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Experiments Titles

1. The Simple Pendulum
2. Hooke's Law and Oscillations
3. Archimedes’ Principle (Buoyant force)
4. Inclined Plane
5. Flywheel
6. Force Table

Introduction to students

Practical work in physics is intended to teach the student how to select and set up apparatus skillfully and well, to make careful observations and precise measurement while at time realizing the limitation of measuring instruments employed, and to use the experiment results obtained to the best advantage.

Graphs

The majority of experiments in physics require the drawing of one graph or more. Graphs not only give an immediate visual picture of results and information, (e.g. how one variable quantity varies with another), but also, they provide the most convenient way of obtaining the average of a set of readings. It is better to draw a graph of different values as ordinates $(\boldsymbol{Y-axis})$ against the corresponding values as abscissas $(\boldsymbol{X-axis})$.

Types of lines in graphs

Lines

Straight | ***Curved*** | ***Irregular***

- ***Straight Lines***

The straight lines occur when there is an increase or decrease in both ***X-*** values and ***Y-*** values.

The general equation of this line is:

$$\boldsymbol{Y = mX \pm c} \qquad \textbf{(1)}$$

The Straight lines can be found in three forms:

1. Intersection the line intercepts the original point $(\mathbf{0},\mathbf{0})$ as represented in the following graph:

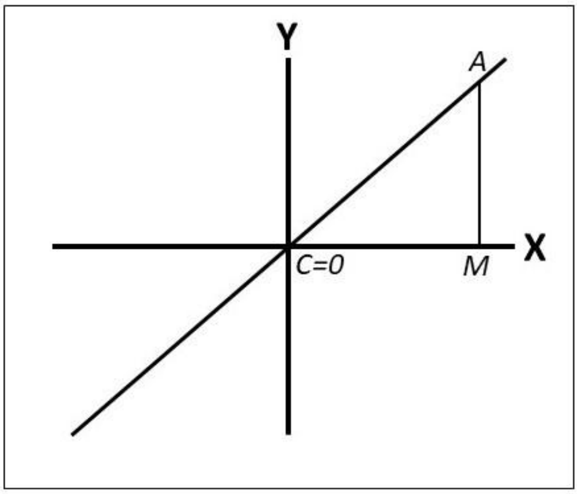

Figure (1): Straight line Intercepting the zero point.

The equation of this line is:

$$\boldsymbol{Y = m\,X} \qquad \textbf{(2)}$$

<u>Prove:</u>

In the △ **AMC**,

$$\tan A\hat{C}M = \frac{AM}{CM} \qquad (2.a)$$

But,

$$A\hat{C}M = \theta \qquad (2.b)$$

And,

$$AM = Y, \qquad CM = X \qquad (2.c)$$

Hence,

$$\tan\theta = \frac{Y}{X} \qquad (2.d)$$

$$Y = X\tan\theta \qquad (2.e)$$

Writing m for $\tan\theta$, then,

$$\boldsymbol{Y = m\,X} \qquad \textbf{(2)}$$

2. Intersection through the $(+\boldsymbol{Y} - axis)$ as represented in the following graph:

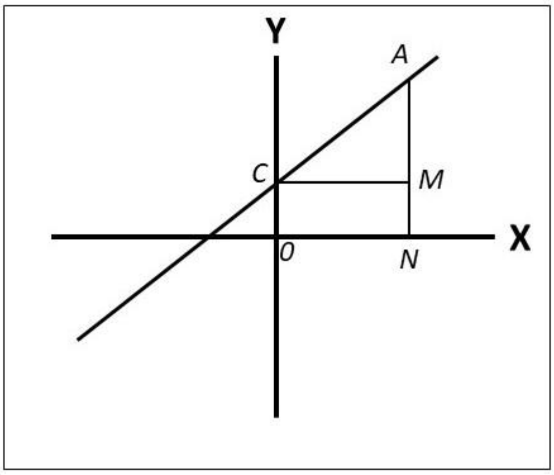

Figure (2): Straight line Intercepting the $(+\boldsymbol{Y} - axis)$.

