الفصل الصيفي

٢٠١٤ - ٢٠١٥

لاب فيزياء ١

للدكتور : منيب الشطناوي

إعداد : براءة الفاعوري

شرح التجارب

Experiment . 1 .

* Collection and analysis of data ...

we have three variables :-

$h \Rightarrow$ the depth of water in the container.

$t \Rightarrow$ time needed to empty the container.

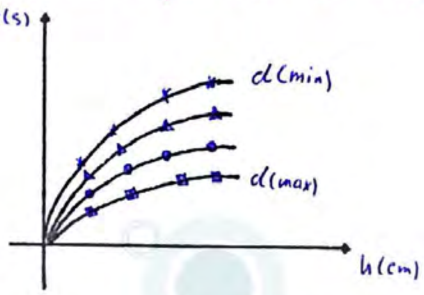
$d \Rightarrow$ diameters of a hole in the bottom of a container.

Types of variables :-

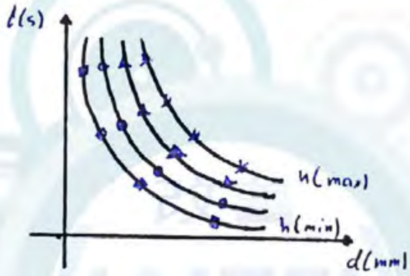
- Independent variables $\Rightarrow$. h - d .
- Dependent variables $\Rightarrow$. t .

In this experiment you will plot four graphs :-

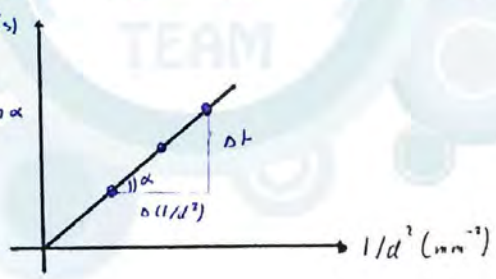
1. plot the time (t) versus the depth (h) for each diameter (d).



2. plot the time (t) versus the diameter (d) for each value of depth (h).



3. plot the time (t) versus $1/d^2$ for h = 30 cm.



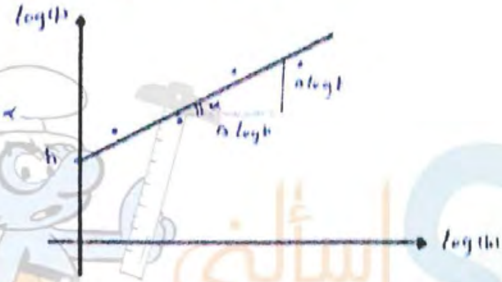
$$\text{Slope} = \frac{\Delta y}{\Delta x} = \frac{\Delta t}{\Delta 1/d^2} = m = \tan\alpha$$

$t = m(1/d^2) + 0$; h: 30 cm

→ empirical relationship .

4. plot $\log t$ versus $\log h$ for $d = 2mm$.

Slope: $\frac{\Delta y}{\Delta x} = \frac{\Delta \log t}{\Delta \log h} = m = \tan\alpha$



$y = mx + b$

$\log t = m \log h + b$

$\log t = \log h^m + b$

$\log t - \log h^m = b$

$\log\left(\frac{t}{h^m}\right) = b$

$\frac{t}{h^m} = 10^b \Longrightarrow t = 10^b \cdot h^m$

→ "empirical relationship"

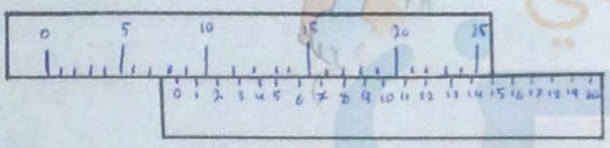
- $\log x - \log y = \log\left(\frac{x}{y}\right)$
- $m \log x = \log x^m$
- $\log x = y$
  $x = 10^y$

Experiment .2.

* Measurements and uncertainties ...

