Exp. No. 1

Measurements

Name: …….…….. Grade: ….....

Student's No.: ……..... Day and Date: ……

Partner's Names: ……... Sec.: ……

Part I: Data and Calculation:

No. of trails	Circumference c(cm)	Diameter d(cm)	$\pi = c/d$	Deviation $d_i = \pi_i - \bar{\pi}$	d_i^2
Mean Value $\bar{\pi}$ =			$\sum_{i=1}^{N} d_i^2$ =		

(1) Calculate the value of π for each measurement.

(2) Calculate the average or the mean value $\bar{\pi}$.

(3) Calculate the deviation of each value from its mean $d_i = \pi_i - \bar{\pi}$.

(4) Calculate d_i^2 and $\sum_{i=1}^{N} d_i^2$

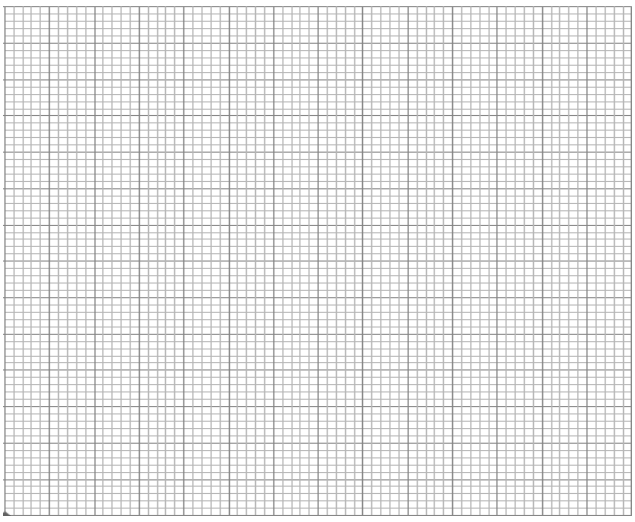
(5) Tabulate your results in Table 1.

(6)Calculate the error in the mean $\Delta\bar{\pi}$ (Standard error)

$$\Delta\bar{\pi} = \sqrt{\frac{\sum_{i}^{n} (d_i)^2}{N(N-1)}}$$

(7) Plot a graph between c and d and determine the slope of this graph S.

(8) What does this slope represent?



(9) Calculate the percentage error in π giving the real value of $\pi = 3.143$.

Percentage error = $\frac{|\ measured\ value - true\ value\ |}{true\ value} \times 100\% =$

Part II: Measuring the Density of a cylindrical rod.

Object	Diameter	height	Mass	Volume	Density
	$d \pm \Delta d$ (cm)	$L \pm \Delta L$ (cm)	$m \pm \Delta m$ (gm)	$V \pm \Delta V$ (cm^3)	$\rho \pm \Delta\rho$ (gm/cm^3)
Cylinder					

Calculation:

The volume of the object = V =

$\Delta V =$

Density $\rho =$

$\Delta\rho =$

Derive the SI unit of density ρ.

Exp. No. 2

Vectors

Name: …….…….. Grade: ….....

Student's No.: ……..... Day and Date: ……

Partners Names: ……..…... Sec.: ……

Data:

(1) Use the force table to find the resultant R of two vector forces and fill the table below

Method	$\|F_1\|$	$\|F_2\|$	θ_1	θ_2	F_x	F_y	$\|R\|$	$\emptyset_R$	Error% In R
Force Table									
Calculation									
Components									
Graphically									

(2) Calculation:

Compute the resultant **R** (magnitude and direction) by direct calculation:

$R = \sqrt{\qquad\qquad\qquad\qquad}$ = ……..……

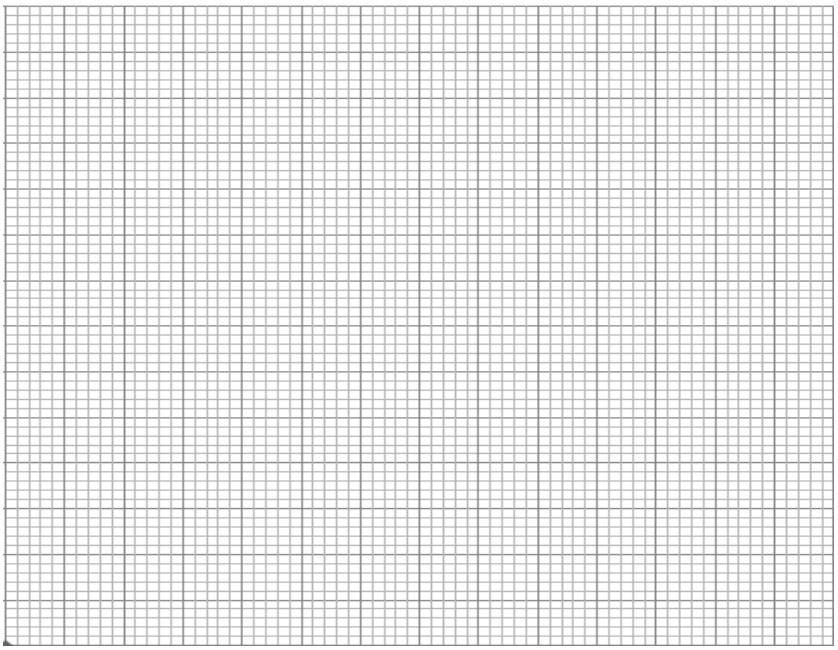
$\phi' = tan^{-1}$ ——— = ... , ϕ = ...