The equation of this line is:

$$\boldsymbol{Y = m\,X + C} \qquad \textbf{(3)}$$

Prove:

In the △ **AMC,**

$$\tan A\hat{C}M = \frac{AM}{CM} \qquad (3.a)$$

But,

$$A\hat{C}M = \theta \qquad (3.b)$$

And,

$$AM = AN - MN \qquad (3.c)$$

But,

$$AN = Y, \qquad MN = OC = C \qquad (3.d)$$

Then,

$$AM = Y - C \qquad (3.e)$$

On the other hand,

$$CM = ON = X \qquad (3.f)$$

Hence,

$$tan\ \theta = \frac{Y - c}{X} \tag{3.g}$$

$$Y = X\ tan\ \theta\ + C \tag{3.h}$$

Writing m for $\tan\theta$, then,

$$\boldsymbol{Y = m\,X + C} \tag{3}$$

3. Intersection through the $(-\boldsymbol{Y} - axis)$ as represented in the following graph:

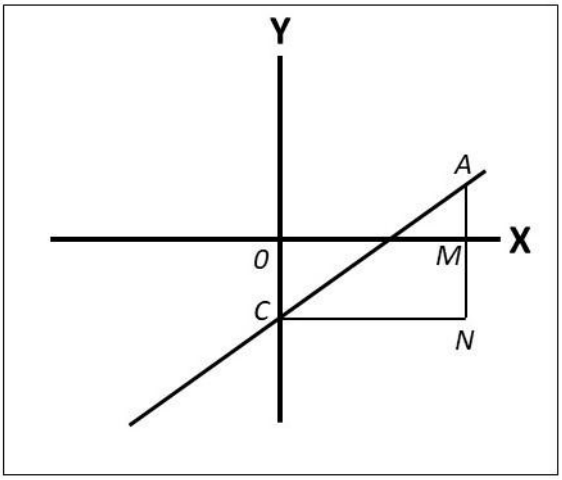

Figure (2): Straight line Intercepting the $(-\boldsymbol{Y} - axis)$.

The equation of this line is:

$$\boldsymbol{Y = m\,X - C} \tag{4}$$

Prove:

In the △ **AMC,**

$$\tan A\hat{C}M = \frac{AM}{CM} \tag{4.a}$$

But,

$$A\hat{C}M = \theta \tag{4.b}$$

And,

$$AM = AN + MN \tag{4.c}$$

But,

$$AN = Y, \qquad MN = OC = C \tag{4.d}$$

Then,

$$AM = Y + C \tag{4.e}$$

On the other hand,

$$CM = ON = X \tag{4.f}$$

Hence,

$$tan\ \theta = \frac{Y + c}{X} \tag{4.g}$$

$$Y = X\ tan\ \theta - C \tag{4.h}$$

Writing m for $\tan\theta$, then,

$$\boldsymbol{Y = m\,X - C} \tag{4}$$

- ***Curved lines***

  The curved lines occur when there is an increase in X_ values with a decrease in Y _ values or a decrease in X _values with an increase in Y- values. So, the curved lines indicate that the relation between the data are in inversely proportional.

- ***Irregular lines***

  The irregular lines occur when there is an increase or a decrease in X-values and Y- values randomly.

The SI System of Units

The system International unites, abbreviated to the SI system of units, was approved in 1960 by the General Conference of Weights and measures. This system is coming to increasing use throughout the world because of its many advantages over the multitudinous national system it is now superseding. A part from its own intrinsic merits, it has the great advantage over all other systems of units in that it is international –the one system that is common to all countries. So once everyone uses the system, gone will be the need to convert laboriously from one system of units to another, involving time and energy that can be more profitably spent.