In this experiment you will learn how to use (Vernier caliper and Micrometer)

Reading of vernier :-



Result ⇒ 8mm + 5 * (Factor) mm =

8mm + 5 * 0.05 mm =

8.25 mm

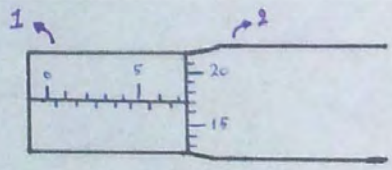
$$\left[\text{Factor} = \frac{1\,mm}{20} = 0.05\,mm \right]$$

* uncertainty $= \frac{1}{2}$ (Factor)

١. ننظر إلى مسطرة الورنية وبالتحديد إلى صفرها ونقرأ العدد الذي على يساره.

٢. ننظر ابتداءً من صفر المسطرة ونحدد أول تطابق تام بين تدريج المسطرة والورنية ثم نضرب العدد بدقة الورنية

Reading of micrometer :-



Result ⇒ 7mm + 17 * (Factor) mm =

7mm + 17 * 0.01 mm =

7.17 mm

$$\left[\text{Factor} = \frac{0.5\,mm}{50} = 0.01\,mm \right]$$

* uncertainty $= \frac{1}{2}$ (Factor)

١. ننظر إلى المقياس 1 ونسجل القيمة مع ملاحظة وجود (أو عدم وجود) تدريج (0.5) ملم على اسطوانة التدريج 1

٢. نقوم بتحديد التطابق بين المقياس 1 والمقياس 2 ونسجل القيمة مضروبة بدقة المايكروميتر.

Experiment .3.

* Vectors : Force table ...

- vectors :- have amagnitude and direction, such as :-
  velocity , Force ...
- Scalares :- have only amagnitude. such as :-
  mass, temperature ...

The addition of vector quantities, in this experiment , will be performed by the following three methods.

- Graphical Method :-
  " head-to-tail method "

* The resultant $\vec{R}$ is found by completing the polygon having $\vec{A}$, $\vec{B}$ and $\vec{C}$ as its side. The magnitude of $\vec{R}$ is determined by measuring its length. While the direction can be determined using a protractor.

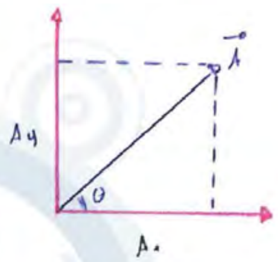
- Method of Components :-

$A_x = \vec{A} \cos\theta$

$A_y = \vec{A} \sin\theta$

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

$\theta = \tan^{-1}\frac{A_y}{A_x}$



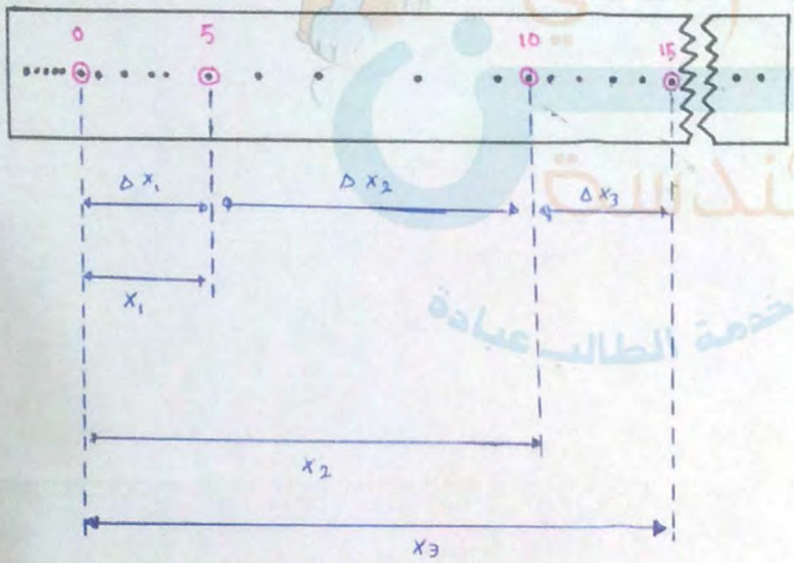
- Force_table :-
  The force_table consists of ahorizontal disk whose rim is graduated in degrees from 0° to 360°, aremovable pin at the center, and anumber of pulleys which can be clamped to the edge of the disk at any position around the circumference. The pulley clamp has an indexing mark to indicate angle.

Experiment .4.

* Kinematics of Rectilinear motion ...

In this experiment you will calculate the acceleration and velocity by using ticker tape.

- The timer marks one dot in each 1/50 second.

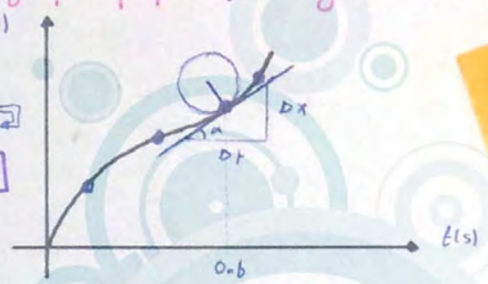


In this experiment you will plot three graphs :-

1. plot on a linear graph paper (x) against (t).

The instantaneous speed at the midpoint $t = 0.6\,s$ ⇒

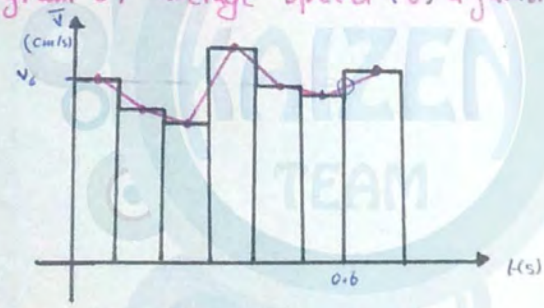
[slope $= \frac{\Delta y}{\Delta x} = \frac{\Delta x}{\Delta t} = m = \tan\alpha$]



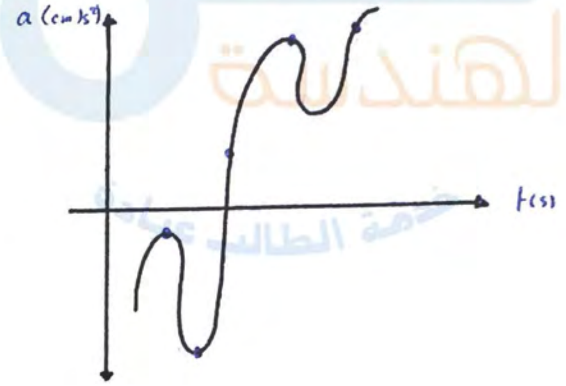
الرسمات قد تختلف من طالب إلى آخر... وذلك بسبب اختلاف سرعة سحب الشريط من الجهاز...

2. plot a histogram of average speed $(\bar{v})$ against (t).

V at $(t = 0.6) = V_6$



3. plot a smooth graph of instantaneous acceleration (a) against the time (t).



Experiment "5"

* Force and motion ...

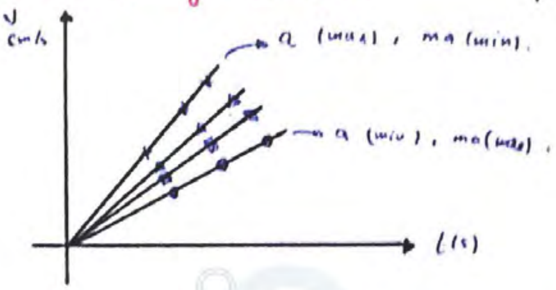
part 1 :- to study the relationship between the acceleration and added mass, while the net force is kept constant.

part 2 :- to study the relationship between the acceleration and the net force, while the mass is kept constant.

In this experiment you will plot three graph:-

1. plot agraph of (v) against (t). part 1

Slope $= \frac{\Delta y}{\Delta x} = \frac{\Delta v}{\Delta t} =$ acceleration "a" cm/s^2



2. plot agraph of added mass (m_a) against ($1/a$).

Slope $= \frac{\Delta y}{\Delta x} = \frac{\Delta m_a}{\Delta 1/a} = m_h . g$

$-b = -(m_c + m_h)$

So from this graph you will find the mass of the glider alone (m_c)

$m_a a = m_h g - m_h a - m_c a$

$\underset{y}{m_a} = \underset{slope}{m_h g} \cdot \underset{x}{\frac{1}{a}} - \underset{b}{(m_h + m_c)}$

3. plot agraph of the hanging weight ($m_h . g$) against the acceleration (a).

slope $= \frac{\Delta y}{\Delta x} = \frac{\Delta m_h g}{\Delta a} = M_{total}$ (dyne)

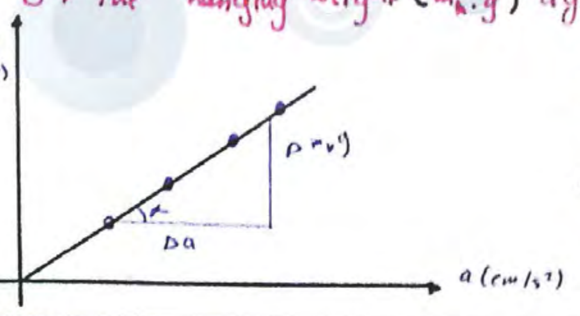
$M_{total} = m_a + m_h + m_c$

$T = (m_a + m_c) a$

$m_h g - T = m_h a$

$m_h g = (m_a + m_c + m_h) a$

y = slope x



Experiment "6"

* Collisions ((Conservation of momentum))...

purpose :-

To analyse the change in momentum of a system by three methods:-

- elastic collision against a fixed barrier.
- elastic collision between two trolleys.
- inelastic collision.

Newton's second law :-

$\sum \vec{F}_{ext} = ma$ special form...

$\sum \vec{F}_{ext} = \frac{d\vec{p}}{dt}$ general form...

$\sum \vec{F}_{ext} = \frac{d(m\vec{v})}{dt}$

$\sum \vec{F}_{ext} = m\frac{d\vec{v}}{dt} + \vec{v}\frac{dm}{dt}$

- if the mass constant $\Rightarrow \frac{dm}{dt} = 0$

$\Rightarrow \sum \vec{F}_{ext} = m\frac{d\vec{v}}{dt} = m\vec{a}$

- $\sum \vec{F}_{ext} = \frac{d\vec{p}}{dt}$

if $\sum \vec{F}_{ext} = 0$ so $\Rightarrow \frac{d\vec{p}}{dt} = 0$ P_{total} = constant.

$\therefore (\vec{P}_{total})_i = (P_{total})_f$

- Linear momentum $\equiv \vec{P}$

$\vec{P} = m\vec{v}$

- $K = \frac{1}{2}mv^2 = \frac{P^2}{2m}$

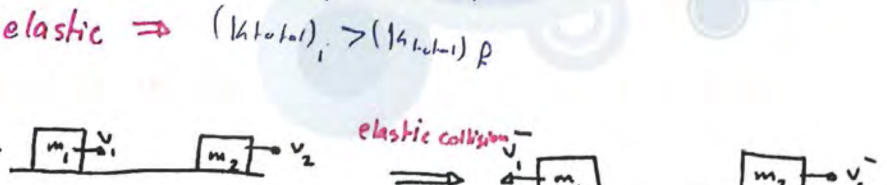
- rebound coefficient (r).

$r = \frac{|v'|}{|v|}$.

Types of collision :-

- elastic $\Rightarrow (K_{total})_i = (K_{total})_f$
- inelastic $\Rightarrow (K_{total})_i > (K_{total})_f$

Ex:-



befor collision after collision.

$P_f = P_i$

$m_1 v_1' + m_2 v_2' = m_1 v_1 + m_2 v_2$

Experiment "7"

* Rotational motion ...

- $\boxed{m} \rightarrow \vec{F}$. $\vec{F} = m\vec{a}$

Torque ≡ عزم القوة ≡ $\vec{\tau}$

$\vec{\tau} = \vec{r} \times \vec{F}$

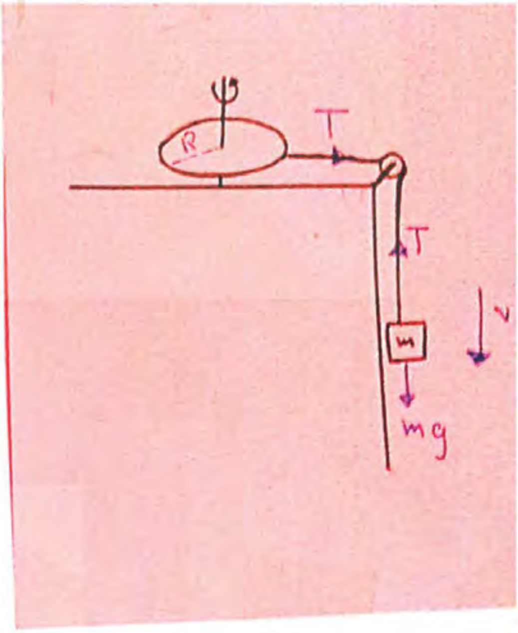
$\tau = rF\sin\theta$

$[\tau] = m.N = N.m$

- $\Sigma\vec{\tau} = I\vec{\alpha}$

I ≡ moment of inertia.

$\vec{\alpha}$ ≡ angular acceleration.



For mass m :-

$mg - T = ma$ 1

For the disk :-

$\Sigma\vec{\tau} = I\alpha$

* $\tau = RT\sin\theta$
* $RT = I\alpha$ 2
* $v = \omega R$ 3
* $a = \alpha R$ 4

using equations 1, 2, 3 and 4 we have :-

$I = mR\left(\frac{g}{\alpha} - R\right) \Longrightarrow (I_o)_A$

* $\tau = I\alpha$

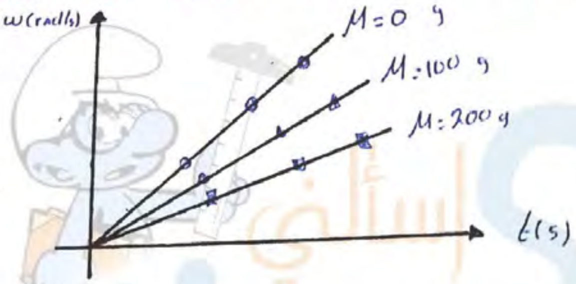
so :- $\tau = mR(g - R\alpha)$

In this experiment you will plot three graphs :-

1. plot agraph of (ω) versus (t) . [τ is constant]

Slope: $\frac{\Delta y}{\Delta x} = \frac{\Delta \omega}{\Delta t} = \vec{\alpha}$

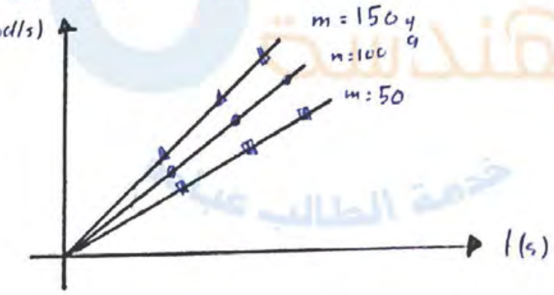
* τ is constant.



2. plot agraph of (ω) versus (t). [I is constant]

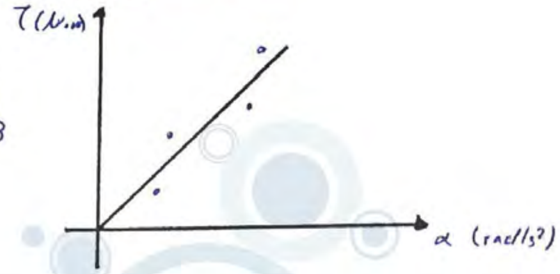
Slope: $\frac{\Delta y}{\Delta t} = \frac{\Delta \omega}{\Delta t} = \vec{\alpha}$

* I is constant.



3. plot agraph of (τ) against (α).

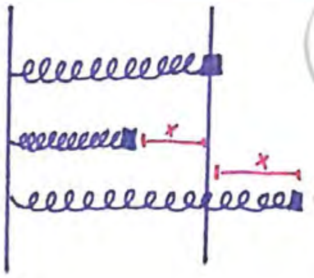
Slope: $\frac{\Delta y}{\Delta x} = \frac{\Delta \tau}{\Delta \alpha} = (I_o)_B$



* percent diff = $\frac{|(I_o)_B - (I_o)_A|}{\text{Average}}$

Experiment .8.

* Simple Harmonic motion (Osillating motion)



$F_s = -kx$ ... Hook's law.

F_s = spring force

$-kx = m\frac{d^2x}{dt^2} \Rightarrow \frac{d^2x}{dt^2} + \frac{k}{m}x = 0$ let $\frac{k}{m} = \omega^2$

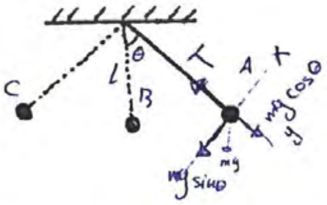
* $\frac{d^2x}{dt^2} + \omega x = 0 \Rightarrow$ H.L.S.O.d equation.

This equation has asolution:-

$x(t) = A\cos(\omega t + \theta)$

$A \equiv$ Constant $\equiv$ amplitude

*



restoring force here is $mg\sin\theta$

$\Sigma F_t = ma_t$

$-mg\sin\theta = m\frac{d^2s}{dt^2}$. $S = l\theta$, $\frac{ds}{dt} = l\frac{d\theta}{dt}$. $\frac{d^2s}{dt^2} = l\frac{d^2\theta}{dt^2}$

$-g\sin\theta = l\frac{d^2\theta}{dt^2} \Rightarrow \frac{d^2\theta}{dt^2} + \frac{g}{l}\sin\theta = 0$ let $\frac{g}{l} = \omega^2$

* if θ is small , then $\sin\theta \simeq \theta$

So $\Rightarrow \frac{d^2\theta}{dt^2} + \omega^2\theta = 0 \Rightarrow$ H.L.S.O.d equation.

This equation has asolution:-

$\theta(t) = \theta_0\cos(\omega t + \theta)$

θ_0 = Constant , $\omega t + \theta$ = phase ω = angular frequency.

$\omega = 2\pi f$, f = frequency = "التردد" , $f = \frac{1}{T}$. $T \equiv$ period = الزمن الدوري

$[f] = \frac{1}{s} = Hz$

$\omega^2 = \frac{4\pi^2}{T^2} = \frac{g}{l} \Rightarrow T^2 = \frac{4\pi^2 l}{g} \Rightarrow T = 2\pi\sqrt{\frac{l}{g}}$

In this experiment you will plot two graphs :-

1. plot $(\overline{T})$ versus (L).

2. plot $(\overline{T})^2$ versus (L).

$$\overline{T}^2 = \frac{4\pi^2}{g} L + 0$$

$$\text{Slope} = \frac{\Delta y}{\Delta x} = \frac{\Delta \overline{T}^2}{\Delta L} = \frac{4\pi^2}{g}$$

Experiment " 9 "

* The law of gases ...

$1\,mol$ = Avogadro's number of a substance $= 6.03 \times 10^{23}$

parameters of gases :-

1 - Volume ≡ V

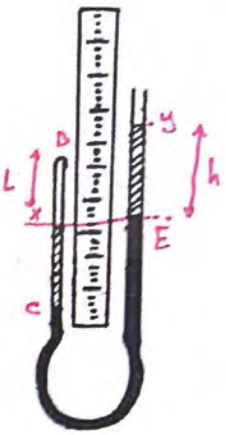
2 - Pressure ≡ P

$$P = \frac{F}{A} \quad N/m^2$$

3 - Temprelure ≡ t

4 - number of moles ≡ n

$[P]$ = pa, atm, mmHg, torr.



at equilibrium $\Rightarrow P = h + P_{atm}$

$$PV = nRt$$

$$(h + P_{atm})AL = nRt$$

$$h = \frac{nRt}{A} \cdot \frac{1}{L} - P_{atm}$$

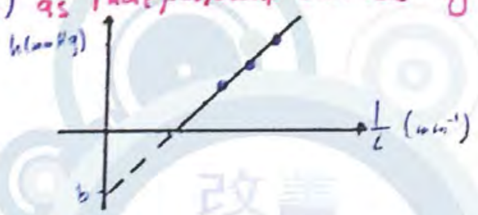
$$y = mx + b$$

$P = h + P_{atm}$
$V = AL$
$[A \equiv Area]$

In this experiment you will plot three graphs :-

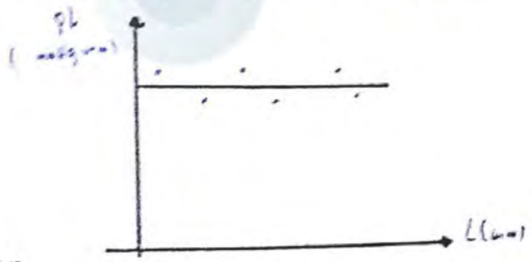
1. plot $(1/L)$ as independent variable against (h).

$[-b = -P_{atm}]$



2. plot graph between (L) and (P)

3. plot graph between (L) and (PL).



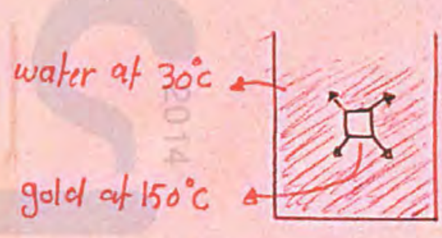
Experiment "11"

* Specific heat capacity of metals...

specific heat capacity ≡ C

$[C] = \frac{\text{energy}}{\text{mass} \cdot \text{Temprature}}$

1 cal = 4.18 J



heat lost by one part of system ≡ heat gained by the other part of the system

Heat energy ≡ Q

$Q = mc\Delta t$

m ≡ mass

C ≡ specific heat capacity

$\Delta t \equiv T_f - T_i$ = chang in temprefure.

* ice at 0°c ⟶ water at 0°c

$Q = Lm$

m ≡ mass

L ≡ latent heat . الحرارة الكامنة

→ L_f = latent heat of fusion

→ L_v = latent heat of vaporization.

* $Q > 0$ ⟹ heat is added to the system.

$Q < 0$ ⟹ heat is taken from the system.

Results :-

$C_2 \pm \Delta C_2$

$\Delta m = \frac{1}{2}(0.01)\,g$

$\Delta t = \frac{1}{2}$ (smallest division)

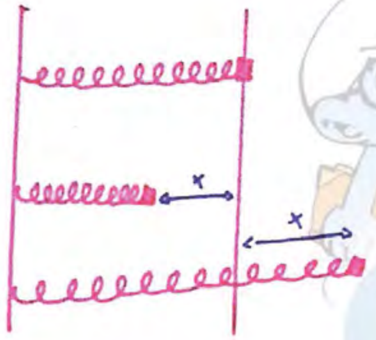
$T_C = \frac{5}{9}(T_F - 32)$

$T_K = T_C + 273.15$

Experiment «12»

* Ballistic pendulum ...