(3) **Find R graphically** (triangle method) using graph paper.

From your drawing, determine:

R = ….....

∅ = ...



(4) <u>Method of components:</u> Compute **R** by the method of components

F_x = ……..…….……..…..……

F_y = ……..……..…..……...

R = ……..……..……..……..….

$$\phi = tan^{-1}\left(\frac{\qquad\qquad}{\qquad\qquad}\right) =$$

(5) Find the **percentage error P.E.** for each case above.

PE = $\dfrac{|\ measured\ value - true\ value\ |}{true\ value} \times 100\%$ (the true value of R is calculated in 1)

……

……

……..…….....……...…..…

……..……..…

……

……

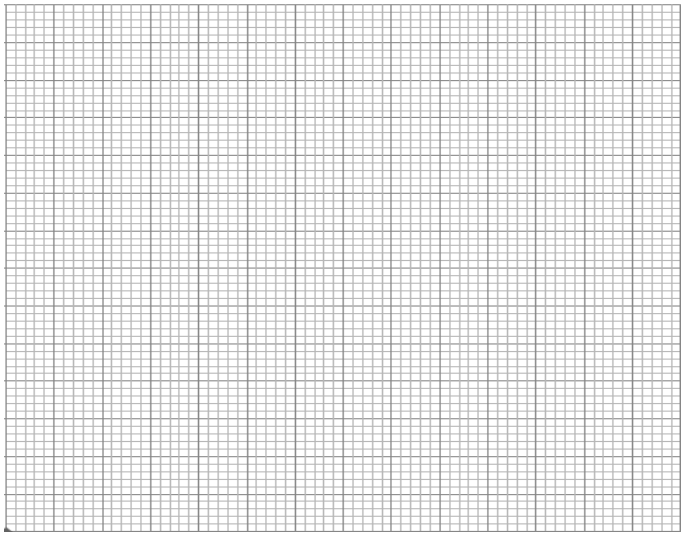
(6) Add the following two vectors: $\vec{u} = 1\hat{i} + 2\hat{j}$, $\vec{v} = 2\hat{i} - 5\hat{j}$

……..……..…..……

……..……...…..…

……

(7) Draw the two vectors described above and add them graphically (i.e. find the resultant)



(8) Split the 3 vectors drawn below into the two given (x,y) components and add them up.

A_x = ...

A_y = ...

B_x = ...

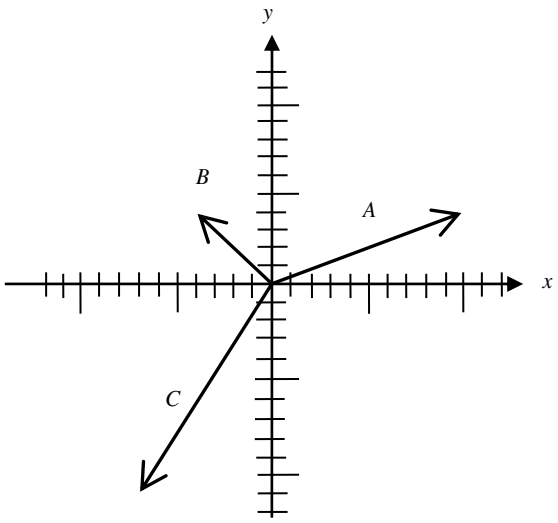
B_y = ...

C_x = ...

C_y = ...

R_x = ...

R_x = ...



