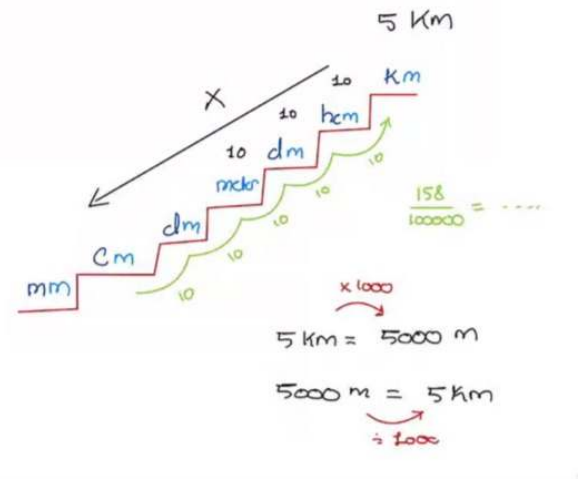
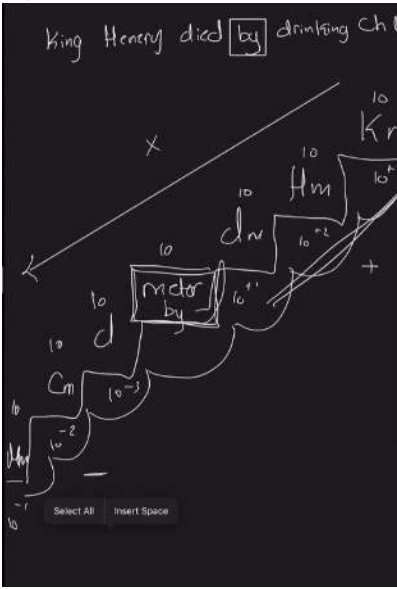


Converting



King Henry died by drinking chocolate milk



* Relative Error = $\left| \frac{\text{experimental value} - \text{actual value}}{\text{actual value}} \right| \times 100 = \text{---} \%$

All memorization formulas

- Exp 1:
- Density = $\frac{\text{mass}}{\text{Volume}}$ g/cm³
 - Cylinder * V = $\pi r^2 h$
 - Sphere * V = $\frac{4}{3} \pi r^3$
 - Paper * V = L x W x Thickness
 - Ruler * V = L x W x Thickness
 - Relative error = $\left| \frac{\text{density given} - \text{density I got}}{\text{density given}} \right| \times 100$

- Exp 2:
- $y_f = y_i + v_i t - \frac{1}{2} g t^2$
 - slope = $\frac{\Delta y}{\Delta x}$
 - $g = \frac{2}{\text{slope}}$
 - Relative error = $\left| \frac{9.81 - \text{gravity I got}}{9.81} \right| \times 100$

- Exp 3:
- force = ma
 - $F_x = F_{x_1} + F_{x_2} = F_1 \cos \theta_1 + F_2 \cos \theta_2$
 - $F_y = F_{y_1} + F_{y_2} = F_1 \sin \theta_1 + F_2 \sin \theta_2$
 - $F_R = |F_R| = |F_R| = \sqrt{(F_x)^2 + (F_y)^2}$
 - $\theta_R = \tan^{-1} \left(\frac{F_y}{F_x} \right)$
 - $\theta_E = \theta_R + 180$
 - Relative error = $\left| \frac{\text{theoretical } F_R - \text{Experimental or Graphical value}}{\text{theoretical } F_R} \right| \times 100$

- Exp 4:
- $V_i = \frac{d}{t_{\text{gates}}}$
 - $t_{\text{flight}} = \sqrt{2 \cdot \frac{h}{g}}$
 - Calculated of zero launch angle = $V_i \cdot t_{\text{flight}}$
 - Calculated of general launch angle = $\frac{V_i^2}{g} \cdot \sin(2 \cdot \theta)$
 - Relative error = $\left| \frac{R_c - R_m}{R_c} \right| \times 100$

- Exp 5:
- F = ma
 - Relative error = $\left| \frac{\text{actual value of mass} - \text{mass I found}}{\text{actual value}} \right| \times 100$

- Exp 6:
- $f_s = k_s N$
 - $N = w = mg = \left(\frac{\text{mass of bar}}{1000} + \text{mass of bar} \right) \times 9.81$
 - $k_s = \frac{f_s}{N}$
 - Relative error = $\left| \frac{\text{actual value (given)} - \text{the coefficient of the force}}{\text{actual value (given)}} \right| \times 100$

- Exp 7:
- $\partial = \frac{\Delta L}{\Delta T L}$
 - Relative error = $\pm \partial h$

