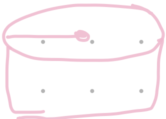
# 1. Measurment & Error

## purpose. measure Density

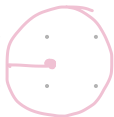
Density = $\frac{mass}{volume}$

unit $g/cm^3$

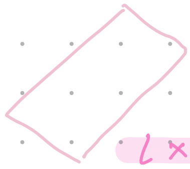
### ☆ Volvem of shapes:



$V = \pi r^2 h$



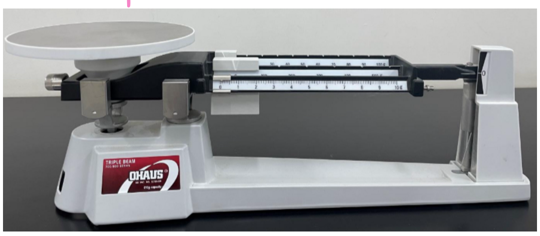
$\frac{4}{3} \pi r^3$



$l \times w \times$ thikness

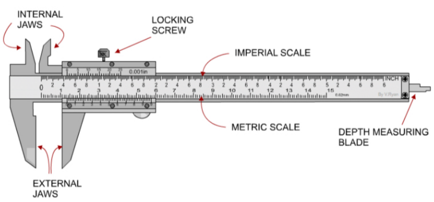
## Apparatus

### 1. Triple beam Balance




to find mass

### 2. Vernier Calliper




to find r or l or w

$\frac{\text{zero value} + \text{line value} \times 0.01}{10}$ from bottom

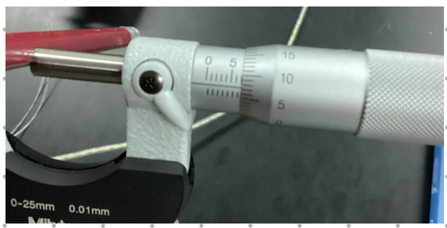

→ $\frac{25 + 5 \times 0.01}{10}$ → ☆ the scale is 10 points it's mm

→ to cm

or just devide all by 1000 mm → m

### 3. Micrometer Calliper

to find thikness


→ $\frac{6.5 + 8 \times 0.01}{10}$

$\frac{\text{the notcoverd value} + \text{zero value} \times 0.01}{10}$

# procedure

1. find Mass using TBB
2. Mesure Volume using Vernier caliper / micrometer
3. Calculate Density using calc
4. calculate error using calc

## Relative Error

$$\frac{\text{real val} - \text{measured}}{\text{real}} \times 100$$

## Conclusion.

measured Density

# 2. Thermal

**purpose.** Find Thermal Expantion Cofficent.

$$\alpha = \frac{\Delta L}{\Delta T \, L}$$

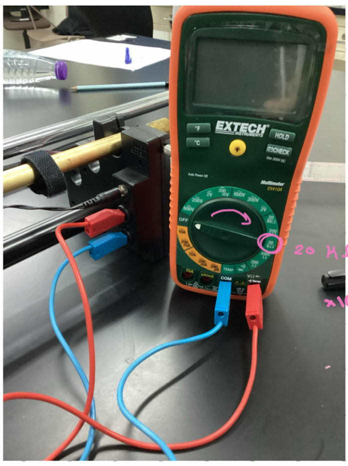
unit: $\frac{1}{C^\circ}$

## Apparatus

1. Metal tube
2. steam generator and water
3. Ruler
4. Oh'ms meter and wires
5. Thermostat /dial gauge

## procedure

1. oppen the Steam generator after adding water
2. mesure the length L of the Tube (from middle of Black circle Left to right)
3. mesure R from ohm meter then look in the table to find Tempreture
4. Apply the Steam then mesure resistant from oh'ms meter and find final Tempreture from table.
5. mesure $\Delta L$ directly from digital guage
6. calculate thermal expantion $\frac{\Delta L}{\Delta T \, . \, L}$