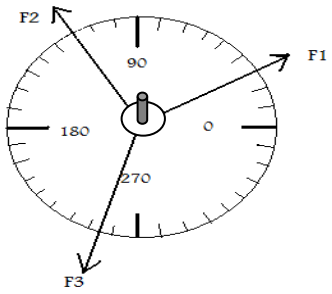
$\vec{A} = (\quad)\,\hat{i} + (\quad)\,\hat{j},$

$\vec{B} = (\quad)\,\hat{i} + (\quad)\,\hat{j}$

$\vec{C} = (\quad)\,\hat{i} + (\quad)\,\hat{j}$

$\vec{R} = (\quad)\,\hat{i} + (\quad)\,\hat{j}$

(9) In the adjacent Fig. the forces are in equilibrium $\mathbf{F}_1$ = 80g dyn and $\mathbf{F}_2$ = 60g dyn. Determine the resultant vector sum **R** of and its direction.



Exp. No. 3

Acceleration on Inclined Plane

Name: …….…….. Grade: ….....

Student's No.: ……..... Day and Date: ……

Partners Names: …….……..…… Sec.: ……

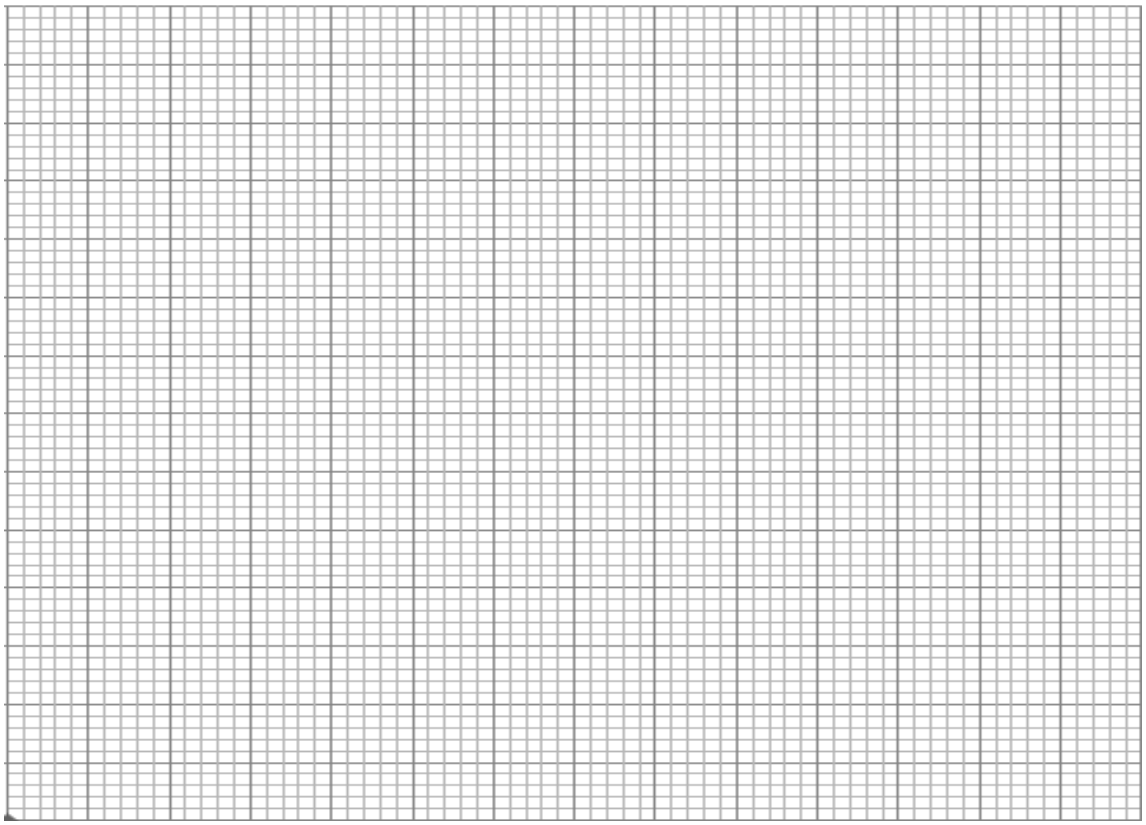
Data:

(1) Measure the sin of the inclination angle $sin\theta = H / L =$

Trial	X (cm)	t_1 sec	t_2 sec	t_3 sec	$\bar{t}$ sec	$\bar{t}^2$ sec^2
1						
2						
3						
4						
5						
6						

(1) For each value of X find the average time squared $\bar{t}^2$, and fill them in the table above.

(2) Plot the distance traveled **X versus** $\bar{t}^2$ and connect the points with the best two lines. **calculate the slope of each, call them** S_{max} **and** S_{min}



(4) Find S_{max} = ……

S_{min} = ……..