Table (1): The International system (SI)

Physical Quantity	Unit	Symbol
Length	Meter	M
Mass	Kilogram	Kg
Time	Second	sec
Electric Current	Ampere	A
Temperature	Degree Kelvin	K
Luminous Intensity	Candela	Cd
Amount	Mole	Mol

All other units are derived from these units. The more important derivative units, which all have special names, are as follows:

Table (2): Derived Units

Physical Quantity	Unit	Abbreviation	Dimensions
Force	Newton	N	$Kg.m / sec^2$
Pressure	Pascal	$Pa, \quad N/m^2$	$Kg / m.sec^2$
Energy	Joule	$J, \quad Nm$	$Kg.m^2/ sec^2$
Power	Watt	$W, \quad J/sec$	$Kg.m^2/ sec^3$
Torque	Meter-Newton	$T, \quad mN$	$Kg.m^2/ sec^2$
Electric charge	Coulomb	C	$A.sec$
Electric potential	Volt	$V, \quad J/C$	$Kg.m^2 / sec^3 .A$
Electrical resistance	Ohm	$\Omega, \quad V/A$	$Kg.m^2 /sec^3.A^2$
Capacitance	Farad	$F, \quad \frac{C}{V}, \quad C^2/J$	$sec^4 .A^2 / kg .m^2$
Inductance	Henry	$H, \frac{J}{A^2}, \Omega.sec$	$Kg.m^2/ sec^2.A^2$
Magnetic flux	Weber	$Wb, \frac{J}{A}, V.sec$	$Kg.m^2/sec^2.A$
Magnetic intensity	Tesla	$T, \frac{Wb}{m^2}, V.\frac{sec}{m^2}$	$Kg / sec^2 .A$
Frequency	Hertz	Hz	$1 / sec$
Luminous flux	Lumen	lm	$Cd.sr$
Illumination	lux	lx	lm / m^2
Disintegration rate	Becquerel	Bq	$1/ sec$
Absorbed dose	Gray	$Gy, \quad J/kg$	M^2 / sec^2

<u>Note</u>: The abbreviation for steradian, the SI unit of solid angle, is sr.

Table (3): Non – SI Units

Physical Quantity	Unit	Symbol
Mass	Gram	G
Length	Foot Centimeter	Ft Cm
Volume	Liter	----
Time	Minute	Min
Force	Dyne Pound force	--- lbf
Energy	Calorie, kilocalorie	$Cal\ ,kcal$
Power	Kilocalories/minute	$Kcal\ ,min$
Pressure	Ponds/inch2 Millimeter of mercury Centimeter of water Atmosphere	Psi $mmHg$ $cmH2O$ atm
Temperature	Fahrenheit Celsius	F C

Experiment No (1)

THE SIMPLE PENDULUM

Objectives:

1. To measure the acceleration due to gravity using a simple pendulum.
2. To investigate the relationship between the length of a pendulum and its oscillation period.

Theory:

A simple pendulum consists of a bob (a spherical mass) hung from a fixture by a very light string of length (L). The mass of the string is much less than the mass of the bob. (In fact, according to the equation below it should be massless). The oscillation period (T) is the time it takes the bob to make one complete cycle of oscillation. If (L) is much greater than the radius of the bob and the amplitude is small $(\theta < 5^{\circ})$, As shown in figure (1), then the period of a pendulum is given by:

$$T = 2\pi\sqrt{\frac{L}{g}} \qquad (1)$$

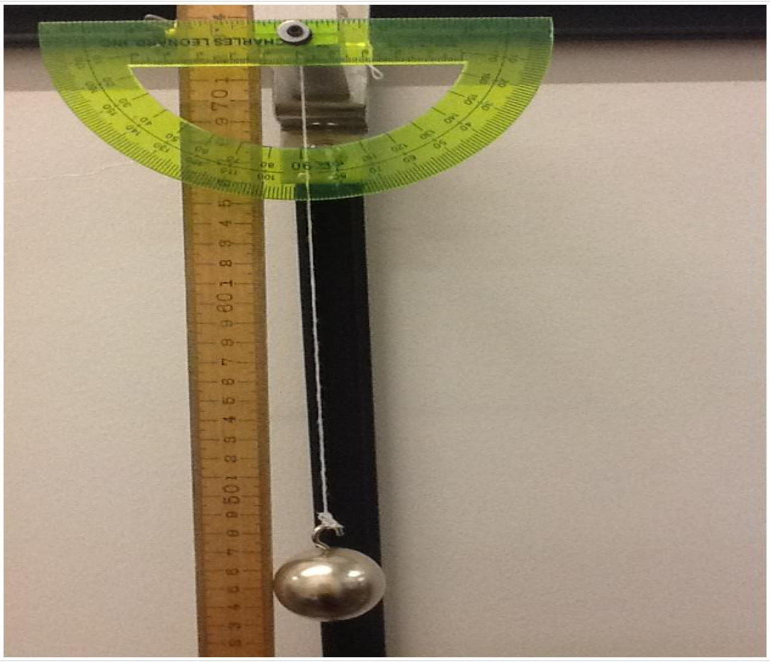

Figure (1): Simple pendulum.