20 kΩ
$\times 10^3$

Red → Temp (1rst connection)
Blue → Com (Sec connection)

| | DATA | | | | CALCULATIONS | | |
|---|---|---|---|---|---|---|---|
| | L(mm) | $R_{rm}$(Ω) | ΔL(mm) | $R_{hot}$(Ω) | $T_{rm}$ (°C) | $T_{hot}$ (°C) | ΔT (°C) |
| opper | | | | | | | |
| rass | 750 | 10050 | 1.05 | 770 | 25° | 96° | 71 |
| minum | | | | | | | |

- L(mm): ruler
- $R_{rm}$: from reading. $R_{rm}$ = reading $\times 10^3$ → Ω, then search table for $T_{rm}$ = C°
- ΔL: from circle directly after steam
- $R_{hot}$: after the Steam
- $T_{rm}$: from table
- $T_{hot}$: after the Steam from table.
- ΔT: change in T

when water comes from tube take values. (after they are stable)

# 3. Energy Conservation

**purpose.** Approve that Energy Is conserved

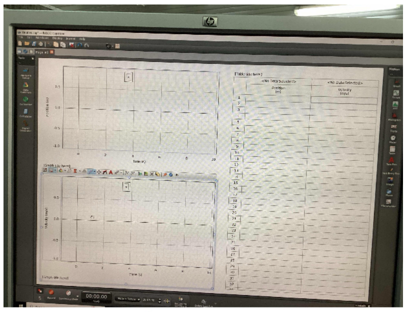
$$KE_i + PE_i = KE_f + PE_f$$

$KE = \frac{1}{2} m v^2$

$PE = mhg$

## Apparatus

1. pasco software
2. motion Sensor
3. interface
4. Free fall system



40 Hz

## procedure

1. pasco sittings → chose 2 graphs + table
   - motion
   - velocity

   Data Sammary
   position → sittings → N. Format → 3 → okay
   * for position and velocity

2. connect motion Sensor with interface

+ same connection in detals in Free fall exp.

3. Drop the ball on the sensor

4. collect data
   The Table will fill itself
   look for value when V = 0.00
   - take the value of position
   - then calculate 3/4 and look for the closest value of p in table
   take the value of V
   Same thing to find V when p = 1/2 and p = 1/4

Calculate KE and PE.

**Conc.**

- Total Energy at different hight are equal
  total Energy in closed System is conserved.

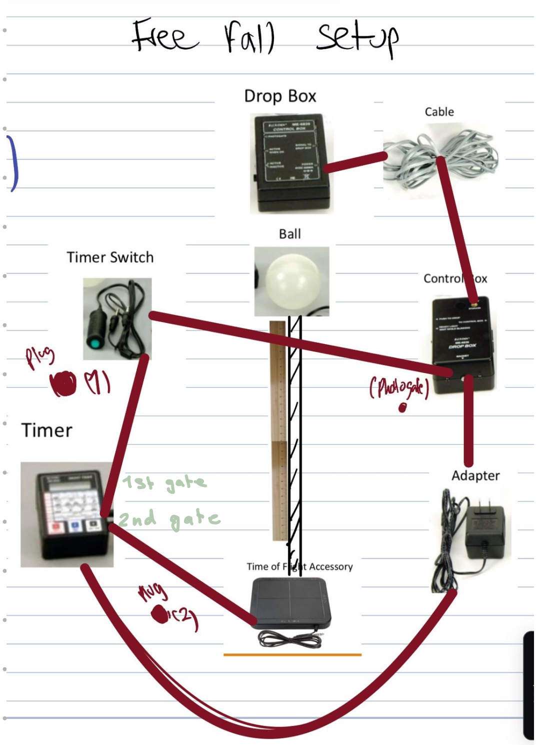
# 4. Free Fall

**purpose.** study the relationship between Time and displacement on freely falling object, measure g

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

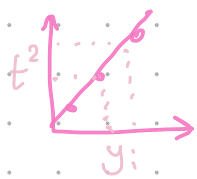
## Apparatus.

1. Drop box
2. Control box
3. Time switch
4. adapter
5. Time of flight
6. Ball
7. Ruler
8. cable
9. timer




## procedure.

1. connection →
2. use ruler to measure initial distance $y_i$ from the bottom of the ball to the Time of flight.
3. drop the Ball and read the timer
4. calculate the acceleration of gravity
   plog the time when hight = 80, 60, 40, 20, 0 and find $t^2$.
   plog the point on graph




find slop between any two points (not the ones u ploged).