- elastic potential energy "U_s"



$F_s = -kx$

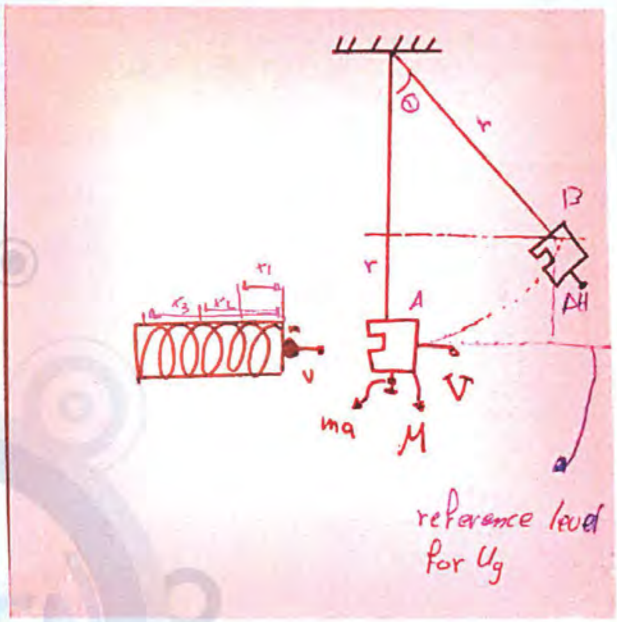
$U_s = \frac{1}{2} k x^2$

- $M_{total} = M + m_a$

- conservation of mechanical energy:

$$\frac{1}{2} k x^2 = \frac{1}{2} m v^2$$

$$v = \sqrt{\frac{k}{m} x^2}$$



Also, conservation of linear momentum:-

$$(P_{total})_i = (P_{total})_f$$

$$mv + 0 = (m + M_{total}) V \quad \text{completely inelastic collision.}$$

$$V = \frac{mv}{(m + M_{total})} \quad \dots\dots 1$$

Also, $[E_{mec}]_A = [E_{mec}]_B$

$$\frac{1}{2} (\cancel{m + M_{total}}) V^2 = (\cancel{m + M_{total}}) g . \Delta h \quad \dots\dots *$$

also, $\Delta h + r\cos\theta = r$

$\Delta h = r - r\cos\theta$

$\Delta h = r(1 - \cos\theta)$

so equation * become:- $\frac{1}{2} \frac{(mv)^2}{(m + M_{total})^2} = g r (1 - \cos\theta)$

$$\frac{m^2 v^2}{(m + M_{total})^2} = 2 g r (1 - \cos\theta) \quad \dots\dots 2$$

$$V^2 = \frac{(m+M_{total})^2}{m^2}\left[2gr(1-\cos\theta)\right]$$

$$v = \frac{(m+M_{total})}{m}\sqrt{2gr(1-\cos\theta)} \quad \ldots 3$$

but from equation 1 :-

$$V = \frac{mv}{m+M_{total}} \Rightarrow V = \frac{m}{(m+M_{total})} \cdot \frac{(m+M_{total})}{m} \cdot \sqrt{2gr(1-\cos\theta)}$$

$$V = \sqrt{2gr(1-\cos\theta)}$$

from equation "2"

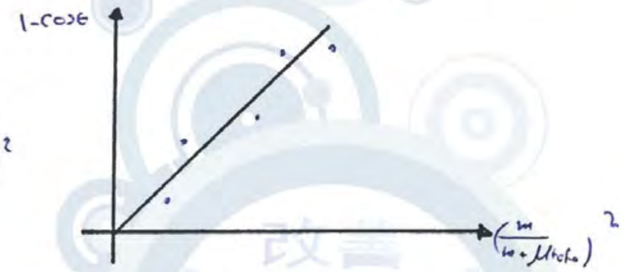
$$1-\cos\theta = \frac{m^2v^2}{(m+M_{total})} \cdot \frac{1}{2gr}$$

$$(1-\cos\theta) = \frac{V^2}{2gr}\left[\frac{m}{m+M_{total}}\right]^2$$

$$y = mx + 0$$

In this experiment you will plot one graph:-

1. plot $(1-\cos\theta)$ versus $(m/(M_{total}+m))^2$



$$\text{Slope} = \frac{\Delta y}{\Delta x} = \frac{\Delta\, 1-\cos\theta}{\Delta\left(\frac{m}{m+M_{total}}\right)^2}$$

$$= \frac{V^2}{2gr}$$