Then, the gravitational acceleration (g) can be expressed in terms of the length and the period of the pendulum by solving for (g) from the above equation.

$$g = \frac{(4\pi^2 L)}{T^2} \quad (2)$$

Note: *Air resistance is ignored.*

Apparatus:

- Pendulum bob and string
- pendulum clamp
- aluminum pole
- large clamp
- Stopwatch
- meter stick
- Micrometer.

Procedure:

1. Measure the diameter of pendulum bob by using micrometer and record the radius of pendulum bob.
2. Measure the length of the pendulum from hanging point to the surface of the pendulum bob (*l*). Record the length of the pendulum in the table below.
3. Pull the bob from the equilibrium position. (This is the dotted line in the picture below and represents where the pendulum hangs when it is still).

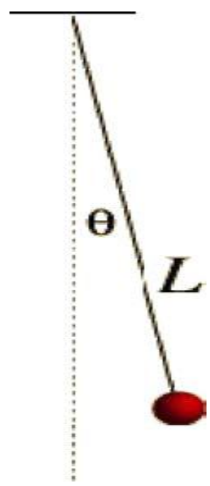

Figure (2): Simple pendulum at the beginning of its oscillation.

4. With the help of a lab partner, set the pendulum in motion until it completes 10 to and fro oscillations, taking care to record this time. Then the period (T) for one oscillation is just the number recorded divided by 10, then determine the (T^2).
5. You will make a total of five measurements for (g) using different values for the length (L).
6. Plot the relationship between the (T^2) on Y-axis and the (L) on the X-axis, then find the slop of this line.

Data Sheet:

L	L=l +r	t_1	t_2	t_3	$Mean = \frac{t_1+t_2+t_3}{3}$	Time for 1 oscillation (period time)	T^2

1. Calculate the slope of the (L vs. T^2) graph and find the value of (g) by using the following equation:

$$g = \frac{4\pi^2}{\text{slope}} \qquad (3)$$

Note: *(radius of pendulum bob)* $r = 1.5\ cm.$

2. Calculate the percentage error of your value for (g).

Discussion:

Read the theory part carefully and answer the following questions:

- Define the period of the pendulum and the gravitational acceleration.
- Compare your result with the accepted value of the acceleration due to gravity ($g = 9.8\ m/s^2$). Calculate the percent difference in your result and the accepted result.
  [Difference %= [(your result - accepted value)/accepted value] x 100%]
- Depending on your results, discuss the effect of the mass of the bob and the length of the pendulum on the period.
- Would you be able to calculate the gravitational acceleration if you increase the amplitude?
- What will change if we move the pendulum to the moon?

Experiment No (2)

Hooke's Law and Oscillations

Objectives:

1. To verity Hooke's law.
2. To determine the force constant of the spring (K).

Theory:

The shape of a body will distort when a force is applied to it. Bodies which are "elastic" distort by compression or tension, and return to their original, or equilibrium, position when the distorting force is removed (unless the distorting force exceeds the elastic limit of the material). Hooke's Law states that if the distortion of an elastic body is not too large, the force tending to restore the body to equilibrium is proportional to the displacement of the body from equilibrium. Stated mathematically:

$$F = -KX \qquad (1)$$

Where (F) is a restoring force, (K) is a constant of proportionality and (X) is the distance the object has been displaced from its equilibrium position. The minus sign signifies that the restoring force acts in the opposite direction to the displacement of the body from the equilibrium position. If a body, which obeys Hooke's Law, is displaced from equilibrium and released, the body will undergo "***simple harmonic***

motion". Many systems, such as water waves, sound waves, ac circuits and atoms in a molecule, exhibit this type of motion.