The real Value of g = 9.81
find relative error.

$g = \frac{2}{slop}$

**Conc.**
calculated acc of gravity

# 5. vector

**purpose:** Finding resultant force $F_R$
resultant angle $\theta_R$
Equillibrant angle $\theta_e$

$F = ma$

$F_x = F_{x_1} \cos\theta + F_2 \cos\theta$

$F_y = F_1 \sin\theta + F_2 \sin\theta$

$F_R = \sqrt{(F_x)^2 + (F_y)^2}$

$\theta_R = \tan^{-1}\left(\frac{F_y}{F_x}\right)$ $\theta_R = \theta_e - 180$ $\theta_e = \theta_R + 180$

## Apparatus.

1. Force table
2. mass & hanger set
3. protractor
4. Graph paper
5. pencil
6. ruler

## Experimental
[always comming]

☆ $m_1$ $\theta_1$ $m_2$ $\theta_2$ will be givin.

1. add them to the table (the blue hanger is 5g)
2. Try different m and θ until the circle is centerd
3. now u have $m_e$ $\theta_e$
4. find $F_R$

$|F_R| = |F_e| = m_e g$

$\theta_R = \theta_E - 18$

## Graphical

1. use protractor to draw $\theta_1$ and use ruler to draw $m_1$ (the length is the grams ÷10)
   if m = 45 g the legth = 4.5 cm
   start from zero point
2. Same for $m_2$ $\theta_2$ but start from wherever you end $m_1 \theta_1$
3. connect them to find $m_R$ $\theta_R$ the θ take it
   - from zero point
   - $m_R$ = cm ×10 → g
   $\theta_e = \theta_R + 180$

## Theoretical

apply Formelas

$F_x = F_1 \cos\theta + F_2 \cos\theta$

$F_y = F_1 \sin\theta + F_2 \sin\theta$

$F_R = F_E = \sqrt{F_x^2 + F_y^2}$

$\theta_R = \tan^{-1}\left(\frac{F_y}{F_x}\right)$

$\theta_E = \theta_R + 180$

Relative Error:

$$\frac{\text{real value} - \text{(from exp) this}}{\text{real}} \times 100$$

## Conc.

calculated resultant force for two other forces

# 6. Projectiles

**Purpose.** determanation of the horizontal range (R) of projectile Shot for various velocities and angles.

**Zero lunch angle:**

$$t = \sqrt{\frac{2h}{g}} \qquad R = V_0 \sqrt{\frac{2h}{g}}$$

unit: m

**General launch angle**

$$R = \left(\frac{V_i^2}{g}\right) \sin 2\theta$$

## Apparatus.

1. projectile launcher
2. smart timer
3. 2 photo gate heads
4. metric measerment tape
5. Carbon - while paper
6. Adapter
7. Loading Rod
8. Ball
9. tape + scissors

## Procedure.

1. connect smart timer with two photogates
2. connect smart timer with adapter
3. put ball inside projectile (1-3 clics)
4. using ruler measure initial hight and d to measure initsial velocities and time

angle

draw line on Table

5. check angles

6. Turn on smart timer

7. pull the ball and mark where will it first hit the carboon paper
   ( first try to see where u should place the white paper )

8. measure horizontal Range using metric measumat tabe.

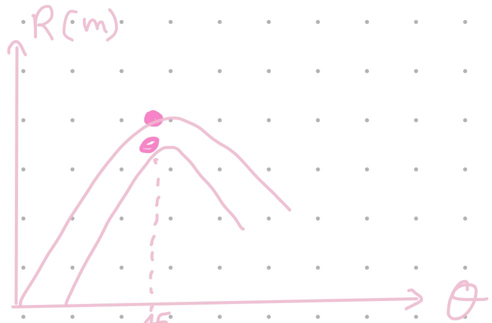
## Relative Error

$$\frac{\text{real value (R calculated)} - \text{R mesured (Experemental)}}{\text{real}} \times 100$$

