Physics 6
Lab Manual

LACC Physics Faculty

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Lab Report Guidelines for Physics 6

There will be approximately eight laboratory experiments performed during the semester for Physics 6. *For each experiment a lab report is due approximately one week after the lab is completed*, (the instructor will indicate the exact due date). The basic information to include in the reports is a description of the experiment, a complete set of data obtained during the experiment, analysis and interpretation of the data, and a conclusion section. By including the following sections, in the order given, you will be writing a complete report*.

1. Cover Page. The cover page should include your name, the name of the experiment, as well as the date you performed the experiment. Also include the names of your lab partners.

2. Lab Manual. Including the actual lab manual in your report provides an accurate description of the experiment.

3. Original Data Sheets. Include any original sheets of paper where data was recorded, plus all graphs and tables printed from the computer.

4. Principle's Section. The principle's section should provide a description of the underlying Physics principles, laws and facts that are being tested by the experiment. This section should also include the derivation of any specific formulas that are to be used in the analysis section. Usually the lab manual will suggest which formulas need to be derived in the principle's section.

5. Calculations and Analysis. The calculations and analysis section should contain all the calculations and error analysis suggested in the lab manual. Carefully answering all the questions and performing all the calculations suggested in the C and A section of the lab manual will complete this section.

6. Tabular Summary. The tabular summary should summarize your calculations by listing the experimental and theoretical values together with the percentage errors of all the important quantities calculated in the analysis section.

7. Conclusion. The conclusion section of the report should include two parts. A brief summary of the purpose of the experiment, including your observations of the physical results, and a statement concerning the factors which may have caused a discrepancy between the experimental and theoretical results, in other words, a statement about the sources of error in the experiment. Try to include at least three well thought out possible occurrences where errors may have crept into the results of your experiment.

Although it is not required, you are encouraged to write your reports on a computer using word processing software and perhaps a mathematical program (like Excel or Mathematica) to help do calculations and graphical analysis. *If you choose to write your report by hand, please write in ink and not pencil! A neat and organized report is definitely a factor in the lab report grade.*

You may discuss your lab reports, and check your calculations with your lab partners and other members of the class, but *it is essential to write the report yourself*. When writing the principle's section and the conclusion section, *be sure to put your ideas in your own words*, and **do not simply copy the principles or purpose sections from the lab manual**. Try to express yourself clearly and correctly, even though grammatical and spelling errors will not be counted against you.

***Note**: Alternate lab report formats (such as a 'technical journal format') are acceptable as long as a discussion of principle's, calculations, results, and a conclusion are included. If you are interested to write your lab report in a different format than the one presented here, please see instructor to discuss the alternate formats.

Measurement of Length

(Physics 6, Experiment # 1)

Purpose:

To study the principle of vernier scales and micrometer screws and to use the vernier and the micrometer in the measurement of length.

Apparatus and Materials needed:

Vernier Caliper and micrometer calipers in both Metric and English systems
Meter stick
Hollow cylinder
Mass balance
Metal cylinders (Brass, Copper, and Steel)

Theory:

A caliper is an instrument used to determine lengths. A caliper with a vernier scale is called vernier caliper and one with a micrometer screw is a micrometer caliper.

The vernier is an auxiliary scale attached to measuring instruments which enables one to make accurate estimates. It has a graduation different from those of the main scale but bearing a simple relation to them. The general principle of all verniers is that the number or vernier divisions is always equal to a smaller number of main scale divisions, usually one less:

$$nV = (n-1)$$

where n is the number of vernier divisions, V is the length of vernier division and S is the length of the main scale division.

The term "least count" or LC is applied to the smallest distance which can be measured accurately by a vernier. It is equal to the difference in length between the main scale division and a vernier division.

$$LC = S - V$$
$$LC = (1 / n) \times S = S / n$$

The zero reading, Z.R. is the vernier division which coincides with any main scale division when the jaws of the calipers are closed.

The actual reading or A.R. can be obtained from the equation below

$$A.R. = p + (q \times L.C.) - (Z.R. \times L.C.)$$

Where p is the exact main scale division just before the zero of the vernier scale
q is the vernier scale division which coincides with any main scale division.

The micrometer caliper consists of a screw mounted on a cylindrical frame. The main scale which is the linear scale (L. S.) is fixed on the cylinder while the screw has a circular scale (C.S.). When the screw is turned, the linear distance that the edge of the circular scale has moved after one revolution is called the pitch of the screw. The pitch (P) usually coincides with the smallest L.S. division. The least count of the instrument is given as:

$$LC = P / n$$

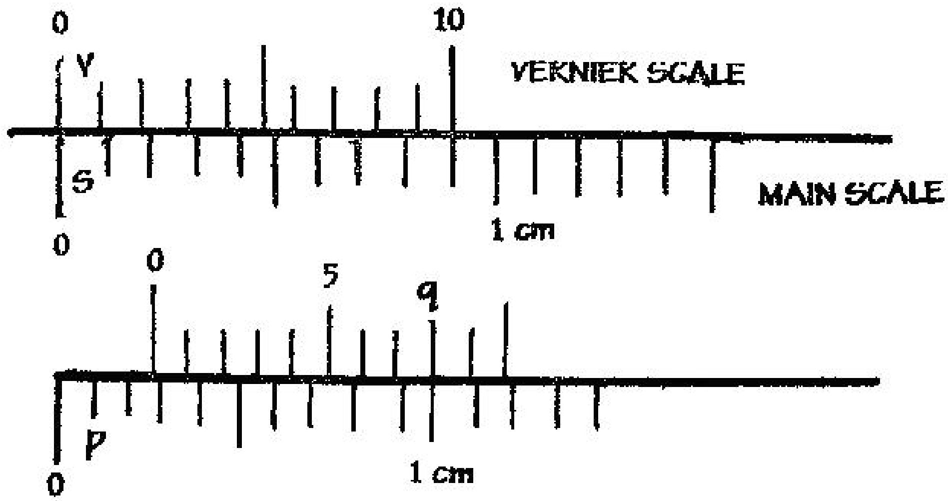
Where P is the pitch
n is the number of divisions in C.S. and the actual reading is given by the equation

$$A.R. = L.S._{\text{reading}} + (C.S._{\text{reading}} \times L.C.) - (Z.R \times L.C.)$$

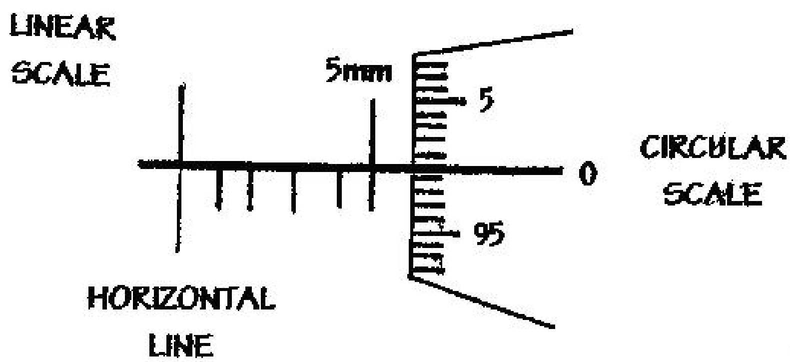
Where L.S. $_{\text{reading}}$ is the linear scale reading just before the edge of the C.S.
C.S. $_{\text{reading}}$ is the division of the C.S. which coincides with the horizontal line of the L.S.
L.S. is the least count.
Z.R. is the zero reading which is the number of division past the zero mark in the C.S. when the caliper is closed

Diagram:

SCALE OF VERNIER CALIPER



SCALE OF MICROMETER CALIPER



Example:

