}{d} = \frac{k_1}{k_2} \frac{V}{d} = k \frac{V}{d} = \frac{V}{d}$

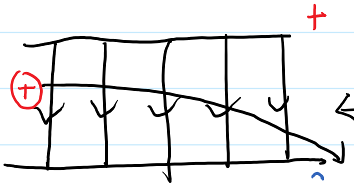
$= 1\ V/m$

electricity from $- \to +$ force from $+ \to -$

so actually $E = - \frac{V}{d}$

$[V/m] = [N/C]$

$E = \frac{F}{Q} = -\frac{V}{d} \Rightarrow F = QE = -\frac{QV}{d}$ $F = \frac{eV}{d}$ for e^-

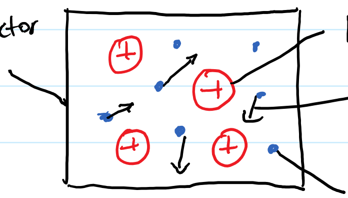


similar to projectile motion $\begin{cases} F_x = 0 \\ F_y = -\frac{QV}{d} \end{cases}$

11/27 Electricity

Monday, November 27, 2017 3:33 PM

Conductor

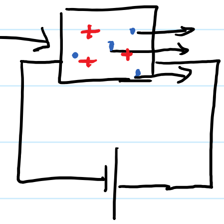


postive ions

random moving

delocalized electrons

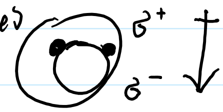
need to provide energy to move e^-



Electric Current (electricity) ⇒ directional motion of charges { metal: free e^- ; electrolyte: free ions

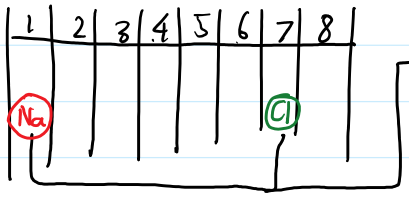
electrolyte

dipoles

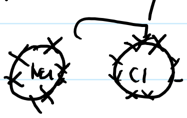


δ^+ δ^- charged

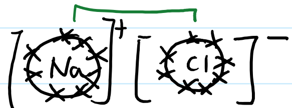
Periodic Table



→ make couple.

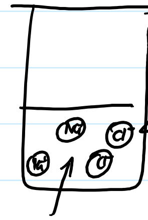


⇒ ionic bond



Both Complete

⇒ dissociation

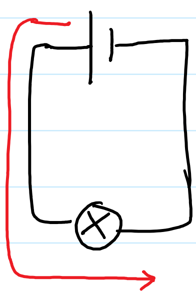


electrolyte → conduct e^-

oxidized ← $\bar{c}$ Na^+ → reduced

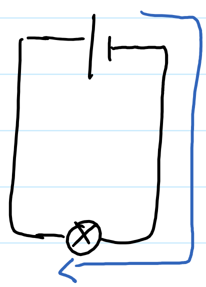
→ charged ions can move and conduct electricity

Direction of current



Direction of current

Conventional Direction



Direction of e^-

real Direction

ANSWER should be

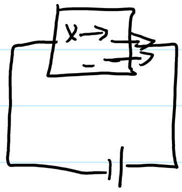
- real direction
- conventional direction

} Both

Electric Current

- Electric current in meaning of phenomena;

Electric Current

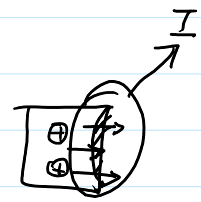


- Electric current in meaning of phenomena: – Directional motion of charges
- Electric current in meaning of I – the rate of flow of charge

Electric Variables

Definition

Current (I) in $\boxed{I = \frac{Q}{t}}$ rate of flow of charge.

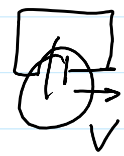


$I = \frac{V}{R}$ is only a statement Unit ⇒ [A] $1A = \frac{1C}{1s}$

Definition

Voltage (V) across $\boxed{V = \frac{E}{Q}}$ energy/work done per unit charge

V = IR is only a statement unit ⇒ [V] $1V = \frac{1J}{1C}$



* It's not p.d. (p.d. 'will be'), voltage 'is'

$[V/m] = [(J/C)/m] = [N\cancel{m}/C\cancel{m}] = [N/C] = [kgm A/s]$

Resistance (R)

$R = \frac{V}{I}$ is a statement, but should be answered as definition: voltage per current

Units ⇒ [Ω]

Power (P) $P = \frac{E}{t}$

$P = \frac{E}{t} = \frac{VQ}{t} = VI$ ⇒ statement only use in electricity

$P = I^2R \;/\; \frac{V^2}{R}$ are only statement

Energy (E) $E = Pt$