Figure (1): Hook's experiment

Apparatus:

- Spring
- Spring scale
- Set of known masses
- meter stick
- clamp

Procedure:

1. Measure the position of the spring. This is your equilibrium position.
2. Add the (50 g) mass pan from the spring and measure the position of the mass pan.
3. Add (100 g) masses to the pan and measure resulting positions of the system, until you have a five 100 g masses on the mass pan.
4. Then remove the masses in reverse order, one at a time, again noting the corresponding displacement. This will effectively give you

two trials, which can be averaged; you may wish to comment on any trends or differences you see between the trials).

5. Graph and analyze of your data.

Note: *Displacements are to be calculated relative to the equilibrium position. For instance, if the average equilibrium position is 20 cm, you would subtract 20 cm from all of your position measurements* $(X = L - L_\circ)$.

Data Sheet:

Mass(gm)	F= Mg(N)	L(cm)	$X = L - L_\circ$

Discussion:

- Describe Hooke's Law.
- What would happen if more and more weights were added? Would the graph continue on linearly? Hint: think about what happens when you pull a spring past its elastic point.
- By using your results, find the gravitational acceleration (g).

Experiment No (3)

Archimedes' Principle (Buoyant force)

Objective:

The purpose of this experiment is to verify Archimedes' principle.

Theory:

Archimedes' principle is one of the well-known laws in fluid mechanics. It was discovered by the ancient Greek mathematician and inventor Archimedes. Archimedes principle states that the upward buoyant force that is exerted on a body immersed in a fluid, whether fully or partially submerged, is equal to the weight of the fluid that the body displays and acts in the upward direction at the center of mass of the displaced fluid. Which means that whatever the shape of the submerged body, the buoyant force is equal to the weight of the fluid displaced. i.e.

The apparent loss in weight of fluid = weight of object in air – weight of object in fluid.

One of the famous examples of Archimedes principle is ships. a ship that is launched sinks into the ocean until the weight of the water it displaces is just equal to its own weight. As the ship is loaded, it sinks deeper, displacing more water, and so the magnitude of the buoyant force continuously matches the weight of the ship and its cargo. The following figure is a simple illustration of Archimedes' principle.

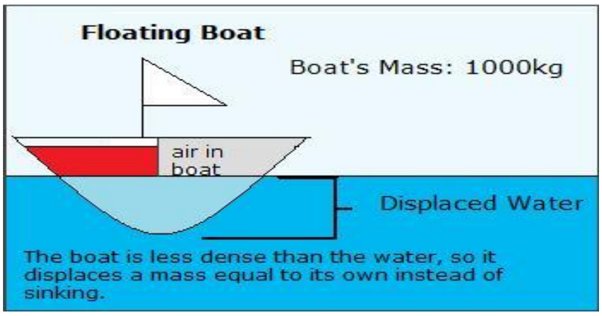

Figure (1): Illustration of Archimedes' principle

Apparatus:

- Spring balance
- Stand
- Weighing balance
- Overflow can
- Iron block
- Beaker

Procedure:

1. Measure the volume of the iron block using volume rule of a cylinder ($V = \pi r^2 h$). where ***(r)*** is the radius and (***h)*** is the height.
2. Weigh the iron block by hanging it on the spring balance and record the weight.
3. Put water in the overflow can.
4. Then, weigh the beaker on the weighing balance and record the weight and keep the beaker on the weighing balance in order to weigh the displaced water.

5. Now the iron block should be fully immersed in the water until the water is displaced to the beaker.
6. When immerse the iron block, it can be seen that its weight is reduces. Record the reduced weight as well
7. Repeat the above steps with an iron sphere.

Data Sheet:

The weight of the beaker with displaced water – the weight of the empty beaker = the weight of water displaced	
The weight of the iron block in air – the weight of the iron block in water = loss of weight of the body	
Volume of the iron block * Density of water * gravity = Buoyant force	

Note: *The density of the water is* $\mathbf{1}\left(\frac{gm}{cm^3}\right)$.

The results of all the above in the table should be equal and thus we demonstrate Archimedes' principle.

Discussion:

- Discuss the results.
- Explain how the submarine works.
- Do a research and write about Archimedes' principle. (a short paragraph is sufficient).