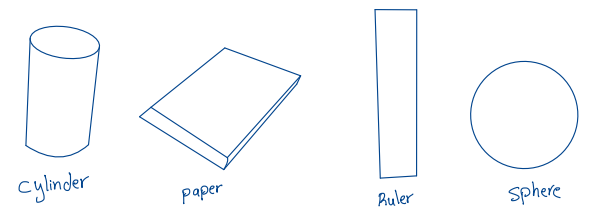
- Exp 8:
- $F = k \Delta x$

- Exp 9:
- $K E_i + P E_i = K E_f + P E_f$
 - $K E = \frac{1}{2} m v^2$
 - $P E = m h g$

- Exp 10:
- momentum P = mv
 - $k = \frac{1}{2} m v^2$
 - $P_{\text{total}} = P_1 + P_2$
 - $k_{\text{total}} = k_1 + k_2$
 - percent difference of p : $\left| \frac{P_f - P_i}{P_i} \right| \times 100\% = \text{---} \%$
 - Relative error = $\frac{P_i - ?}{P_i} \times 100$ $\leftarrow \pm \partial k$

Experiment 1 Measurement & Error

Purpose: Using 3 different lab apparatus to measure the density of four objects



Theory: • density (ρ) = $\frac{\text{mass (m)}}{\text{Volume (V)}}$ unit: $\frac{\text{g}}{\text{cm}^3}$

- Cylinder (V) = $\pi r^2 h$
- Sphere (V) = $\frac{4}{3} \pi r^3$
- Paper (V) = $l \times w \times \text{thickness}$
- Ruler (V) = $l \times w \times \text{thickness}$

Apparatus:

1- Triple-Beam Balance, 2- Vernier Calliper, 3- Micrometer Caliper



How to use it?

1- make sure every beam set to zero & the beam line match the zero



2- place the object

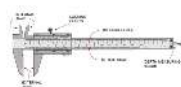


3- Move the beam one step forward till it fell down the put it on step back



until the line becomes a straight line to the zero

* To write it add them "not sure"



Sphere, Cylinder

How to use it?

1- place the object in the Vernier Caliper



2- Add the middle ruler number with the ruler

* for the middle ruler: check what's aligned with the zero of the third ruler.

* for the third ruler: check for an aligned line with the middle one



3- To find the radius, divide "d" by 2
 $r = \frac{d}{2}$



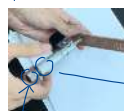
Paper

How to use it?

1) make it's aligned with the zero



2) place the object



open it & close it from here

1 click

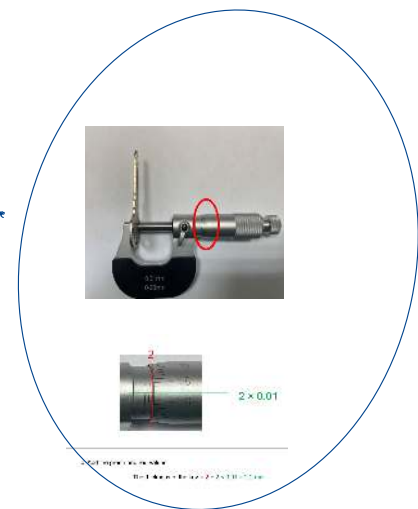
3) Read this one first



what's aligned is zero
Thickness = $3 + (0.01 \times 0)$

So = 3 mm

5) Convert to cm
 $\frac{3}{10} = 0.3 \text{ cm}$



Procedure:

- 1- Measure the mass using the Triple Beam Balance
- 2- Measure the volume of ruler, sphere, and cylinder using Vernier caliper (Use the formulas)
- 3- Measure the volume of paper using micrometer caliper

Calculations:

Data and Calculations

Quantity : Unit :	Mass (g)	Dimension1 (cm)	Dimension2 (cm)	Dimension3 (cm)	Volume (cm ³)	Density (g/cm ³)	Relative Error (%)
Ruler Real density:		Length=	Width=	Thickness=	$V = L \times W \times T$ =		
Paper Real density:		Length=	Width=	Thickness=	$V = L \times W \times T$ =		
Cylinder Real density:		height=	Diameter=	radius=	$V = \pi r^2 h$ =		
Sphere Real density:		-	Diameter=	radius=	$V = \frac{4}{3} \pi r^3$ =		

formula for relative error:

$$\frac{|\text{actual value} - \text{experimental value}|}{\text{actual value}} \times 100\%$$

Conclusion:

we learned how to measure the densities of the objects.

Experiment 2 Free Fall

Purpose: study the relation between the displacement and time of a freely falling object & measure the acceleration of gravity.