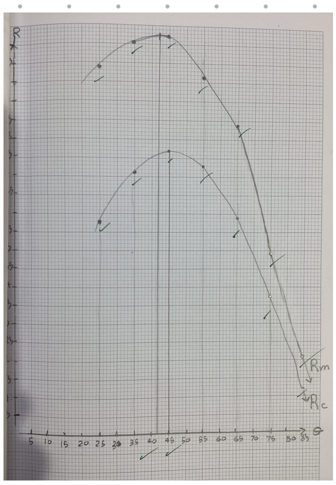
Gate 1 = short
Gate 2 = Medium
Gate 3 = Long

## For General Launch Angle:

plog a graph between R measured and it's angle
R calculaten and it's angle




max at θ = 45°




## Conc:

used the equation of motion to determain R of projectile.

# 7. Newton Law



**purpose.** Finding mass of a car using newton's 2nd law By Studing the relation ship between a and F of the car

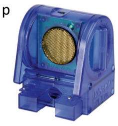
$F = m a$

- F ← by force sensor
- m ↓ our goal
- a ↘ $a = \frac{v}{t}$

## Apparatus.


1. force Sensor
2. dynamics System — the road of the car
3. computer interface
4. pas car
5. pasco Software
6. smart pully
7. mass and hanger set
8. motion Sensor

p

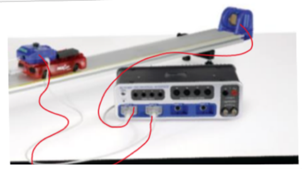


Motion sensor

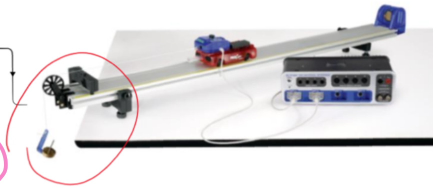
## procedure.

☆ sitting → chose 3 + chang Sign

1. open pasco - chose 2 graphs + table

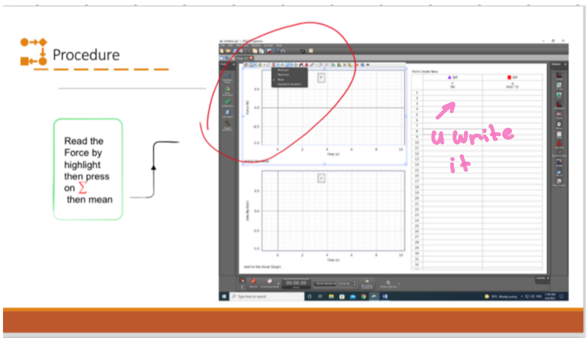


2. Connect force / motion sensors to interface

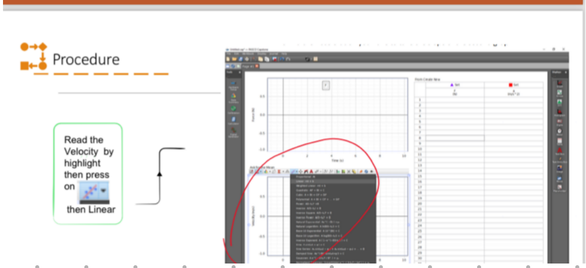


3. add hanger and masses to the car

4. read the force and acceleration (slope of v,t)




→ force (mean)




→ velocity (same time, linear slope)

slope $\frac{\Delta F}{\Delta a}$

↳ the expermental m

compare it with real m to find Relative Error.

# 8. Friction Force

purpose. find coefficant of static friction
find coefficant of Kinatic friction

$\mu_k = \frac{f_k}{N}$ $\mu_s = \frac{f_s}{N}$ → static friction f

N → N = W = mg

no unit

## Apparatus.

1. force sensor
2. Triple bean balance
3. pasco software
4. computer interface
5. Friction Accessory + String
6. Bar masses
7. Motion Sensor

## procedure.

1. open pasco + choose 2 graphs + Table
2. Connect motion / force Sensor to interface
3. connect force sensor with friction Accesory
face the motion sensor to " "
4. read the $f_s$ (Max) from the graph
read the $f_k$ (mean)