Experiment No (4)

Inclined Plane

Objectives:

1. Finding the coefficient of static friction.
2. Determining the values of the forces acting on the roller.

Theory:

An ***inclined plane***, also known as a ***ramp***, is a flat supporting surface tilted at an angle, with one end higher than the other, used as an aid for raising or lowering a load. Since it is used for raising and lowering various bodies then there are forces acting on it. Figure one shows the forces acting on a sliding body.

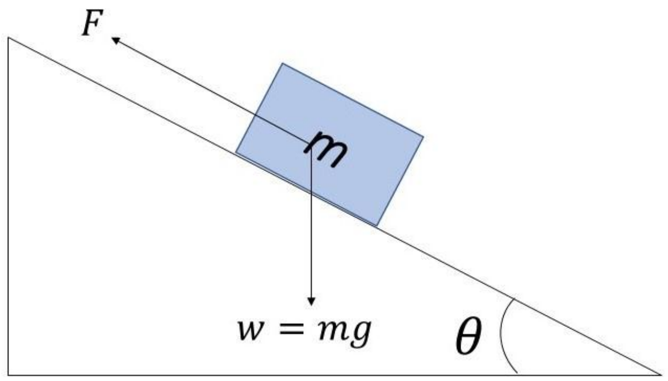

Figure (1): Forces acting on a sliding body on an inclined plane

One of these forces is the frictional force which can be found by:

$$F = \frac{Mg}{2} \qquad (1)$$

However, for a rolling body the equation becomes:

$$F = \frac{Mg}{6} \qquad (1.a)$$

Where (M) is the resultant mass of abstracting the mass of the roller when it rolls down from the mass of the roller when it rolls up.

$$m_2 - m_1 = M \qquad (2)$$

$\boldsymbol{m_1}$: The mass of the roller when rolling down the ramp.

$\boldsymbol{m_2}$: The mass of the roller when rolling up the ramp.

Another force acting on the roller is its weight. When the iron roller rolls down, its weight is

$$w_1 = (m_1 + s)g \qquad (3)$$

Where (s) is the mass of the scale pan. In the same way, the weight of the roller when it rolls up is

$$w_2 = (m_2 + s)g \qquad (4)$$

Then the net weight is

$$w = \frac{w_2 + w_1}{2} \qquad (5)$$

Now the coefficient of the static friction between the surfaces of the iron roller and the inclined plane can be found by

$$\mu_s = \tan\theta \qquad (6)$$

Where (θ) is the angle of repose which can be defined as the minimum angle of inclination required for the body to just start sliding down on the inclined plane.

Apparatus:

- Inclined plane with frictionless pulley.
- Iron roller.
- Scale pan.
- Weights.
- Protractor.
- Balance.

Procedure:

The mass of the scale pan is (40 gm) and the mass of the iron roller is (280 gm).

1. Connect the iron roller and the scale pan with rope.
2. Set the iron roller on the inclined plane (noting that there are no weights on the scale pan). Then start to raise the inclined plane slowly until the wooden block starts moving with constant acceleration. Determine the angle of repose by noticing the protractor.
3. Determine the coefficient of static friction.
4. Adjust the angle of inclination to (20°).
5. Add some weights to the scale pan while the block is down the inclined plane until it moves up and calculate the total mass of the weights and record it.
6. Remove some weights until the block slides down and calculate the mass of the weights.
7. Draw a graph to show the relation between the angle on *x-axis* and the frictional force the *y- axis*.

Data Sheet:

Angle of Inclination	Mass added in pan		Total weights		Force Acting on the body $w = \frac{w_2 + w_1}{2}$	Frictional force $F = \frac{(m_2 - m_1)g}{6}$
	Roller rolls down (m_1)	Roller rolls up (m_2)	$w_1 = (m_1 + s)g$	$w_2 = (m_2 + s)g$		

Discussion:

- What are some practical examples of an inclined planes?
- Discuss the resulting graph.
- Do a research on inclined plane and write a short paragraph.

Experiment No (5)

Flywheel

Objective:

The purpose of this experiment is to determine the moment of inertia for flywheel.