Theory: $y_f = y_i + v_i t - \frac{1}{2} g t^2$

Apparatus:

1- Drop Box , 2- Control Box , 3- Adaptor , 4- Timer switch , 5- Time of flight accessory , 6- Ball , 7- Cable , 8- Ruler, 9- Timer



How to use it?
1 click red
3 blue
1 click black

Procedure:

1- connect the flight accessory to the timer in 2 & connect the timer switch in 1

2- connect in the other side of the timer to the control box



3- connect the adaptor to the control box

4- connect the cable to control box and drop box

5- Attach the ball to the drop box

6- Measure the height of the ball using a ruler



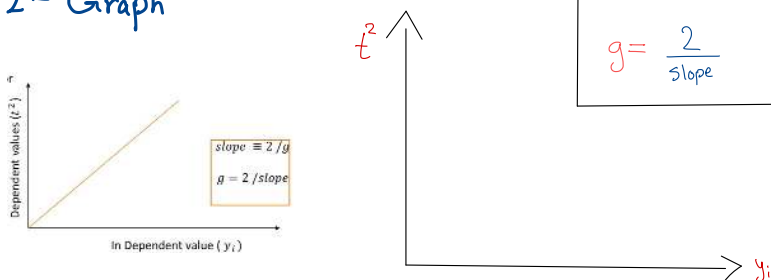
7- Set timer & start clicking the timer switch to drop the ball & read the time

Calculations:

1- Table

	From Timer	Calculate
y_i	t	t^2
80		
60		
40		
20		
0		

2- Graph



$$\text{Slope} = \frac{\Delta(t^2)}{\Delta y}$$

$$g = \frac{2}{\text{slope}}$$

3- Calculate the Relative error:

$$\text{Relative error} = \frac{|\text{Real value} - \text{Experimental value}|}{\text{Real value}} \times 100$$

9.81 (Real value) gravity found (Experimental value)

Conclusion:

we calculated the acceleration of gravity of the earth.

Experiment 3 Vectors

Purpose: Finding the resultant force F_R and Resultant angle θ_R and Equilibrant angle θ_e ; in 3 methods Experimentally, Graphically, and Theoretically

- Theory:**
- Force : $F = ma$
 - Force in x-direction : $F_x = F_{x_1} + F_{x_2} = F_1 \cos \theta_1 + F_2 \cos \theta_2$
 - Force in y-direction : $F_y = F_{y_1} + F_{y_2} = F_1 \sin \theta_1 + F_2 \sin \theta_2$
 - Resultant force : $|F_R| = |F_e| = \sqrt{(F_x)^2 + (F_y)^2}$
 - Resultant angle : $\theta_R = \tan^{-1}(\frac{F_y}{F_x})$
 $\theta_R = \theta_e - 180$
 - Equilibrant angle : $\theta_R + 180$

Apparatus:

1- Force table , 2- Mass & hanger set, 3- Protractor , 4- Graph paper , 5- pencil , 6- Ruler



Procedure :

Experimental method:

* Note : when we find m , we subtract 5

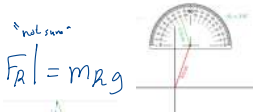
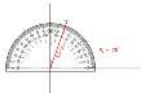
- 1- Add m_1 & set θ_1 in the force table
- 2- Add m_2 & set θ_2
- 3- Try different masses m_e & θ_e until the transparent ring on the force table centered
- 4- When you find m_e & θ_e , calculate F_R & θ_R by using:
 $|F_R| = |F_e| = m_e g$ and $\theta_R = \theta_e - 180$

Graphical Method:

- 1- m_1 & m_2 will be given in grams convert them to cm to graph
- 2- using the protractor draw θ_1 put a dot then using a ruler start for (0,0) a draw "m" line towards θ_1 direction
- 3- Do the same for θ_2 and m_2 , letting the 90 that is on the protractor be on the θ_1 "reference"
- 4- Use the ruler to draw $m_R \rightarrow m_R = \square \text{ cm} \times \frac{\log}{1 \text{ cm}} \square \text{ g}$, $|F_R| = m_R g$

- 5- Use the protractor to measure $\theta_R = \square^\circ$
 $\theta_e = \theta_R + 180$

$$\square \times \frac{1}{10g} = \square \text{ cm}$$



Theoretical Method:

	(N)	angle	X- component	Y- component
F_1	$F_1 = m_1 \cdot g$	70	$F_{x1} = F_1 \cos \theta_1$	$F_{y1} = F_1 \sin \theta_1$
F_2	$F_2 = m_2 \cdot g$	110	$F_{x2} = F_2 \cos \theta_2$	$F_{y2} = F_2 \sin \theta_2$
F_3	-	-	-	-
-	-	-	$F_R = F_{x1} + F_{x2}$	$F_y = F_{y1} + F_{y2}$