(5) Find the slope $S = (S_{max} + S_{min}) / 2$ =……

(6) Find the error in the slope $\Delta S = (S_{max} - S_{min}) / 2$

…….....

(7) Find the acceleration due to gravity $g = \frac{a}{sin\theta} = \frac{2S}{sin\theta}$ =

…….

(8) Find the error in g

Δg =……..……..…

(9) Questions:

(1) Find the velocity of the glider at the bottom of the inclined plane in terms **X, g,** and **sinθ.**

(2) Is g constant at all locations on earth? Why?

(3) Discuss your result for g.

Exp. No. 4
Newton's second law

Name: …….. Grade: ……

Student's No.: …….. Day and Date: ……

Partners Names: …… Sec.: ……

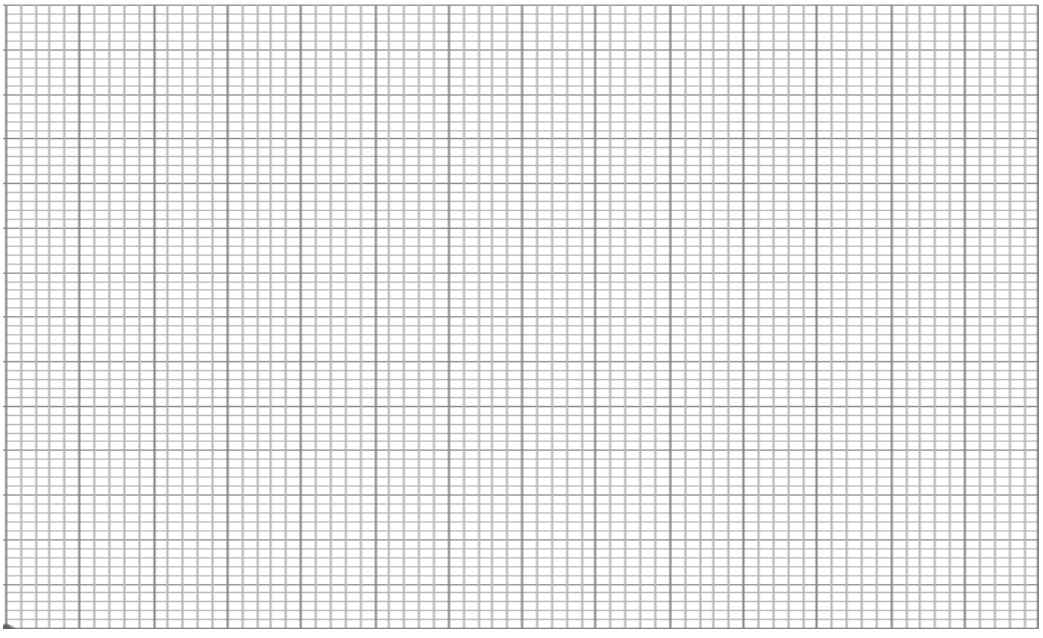
Data:

Part I. changing m keeping force constant. ($M_H = \cdots\cdots\cdots\cdots M_G = \cdots\cdots\cdots\cdots$ **)**

M (gram)	t_1 sec	t_2 sec	t_3 sec	v_1 cm/ sec	v_2 cm/sec	a cm/sec^2	1/a

(1) Plot $\frac{1}{a}$ vs. M and determine M_G from the vertical intercept. $b = \frac{M_H + M_G}{M_H g}$

Determine g by finding the slope $S = \frac{1}{M_H g} \quad \Rightarrow g = \frac{1}{M_H S}$