Theory:

The flywheel consists of a heavy circular disc ***(massive wheel)*** fitted with a strong axle projecting on either side. The axle is mounted on ball bearings on two fixed supports. There is a small peg on the axle. One end of a thread is loosely looped around the peg and its other end carries the weight-hanger.

Let (m) be the mass of the weight hanger and hanging rings (weight assembly). When the mass (m) descends through a height (h), the loss in potential energy is

$$P_{loss} = mgh \qquad (1)$$

The resulting gain of kinetic energy in the rotating flywheel assembly (flywheel and axle) is

$$K_{flywheel} = \frac{1}{2} I\omega^2 \qquad (2)$$

$\boldsymbol{I}$**:** moment of inertia of the flywheel assembly

$\boldsymbol{\omega}$**:** angular velocity at the instant the weight assembly touches the ground.

The gain of kinetic energy in the descending weight assembly is

$$K = \frac{1}{2}mv^2 \qquad (3)$$

$\boldsymbol{v}$**:** velocity at the instant the weight assembly touches the ground.

The work done in overcoming the friction of the bearings supporting the flywheel assembly is

$$w_{friction} = nW_f \qquad (4)$$

$\boldsymbol{n}$**:** number of times the thread is wrapped around the axle.
$\boldsymbol{W_f}$**:** work done to overcome the frictional torque in rotating the flywheel assembly completely once.
Therefore, from the law of conservation of energy we get

$$P_{loss} = K_{flywheel} + K_{weight} + W_{friction} \qquad (5)$$

Substituting (1), (2), (3), and (4) in (5), we get

$$mgh = \frac{1}{2}I\omega^2 + \frac{1}{2}mv^2 + nW_f \qquad (6)$$

Now the kinetic energy of the flywheel assembly is expended in rotating (N) times against the same frictional torque. Therefore,

$$NW_f = \frac{1}{2}I\omega^2 \quad \Rightarrow \quad W_f = \frac{1}{2N}I\omega^2 \qquad (7)$$

If (r) is the radius of the axle, then velocity (v) of the weight assembly is related to r by the equation:

$$\omega = \frac{v}{r} \qquad (8)$$

By substituting equation (7) and (8) in equation (6) we get

$$mgh = \frac{v^2}{2}\left\{m + \frac{I}{r^2}\left(1 + \frac{n}{N}\right)\right\} \qquad (9)$$

When the acceleration of falling weight is constant, the velocity of the hanging mass (m) in thread will be double of its average velocity all the way from the its residing until it reaches the floor.

Where:

$$h = \frac{1}{2}(v_o + v)t \qquad \text{(a)}$$

Where (v_o) is initial velocity and equal to zero at the beginning of motion and (v) is velocity of falling. Then,

$$h = \frac{1}{2}vt \quad \Rightarrow \quad v = \frac{2h}{t} \qquad \text{(b)}$$

Now solving equation (5) for I we get

$$I = mr^2\left\{\frac{N}{N+n}\right\}\left(\frac{gt^2}{2h} - 1\right) \qquad (10)$$

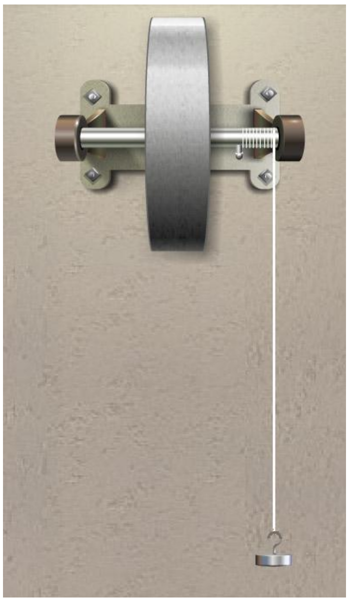

Figure (1): Flywheel

Apparatus:

- Flywheel.
- A strong and thin thread.
- A few masses.
- Metric ruler.
- Stop watch.
- Vernier.