$|F_R| = |F_e| = \sqrt{(F_x)^2 + (F_y)^2}$ $\theta_R = \tan^{-1}(\frac{F_y}{F_x})$ $\theta_e = \theta_R + 180$

Results :

Method	F_R (N)	θ_R	θ_e	R% of F_R	R% of θ_R	R% of θ_e
Experimental						
Graphically						
Theoretically	1.05	87.44	267.43	-	-	-
{ Real value }						

$$\text{Relative error} = \frac{|\text{Real value} - \text{Experimental or Graphical value}|}{\text{Real value}} \times 100$$

Conclusion:

we learned how to calculate the resultant force for two forces.

Experiment 4 Projectile

Purpose: Determine the horizontal range [R] of a projectile shot for various initial velocities v_i and angles θ

Theory:

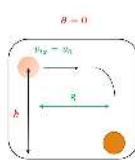
The equation of motion (2D): $\Delta \text{ distance} = v_i t + \frac{1}{2} a t^2$

$\Delta y = v_{iy} t + \frac{1}{2} a_y t^2$
 $\Delta y = y_f - y_i = 0 - h$
 $a_y = -g ; v_{iy} = 0$
 $-h = \frac{1}{2} - g t^2$
 $t = \sqrt{2 \frac{h}{g}}$

$\Delta x = v_{ix} t + \frac{1}{2} a_x t^2$
 $a_x = 0 ; \Delta x = R ; v_{ix} = v_0$
 $R = v_0 t$
 $R = v_0 \sqrt{2 \frac{h}{g}}$

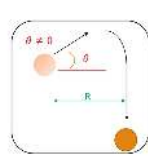
• Zero launch angle:

* $t = \sqrt{2 \cdot \frac{h}{g}}$ * $R = v_i \sqrt{2 \cdot \frac{h}{g}}$



• General launch angle:

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



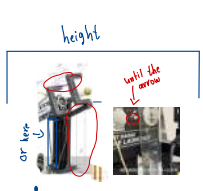
Apparatus:

- 1- projectile Launcher , 2- Smart Timer , 3- Two photo gate heads , 4- Metric measurement tape , 5- Carbon paper & white paper, 6- Adaptor , 7- loading Rod, 8- Steel or plastic ball, 9- Tape & Scissors

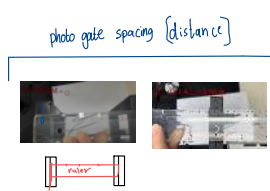


Procedure:

- 1- connect the two photo gates & the adaptor to the timer . * & plug the adaptor to the electricity
- 2- Measure the projectile height & photo gate spacing to measure the initial velocities & flight time.
- 3- Insert the ball inside the projectile launcher & using the iron rod "click once" for the first time then "twice" for second
- 4- Turn on the timer & check the angle
- 5- pull up the string & see where the ball hit on the bench
- 6- Measure the horizontal Range "R" using metric measurement tape [meter]



* Convert cm to m : $\div 100$



Calculations:

1- Table

* Zero launch angle:

* General launch angle:

Search timer

* Formulas :

- $v_i = \frac{d}{t}$ ← $\frac{\text{photo gate distance}}{\text{timer}}$
- $t_{\text{flight}} = \sqrt{2 \cdot \frac{h}{g}}$ ← $\frac{\text{height of the projectile}}{0.81}$
- $R_{\text{calculated}} = v_i \times t_{\text{flight}}$
- $R_{\text{measured}} = \text{ruler or meter}$

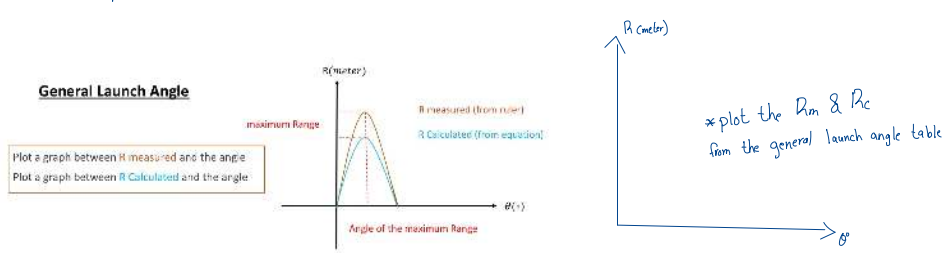
Timer

* Formulas :