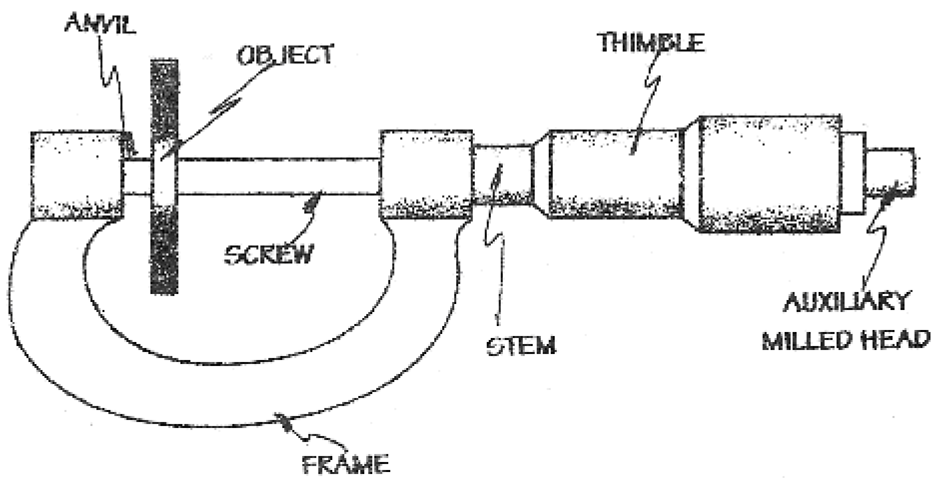
(Assume ZR = 0)

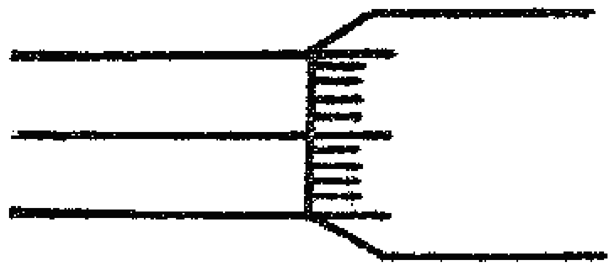
P = 0.2, q = 8
A.R. = 0.2 + 8 (0.01)
A.R. = 0.28

(Assume ZR = 0)

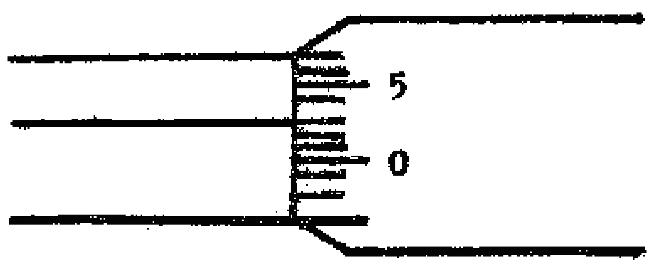
L.S. = 6 mm, C.S. = 0
A.R. = 6 mm + 0 (0.01 mm)
A.R. = 6.0 mm

MICROMETER CALIPER

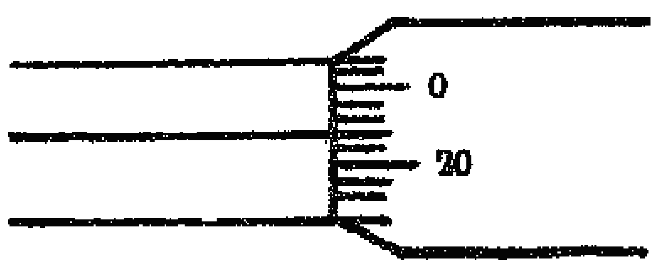




FOR NON ZERO READING

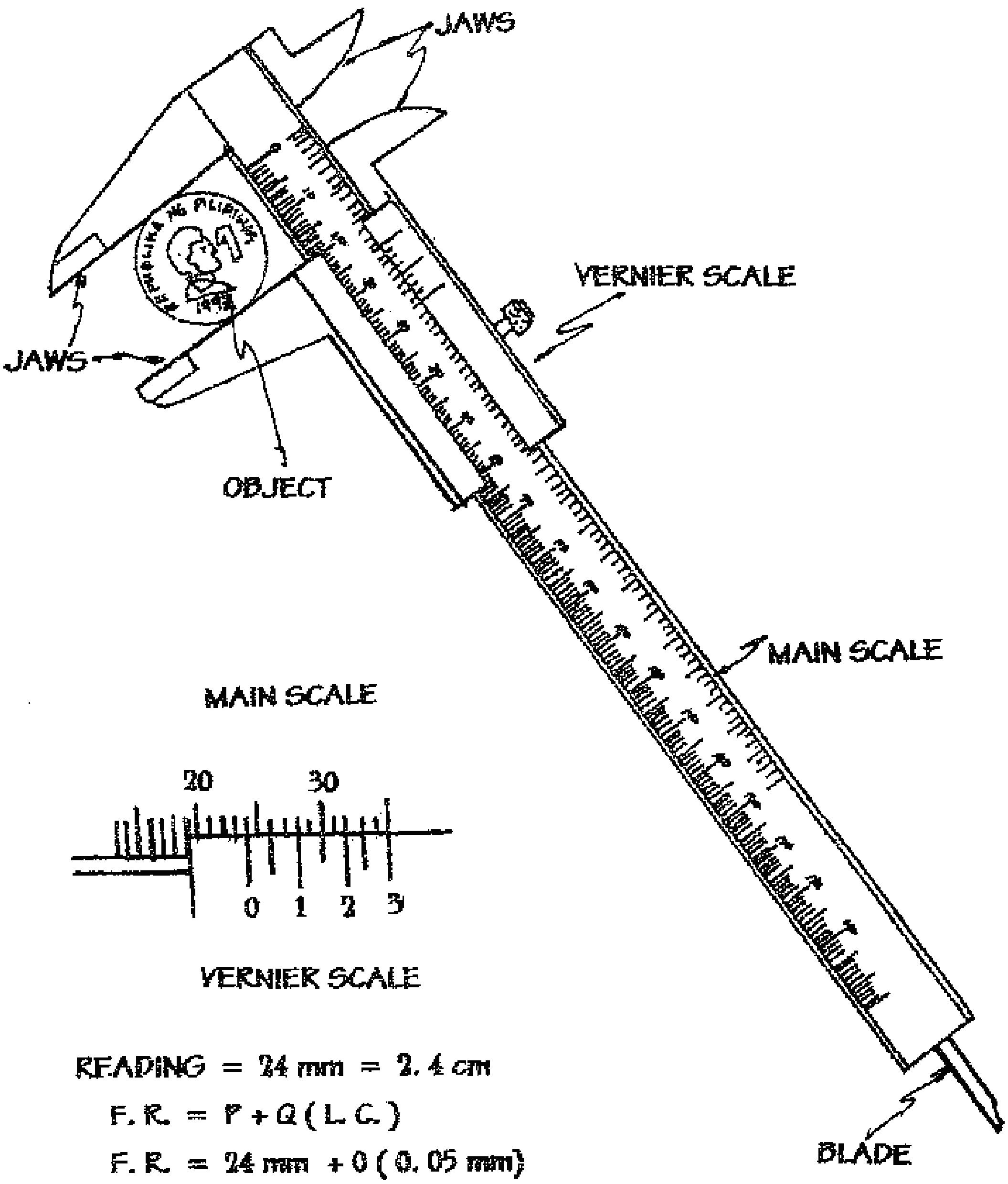


ZERO CORRECTION $= 3 \times 0.001 = 0.003$ in



ZERO CORRECTION $= 3 \times 0.001 = -0.003$ in

VERNIER CALIPER



READING = 24 mm = 2.4 cm

F. R. = P + Q (L. C.)

F. R. = 24 mm + 0 (0. 05 mm)

F. R. = 24 mm

Procedure:

Click through each of the Tabs at the site listed below:
http://www.olabs.edu.in/?sub=1&brch=5&sim=16&cnt=4
Then measure and report the objects in the simulator here:
http://www.olabs.edu.in/?sub=1&brch=5&sim=16&cnt=4

Part A: Determination of the least count

1) Examine the vernier caliper.
2) Record the number of the vernier divisions and the length of the smallest main scale division.
3) Calculate the least count.
4) Repeat using a vernier caliper in the English system and micrometer caliper in the Metric system.
5) Measure the width of a meter stick using these instruments.

Part B: Measurements on a hollow cylinder

1) With the use of a vernier caliper, measure the external and internal depths, external and internal diameters of the hollow cylinder. Take several measurements of each dimension for consistency.
2) Weigh the cylinder with the electronic balance.

Data:

A: Determination of Least Count

	Vernier Caliper		Micrometer
	Metric	English	Metric
Number of vernier divisions (n)			
Length of smallest main scale of division (s)			
Least count (LC)			
Width of meter stick			

B: Measurement on a Hollow Cylinder using Vernier Caliper

Inner depth (h_1)	cm
Outer depth (h_2)	cm
Interior diameter (d_1)	cm
Exterior diameter (d_2)	cm
Inner volume (V_1)	cm^3
Outer volume (V_2)	cm^3
Volume of cylinder (V)	cm^3
Density of cylinder (ρ)	g/cm^3
Mass of cylinder (m)	g
Actual mass (m_0)	g
% Error	%

C: Measurement on a Metal Cylinder using Micrometer Caliper
(Pick any two different metals out of three)

Name of Metal	Diameter (cm)	Length (cm)	Volume (cm^3)	Mass (g)

Name of Student: ____

Date Performed: ____

Instructor's Initial: ____

Computations:

1) Calculate the volume of the cylinder.
2) Compute the mass of the cylinder from the obtained volume and density.
3) Find the percentage error between the calculated mass and the actual mass.

Concurrent Forces

(Physics 6, Experiment # 2-A)

Purpose:

To determine the relative directions and magnitudes of three concurrent forces which are in equilibrium.

Apparatus and Materials needed:

Force Table, Support, and Base
Ring with 3 strings tied to it
Scissors
Protractor
Ball headed pin
3 mass hangers
Slotted masses
3 clamp-on pulleys

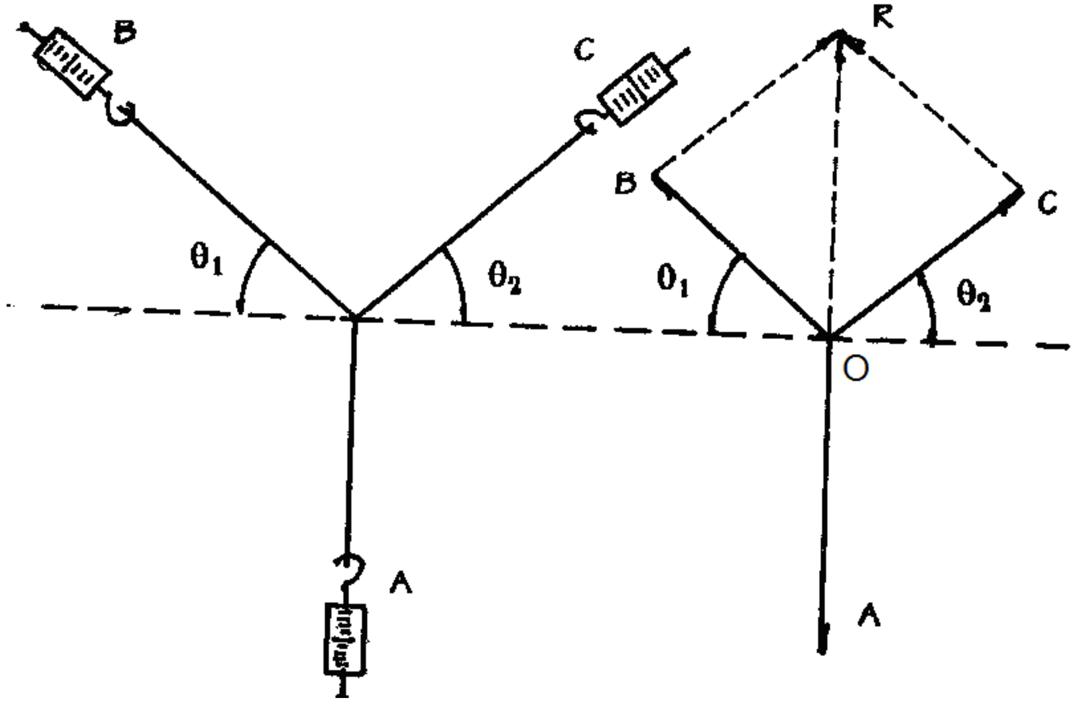
Theory:

In many structures such as roof and bridges and in many machines such as sailboats and airplanes, there are forces which are applied at the same point or if extended pass through a common point. Such forces are called concurrent forces. This experiment aims to study the conditions under which concurrent forces are in equilibrium.

Procedure:

1) To the middle of a piece of string, tie a second piece about half as long. At each of the free ends, attach a spring balance and arrange on the table clamps as shown in a diagram below.
2) Pull each balance until its index is about in the middle of the scale. Then, slip a piece of paper under the cord connecting the balances.
3) Draw a line directly under each cord to show the direction of each cord. Take note of the angles which the cords make with the horizontal.
4) Record the force indicated by the balance beside each line on the diagram. Remember to subtract the zero reading of each balance in horizontal position.

Diagram:



Data:

Trial	Spring Balance Reading		
	A	B	C
1			
2			

Name of Student: ___________________________________

Date Performed: ___________________________________

Instructor's Initial: ___________________________________

Graphical Construction:

1) Prolong the three lines representing the three forces until they intersect at a common point.
2) Measure off on each line a distance corresponding to the force according to any convenient scale such as 50 g to 1 cm.
3) Place an arrowhead at the end of each measured line and erase that part of each line which lies beyond the arrowhead.
4) On any two of these lines, construct a parallelogram, using a ruler and a pencil compass to get the lines exactly parallel.
5) Draw the original force lines (OA, OB, and OC) as solid lines, the lines needed to complete the parallelogram (BR and CR) as dotted lines and the diagonal (OR) as a broken line.
6) Draw the diagonal of this parallelogram from the central point. Measure its length and compute the magnitude it represents. This diagonal represents the resultant of the two forces which forms the side of the parallelogram.
7) The third force OA which balances the two forces OB and OC is called their equilibrant.

Analysis:

What has been proven regarding the magnitude and direction of the resultant of two concurrent forces?

Problem:

Graphically, find the resultant of two 10 N forces applied at the same point when

a) the angle between the forces is 30 degrees; and
b) the angle between them is 130 degrees.

Friction

(Physics 6, Experiment # 2-B)

Purpose:

To study frictional forces, in particular, to measure the coefficients of static and kinetic friction and also to determine the factors that affect the coefficient of friction.

Apparatus and Materials needed:

Friction board
Wooden block with faces of different areas
Weight hanger
Set of slotted masses
Pulley
Meter stick

Theory:

When one body moves over another body, frictional forces act on each body parallel to the surfaces in contact and opposite the motion of the bodies.

Friction acting between bodies at rest is called static friction (f_s) while friction acting on bodies in motion is called kinetic friction (f_k).

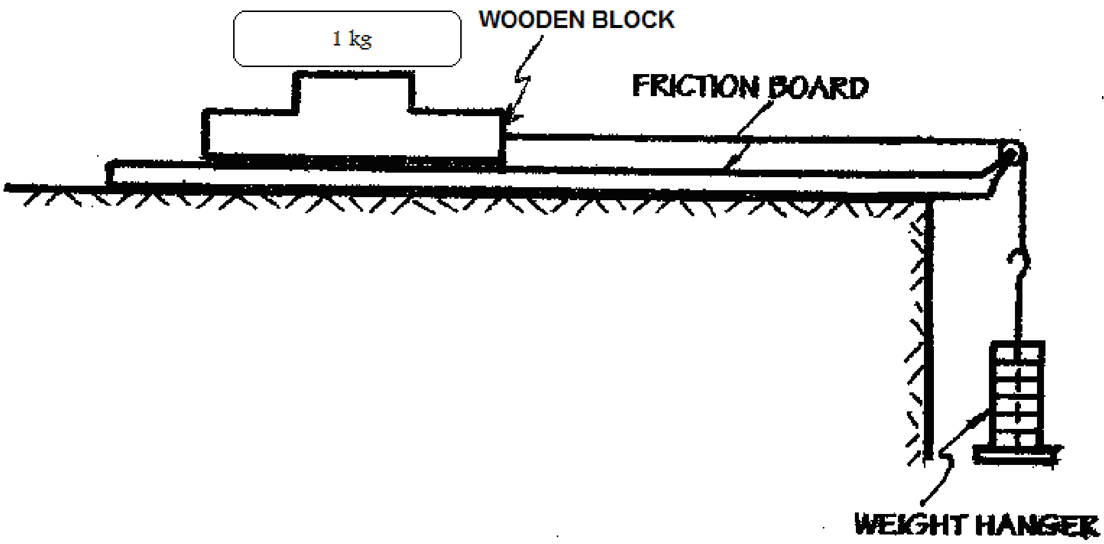
When a small force, F, acts on a block of weight W, the block will remain at rest because a force, f_s, opposes it. As F is increased, it will reach a certain value at which the block will start to move. This value of F will be equal to the maximum value of f_s and is proportional to the normal force N. Force N is the force pressing the surfaces together. If the block is lying on a horizontal surface and the force F is parallel; then, N is equal to the weight (W) of the block. The proportionally constant between f_s and N is called coefficient of static friction denoted by μ_s. The mathematical relation between f_s, N and μ_s is

$$\mu_s = f_s / N$$

When the block has started to move, a smaller force is needed to keep it moving with uniform velocity. The force is opposed by the force of kinetic friction f_k given by the formula:

$$\mu_k = f_k / N$$

Diagram:



Procedure:

Part A: Measurement of the Coefficient of Static Friction

1) Weigh the block of wood.
2) Place the block on a polished wooden board.
3) Attach a string to the wooden block, pass string over pulley and attach a weight hanger to other end of the string.
4) Add slotted masses to the weight hanger one at a time until the block just starts to move.
5) Record the Force (proportional to the mass) needed to just start the block moving. Use data table A.
6) Repeat with different loads on the block.
7) Calculate the coefficient of static friction.

Part B: Measurement of the Coefficient of Kinetic Friction:

Repeat part A (1-5), this time to determine the force necessary to keep the block moving therefore to calculate the coefficient of kinetic friction.

Data:

A: Measurement of the Coefficient of Static Friction

Trials	Tangential Force, F	Normal Force, N	μ_s
1	g	g	
2	g	g	
3	g	g	
4	g	g	

B: Measurement of the Coefficient of Kinetic Friction

Trials	Tangential Force, F	Normal Force, N	μ_k
1	g	g	
2	g	g	
3	g	g	
4	g	g	

Computations:

1) From the data of parts A and B, calculate the coefficient of friction for each of the observations. Determine the average values of μ_s and μ_k. Compare the values of μ_s and μ_k.

Analysis:

The average μ_s and μ_k of wood on wood are ________ and ________.

Problems:

1) A block weighing 20 N rests on a horizontal surface. The coefficient of static friction between the block and the surface is 0.40 and the coefficient of kinetic friction is 0.20. What is the minimum force which will keep the block in motion once it has started to move?
2) A safe weighing 600 N is to be lowered at a constant speed down skids 4m long from a platform 2 m high. If the coefficient of kinetic friction between the safe and skids is 0.30.
   a) Will the safe need to be pulled down or held back?
   b) How great a force parallel to the skids is needed?

Newton's Second Law of Motion and the Atwood's Machine

(Physics 6, Experiment # 3)

Purpose:

To use the Atwood's machine to explain the concept of net force in Newton's second law of motion.

Apparatus and Materials needed:

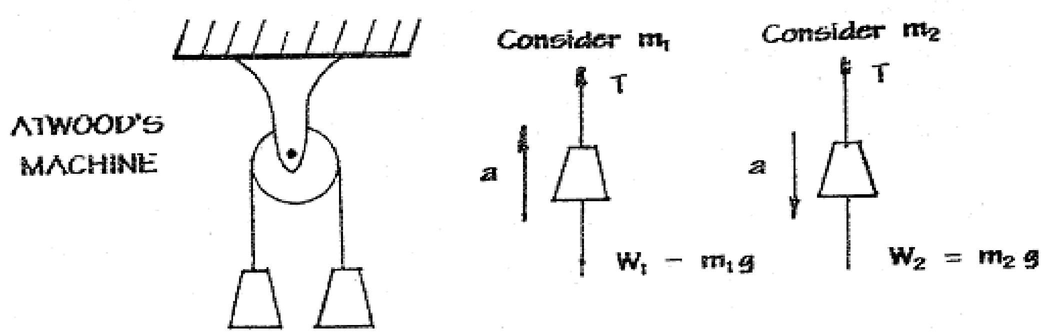
Atwood's machine
Stopwatch
Two sets of slotted weights

Atwood's machine apparatus with the items listed below will be prepared by lab technician. (Refer to the diagrams)

Two 50-g weight hangers
2 m metal string or strong cord

Theory:

FREE BODY DIAGRAM



For m_1

$\Sigma F_Y = m\,a$

$T - W_1 = m_1 a$

$T - m_1 g = m_1 a$ (1)

For m_2

$\Sigma F_Y = ma$

$W_2 - T = m_2 a$

$m_2 g - T = m_2 a$ (2)

ADD EQUATIONS 1 AND 2

$T - m_1 g = m_1 a$

$-T + m_2 g = m_2 a$

TO YIELD

$m_2 g - m_1 g = m_1 a + m_2 a$

$g\,(m_2 - m_1) = a\,(m_1 + m_2)$

$a = (m_2 - m_1)\, g\, /\, (m_1 + m_2)$

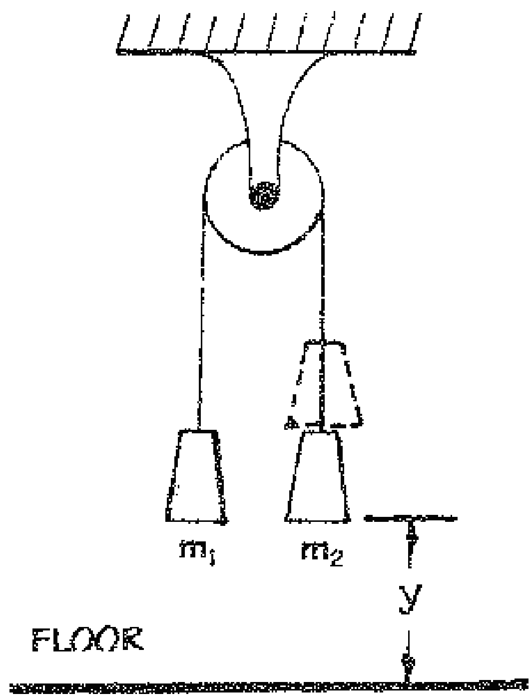
Newton's second law of motion explains that for a body of mass m to accelerate, there must be the presence of a "net" force (unbalanced or resultant force). The acceleration produced is proportional and in the same direction of the "net force".

The Atwood's machine consists of two (2) masses m_1 and m_2 attached to a light and flexible string passing over a fixed frictionless pulley. The masses are released at the same level and the acceleration is computed from the "net force" and the total mass accelerated.

Procedure:

1) Refer to the diagram. Put identical mass of 800 g on both weight hangers. The weight hangers should be at the same level. The string should be long enough for m_2 to reach the floor.
2) Add m = 50 g to m_2. Record the time for m_2+ m to reach the floor. The time starts at the instant m_2+ m descends.
3) Measure the distance between m_2 and the floor.
4) Repeat steps 1 to 3. Add m = 100 g to m_2. Then, m = 150 g. Record the results in the data sheet.

Diagram:



Data:

	Time, t (s)	Acceleration, a (cm/ s^2)	Atwood's Machine, a (cm/ s^2)
$m_1 = m_2 = 800g$			
$m_2 + 50$ g			
$m_2 + 100$ g			
$m_2 + 150$ g			

Name of Student: ____

Date Performed: ____

Instructor's Initial: ____

Computations:

1) From the measured value of time, t, and distance, y, find the acceleration of the system for each added mass to m_2 using the following equations

$$y = v_0\, t + ½\,(a\, t^2),\ \text{when } v_0 = 0;\ a = 2y/\, t^2$$

2) Find the acceleration for each added mass using the derived equation from the Atwood's machine

$$a = g\,(m_2 - m_1) / (m_1 + m_2)$$

Note: The actual value of m_2 in the experiment is $m_2 + m$

3) Compare the accelerations computed for each mass in steps 1 and 2

Questions:

1) In Atwood's machine, if $m_1 = 1$ kg and $m_2 = 1.2$ kg, find the distance covered by each mass at t = 1 sec when released from rest. What is the tension in the cord?
2) From Newton's second law of motion, the acceleration is proportional and in the same direction as the "net" force. Does it mean that the direction of acceleration is in the direction of motion? Explain.
3) Why do you feel "heavy" when the elevator goes up? Why do you feel "light" when the elevator goes down? Does this mean that your mass is not constant?

Uniform Circular Motion

(Physics 6, Experiment # 4)

Purpose:

To study centripetal and centrifugal forces on a body moving in a circular motion.

Apparatus and Materials Needed:

Meter sticks
Mass balance
One set of brass masses or slotted weights
Stopwatch

Centripetal force apparatus with the items listed below will be prepared by lab technician. (Refer to the diagrams)

Centripetal force apparatus (rubber ball or stopper, string, washer, plastic tubing)

Theory:

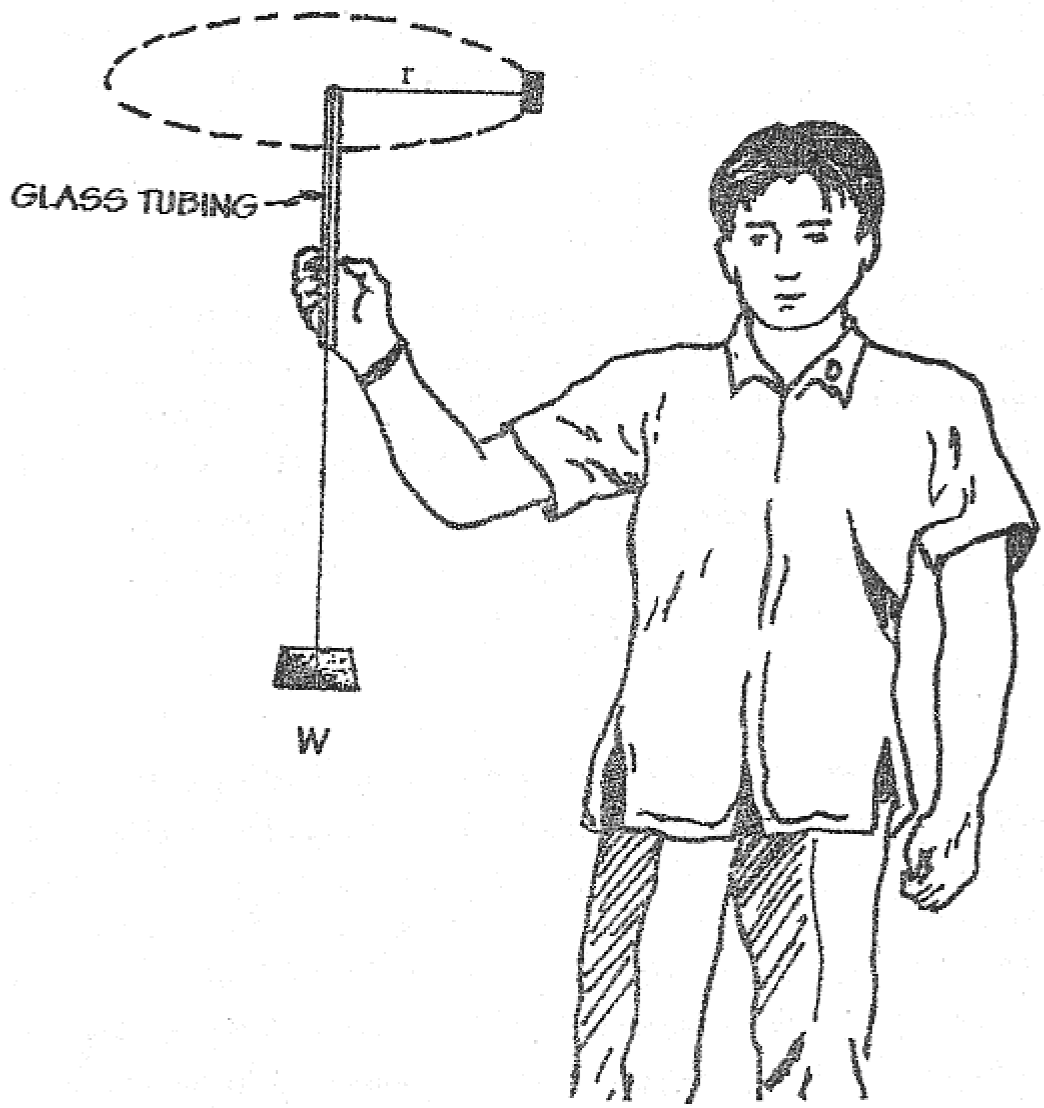
A body in uniform circular motion is moving with a velocity constant only in magnitude but is continuously changing in direction. Any change in either direction or magnitude of the velocity produces acceleration. This acceleration is directed toward the center, hence it is called centripetal acceleration. From Newton's second law of motion, there is a force also directed toward the center. This force is called the centripetal force. The centripetal force is equal in magnitude but is opposite in direction to the centrifugal force.

Procedure:

1) Refer to the diagram. Hold the tube vertically up and whirl the rubber stopper in a horizontal circle. Adjust the velocity of the stopper so that the weight of the washer is just supported by the cord. (The washer should remain stationary with its distance from the end of the tube equal to the distance of the stopper from the other end.)
2) With the velocity almost uniform, start counting the number of revolutions made by the stopper in one (1) minute. (Another observer should watch the time.)
3) At the end of one (1) minute, grasp the cord and mark it with a pen or chalk at the bottom of the tube when the stopper is whirling with constant velocity.
4) Measure the radius of the circle from the top of the tube to the stopper.
5) Repeat steps 1 to 4 using the same interval of one (1) minute. Use r – 20 cm and r + 20 cm. Record all results in the data sheet.

Diagram:

RUBBER STOPPER IN CONSTANT MOTION



Data

Mass of washers = M = ________________g
Mass of rubber stopper = m = _________________g

Radius of Circle (cm)	Number of Revolutions (θ)	Time (s)	$\omega = \theta / t$	$F_c = mv^2/r = m\omega^2 r$ (Exp.)	T = Weight of the washer (Mg) (Std.)	% Error
r = cm						
r − 20 cm						
r + 20 cm						

Name of Student: ____

Date Performed: ____

Instructor's Initial: ____

Computations:

1) Find the angular velocity, ω, in revolutions per second (rps) for each trial using the following relations:

$$\omega = \theta / t = 2\pi r / t$$

NOTE : In one revolution, $\theta = 360°$ and $S = 2\pi f$

S is the linear displacement in cm
$\theta = S / r$ is the angular displacement in radians

2) From the mass of the rubber stopper, the angular velocity, ω, and radius, r, calculate the centripetal force for each trial.

$$F_c = mv^2 / r, \text{ however } v = \omega r \text{ hence } v^2 = \omega^2 r^2$$

$$\text{Thus, } F_c = m\omega^2 r^2 / r = m\omega^2 r$$

3) Compare F_c to the weight of the washers.
4) Get % error using weight of washers as standard value.

Simple Machines

(Physics 6, Experiment # 5)

Purpose:

To know the different types of simple machines and operations. To measure the actual mechanical advantage (AMA), ideal mechanical advantage (IMA) and the efficiency of these machines.

Apparatus and Materials Needed:

Compass caliper
Meter stick
One set of slotted weights
Protractor
1 kg weight

Apparatus such as Compound Pulley system, Wheel and Axle, and Inclined Plane with the items listed below will be prepared by lab technician. (Refer to the diagrams)

Iron stand
Right angle clamp
50 g weight hanger
String
Spring balance
Metal carriage or cart
Pulley system (single and compound)
Wheel and axle friction board with pulley

Theory:

Simple machines are devices where a maximum energy applied or work input produces a much higher work output. These simple machines make "mechanical" work easier. Some of these machines are the inclined plane, lever, wheel and axle, pulley system and others.

The mechanical advantages, AMA and IMA of these simple machines can be computed. The IMA is the ratio of the distance moved by the applied force, F. AMA = W / F. Efficiency is the ratio of AMA to IMA or Eff = AMA/IMA × 100% in percentages.

Procedure:

1) Pulley systems: Refer to the diagram for pulley system.

   a) Single Fixed Pulley:

Find the force F required to lift a weight of W of1 kg weight. Measure the distance, d_f, of the force and d_w of the load W. Record these information in the data sheet.

b) Compound Pulleys (block and tackle):

Using two (2) strands or strings, find the force required to lift a weight of W of 1 kg weight at constant speed. Repeat with six (6) strands. Measure the distances d_f and d_w.

2) Wheel and Axle: Refer to the diagram for wheel and axle.

Cling 1 kg weight W to the smallest wheel. Find the force F on the largest wheel to lift the 1 kg weight with a constant speed. Measure d_f and d_w. With a compass caliper, measure the diameters of the small and big wheels. Record all information in the data sheet.

3) Inclined plane: Refer to the diagram for inclined plane.

With $\theta = 30°$ and W = 1 kg on the carriage, find the force F needed to raise W to a height d_w at a constant speed and length d_f covered by the force F.

<u>Data:</u>

1. Pulley System

	Number of Strands		
	1	2	3
F (g)			
W (g)			
d_f (cm)			
d_w (cm)			
AMA			
IMA			
Eff			

2. Wheel and Axle

D (wheel)	cm
D (axle)	cm
F	gm
W	gm
d_f	cm
AMA	
IMA	

3. Inclined Plane

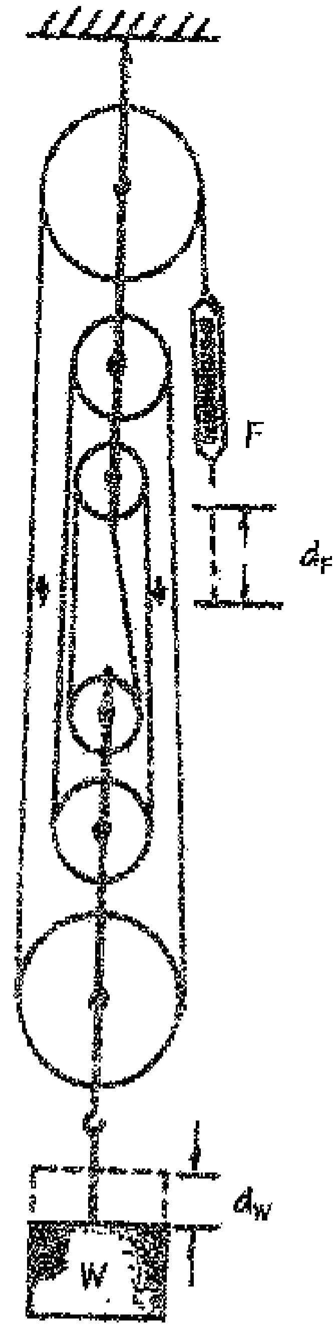
F	gm
W	gm
d_f	cm
d_w	cm
AMA	
IMA	
Eff	

Name of Student: ____

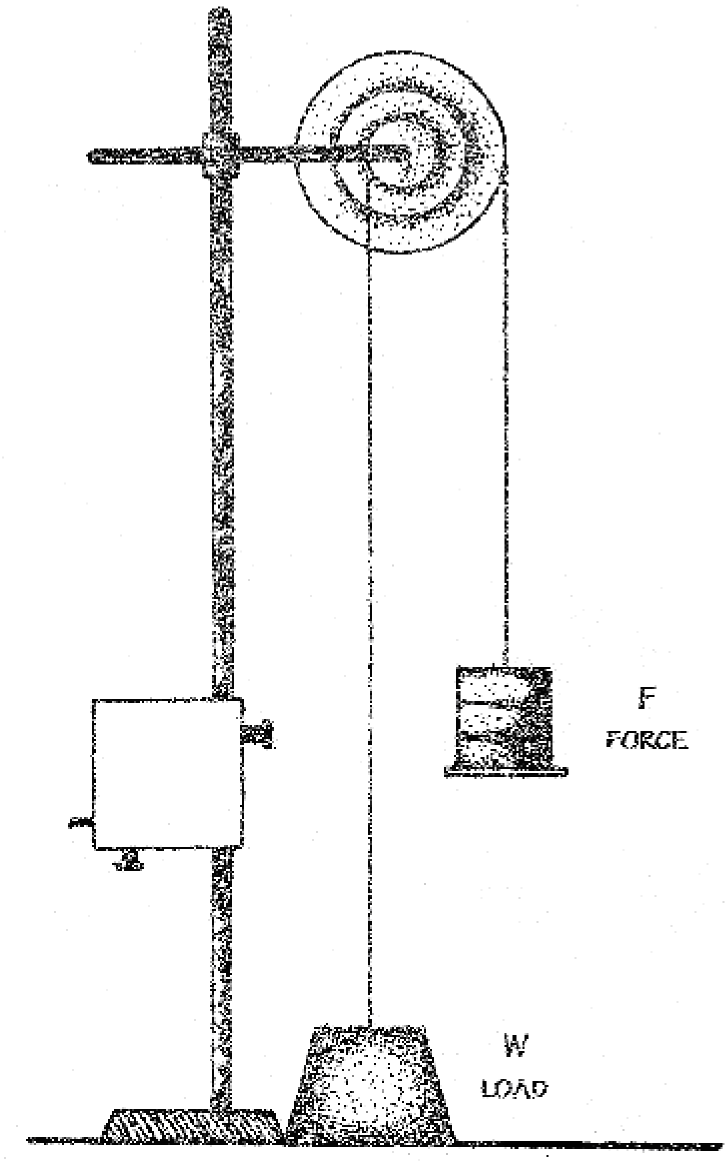
Date Performed: ____

Instructor's Initial: ____

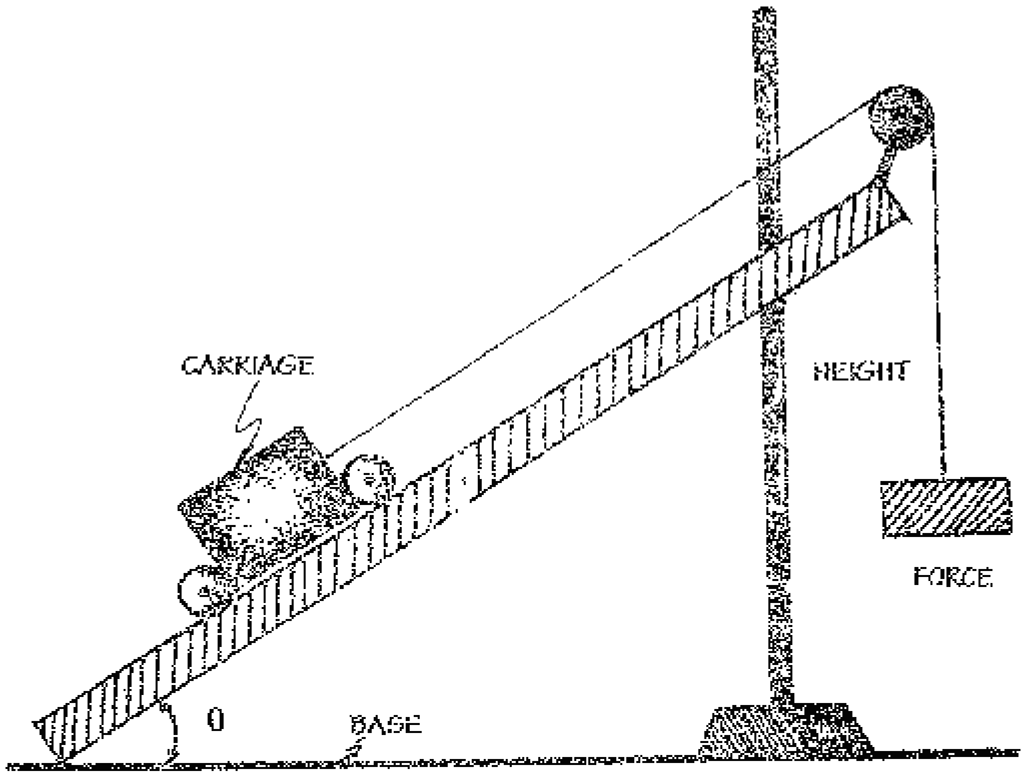
COMPOUND PULLEY
(BLOCK AND TACKLE)



WHEEL AND AXLE



INCLINED PLANE



Computations:

1) Compute the IMA of the pullet system from the ratio of the displacements and compare with the number of strands. Find the AMA and efficiency of each pulley system.
2) Compute the IMA of the wheel and axle from the ratio of displacements and compare it with the ratio of their diameters. Find the AMA of the wheel and axle.
3) Compute the IMA for the inclined plane from the ratio of the displacements and compare it with the ratio of length to the height of the inclined plane.

Questions:

1) Which among these simple machines is the most efficient? Why?
2) A hidden mechanism has a load of 250 N and is 75%. If a force of 500 N is needed to raise the load, how are the ropes arranged? Find the IMA and AMA of this pulley system. Sketch the arrangement.

Conservation of Linear Momentum and the Collision Theory

(Physics 6, Experiment # 6)

Purpose:

To study the principle of conservation of mass and the velocity of a moving body.

Apparatus and Materials Needed:

Ballistic pendulum apparatus
Plumb bobs
Carbon paper
Iron stand
Pendulum clamp
Mass balance
One set of brass masses
String
Meter stick
Table clamp (C-clamp)

Theory:

Just like matter and energy, momentum is also conserved. The conservation of linear momentum states that the momentum before and momentum after of colliding bodies are equal and in any type of collision, momentum is conserved.

The ballistic pendulum is used here to find the initial velocity of the ball. It is later used in a realistic collision with a metal ball to verify the conservation of linear momentum. Momentum is the product of the mass and the velocity of a moving body. In symbols,

$$p = m \times v$$

where p is the momentum in kg-m/s
m is the mass of the body in kg
v is the velocity of the body in m/s

Procedure:

Part A: Velocity of the Ball

1) Refer to the diagram for part A. Place the Ballistic pendulum apparatus and secure it with a table clamp (C-clamp) along the edge of the table. With the spring gun placed at the edge of the table, fire the gun and note the spot where the metal ball will land. Place a wooden box and position it under the location of the spot you just found to avoid the damage to the floor. Fire the gun again to locate the exact landing spot and use a piece of masking tape to mark it. Take a sheet of carbon paper along with a white paper underneath and place it under the center of the

spot indicated by the masking tape. Secure the paper with a masking tape. Fire the gun three times.

2) Measure the horizontal distance covered by the metal ball each time it is fired. Get the average of these horizontal distances.
3) Measure the height of the table from the edge where the spring gun is placed to the floor. Subtract the thickness of the wooden box. Record all these information in the data sheet.

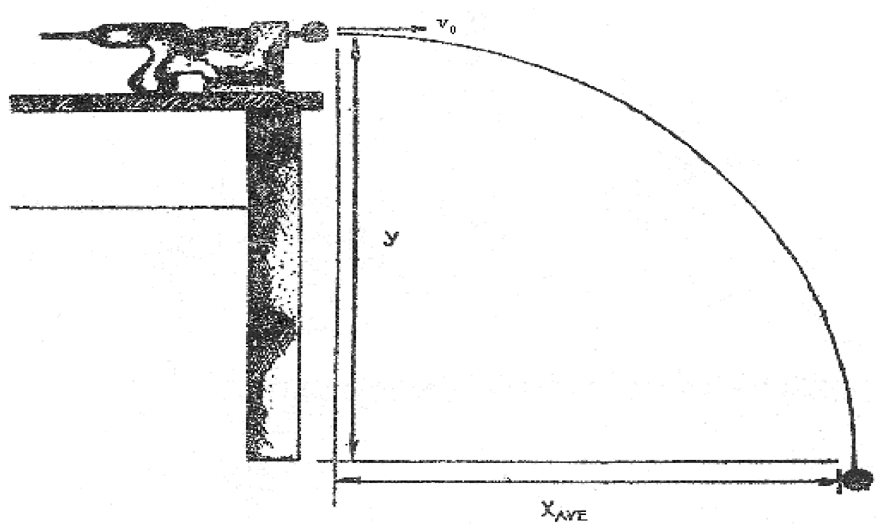
Part B: Conservation of Linear Momentum in an Inelastic Collision

1) Refer to the diagram for part B. Release the pendulum from the rack and allow it to settle in its lowest position. Fire the metal ball into the pendulum and note of the tooth number on the rack where the metal ball comes to rest. Make at least three (3) trials.
2) Get the average height of these measurements. (The measurement should be from center to center of the ball or from the lowest point of the pendulum to the maximum height it has reached.)
3) Remove the pendulum from its support and measure its mass and the mass of the metal ball on the platform balance.

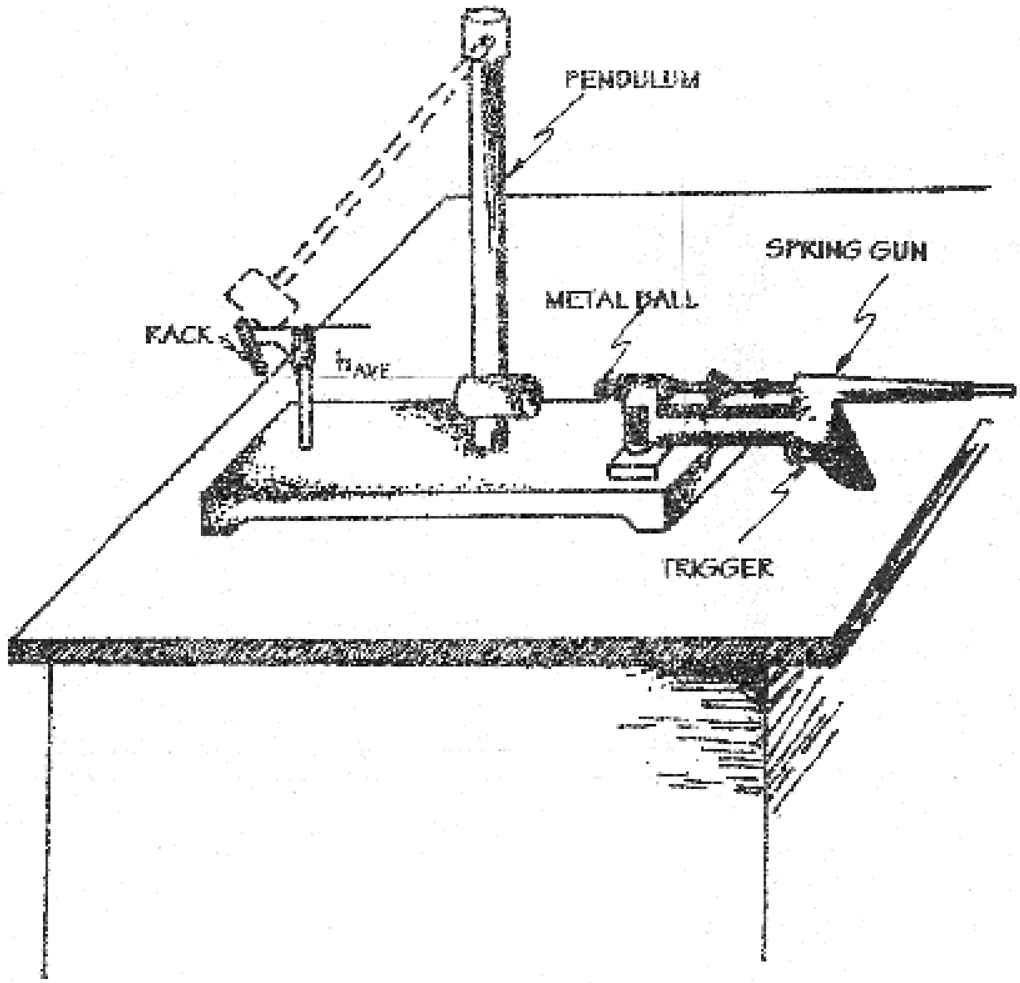
CAUTION: Do not play with the spring gun. Go not compress the spring unless you are ready to fire. Do not stay in from of the gun.

Diagram:

Part A
Ballistic Pendulum



Part B
Spring Gun Ballistic Pendulum



Data:

Part A

Height of the table, Y: _____________ cm
Horizontal distance, X_{AVE} : _____________cm

Part B

Mass of the metal ball: ___________ g
Mass of the pendulum: ___________ g
h_{AVE}: __________ cm

Name of Student: ____

Date Performed: ____

Instructor's Initial: ____

Computations:

1) From the X_{AVE} and Y with $\theta = 0°$, find the velocity of the ball using the equation
$$y = x \tan\theta - gx^2 / 2v_0\cos^2\theta$$

2) Compute and compare the momentum of the system (metal ball and pendulum just before and after collision.)

$$P_{BEFORE} = P_{AFTER}$$
$$m_0 v_0 + MV = m_0 u + M u$$
But $MV = 0$ at rest, thus
$$m_0 v_0 = u (m_0 + M)$$
$$u = m_0 v_0 / (m_0 + M)$$
Also, $u = 2 g h_{AVE}$

where u is the common velocity of the metal ball and the pendulum
v_0 is the initial velocity of the ball in cm/s
m_0 is the mass of the metal ball in g
M is the mass of the pendulum in g.

3) Compute the K.E. of the ball before collision. With the common velocity u, compute the K.E. of the metal ball and the pendulum. Compare their K.E.

Questions:

1) What are the different types of collisions? Give examples for each type.
2) A 0.08 kg bullet moving with a speed of 350 m/s strikes a stationary block of mass 35 kg suspended as a ballistic pendulum. Find the height reached by the block and bullet after an inelastic collision.

Velocity of Sound

(Physics 6, Experiment # 7)

Purpose:

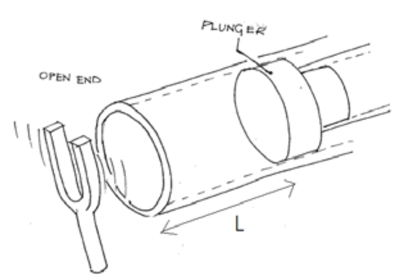
To determine the velocity of sound in air by measuring the wavelength of standing waves of a known frequency.

Apparatus and Materials Needed:

Telescoping resonance tube
Support for tube
Three tuning forks of different frequency
Rubber striking mallet
Thermometer
Meter stick

Procedure:

Select tuning forks with different frequencies. When striking the forks, only use the rubber mallet as hitting them against a hard object will cause them to go out of tune and they will vibrate with an unknown frequency. Starting with the plunger in the resonance tube as far out as possible, slowly move it inwards while listening to the sound that is created when a vibrating tuning fork is placed in front of the open end. You may have strike the fork again during this period. You will notice that for a particular position of the plunger, the sound emanating from the open end seems louder than at other positions. Measure the distance between the front of the plunger and the end of the tube and call this distance L_1 in your lab notes. Now, again with a vibrating tuning fork held at the open end of the tube, continue to move the plunger inwards from this first point of resonance and listen for the second point of resonance that is closest to the first one detected. Measure the distance between the front of the plunger and the open end of the tube and call this distance L_2 in your notes. Record the frequency of vibration of the tuning fork, L1, and L2 in your lab notes. Repeat the measurement twice more using a different tuning fork each time. Record the air temperature in the room. Make a careful sketch of your apparatus in your notes and record all details that you think are important.



Questions and Analysis

1. Present your experimental data in the form of a table. Clearly indicate the units and give each column an appropriate heading. Give the table a meaningful title.

2. Sketch a diagram of the pressure waves in the tube for consecutive points of resonance. Is it possible to determine which harmonic has been excited?

3. Use your data to determine the speed of sound in the tube for each set of measurements. Clearly show your working and determine the average value

4. The speed of sound in air is empirically related to the air temperature according to the following formula: $V_T = 331 + 0.61T$. Where V_T is the speed of sound in air in m/s and T is the the air temperature in °C. Compare your result with that predicted by the empirical equation and calculate the % error.

5. In your conclusion, in addition to discussing your results, discus what other factors might affect the speed of sound in the tube and the frequency of resonance of a tube closed at one end.

Include your original lab notes in your write up.

Name of Student: ______________________________

Date Performed: ______________________________

Instructor's Initial: ______________________________

Determination of the Latent Heat of Fusion of Ice

(Physics 6, Experiment # 8)

1. Method:

You will be given the following materials:

Alcohol Thermometer
Insulated container (calorimeter)
Warm water supplied from electric kettle
Crushed Ice
Paper towels
Electronic Balance

Your task is to use these materials to determine the latent heat of fusion of ice. You are to work in groups but you will each submit an individual report.

2. Analysis and Write Up

You will write up your experiment using a formal format for the communication of scientific data. The report is written in the third person and past tense. The report should be in the past tense as it describes something that was done in the past and in the third person because what was done should be more important than who did it. This means that you should write:

"A calorimeter was used to minimize heat absorbed from the environment"

Instead of

"I use a calorimeter to minimize heat absorption from the environment"

The report will contain the following sections:

Abstract or Summary: The abstract summarizes the report. It is intended to convey the most essential parts of the report so that the reader can gain a quick idea of the aims and results of the study. It is best to compose the abstract after the main body of the report has been completed. You should write the abstract last.

Introduction: Gives enough background to the experiment so that one of your peers can understand the rest of the report. Use references if necessary to avoid having to repeat something that can already be found in published material.

Method: In this section, the method and procedures used are described in detail. Enough information must be given so that the reader could repeat your experiment if they had the same equipment available. Including the manufacturer's name and model number of equipment if appropriate. If the method is detailed elsewhere then it is acceptable to reference the publication where it can be found. Diagrams should be properly referred to and placed reasonably close the text that refers to them. Diagrams should be given figure numbers. All figures and graphs should be presented with informative captions underneath them.

Results (and Discussion): In this section, the results obtained are presented and their meaning and interpretation discussed. Present your data logically using appropriate methods such as tables or graphs. You should indicate the precision and units of all the data shown. The conclusions and interpretations that you make should show that you were thinking in a logical, objective, and reasonable manner.

Conclusion (sometimes called Discussion): Emphasizes the document's most significant data and ideas and often offers an evaluation or judgment. Recommendations for further work may be made

References: list any references that you have cited in your report. Cite references using the MLA style: http://www.library.cornell.edu/newhelp/res_strategy/citing/mla.html#mla

Scientific Paper Analysis

To gain familiarity with this format, please complete the scientific journal paper analysis assignment below.

Your paper should look very much like the sample below when you have completed your writing assignment.

Scientific Paper Analysis Assignment

Please read the scientific paper below and answer the following questions

1) What was the precision of the individual bird mass measurements? What is the simplest instrument that you have used that will give you the same precision?
2) Why did the authors mention that they calibrated the sensors with static weights before and after each run?
3) They measure the force on the perch, how is this related to the pushing force of the bird's legs on its body? Which basic principle of classical physics is this relationship an example of?
4) In figure 1 the zoologist makes an error, what is it?
5) Draw a free body diagram of the bird and use the measurements of the average vertical force and the average mass of the bird to check the zoologist's calculation of the maximum vertical acceleration.
6) The zoologist makes a statement: "This acceleration would propel the bird to a height of approximately 3 cm above the perch". How would you rephrase it so that it makes more sense to someone educated in physics?

Name of Student: ________________________________

Date Performed: ________________________________

Instructor's Initial: ________________________________