Procedure:

1. Attach one end of the thread to load the weights and wrap the other end around the axis of the wheel and the length of the thread must be approximately equal to the distance between the axis and the surface of the earth.
2. Measure the height (h) of the weight from the floor.
3. Let the weight falling and the weight reaches the floor and the thread detaches itself from the axel.
4. Measure the number of revolution (n) for the flywheel before the weight reaches the floor.
5. Measure the number of revolution (N) for the flywheel after the weight has reached the floor and before the flywheel stop.
6. Measure the time (t) taken to reach the weight to the floor.
7. Repeat these steps for the same weight and calculate the $(n_{ave.}, N_{ave}$ and $t_{ave.})$.
8. Measure the radius of the flywheel axis (r) by using the Vernier.
9. Using equation (6) to calculate the amount of inertia.
10. Change the weight and repeat all steps (2→9).

Data Sheet:

m (gm)	h (cm)	t (sec)	n (rev)	N (rev)	I ($gm.cm^2$)
500					
600					
700					

Discussion:

- What is the flywheel and what are the scientific application which depend on its work idea?
- Why the flywheels mass centralizes in its outer edge?
- Why the flywheel stopped from rotation after period from the time.
- Derive the mathematical relationship which calculates the moment of inertia for flywheel.
- Calculate the achieved work against the friction force from equation (3) per weight.

Experiment No (6)

Force Table

Objective:

1. To have a qualitative and a quantitative feeling of vectors and to study the condition of static equilibrium.
2. To resolve forces into components, both experimentally and algebraically.

Theory:

The direction of a vector is measured from the positive $\boldsymbol{X} - axis$ in a counter-clockwise direction ***(standard procedure)***, then the following is true

The magnitude of (***x***-component)

$$F_x = F\ cos\theta \qquad (1)$$

The magnitude of (***y***-component)

$$F_y = F\ sin\theta \qquad (2)$$

The direction of the vector

$$\theta = \tan^{-1}\left(\frac{F_y}{F_x}\right) \qquad (3)$$

When you add vector, they yield to ***resultant R***. To add vector mathematically, you need to first determine the ($\boldsymbol{x}$ and $\boldsymbol{y}$ −components**)** of each vector ($\boldsymbol{F_x}$) is the sum of the ($\boldsymbol{x - component}$) and ($\boldsymbol{F_y}$) is the sum of the ($\boldsymbol{y - components}$). Thus, the magnitude of ***R***

$$R = \sqrt{F_x^2 + F_y^2} \qquad (4)$$

And the direction of ***R***

$$\theta = \tan^{-1}\left(\frac{F_y}{F_x}\right) \qquad (5)$$

Calculate the magnitude and direction of ***R*** for your forces.

<u>Note:</u> *Verify that the angle (θ) is in the proper quadrant based upon your (F_x) and (F_y). Your calculator will give you only one of two possible angles (the correct angle or the correct angle plus 180 degrees).*

Apparatus:

- force table with center pin
- three pulley clamps
- six mass flanges
- plastic ring
- ten (50) grams masses
- string

Procedure:

1. If values from part one and two agree, use the force table to verify these answers. First, level the force table using the three-screw attached to the base of the table and the carpenters level. Place pulleys at the position specified by the force card; add masses to provide the forces. Use100 grams to represent each newton of force. If the values obtained for the resultant are correct, then the equilibrant will balance the system and the ring will be positioned in the middle of the force table add the equilibrant force to the proper position.
2. To determine the uncertainty in the magnitude and direction of the equilibrant:

a. δm- add mass to the equilibrant until the ring shifts, but dose not touch the pin

b. $\delta \theta$- adjust the position (θ) until the ring shifts, but dosent touch the pin.

Have your instructor pull the pin to check.

Data Sheet:

Method	**Equilibrant**	
	Magnitude	**Direction $(\boldsymbol{\theta})$**
Experiment		
Component $\boldsymbol{R_x} =$ $\boldsymbol{R_y} =$		
Graphical		

Graphical:

Note: $1\ cm\ = 100\ g\ =\ 1\ N$

Discussion:

- Write about what you learned in this experiment. Remember to explain how you reached your conclusion.
- Were forces produced by the three weights from the hanging masses the only forces affecting the tensions in the strings?
- If the center ring were to have considerable mass, what effect would it have on the experiment?
- If your results are not what you expected, explain why. What are possible sources of error in this experiment?