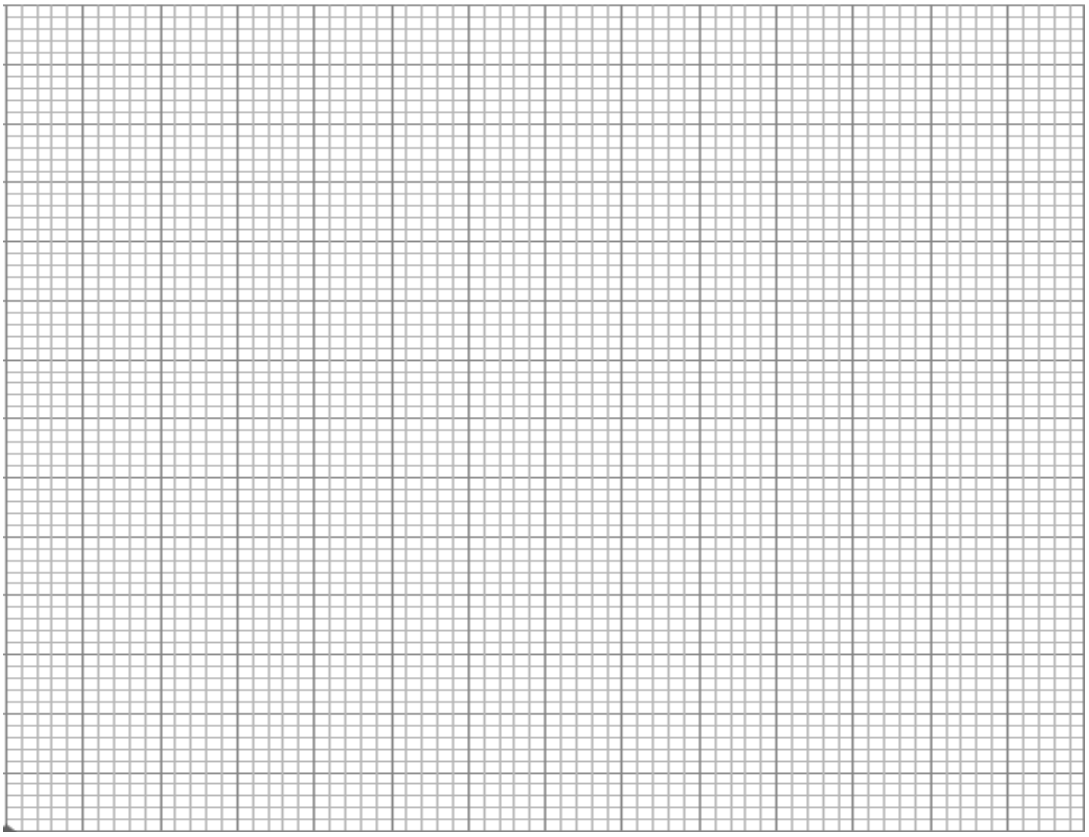
Measured M_G	**From graph M_G**	$\frac{\Delta M_G}{M_G}\%$	**Accepted g**	**From graph g**	$\frac{\Delta g}{g}\%$
(gm)	(gm)		(cm/sec^2)	(cm/sec^2)	
			980		

Part II: Dependence of acceleration on force at constant mass

M (g)	$F_{net} = M_H g$ (dyne)	t_1 sec	t_2 sec	t_3 sec	v_1 cm/	v_2 cm/sec	a cm/sec^2

Plot $F_{net} = M_H g$ versus a, and determine the slope = total mass

$S = (M_H + M_G + M) = M_G + 50$ Find M_G From S.



Slope = total mass (gm)	(M_G from slope) (gm)	$\frac{\Delta M_G}{M_G}\%$

Exp. No. 5

Friction

Name: ……..……... Grade: ……

Student's No.: ……. Day and Date: ……...……

Partners Names: …….…… Sec.: ……..……..……

DATA: Part1: Use the horizontal plane and fill the table below:

Trial	**M (kg)**	**m_s (kg)**	**N=Mg**	$f_s = m_s g$	$\mu_s = \frac{f_s}{N} = \frac{m_s g}{Mg}$	**m_k (kg)**	$f_k = m_k g$	$\mu_k = \frac{f_k}{N} = \frac{m_k g}{Mg}$
Without load								
With load								

(1) What is the value of $\mu_s =$ ……..…..

(2) What is the value of $\mu_k =$ ……..……..

Part2: Use the inclined plane and fill the table below

Trial	b	H	θ_s	$\tan\theta_s = h/b$	$\mu_s = tan\theta_s$	$\bar{\mu}_s$
Without load						
With load						

Trial	θ	m_k	cos θ	tan θ	μ_k	$\bar{\mu}_k$
Without load						
With load						

<u>Derive the equation</u> $\mu_k = \frac{m_k}{M\cos\theta} - tan\theta$ **and use it to fill the table above.**

Exp. No. 6

Uniform Acceleration motion

Name: …… Grade: ……..……

Student's No.: ……. Day and Date: ……..……..……

Partner's Names: ……...…... Sec: …….