- $v_i = \frac{d}{t}$ ← $\frac{\text{photo gate distance}}{\text{timer}}$
- $R_m = \text{Ruler or meter}$
- $R_c = \left(\frac{v_i^2}{g}\right) \sin(2\theta)$

Relative error = $\frac{|\text{Real value (R calculated)} - \text{Experimental (R measured)}|}{\text{Real value}} \times 100$

2- Graph



Conclusion:

we used one of the equations of motions to determine the horizontal range "R" of a projectile shot

Experiment 5 Newton law

Purpose: finding the mass of a car using newton second law , by studying the relationship between the acceleration of the car and the force acting on it and the car's mass

Theory:

$$F = ma$$

mass = our goal
 force apply to the car, finding it by using the force sensor
 acceleration of the car
 finding it by using the motion sensor

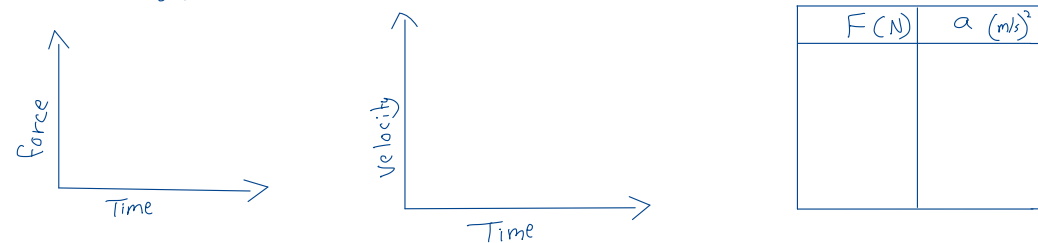
Apparatus:

1- force sensor, 2- dynamic system, 3- computer interface, 4- PASCAR, 5- Capstone Software, 6- Smart pulley with clamp, 7- Motion sensor, 8- Mass & hanger set & physics string



Procedure:

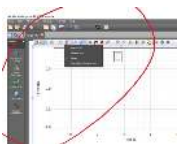
- 1- connect the force sensor & motion sensor to the computer interface & turn on the computer interface
- 2- Connect the string with the hanger to the car
- 3- Open Capstone Software & make sure it's connected from the hardware set up
- 4- Choose 2 graphs and 1 table



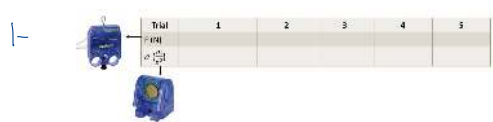
5- put the car on the middle "click run" & leave the car. "click stop, before it hits the end.

6- Then create a new page (Table & Graph) "put force & acceleration" on table & graph then take the linear

7- In force we take the mean "highlight the same time interval of velocity" & in velocity we take the linear "highlight the increasing



Calculations:



2- Compare our equation with the line equation:

$$F = ma$$

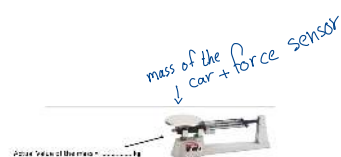
$y = \text{slope } x$

of the mass
 of the mass

3- Relative Error R = $\frac{|\text{Actual value} - \text{Experimental value}|}{\text{Actual value}} \times 100$

Relative Error R = %

Note :



Conclusion:

we found the mass of the car using newton second law

Experiment 6 Friction Force

Purpose: 1- find the coefficient of static friction μ_s & kinetic friction μ_k

Theory: * Applying a force to an object & the object is not moving until we arrive to the static frictional force * Applying a force to an object and the object is moving in same speed all the time (acceleration = 0)

$$f_s = \mu_s N \leftarrow \text{Normal force } N = w = mg$$

static frictional force

coefficient of static friction $\mu_s = \frac{f_s}{N}$

$$f_k = \mu_k N \leftarrow \text{Normal force } N = w = mg$$

kinetic frictional force

coefficient of kinetic friction $\mu_k = \frac{f_k}{N}$

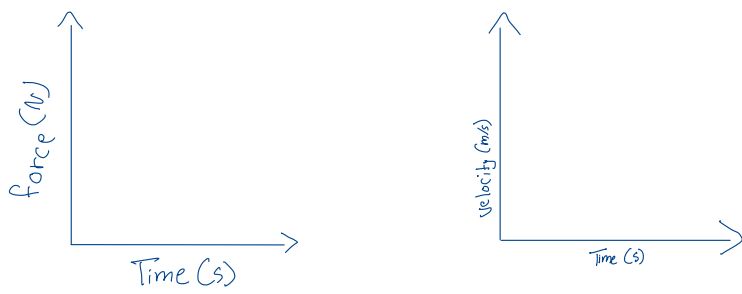
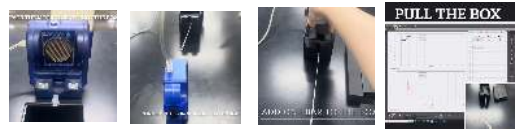
Apparatus:

- 1- Force sensor, 2- Computer Interface, 3- Triple beam balance, 4- Friction Accessory & String, 5- Capstone Software, 6- Motion Sensor, 7- Bar masses



Procedure:

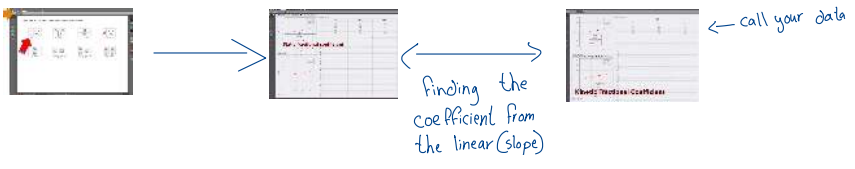
- 1- Connect the force sensor with the friction accessory. Face the motion sensor to the friction accessory.
2- Connect the motion and force sensors with the interface
3- Open the PASCO software and choose two graphs and table



f_s (N)	f_k (N)	N (N)

← Normal force : $N = m \cdot g$

- 4- If it has negative values → change the sign to positive
5- highlight from a certain time to time in both graphs [not sure]
6- f_s is the graph with force(N) → "Take the max"
7- f_k is the graph with velocity(m/s) → "Take the mean"
8- Open a new page choose Table & Graph and add a column)



Calculations:

1- Calculate the normal force (N) from the beginning

$$N = mg = \left(\frac{500g}{1000} + \text{mass of box in g} \right) kg \times 9.81$$

← for one bar

$$= \left(\frac{1000}{1000} + \text{mass of box} \right) \times 9.81$$

← for two bars

$$= \left(\frac{1500}{1000} + \text{mass of box} \right) \times 9.81$$

← for three bars

$$= \left(\frac{2000}{1000} + \text{mass of box} \right) \times 9.81$$

← for four bars

2- Find the relative error of μ_s & μ_k

Relative Error $R = \frac{\text{Actual value} - \text{Experimental value}}{\text{Actual value}} \times 100$

The coefficient of the forces

The relative error of $\mu_s = \text{---} \%$

The relative error of $\mu_k = \text{---} \%$

Conclusion:

we calculated the static frictional force & kinetic frictional force

Experiment 7 Thermal Expansion



Purpose: find thermal expansion coefficient

Theory: $\alpha = \frac{\Delta L}{\Delta T L}$

Annotations:

- α : Thermal expansion coefficient
- ΔL : increase in the length of the tube in mm
- ΔT : Difference in temperature
- L : length of the tube

Apparatus:

- 1- Metal tube , 2- Steam generator & water, 3- Ruler, 4- Ohm's meter & wires , 5- Thermostat and dial gauge

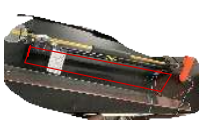


Red -> Temp
Blue -> Com



Procedure:

- 1- measure the length of the tube from middle black to black
- 2- Turn on the dial gauge & zero it out
- 3- Connect the multimeter "Ohm's meter" Red & blue wire (Red right, blue left)
- 4- Turn the dial from off to 20 KOHM
- 5- Black wire from tube connect it to first hot
- 6- Insert Steam generator to tube
- 7- The number you see in multimeter convert it from KM to KOhm by multiplying by 1000 = ohm
- 8- Then search the closest number T_m in the table given
- 9- Wait for steam "smoke" then take the number, it will be R_{hot} then search for T_{hot} in the table
- 10- ΔL is the dial gauge



Calculations:

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

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

1-

IV. Data and Calculations:

	DATA				CALCULATIONS		
	L(mm)	R _{cool} (Ω)	ΔL(mm)	R _{hot} (Ω)	T _{cool} (°C)	T _{hot} (°C)	ΔT(°C)
copper							
brass							
aluminum	750	1250	1.39	840	20	70	50

Annotations:

- ruler
- from reading the ohm's meter
 $R_{cool} = \text{reading} \times 10$
- from the gauge, after steam
- reading the steam meter after the steam
- search for the R_{hot} in the table
- search for the R_{cool} from the table
- T_{hot} - T_{cool}

Using the equation $\Delta L = \alpha L \Delta T$, calculate α for copper, steel, and aluminum:

Check the table

$\alpha_{Cu} =$

$\alpha_{brass} =$

$\alpha_{Al} = \frac{\Delta L}{L \Delta T} \rightarrow \frac{1.39}{750(70-20)} = 2.53 \times 10^{-5} \frac{1}{^\circ C}$

V. Results and Discussion:

Thermal expansion coefficient of the tube

$\alpha = \frac{0.01}{^\circ C}$

$\frac{4 - 0.01 \times 100}{2.5 \times 10^{-5}} \times 100 = 7.0$

2- Substitute:

$\alpha = \frac{\Delta L}{L \Delta T} = \square \frac{1}{^\circ C}$

? not sure

3- find the relative error:

Relative Error R = $\frac{|\text{Actual value} - \text{Experimental value}|}{\text{Actual value}} \times 100$

Relative Error R = %

Conclusion:

we found the thermal expansion coefficient

Experiment 8 Spring

Purpose: find the spring constant k

Theory: $F = k \Delta x$

force spring constant spring displacement

Apparatus:

- 1- Force sensor, 2- Capstone Software, 3- Computer interface, 4- Clamp, 5- Ruler, 6- Five Springs



Procedure:

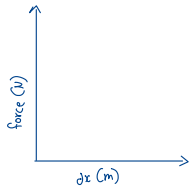
1- connect the spring with the clamp

2- connect the spring with the force sensor

3- connect the force sensor with interface

4- fix the ruler on the bench

5- Open Pasco Software and choose graph & table



Force (N)	dx (m)

insert the values you will expand the spring 10 cm at a time = 0.1 meter

dx (m)
0.1
0.2
0.3
0.4
0.5

*Expanding: expand the spring 10 cm at a time [each time you expand it press (keep on) on the software & find the (spring constant k) from the (slope)]

*Compressing: Insert the values of dx you will compress the spring 0.5 cm at a time = 0.005 meter

"The opposite of expanding"

"In compressing, change the ruler position"

dx (m)
0.005
0.010
0.015
0.020
0.025

Conclusion:

we found the spring constant for five different springs

* Similar to free fall

Purpose: Approve that energy is conserved

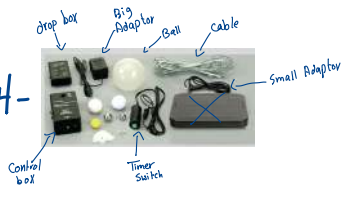
Theory: $KE_i + PE_i = KE_f + PE_f$

$$. KE = \frac{1}{2}mv^2$$

$$\cdot PE = mhg$$

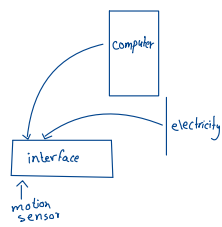
Apparatus:

1-Capstone Software, 2- Motion sensor, 3-Pasport interface 4-



Procedure :

- 1- connect the interface to the computer & to the electricity using the adaptor
- 2- Connect the motion sensor to the interface
- 3- Using the cable , connect the drop box & control box together
- 4- Connect the timer switch to the control box & interface
- 5- Attach the ball
- 6- Open PASCO software & choose graph and table

[illegible]

- 7- press start in the software then press the green button on the timer switch

- 8 - Read the height & velocity of the ball from the software

Calculations:

software software $v = mgh$ $K = \frac{1}{2}mv^2$ $PE + KE$

	H (m)	V (m/s)	PE (J)	KE (J)	E (J)
initial h					
$\frac{1}{4}$ h					
$\frac{2}{4}$ h					
$\frac{3}{4}$ h					

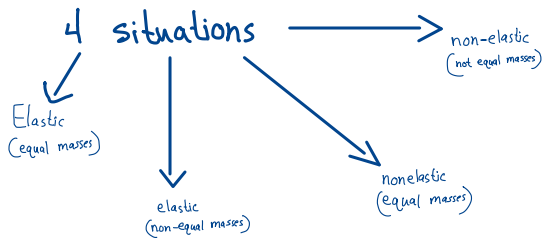
* Don't forget to convert $g \xrightarrow{\div 100} kg$

Conclusion:

The total energy of the closed system is conserved

Experiment 10 conservation of Momentum

Purpose: Investigate the conservation of momentum and kinetic energy



Theory:

- Momentum: $\vec{p} = m \times \vec{v}$
- Kinetic energy: $KE = \frac{1}{2}mv^2$
- law of conservation of momentum: $\vec{p}_{\text{Total before Collision}} = \vec{p}_{\text{Total After Collision}}$

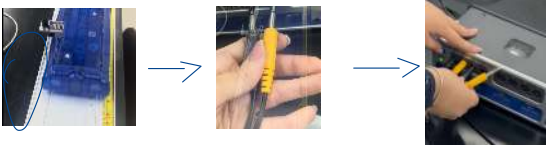
Apparatus:

1- Mass Balance, 2- 1.2 Dynamic Track, 3- Computer interface, 4- Two PAS cars, 5- Capstone software, 6- Smart pulley with clamp, 7- 250g Mass Bars, 8- Rotary Motion ^{Sensor}



Procedure:

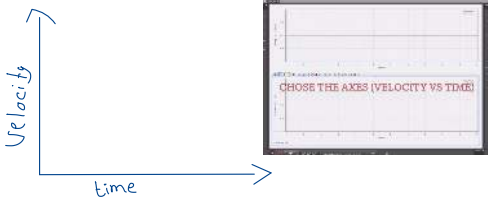
- Take the string of the blue car & connect it to "1" and "2" in the interface then do the same on the other car and connect it in "3" and "4"
- Connect the interface to the computer & connect the rotary motion sensor to the interface



- Open capstone software → Choose 2 graphs → make sure the cars are connected in the software → Hardware Set up → add sensor → Digital sensors → Rotary Motion Sensor Do this for both cars

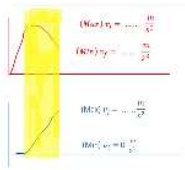


4- Choose Velocity & Time



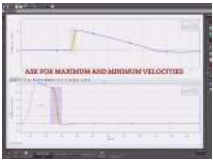
*** Inelastic Collision [equal masses] * black faces black ***

- Use the same mass car with the "black" towards each other
- Car 2 is at rest, press the "start" and push cart 1 towards cart 2 then click stop
- In the graph, highlight the velocity of cart 1 just before and after the collision Ask for maximum & minimum velocities
- Do the calculations, then calculate the percent difference

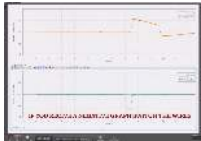


moving car, highlight the decreasing

stable car, highlight the increasing

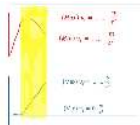


* Exchange yellow & black gates



*** Inelastic Collision [unequal masses] * black faces black ***

"Same just change the mass"

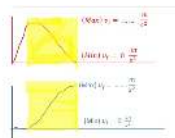


moving = decreasing

stable = increasing

*** Elastic Collision [equal masses]**

"Same but don't let the blacks face each other"

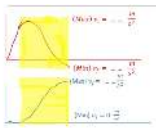


moving = decreasing

stable = increasing

*** Elastic Collision [unequal masses]**

"Same as this, just change the mass"



moving = decreasing

stable = increasing

Calculations:

1- This Table for all 4 situations

Part 2A: Equal masses
 $m_1 = m_2 = \dots (kg)$

	Cart 1				Cart 2				Total	
	v_1 ($m_1 v_1$)	p_1 ($\frac{1}{2} m_1 v_1^2$)	v_2 ($m_2 v_2$)	p_2 ($\frac{1}{2} m_2 v_2^2$)	v_1 ($m_1 v_1$)	p_1 ($\frac{1}{2} m_1 v_1^2$)	v_2 ($m_2 v_2$)	p_2 ($\frac{1}{2} m_2 v_2^2$)	Total P	Total K
Before (Initial)										
After (Final)										

$P_i + P_f \rightarrow K_i + K_f$

* Velocity from the graph $\leftarrow ?^o$

* $P = \text{mass} \times \text{velocity} = mv$

* $K = \frac{1}{2} mv^2$

* $P_{\text{Total}} = P_1 + P_2$

* $K_{\text{total}} = K_1 + K_2$

2- The percent difference of P

$$\frac{|P_f - P_i|}{P_i} \times 100\% = \text{---} \%$$

Part 2A: Equal masses
 $m_1 = m_2 = \dots (kg)$

	Cart 1				Cart 2				Total	
	v_1 ($m_1 v_1$)	p_1 ($\frac{1}{2} m_1 v_1^2$)	v_2 ($m_2 v_2$)	p_2 ($\frac{1}{2} m_2 v_2^2$)	v_1 ($m_1 v_1$)	p_1 ($\frac{1}{2} m_1 v_1^2$)	v_2 ($m_2 v_2$)	p_2 ($\frac{1}{2} m_2 v_2^2$)	Total P	Total K
Before (Initial)										
After (Final)										

Relative Error R = $\frac{|\text{Actual value} - \text{Experimental value}|}{\text{Actual value}} \times 100$

Relative Error R = %

P_i $\rightarrow$ $? \text{ I don't know}$

Discussion:

All are conserved except the kinetic energy of a system in Inelastic collision is not conserved

Conclusion:

The momentum of a system in INELASTIC and ELASTIC collisions is conserved.