Relative error → depending on the material see the real value

Conc. $\mu_s > \mu_k$

# 4. Spring Force

**purpose.** find spring constant K

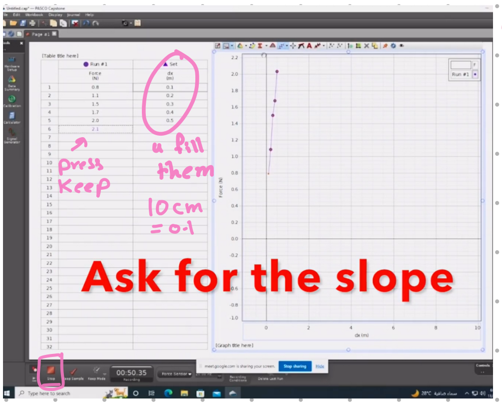
$F = K \Delta x$ → displasment

↓ our goal (K)

Slope $\frac{\Delta F}{\Delta x} = K$

## Apparatus.

1. Force Sensor
2. pasco
3. com interface
4. clamp
5. roler
6. springs




## procedure.

1. open pasco, chose graph + Table Force + d
   - choose KEEP mode
   - change force sign
   - press zero on sensor

2. connect force sensor with interface

3. Connect the spring with the clamp + the force sensor. fix the roler

4. Expand the spring 10cm each time (press keep)

find K from the slop.

Long, Shiny, Doll → Expand

Heave, Light → compress

**conc.** found K for differend kinds of springs

# 10. momentom

**purpose.** investigate the conservation of momentom & Kinatic energy of a system in collision.

**Elastic**

$KE_i = KE_f$

Kinatic energy is conserved

**Inelastic**

K Energy is not conserved

$P$ is conserved in Both

$$P = m \times v$$

$$KE = \frac{1}{2} m v^2$$

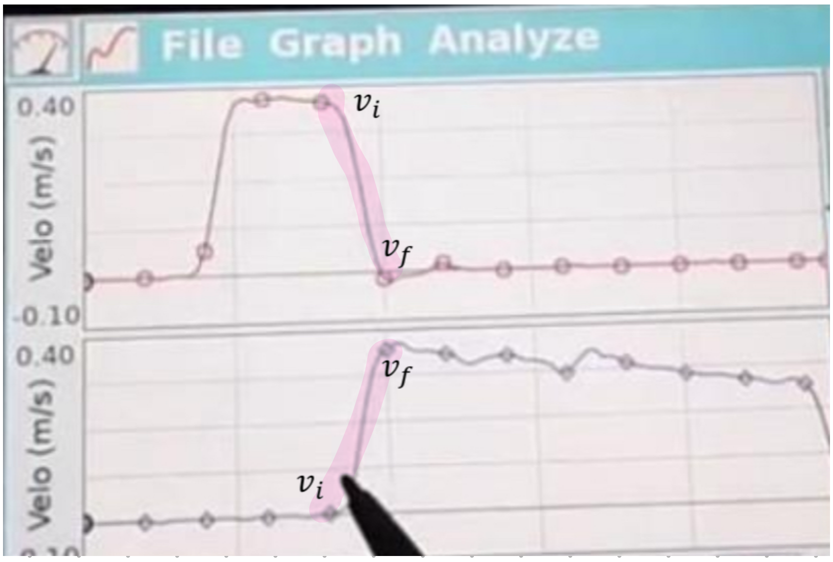
☆ $$P_{total\,i} = P_{total\,f}$$

## Apparatus.

1. Mass balance
2. pasco
3. com interface
4. Dynamic track
5. two pas cars
6. Smart pully
7. 250 g mass
8. Rotary motion Sensors

## procedure.

1. open pasco, choose 2 graphs → ☆ you have to add Senso manually (digital - RM) 1 and 2
2. Connect rotary-motion sensors with inteface
3. Do the collicions when $m_1 = m_2$, $m_1 \neq m_2$
   - Elastic
   - Inelastic
4. From graph take values of $V_i - V_f$




moving car

stable car

☆ if u got negativ values exchange yellow and black gates

Highligt + find [min, max]

$p = m \times v$

add $p_i$ and $p_f$ to find $p_{total}$

Relative error: the inisial $p$ is the real valve

**Conc.** the momentom in ellastic / inelastic is conserved.