Density of steel, ρ_{st} = 7.9 gm/cm^3, copper ρ_{Cu} = 8.23 gm/cm^3

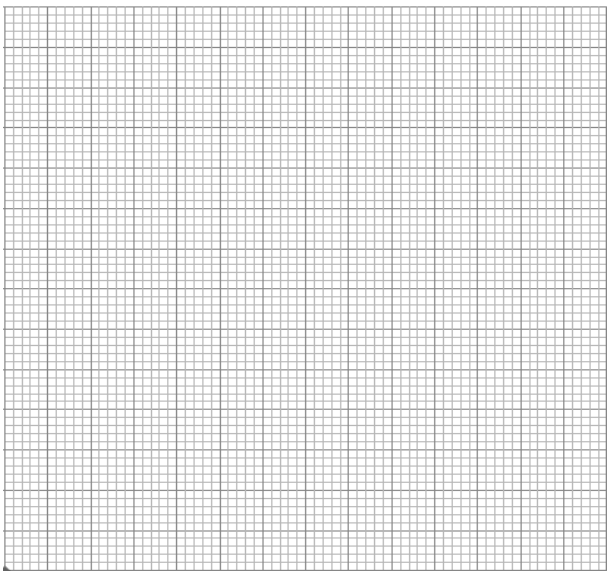
Trial	Mass of the ball	t_1	t_2	t_3	$\overline{t}$

Table 1: To show that free fall time does not depend on mass

Table 2: Fill table 2 and use it to determine the acceleration due to gravity g.

Trial	Mass of the ball	t_1	t_2	t_3	$\overline{t}$	$\overline{t}^2$	Distance y (m)
1							
2							
3							
4							
5							

(1) From the graph of y versus $\overline{t}^2$



Find the slope S and g

S = ……

g = ……..…

(2) Calculate the error in g, **$\Delta g = 2\Delta S$**

Question 1: Prove that the covered distance in the gravity of the earth does not depend on the mass of the falling object.

Question 2: Derive the equation $y = \frac{1}{2} g t^2$.

Exp. No. 7

Atwood's Machine

Name: ……...……..…… Grade: ……..….

Student's No.: ……..…….Day and Date: ……..…

Partner's Names: ……Sec: …….……..……..…..

(1) Fill the table below

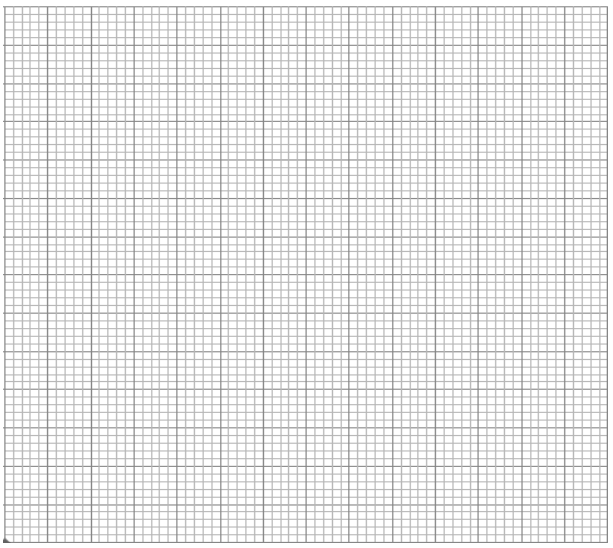
	M_1 (g)	M_2 (g)	t_1(s)	t_2(s)	t_3(s)	$\bar{t}$ (s)	$\bar{t}^2$	Y(m)	a_{th}	F_{net}	a_{exp}	$\frac{M_2 - M_1}{M_2 + M_1}$
Run1												
Run2												
Run3												
Run4												
Run5												
Run6												

(2) Plot $\mathbf{a_{exp}}$ versus $\frac{M_2 - M_1}{M_2 + M_1}$ find the slope.

Slope =S= ……...

g = ……..……

Δg = ……



Questions:

(1) Suppose there is an Atwood machine with M_1=0.5 kg and M_2=1 kg.
What is the acceleration of such a system if the friction is negligible (g = 10 m/s^2)?

(2) What is the net force in an Atwood machine if M_1=1 kg and M_2=2 kg?

Exp. No. 8

Energy Conservation

Name: …….…….. Grade: ….....

Student's No.: ……..... Day and Date: ……

Partners Names: …….……..…… Sec.: ……

Table 8.1

Mass1	h(cm)	Y(cm)	t(sec)	x(cm)	V_{th}	V_{exp}

Table 8.2

$E_A = mgh$	$E_B = \frac{7}{10} m(v_{th})^2$	$E_B = \frac{7}{10} m(v_{exp})^2$

Q1. Compare the values calculated in columns 1 with 2 and 3 in table 8.2.

Q2. Is the energy of the rolling sphere conserved between A and B?

