Umm Al-Qura University

College of Applied Science

Physics Department

Physics 101

Experiment 1

Graphing

Student name: ……………….…………………………..…………

University ID: ……………….…………………………...……….

Group Number: …………………………………….……………….

Exercise 1:

A student uses the simple pendulum experiment to determine the gravitational acceleration. The result from that experiment was 10.1 m/s2. On the other hand, the theoretical value of gravitational acceleration is 9.8m/s2.

Calculate the absolute error, the relative error, and the percentage error.

The Solution:

1) Absolute error:

$\Delta x = |X_{exp} - X_{th}| = |10.1 - 9.8| = 0.3\ m/s^2$

2) Relative error:

$R.E = \frac{|X_{exp} - X_{th}|}{X_{th}} = \frac{|10.1 - 9.8|}{9.8} = 0.0306$

3) Percentage error:

$P.E = \frac{|X_{exp} - X_{th}|}{X_{th}} \times 100\% = 3.06\%$

Exercise 2:

A teacher performed an experiment to determine the value of an electrical resistance in the lab. The result of the resistance in the lab was 120 **Ω**, and the real value is 100 **Ω**.

Calculate the absolute error, the relative error, and the percentage error.

The solution:

1) Absolute error:

$\Delta x = |120 - 100| = 20$

2) Relative error:

$R.E = \frac{|120 - 100|}{100} = 0.2$

3) Percentage error:

$P.E = 0.2 \times 100\% = 20\%$

Exercise 3:

We report in the table the velocity v of an object with time t. It is expected that the data obey a linear relation: $v = v_0 + at$.

You are asked to carefully plot the graph v versus t and analyze the graph to obtain its slope and y-intercept.

Then, they will be used to obtain the acceleration a and the initial velocity v_0 of the object.

t (sec)	5	10	15	20	25	30	35
v (m/s)	10.6	14.3	17.8	21.2	24.1	27.7	31.1

From the graph and data analysis derive the value of the acceleration (a).

The solution:

1) The independent variable is ……t (Sec)……

   And the dependent variable is ……V (m/s)……

2) The rough scale for x–axis: …… $\frac{35}{7}$ = 5 …… 5 كل مربع

   And the partial scale for x–axis: …… $\frac{5}{10}$ = 0.5 ……

   ملاحظة يمكن ١ مياه ومقارنة مختلف مثلا

   $x = \frac{35}{10} = 3.5$

3) The rough scale for y–axis: …… $\frac{31.1}{10}$ = 3.11 ……

   And the partial scale for y–axis: …… $\frac{3.11}{10}$ = 0.311 ……

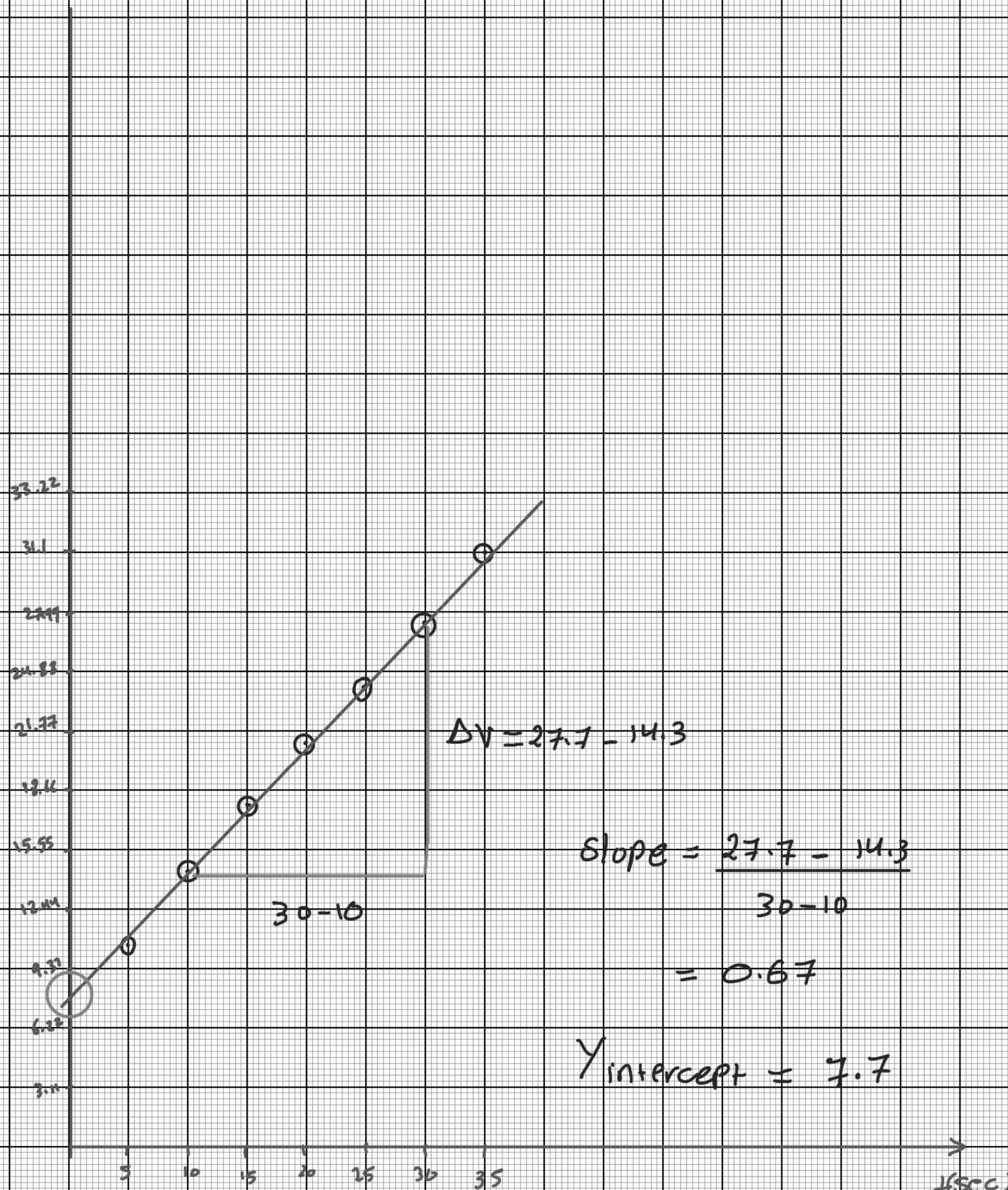
4) The slope of the straight line= …… 0.67 ……

   Then, the acceleration (a)= …… $\frac{\Delta v}{\Delta t}$ = a = slope = 0.67 m/s²

5) The y-intercept = …… 7.7 ……

   Then, the initial velocity v_0= …… 7.7 m/s ……

t (sec)	5	10	15	20	25	30	35
v (m/s)	10.6	14.3	17.8	21.2	24.1	27.7	31.1



Slope = $\frac{27.7 - 14.3}{30 - 10}$

= 0.67

Y intercept = 7.7

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Experiment 2

Accurate Measurements

Student name: ……………….………………………….…………

University ID: ……………….……………………………..………

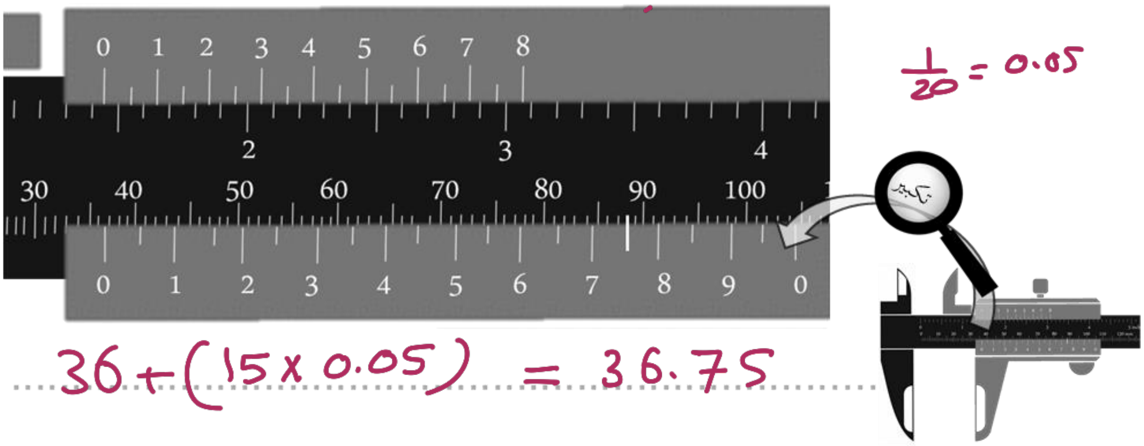
Group Number: …………………………………………..…………………

Part 1: – Vernier caliper scale:

- Vernier caliper least measurement accuracy= .... $\frac{1}{\text{عدد خطوط الورنية}} = \frac{1}{20} = 0.05$
- Zero error: ... تختلف الورنية والقراءة الظاهرة تكون الخطأ الصفري ...

Exercise 1:

What is the reading of the vernier caliper in the image below?

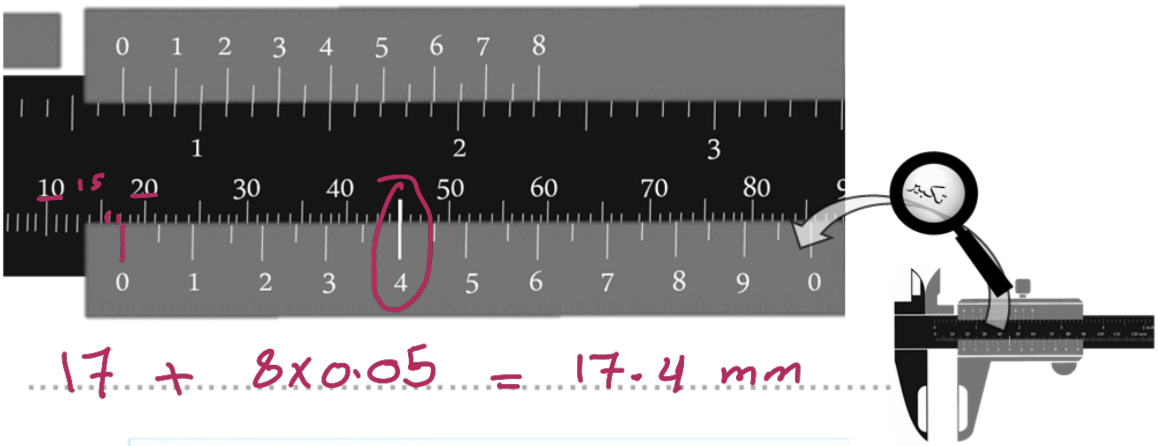


$\frac{1}{20} = 0.05$

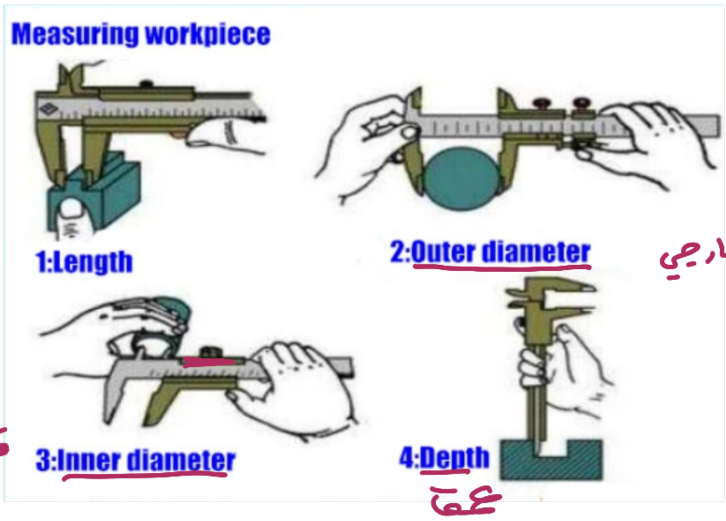
$36 + (15 \times 0.05) = 36.75$

Exercise 2:

What is the reading of the vernier caliper in the image below?



$17 + 8 \times 0.05 = 17.4$ mm



القطر الخارجي

قطر خارجي

قطر الداخلي

عمق

Measurements done in the lab

By using the vernier caliper, take different measurements, record them in the table below and calculate the average reading of each part of the cylinder.

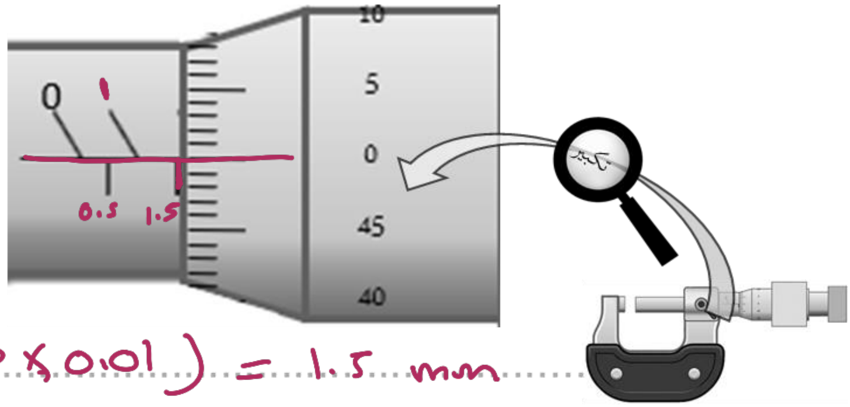
Object	1st Reading	2nd Reading	3rd Reading	The average
Outer diameter of the cylinder	13.2	13.3	13	$\frac{13.2+13.3+13}{3}$
Inner diameter of the cylinder				
Outer length of the cylinder				
Inner length of the cylinder				

Part 2: Micrometer Measurements:

- Micrometer least measurement accuracy= ……0.01 (دقة)……
- Zero error: ……نتحقق لميكروميتر حتى نقرأ الخطأ الصفري……

Exercise 3:

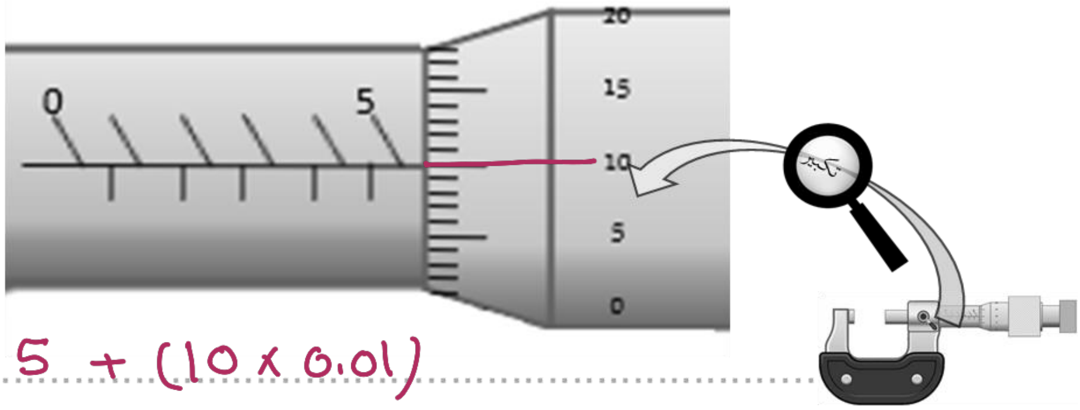
What is the reading of the micrometer in the image below?



$1.5 + (0 \times 0.01) = 1.5$ mm

Exercise 4:

What is the reading of the micrometer in the image below?



$5 + (10 \times 0.01)$

5.1 mm

Measurements done in the lab

By using the micrometer, take different measurements, record them in the table below and calculate the of each measurement.

Measuring Type	1st Reading	2nd Reading	3rd Reading	Average
قطر Rod diameter قضيب معدني	✓ 2mm	✓ 2.1	2	$\frac{2+2.1+2}{3}$
Slice thickness سماكة شريحة				

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Experiment 3

Vector Addition (Force Table)

Student name: ……………….……………………….………….

University ID: ……………….…………………………...………

Group Number: …………………………………….……………….

- Objectives:

1. Using the force table to experimentally determine the force that balances two other forces.
2. Checking the rule of adding two vectors using three methods: experimentally, analytically, and graphically.

- Equipment:

Force table - Hanger set - A set of mass - Protractor - Ruler

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- Used Equations:

$F_{1x} = F_1 \cos\theta_1$ $\qquad$ $F_{1y} = F_1 \sin\theta_1$

$F_{2x} = F_2 \cos\theta_2$ $\qquad$ $F_{2y} = F_2 \sin\theta_2$

$F_x = F_{1x} + F_{2x}$ $\qquad$ $F_y = F_{1y} + F_{2y}$

$F_R = \sqrt{F_x^2 + F_y^2}$ $\qquad$ $\theta = \tan^{-1}\left(\frac{F_y}{F_x}\right)$

- Theory:

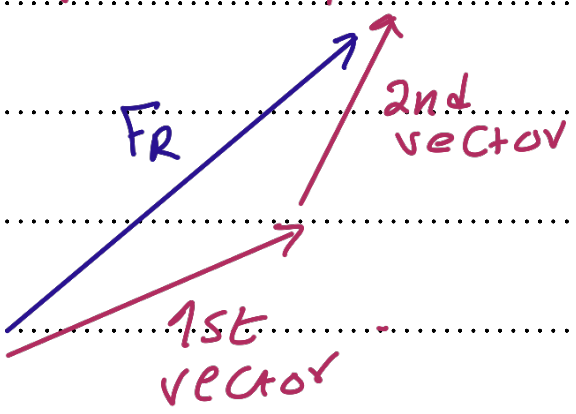
In This experiment we will add forces which are vectors experimentally using force table and then will compare the results obtaind by

1) Component Method

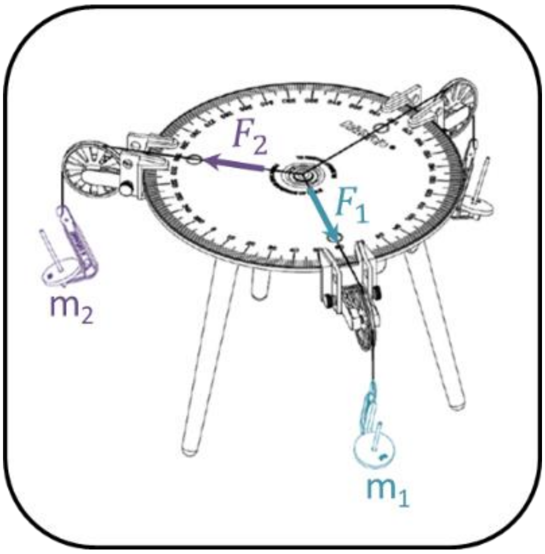
$F_R = \sqrt{F_x^2 + F_x^2}$ $\theta = \tan^{-1}\left(\frac{F_y}{F_x}\right)$

$F_x = F\cos\theta$ $F_y = F\sin\theta$

2) Graphical Method



Part 1.: – **Adding vectors practically**:



1) By using the force table shown in the figure above hang a mass m_1 of 65 gm, at angel $\theta_1 = 75^o$ and a mass m_2 of 40 gm, at angel $\theta_2 = 330^o$

2) complete the following table

Vector	Total mass m (g)	Total mass m (kg)	Force (F): $F = mg$ (N)	Direction: Angle θ ( )
First force: $\overrightarrow{F_1}$	65	0.065	$F_1 =$ 0.637	$\theta_1 =$ 75
Second force: $\overrightarrow{F_2}$	40	0.040	$F_2 =$ 0.392	$\theta_2 =$ 330
Balanced force $\overrightarrow{F_B}$	70	0.07	$F_B =$ 0.686	$\theta_B =$ 220

3) Find $\overrightarrow{F_{exp}}$:

The resultant force is $\overrightarrow{F_1} + \overrightarrow{F_2} = \overrightarrow{F_R} = -\overrightarrow{F_B}$, so $\overrightarrow{F_R}$ has the same magnitude as $\overrightarrow{F_B}$ but has opposite direction:

$F_{exp} = F_B =$ ...226...... and $\theta_{exp} = \theta_B - 180° =$....40...............

Part 2.: – Adding vectors theoretically:

A) Component method

From part.1. we've found that:

$F_1 =$ 0.637 $\theta_1 =$ 75

$F_2 =$ 0.392 $\theta_2 =$ 330

1) Calculate the theoretical value of the resultant force magnitude F_{th1}

$F_{1x} = F_1 \cos\theta_1 = 0.637 \cos 75 = 0.1649$

$F_{1y} = F_1 \sin\theta_1 = 0.637 \sin 75 = 0.61529$

$F_{2x} = F_2 \cos\theta_2 = 0.392 \cos 330 = 0.3394$

$F_{2y} = F_2 \sin\theta_2 = 0.392 \sin 330 = -0.196$

$F_x = F_{1x} + F_{2x} = 0.50435$

$F_y = F_{1y} + F_{2y} = 0.4193$

$F_{R_{th}} = \sqrt{0.50435^2 + 0.493^2} = 0.6558$

2) Calculate the resultant force direction $\boldsymbol{\theta_{th1}}$:

$\theta = \tan^{-1}\left(\frac{F_y}{F_x}\right) = \tan^{-1}\left(\frac{0.4193}{0.50435}\right) = 39.7^{\circ}$

3) Calculate the percentage error:

The % error in magnitude $(F_{exp}$ & $F_{th2}) =$ $\left|\frac{0.6558 - 0.686}{0.6558}\right| \times 100\%$

The % error in direction $(\theta_{exp}$ & $\theta_{th2}) =$ $\left|\frac{40 - 39.7}{39.7}\right| \times 100\%$

B) **Graphical Method**

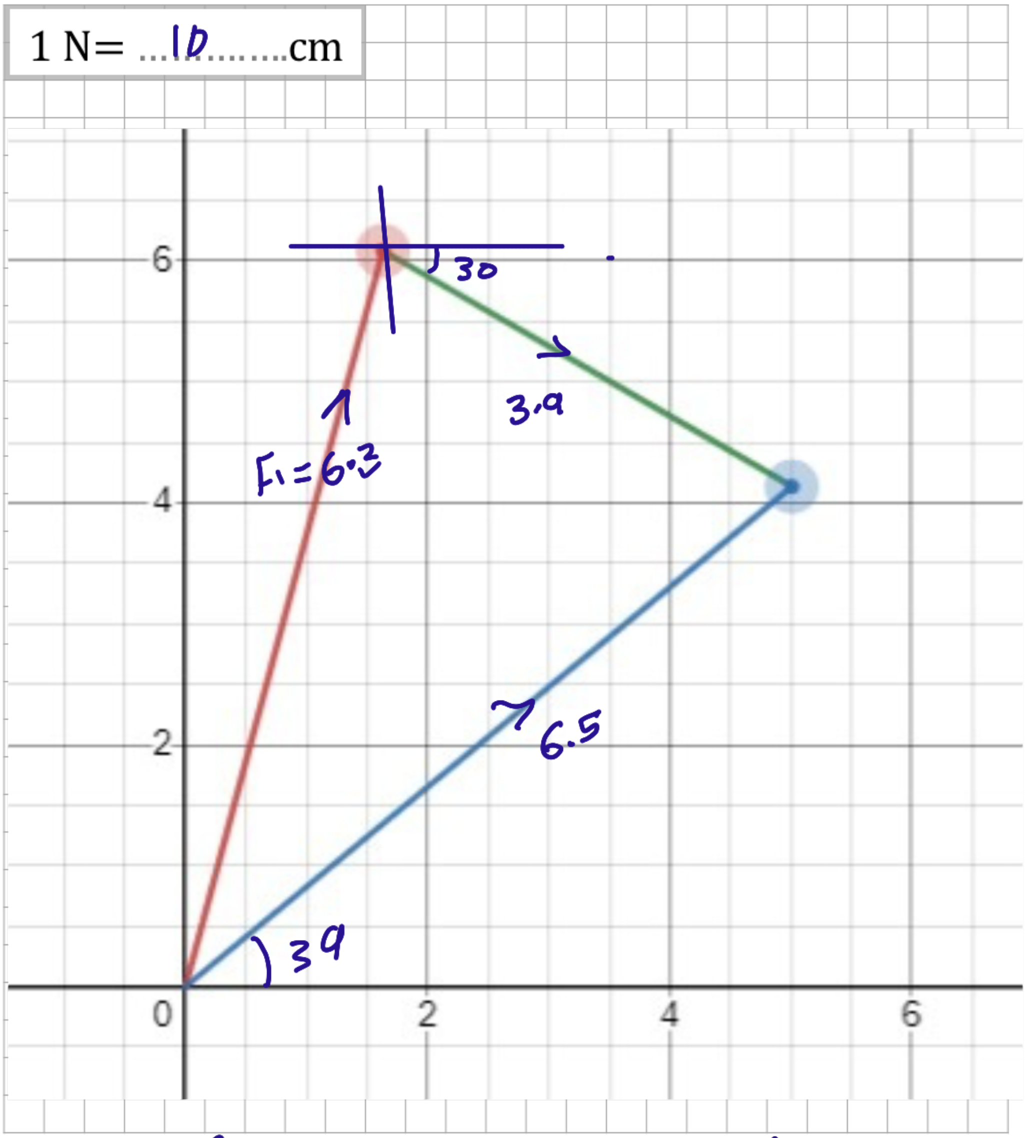
From part.1. we've found that:

$F_1 =$ 0.637 $\theta_1 =$ 75

$F_2 =$ 0.392 $\theta_2 =$ 330

1) Calculate the theoretical value of the resultant force magnitude and direction.

1 N= 10 cm



$F_{th2} =$ 0.65 $\theta_{th2} =$ 39

4) Calculate the percentage error:

The % error in magnitude $(F_{exp}\ \&\ F_{th2}) =$ $\left|\frac{0.65 - 0.686}{0.65}\right| \times 100\%$

The % error in direction $(\theta_{exp}\ \&\ \theta_{th2}) =$ $\left|\frac{39 - 40}{39}\right| \times 100\%$

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Experiment 4

Free Fall

Student name: …………………..……………………………..…………

University ID: ………………..…………………………….…..………

Group Number: ……………………………………….……………….

- Objectives:

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- Equipment:

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- Used Equations:

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- Theory:

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Part 1.: – **1st ball** (**………gm**):

N	Δy (cm)	Δy (m)	t_1 (s)	t_2 (s)	t_3 (s)	t_{ave} (s)	t^2 (s^2)
1							
2							
3							
4							
5							

Simplify the previous table:

Δy (m) **× 10** ◯					
t^2 (s^2) **× 10** ◯					

Plot the graph Δy versus t^2, the gravity acceleration=

g_{exp} =………………………………………………………………………

Calculate the percentage error for the acceleration of gravity g is:

……………………………………………………………………………

Part 2.: – 2^{nd} **ball** (**………gm**):

N	Δy (cm)	Δy (m)	t_1 (s)	t_2 (s)	t_3 (s)	t_{ave} (s)	t^2 (s^2)
1							
2							
3							
4							
5							

Simplifying the previous table:

Δy (m) × 10					
t^2 (s^2) × 10					

Plot the graph Δy versus t^2, the gravity acceleration=

g_{exp} =………………………………………………………………

Calculate the percentage error for the acceleration of gravity g is:

…………………………………………………………………

Conclusion:

By comparing the percentage errors in Part 1. and Part 2., conclude the influence of the mass and the volume on the gravity g.

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Experiment 5

Newton's 2nd Law of Motion

Student name: …………………..…………………………..…………

University ID: …………………..…………………………...………

Group Number: ……………………………………….………………

- Objectives:

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- Equipment:

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- Used Equations:

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- Theory:

M_2 (g)	M_2 (kg)	$\frac{M_2}{M_1 + M_2}$	a_1 (cm/s^2)	a_2 (cm/s^2)	a_3 (cm/s^2)	a_{Ave} (cm/s^2)	a_{Ave} (m/s^2)

Simplify the previous table:

a_{Ave} (m/s^2) **× 10**○					
$\frac{M_2}{M_1 + M_2}$ **× 10**○					

Known values

The mass of the cart + the two masses added to the cart $M_1 = 1000\ g$

The acceleration of gravity $g = 9.8\ m/s^2$

Plot the graph a versus $\frac{M_2}{M_1+M_2}$, the gravity acceleration=

g_{exp} =………………………………………………………………………

Calculate the percentage error for the acceleration of gravity g is:

…………………………………………………………………………………

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Experiment 6

Projectile Motion

Student name: ……………….……………………….…………

University ID: ……………….…………………………..………

Group Number: …………………………………….……………

- Objectives:

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- Equipment:

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- Used Equations:

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- Theory:

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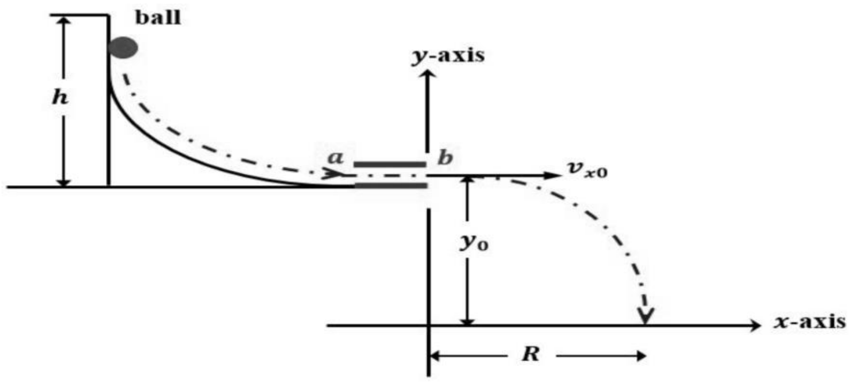
- procedures:



The height y_o =......................cm=.......................m

∴ The value of the time of flight t_f =...

Part 1: **Calculating the theoretical value of the range of the projectile R_{th} and comparing it with the experimental value R_{exp}**:

the theoretical value of the range R_{th}				the experimental value of the range R_{exp}	Percetage error ( )
Used Equation					
d_{ab} ( )	t_{ab} ( )	v_{xo} ( )	R_{th} ( )	R_{exp} ( )	

Part 2: **– The time of flight of projectile t_f**:

1) Deducing the experimental value of the time of flight t_f:

By plotting R_{exp} versus v_{xo} the slop (m) =...

∴The time of flight t_f = ...

2) Calculating the theoretical value of the time of flight t_f:

Equation used:

....

The value of the time of flight t_f:

....

3) Calculating the percentage error:

The equation used for calculating the percentage error:

....

The percentage error value=

....

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Experiment 7

Measuring the Coefficients of Friction

Student name: ………………..………………………..…………

University ID: ………………..…………………………...………

Group Number: ………………………………………..……………

- Objectives:

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- Equipment:

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- Used Equations:

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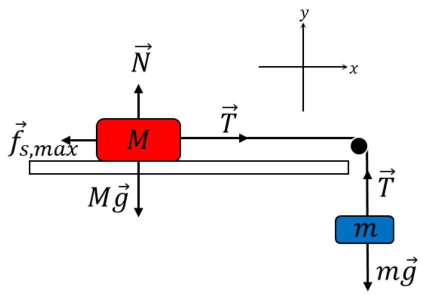
- Theory:

- procedures:

Part 1: Calculating the static friction coefficient μ_s on a horizontal surface:



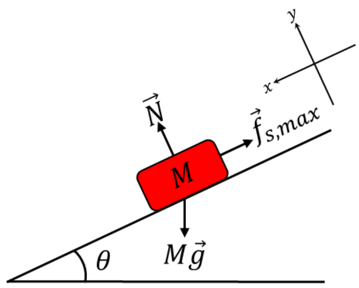
m (g)					
M (g)	186.5	235.5	286.5	336.5	386.5

By plotting m versus M, the slope =...

∴the static friction coefficient μ_s = ...

Part 2: Calculating the static friction coefficient μ_s on an inclined surface:

θ_1	θ_2	θ_3	θ_{avg}



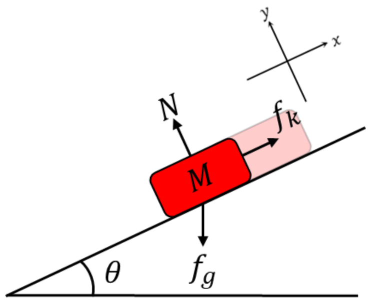
∴ The static friction coefficient μ_s =...

Comparison between the results of μ_s from **part1 and2**:

....

Part 3: Calculating the kinetic friction coefficient μ_k on an inclined surface:

θ_1	θ_2	θ_3	θ_{Avg}



∴ The kinetic friction coefficient μ_k =..

Observations:

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