Q3. Calculate **the time** of fall from y= 40 cm, and find the energy E for **x=28 cm** in Ergs (Er) and Joules (J). What is the potential energy at point A in Er and J for **h=7 cm**? What is E at B for this h? (take **m=10 gram**)

Exp. No. 9

Conservation of Linear Momentum

Name: …… Grade: ……..……

Student's No.: ……Day and Date: ……

Partners Names: ……Sec: …….

Part 1: Collision in 1D. (Table 1)

Mass1	Mass2	h(cm)	y(cm)	X (cm)	X′ (cm)	x' (cm)	V(cm/s)	V′(cm/s)	v'(cm/s)

MV (gm.cm/sec)	mv' (gm.cm/sec)	MV' (gm.cm/sec)	MV'+ mv' (gm.cm/sec)

Q1. Compare the values calculated in columns 1 and 4. (They must be equal)

Part II: Collision in 2D. (Table 2)

Mass1	Mass2	h(cm)	$\vec{R}$ (cm)	$\vec{R}'$(cm)	$\vec{r}'$(cm)	θ_1	θ_2	$\theta=\theta_2-\theta_1$

h(cm)	$P_i^2 = (MR)^2$	$P_f^2 = (MR')^2 + (mr')^2 + 2(MR')(mr')\cos\theta$

Table (3)

Mass1=Mass2	h(cm)	X (cm)	X′(cm)	x′(cm)	θ	$\vec{X}+\vec{x}$
						$\theta=\theta_2-\theta_1$

Q2. Compare the values calculated in columns 2 and 3. (They must be equal)

Q3. Since $\vec{p}_i = \vec{p}_f$ and $\vec{p}_i$ is along the x-direction, check whether $p_{fy} = 0$.

Q4. From table 3, measure vectors X , X′, and x′, find the sum from the graph, does this sum equals vector X

Exp. No. 10

The Pendulum

Name: ……..…..……Grade: ……..……

Student's No.: ……...… Day and Date: ……

Partners Names: ……..... Sec: ……

Part 1: Determine the spring constant.

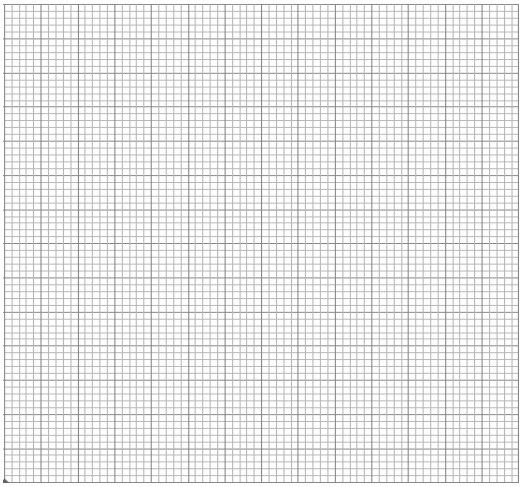
Trial	Total mass	Spring elongation	Force of Gravity(dyne)	Spring constant (dyne/cm)
	M (gm)	X (cm)	F= mg (dyne)	K = mg/X (dyne/cm)
1				
2				
3				
4				
5				

Find the value of k:

(1) $k_{avg} = (k_1+k_2+k_3+k_4+k_5)/5$ =
……

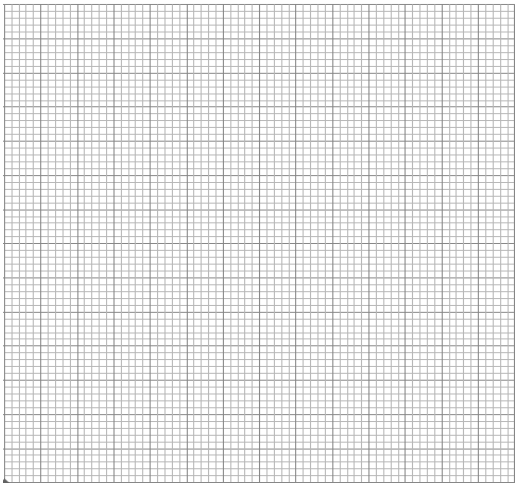
(2) Plot mg vs. x .

Determine k from the slope = S = k =
……



Part 2: Spring Harmonic Motion.

m(g)	t_1 (for 10 Oscillations)	t_2 (for 10 Oscillations)	Avg. Period T = $(t_1+t_2)/20$	T^2



Plot $\mathbf{T^2}$ versus **m** and determine **k from slope S** (from the table below)

Slope = S= $4\pi^2/k$ → $k = 4\pi^2/S$ =

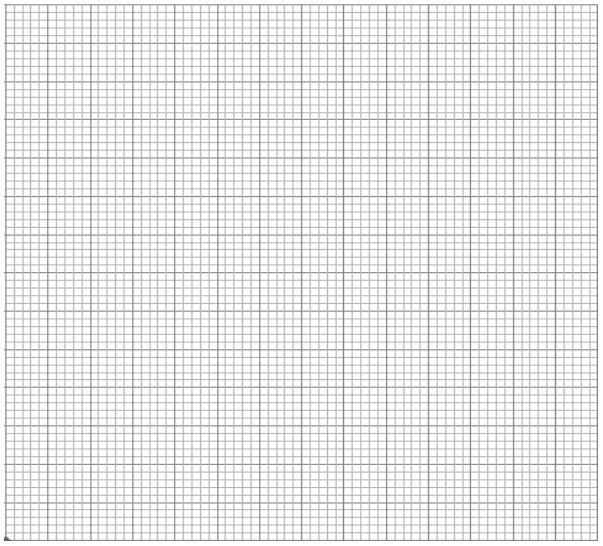
Part 3: Pendulum.

L(length) (cm)	t_1(for 10 Oscillations)	t_2 (for 10 Oscillations)	$T = (t_1+t_2)/20$	T^2

Plot $\mathbf{T^2}$ versus L and determine **g** from slope **S**

Slope = S = $4\pi^2/g$

g = $4\pi^2/S$ =



Questions:

1- Is the period of the simple pendulum, in general depends on the amplitude?

2-What is the relation between k's and k'eq for parallel and series combinantion?

3- If the length of pendulum clock depends on temperature, in summer will the clock gain or lose time? Explain your answer.

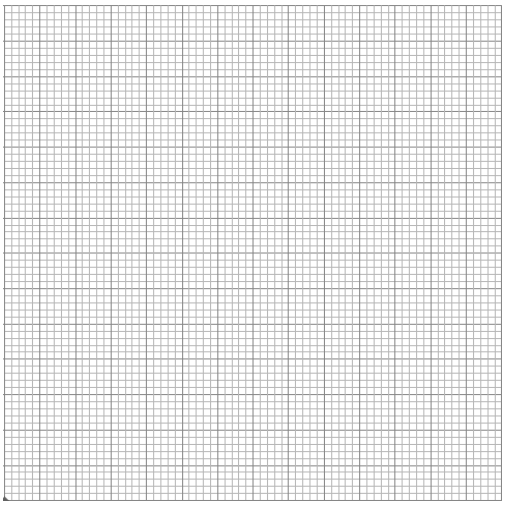
Exp. No.11
The Viscosity

Name: …….....….Grade: …….……

Student's No.: …….....… Day and Date: ……

Partners Names: …….....……..... Sec: ……

Part 1: to show that a small sphere falls with a constant terminal velocity.
Construct a velocity-time graph and a velocity-distance graph. These will show the ball bearing accelerating until it reaches terminal velocity.

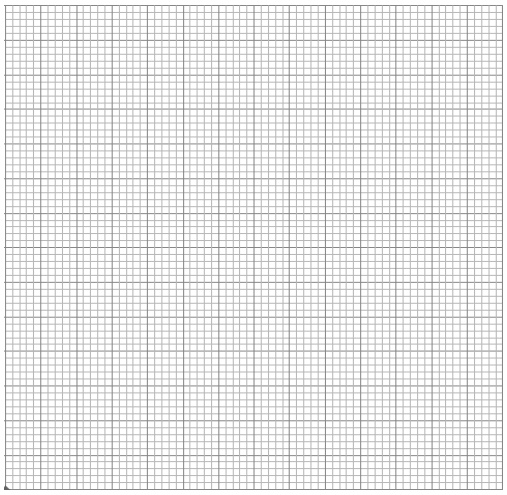


h(cm)	t_1 (sec)	t_2 (sec)	t_3 (sec)	$\bar{t}$ (sec)	$v=h/\bar{t}$ cm/sec

Plot h vs $\bar{t}$ and determine v_t

Part 2: Determination of the coefficient of viscosity:
Repeating the experiment with ball bearings of different mass and diameter will show that the terminal velocities of different bodies are different.

Sphere density = 7.8 gm/cm^3
Liquid density = 1.12 gm/cm^3 h =50 cm



d(cm)	d^2	t_1 (s)	t_2 (s)	t_3 (s)	$\bar{t}$ (s)	v	η

Plot a graph of d^2 vs. v_t. From the graph,

Determine the coefficient of viscosity.

The slope $= S =$

The coefficient of viscosity η =

What is the unit of η: