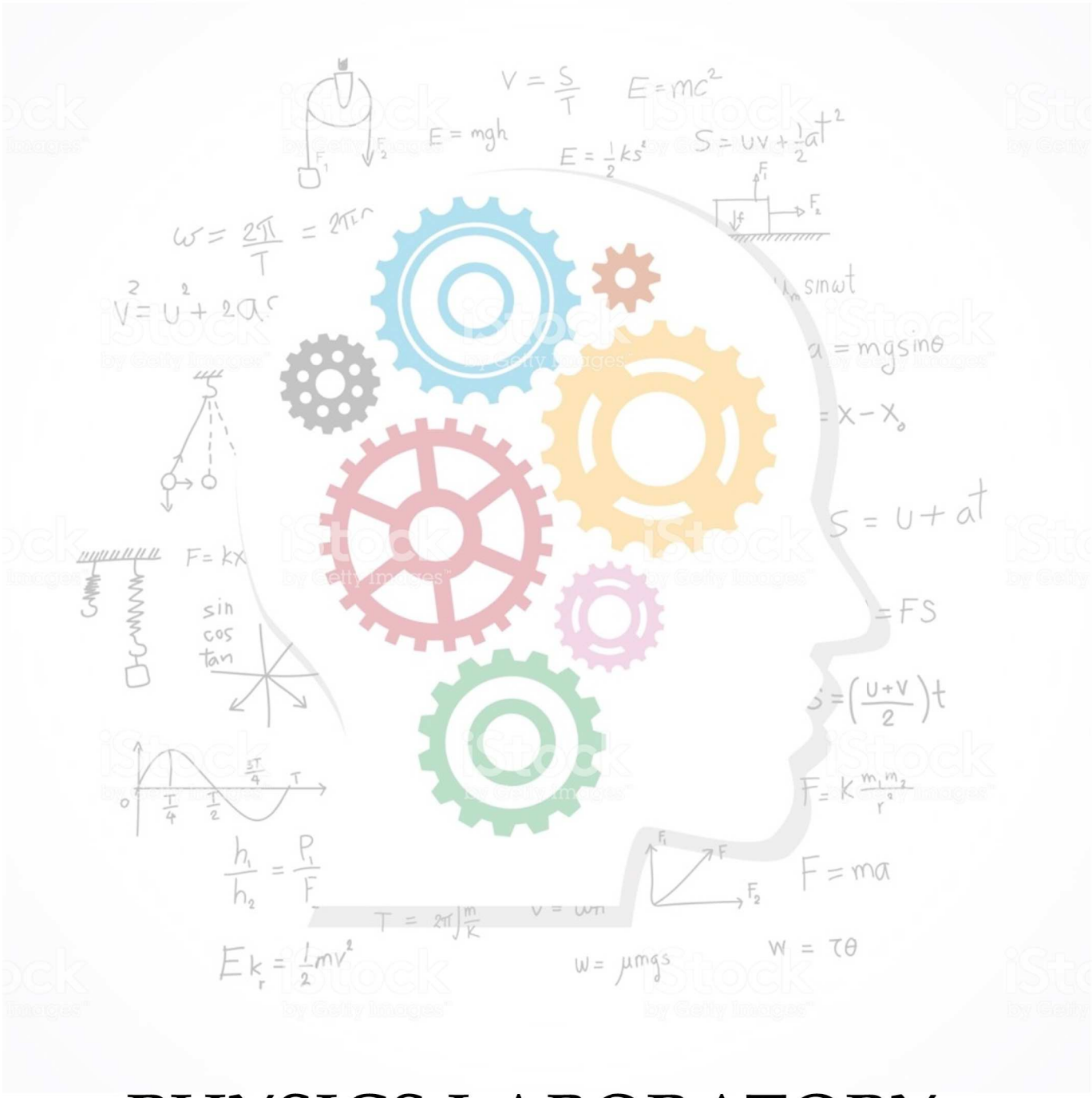
Republic of the Philippines

Mountain Province State Polytechnic College

Bontoc, Mountain Province



PHYSICS LABORATORY OPERATION MANUAL 2014

VISION

A preferred university of developmental culture and inclusive growth.

MISSION

It shall produce globally competitive leaders molded from a tradition of excellence in instruction, research, effective governance, sustainable entrepreneurship and an environment that assumes major responsibility in cultural vitality and well-being of the community.

GOALS

1. Attain and sustain quality and excellence for university hood;
2. Promote relevance and responsiveness;
3. Broaden access and equity;
4. Enhance efficiency and effectiveness; and,
5. Develop harmony within the College, and with stakeholders and benefactors.

MAJOR THRUSTS

H - Hearty Approach to Management & Governance, & Transformational Leadership

E - Enriched Academic Programs

R - Relevant Student Services, Development, and Welfare Program

I - International and Local Linkages

T - Technology, Facilities, and Assets Enhancement Program

A - Aggressive Staff Development and Welfare Program

G - Gainful Resource Generation and Enterprise Development Program

E - Excellent Researches and Relevant Extension

RATIONALE

The Operations Manual contains all essential information for the users to make full use of the different laboratory equipment and apparatuses present inside each laboratory room.

This manual includes a description of the functions of the different apparatuses, policies and guidelines (for both students and instructors) in using the laboratory room and apparatuses, precautionary measures inside the laboratory rooms and step - by -step procedures for each apparatus access and use.

INTRODUCTION

The Physics laboratory room was established as instructional resources for the completion of academic or college-related work. The foremost goal is to provide students with a comfortable academic environment to perform class requirements, by using up-to-date technology. Further, to encourage and assist students and faculty to optimize their scientific knowledge and skills through classroom activities, training and individually pass learning.

Each person has the responsibility to use the existing equipment for appropriate uses and in a proper manner. The following policies and procedures are intended to help in the operation, scheduling, maintenance and security of the laboratory.

PREFACE

The Physics Laboratory Operation Manual is designed for college instructors and students especially for those who are enrolled in subjects with laboratory and utilizes the laboratory room for their laboratory period.

The contents of the manual have been arranged such that the policies and guidelines (on cleanliness, do's and don'ts, operation of the room, precautionary measures) for both instructors and students comes first.

The manual includes all the functional old and newly procured apparatuses and equipment. It follows the name of the apparatus, how to operate it and the safety measures in handling each apparatus.

SUMMARY PAGE

The Physics Laboratory Manual contains the rules, policies, guidelines, safety tips, laboratory conduct and appropriate laboratory usage which both instructors and students should be aware of and abide while inside the laboratory room. It also includes the guidelines to be followed in borrowing needed apparatus and equipment.

Aside from that, the revised manual incorporates the pictures of the different apparatuses and equipment ready as reference for both instructors and students. It was designed to update all the newly procured apparatus and equipment present in the laboratory including the operation, maintenance and safety measures in using each of the apparatus.

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CHAPTER 1

POLICY FOR APPROPRIATE PHYSICS LABORATORY USAGE

It is important for everyone to realize that there is attached responsibility to the Instructor including the students every time they use the Physics laboratory room during class and experiment sessions.

Physics Laboratory Guidelines and Policies for Students:

In using the Physics laboratory facilities, the student:

1. Must follow rules on the use of the laboratory room such as the prohibition of drinking, eating or smoking in the laboratory room.

2. Must not perform any unauthorized experiments.

3. Must conserve gas, water and materials of any kind used in the laboratory.

4. Must observe proper disposal of solid waste and chemical waste used in the experiment.

    a. The solids must be disposed by placing them in waste cans, unless it is readily soluble in water.

    b. The gutter must be used for the disposal of water only.

    c. Small amounts of corrosive flammable liquids may be flushed down the sink with plenty of water. Larger amounts of such solvent should not be poured off on the sink.

    d. Table or floor spilled with acids or bases must be washed immediately with plenty of water.

5. Agrees to be careful in handling laboratory apparatuses and equipment.

6. Must be cautious in performing experiments and in handling chemicals. The student must observe the following cautions in performing experiments and in dealing with chemicals:

7.. Always pour concentrated acid into water. Never pour water into acids.

8. Agrees not to work alone in the laboratory.

9. Informs the Instructor of any problems occurring with the use of the equipment.

10. Must turn off water and gas supply and make sure that the working area is clean before leaving the laboratory room.

11. Understands that violation of the above mentioned conditions shall result to punitive action and must be answerable to appropriate authorities. Accidents due to negligence of students shall be the sole responsibility of the students concerned.

12. Agrees that the above conditions shall remain for as long as enrolled student uses the Physics facilities.

Physics Laboratory Guidelines and Policies for Instructors:

1. In using the Physics laboratory facilities, the Instructor must follow the following guidelines and policies:

   When the laboratory is used for instructional/laboratory purposes, the Instructor is responsible for the supervision and conduct of the students during the entire class or laboratory period. During the assigned time, only the enrolled students for the subject should be in the room. The Instructor has the authority to send out anyone who is not a member of the class.

2. The following becomes the added function of the Instructor during the conduct of

   laboratory classes:

- The Instructor is responsible for the efficient functioning of the Laboratory during regular student usage.
- The Instructor should report all defective apparatuses/equipment which were issued before the conduct of laboratory experiments or activities.
- The Instructor is responsible for securing the laboratory when leaving. The entrance and exit to the laboratory must be locked and secured when the laboratory is vacated.
- The Instructor assigned for the scheduled time needs to be present before the students can enter the laboratory room.
- The Instructor is responsible for maintaining the equipment in the laboratory during the experiment session by reporting problems to the laboratory in-charge.
- The Instructor sees to it that the laboratory and workstations must be left tidy for the next users.

CHAPTER 2

PHYSICS LABORATORY CONDUCT

1. Scheduled classes are given priority over other users.
2. Eating, drinking, smoking or chewing tobacco/ momma shall strictly be prohibited inside the laboratory.
3. Students who destroy any laboratory apparatus or equipment in the laboratory shall be held financially responsible. Fines for replacement shall be determined according to the value of the damaged items and shall be assessed by the Laboratory custodians.
4. Appropriate attire is required (laboratory gowns and face masks required).
5. Do not let another person use the apparatuses/equipment assigned to a certain group.
6. The use of Chemistry, Biology and Physics laboratory rooms must be limited to laboratory classes only. The use of such rooms for other purposes requires permit from the General Services Office.
7. Failure to adhere to Physics laboratory policies and procedures may result in permanent suspension of lab privileges.

CHAPTER 3

CLEANLINESS, ORDERLINESS AND DISCIPLINE INSIDE THE LABORATROY

1. Before Experiment

a. Wear your laboratory gown.

b. Clean you're working area/table, sink, and floor.

c. Set all your personal belongings on the shelves under the working tables:

No other things should be placed on top the working table except those materials needed in the experiment.

Secure all personal belongings (money, calculators, cellphones etc.) in your pockets.

d. Accomplish completely the requisition slip as to necessary materials from the stockroom.

- Double check your list before going to the stockroom counter.
- Request for additional equipment or chemicals will not be entertained at the stock room.
- Double check the quantity and condition of the material needed for a particular experiment upon issuance from the stockroom counter.
- Bring out your material from the class locker.
- Prepare the list and labels of the reagents needed for the experiment.
- Prepare the apparatuses needed.
- Get the reagents from the dispensing section.

2. During the Experiment

a. Set all the materials (chemicals, apparatus and others) on the working table

b. Position yourself around the working table where you can visualize and observe the experiment procedures and results.

c. Perform the experiment systematically.

d. Record significant observations.

e. Double check whether you have obtained the required data in the experiment.

3. After the experiment

a. All the leaders must present their notebooks/manuals signed by the faculty.

b. Leaders collect checked manuals of members and affix their signature/date.

They must make sure that:

- Materials are returned to the stockroom.
- Wastes and unused reagents must be disposed properly.
- Glassware are washed and wiped dry.

Working tables or working areas are cleaned.

c. Class materials must returned in lockers.

d. Faculty must inspect group area.

e. Faculty should dismiss the class by group.

CHAPTER 4

PHYSICS LABORATORY GUIDELINES ON BORROWING APPARATUSES OR EQUIPMENT

1. Issuance of apparatuses/ equipment shall be made only when the borrower presents a duly accomplished borrower's slip.

2. Request for apparatuses/equipment should be made one (1) day before the actual performance of the activity.

3. All borrowed items should be returned on time with conditions that all apparatuses/equipment are clean and dry before they are returned.

4. The borrower is held responsible for any damage or loss of apparatuses/equipment during the laboratory period.

5. In case of breakage or loss, the borrower must replace the broken item.

6. All borrowed items that were damaged during the performance of activities must be repaired before they are

Note: In purchasing items for replacement, the concern student should get the proper specification from the Laboratory In-charge before buying. Replacement with wrong specification will not be accepted.

Procedures in Borrowing Laboratory Apparatuses and Equipment

1. Read carefully the laboratory activity before securing a borrower's slip.
2. Identify the needed apparatuses/ equipment for the activity.
3. Secure borrower's slip from the laboratory in-Charge.
4. Fill the borrower's slip properly.
5. Let the respective laboratory instructor sign the borrower's slip.
6. Submit the fully accomplished borrower's slip to the laboratory in– Charge with valid school ID.
7. Wait for the requested apparatuses/ equipment.

Procedure in Borrowing Laboratory Apparatuses and Equipment

FLOWCHART	RESPONSIBLE	DETAILS
Identifies the needed apparatuses/ equipment for the activity.	Instructor	Laboratory instructor will identify the needed apparatuses/equipment for the activity basing from the activity sheet.
Submits the list of needed apparatuses/equipment	Students	Students will submit the list of needed apparatuses/equipment to the laboratory custodian.
Issues borrower's slip	Laboratory Custodian	Laboratory custodian issues borrower's slip basing from the list of needed apparatuses/equipment.
Fill-up borrower's slip	Students	Students will fill-up properly the borrower's slip basing from the list of needed apparatuses/equipment.
Borrower's slip be signed by the instructor	Instructor Student	Students will bring the borrower's slip to the instructor for him/her to sign if the apparatuses are all listed.
Yes / No Form duly accomplished	Student	Student will submit duly accomplished borrower's slip to the laboratory custodian one (1) day before the actual performance
Prepares requested apparatuses or equipment	Laboratory Custodian	Laboratory custodian will prepare the requested apparatuses following what is listed in the borrower's slip.
Signs borrower's slip and issue requested apparatuses/equipment	Laboratory Custodian	Laboratory custodian will sign the borrower's slip and issues requested apparatuses/equipment on t he day of the activity.
Gets issued apparatuses / equipment together with the borrower's slip.	Student	Students will get the apparatuses from the laboratory custodian together with the borrower's slip. Borrower's slip ill be returned to the laboratory custodian together with the apparatuses after the

CHAPTER 5

HAZARD CODE AND FIRST AID TREATMENTS

NUMERICAL HAZARD CODE

Chemicals vary as to degree of hazard. The following hazard codes serve as basis in the cautious handling of chemicals.

Substances are rated on a scale of 0 (non-hazardous) to 4 (extremely hazardous) in each of four hazard categories:

Health hazard – the danger or toxic effect a substance presents if inhaled, ingested, or absorbed.

Flammable hazard – the tendency of a substance to burn.

Reactivity hazard- The potential of a substance to explode or react violently with air, water or other substances.

Contact hazard- the danger of a substance present when exposed to skin, eyes and mucous membranes.

Rating Scale

4	3	2	1	0
Extreme	Severe	Moderate	Slight	None

FIRST AID TREATMENTS

a. First Aid for Chemical Burns

- Rinse the chemical off the skin w/ cool gently running water for at least 20 minutes.
- Remove any contaminated clothing and jewelry.
- Gently wrap the burnt area with sterile gauze or clean cloth if available.

· Do try to neutralize the chemical with acid or alkali.

· Do not apply ointment or other topical treatments.

b. Chemical in the Eye

- Tilt the head so that the injured eye is downward, thus preventing the chemical to run into the unaffected part.
- Keep the eye open gently with your fingers and rinse out the eye with cold running water for 10-15 minutes.
- Apply a loose sterile eye dressing or a clean piece of cloth over the injured eye.

c. First Aid for Cuts and Scrapes

1. Stop Bleeding.

· Apply gentle pressure w/ sterile gauze or a clean cloth.

· Elevate the wound.

2. Clean the wound.

· Rinse the wound w/ clean water.

· Do not use soap, iodine, alcohol or hydrogen peroxide; this can be irritating to the tis-

3. Apply antibiotic.

· Once the wound has stopped bleeding and has been rinsed clean, apply a thin layer of antibiotic cream or ointment to the wound.

4. Cover the wound.

· Keep the wound covered with an adhesive bandage or sterile gauze as it heals; this will keep the wound clean and prevent infection.

d. First Aid for Poisoning

In case of poisoning, the following first aid measures can be taken:

· Fresh air— If the person has inhaled the poison, then he must be allowed to intake fresh air immediately, as soon as possible.

· Dilution—In case of intake of poison through mouth, the person must be made to drink water or milk in order to dilute the poison.

- Do not induce vomiting. Turn the person to a left lateral position, keep the victim's chin raised at a slight angle and call for immediate medical help. (This helps keep the airway clear and allows better circulation of blood)

1. SPRING GUN BALLISTIC PENDULUM

OPERATION

How to use the Spring Gun Ballistic Pendulum:

1. Set the apparatus on one edge of the table.
2. Check the apparatus accessories as follows:
   - 3 steel round ball which serves as bullet
   - Spring and rod

   Pendulum that serve as guide
3. Tighten the knot on the butt of the ballistic gun.
4. Insert the spring inside the butt of the ballistic gun.
5. Be sure that the guide rod is locked to the trigger.
6. Adjust the pendulum at 90° so that the rod will be directed to a straight line.
7. Pull one steel ball inside the pendulum.
8. Before pulling the trigger, make sure that no one is in front or the direction of the bullet is clear to avoid accident.
9. Pull the trigger for observation and adjust the pendulum when necessary.

2. VOLTMETER

OPERATION / PRECAUTIONARY MEASURES

How to Use the Voltmeter:

1. Plug the probes into the meter. Red goes to the positive (+) and black to the negative (-).
2. Turn the selector dial or switch to the type of measurement you want. To measure direct current - a battery, for example - use DCV. To measure alternating current, such as a wall outlet, use ACV.
3. Choose the range setting. The dial may have options from 5 to 1000 on the DCV side and 10 to 1000 on the ACV side. The setting should be the top end of the voltage you are reading. Not all voltmeters have this setting.
4. Turn the meter on.
5. Hold the probes by the insulated handles and touch the red probe to the positive side of a DC circuit or either side of an AC circuit. Touch the other side with the black probe.
6. Read the digital display or analog dial.

Tips & Warnings

- Attach alligator clips to the probes before you turn on the meter. These are useful for hands-free operation and keep fingers out of dangerous areas.
- A battery is good if the reading is within 20 percent of the rating on the battery or appliance. In other words, a reading of 7.2 or higher means a 9-volt battery is acceptable.
- Don't use a meter with a cracked housing or probes with bare wires showing.
- Never use the ohm setting on a multimeter on live voltage. You will damage the meter.

Use a voltage probe or test light if you just want to check if a circuit is live.

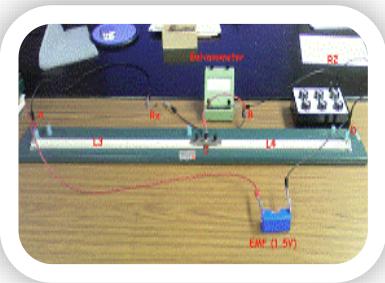
3. AMMETER

OPERATION

How to Use Ammeter:

1. Examine the structure of a simple circuit. The simplest possible circuit may be shown with a battery and light bulb. The negative terminal of the battery is connected to the negative terminal of the light bulb with a lead. Similarly, the positive terminal of the battery is connected to the positive terminal of the light bulb with the other lead.
2. Observe the inputs for an ammeter. A very basic ammeter might have one input and one output. However, a commercial multimeter should have a specific input for measuring current (typically marked "A" for amperage. The output is commonly marked "COM" for common ground.
3. Turn the ammeter on and set the selector to detect direct current (DC) amperage. A simple ammeter may only be able to detect amperage but a multimeter can detect various electrical quantities and will need to be "told" which quantity to measure. If the ammeter has a selector for the range of current to display, select the highest available setting.
4. Disconnect the positive lead from the light bulb and touch the probe from the ammeter's input (A) to the positive lead from the battery. Touch the probe from the ammeter's negative terminal (COM) to the positive terminal of the light bulb.
5. Select progressively lower current ranges until you get a measurable result. If your ammeter has this option, you'll want to "scale down" rather than "scale up". This will avoid damaging the ammeter by subjecting it to a level of current that it's not prepared to measure.

4. WHEATSTONE BRIDGE



OPERATION

Procedure:

1. Secure connecting wire with alligator of the same size.
2. Connect the wire on the designated connecting point. Use red or yellow color for positive and black or green for negative.
3. Connect the galvanometer at the center (designated connecting point).
4. Before connecting to the power supply, be sure that the voltage is adjusted to the voltage that you want before introducing the current.
5. Always check the connectors before turning on the voltage.
6. Never use high voltage to avoid electrocution.
7. Always refer to the diagram for reference or call the attention of the technician for assistance.

5. FORCE TABLE

OPERATION

Assembly

1. Remove the three legs from the clips on the bottom of the plastic force table disk.

2. Screw the legs into the holes on the bottom of the disk.

3. Attach three pulleys and clamps to the rim of the disk. If more than two forces are to be added, use the desired number plus one pulley and clamp for the equilibrant force.

There are two ways to attach the strings to the table:

- The first way uses the conventional ring in the center of the table and the second way uses an anchor string through the hole in the center of the table. The advantage of the anchor string is that a higher precision can be achieved because a single knot is being centered instead of the massive ring.
- The anchor string keeps the masses from falling to one side when the system is not in equilibrium.

NOTE: In both methods it is important to adjust the pulleys so that the strings are parallel to the top surface of the Force Table, and as close to the top surface as possible. When adjusting the pulleys, don't let the ring rest on the top surface.

1. Ring Method

1. To use this method, screw the center post up until it stops so that it sticks up above the table.
2. Place the ring over the post and tie one 30 cm long string to the ring for each pulley. The strings must be long enough to reach over the pulleys.
3. Place each string over a pulley and tie a mass hanger to it.

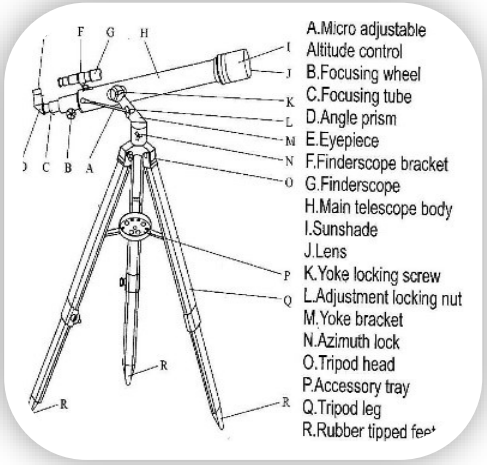
NOTE: A string can be attached to the PASCO mass hanger by wrapping the string several times (4 or 5) around the notch at the top of each mass hanger.

2. Anchor String Method

1. Cut two 60cm lengths of string and tie them together at their centers (to form an "X"). Three of the ends will reach from the center of the table over a pulley; the fourth will be threaded down through the hole in the center post to act as the anchor string.
2. Screw the center post down so it is flushed with the top surface of the table.
3. Thread the anchor string down through the hole in the center post and tie that end to one of the legs. Put each of the other strings over a pulley and tie a mass hanger on the end of each string.

NOTE: A string can be attached to the PASCO mass hanger by wrapping the string several times (4 or 5) around the notch at the top of each mass hanger.

6. ASTRONOMICAL TELESCOPE



OPERATION / MAINTENANCE / PRECAUTIONARY MEASURES

OPERATION

- Extend the legs and lock them at the desired height using the win nut (1) supplied.
- Connect the three legs to the tripod head (O) using the wing nut and the bolt (20).
- Then attach the accessory tray (P) to the flanges of the tripod legs using the adjustment nuts and bolts supplied.
- Once all the bolts have been tightened down fully, the telescope's main body can be attached to the tripod yoke (M). Mount the telescope's main body (H) in the yoke (M) and adjust it using the large locking screw (K). Then tighten down the yoke.

- Remove the finders cope (G) with the attached bracket (F) from its box. Then remove the two knurled thumbscrews from the telescope's main body (H). Locate the finderscope bracket on the finderscope bracket on the telescope's main body holes drilled in the bracket base line up with those exposed in the telescope's main body. Refit the two knurled thumbscrews and tighten them down securely.
- Insert the angle prism (D) into the focusing tube z(C). Hold it in place by tightening down the corresponding mounting bolts.
- Fit the eyepiece (E) into the angle prism (D). The eyepiece also requires adjusting using the small tightening screw.
- If you wish to use the eyepiece extension prism with 1.5x magnification factor or the 3x magnification Barlow lens, insert it between the eyepieces.

FINDERSCOPE ADJUSTMENT

- As the telescope only refers a limited of view, it may be fairly hard to locate a given star or planet for observation. This is why the telescope is fitted with a cross-hair finder scope for orientation purpose. We recommend performing the following adjustment in daytime.

1. Insert the eyepiece with the lowest magnification factor into the angle prism connector. Observe an easily observe recognizable object that is no more than 300 meters away. Swivel the telescope through its horizontal axis and adjust it along the vertical axis until the object is located right in the center of your field of your view, then immobilize the telescope by tightening it down surely.
2. Now look through the finder scope. If the object seen through the telescope cannot be seen, slacken the adjusting nut and move the finder scope until you can see the object. Then tighten down the adjusting nut making sure that the objects remains visible in the center of the finder scope. To simplify this procedure, use the adjusting nut to position the object in the center. The finder scope will move in the direction in which the nut is turned. As soon as the eyepiece adjustment coincides with that of the finder scope, all of the nuts can be finally tightened down.

ATITUDE-AZIMUTH MOUNT

- The telescope is fitted with an Altitude-Azimuth mount. "Altitude "refers to the telescopes up and down or vertical movement, while "Azimuth" refers to its sideways or horizontal movement.

The Altitude azimuth mount is used in conjunction with the micro adjustable Altitude control azimuth Lock (N) let you see the entire night sky or any celestial body without having to move the tripod

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The Altitude azimuth mount is used in conjunction with the micro adjustable Altitude control azimuth Lock (N) let you see the entire night sky or any celestial body without having to move the tripod.

Which magnification should be chosen?

SELECTING A SUITABLE EYEPIECE

The magnification defines the telescope's ability to enlarge an image or to bring it closer in order to see it better.

$$\text{Example:} \frac{\text{700 mm focal length}}{\text{Eyepiece focal length 12.5 mm}} = \text{56x magnification}$$

The required degree of magnification depends on the object to be observe.

- To this end, we recommend conforming to the following general guideline: ideal viewing conditions are obtained when the magnification factor corresponds to no more than 15 to 20 times the lens diameter, i.e. the optimal magnification of 100x to 125x obtained with a 60 mm diameter lens makes it possible to observe most celestial bodies. We recommend using a lower magnification factor by observing the stars as the field view will be wider so that the object being observed will be easier to locate.
- The highest magnification factor should only be used for especially finely detailed observations of the moon.
- This is because the moon is relatively close and exceptionally bright, so that good detail resolution is obtained even with the high magnification ratio.

BARLOW LENS

- The Barlow lens increases the magnification factor provided by the telescope. A 3x Barlow lens will therefore triple the telescope's magnification power. Consequently it is possible to triple a 56x magnification factor to increase it to 168x using a 3x factor Barlow lens.
- The highest magnification factor Barlow lens should only be used for very bright, large objects such as the moon and the brightest planets or during observations when conditions are optimal.
- Do not use Barlow lens and the eyepiece extension in conjunction with the angle prism for the combination leads to especially low resolution and results in the inability to properly focus viewing. If you wish to use the Barlow lens, remove the angle prism from the telescope.
- Fit the Barlow lens to the focusing tube, then fit the required eyepiece directly onto the Barlow lens. Focusing is then performed in the usual way.

GENERAL CONSIDERATIONS

- Avoid sudden temperature fluctuation likely cause any dampness in the air to condense on the telescope's lens. If this phenomenon occurs, place the lens at a moderate distance away from a heat source and let the dampness evaporate away progressively.

WARNING: To avoid any eye injury, never look directly into another optical instrument through the telescope and never observe the sun with unprotected eyes!

7. CALORIMETER

OPERATION / MAINETENANCE / PRECAUTIONARY MEASURES

How To Use The Calorimeter:

- The measurement of the specific heat
- Determination of electro thermal equivalent

STRUCTURE

- The outer cylinder (aluminum)
- Covering frame
- Graduated cylinder (aluminum)
- Thermal sleeve
- Terminal cover plug
- Connecting rod; electric wire; rubber plug; cover plug; stirrer

♦ Determination of specific heat of objects when put on the cover plug cover frame to experiment, if change the experimental determination of electro thermal equivalent, then dress up with heating wire assembly for use in experiments, such replacement is convenient, and the utility.

TECHNICAL REQUIREMENTS

- The heating wire into the nickel wire , the resistance value of 2+0.2 and 1+0.1 omega
- The wire working state. Current 1.7-2A, voltage 6V 100ML water through 10min, reaches the ascending temperature 10 degrees Celsius.

EXPERIMENTAL METHOD

- Experiment (a) specific heat measurement step:
- Scale of calorimeter cylinder quality, then filled with water of half full of water quality and scale, Germany
- The cylinder into the thermal sleeve formed within the calorimeter and measuring temperature, Shui Dechu.
- The boiling water from the heating beaker, clamp the metal cylinder removed rapidly into the calorimeter inside the cylinder, mounted on the cap frame, gently with a stirrer stirring rod and measure its quantity, high temperature, or after mixing temperature.
- Remove the metal cylinder action filter dry, on the scale of its quality.

The experiment is finished, you can according to the heat balance equation for calculation of the experimental results of the data into the following equation:

M1C (T-T) + M1 (t-t10)=MC (T1-T)

Where:

- Volume heat exchanger cylinder (aluminum) quality = M1
- Water quality = M2
- The initial temperature of water = t
- Metal cylinder quality = m
- Metal cylinder heated temperature = T1
- After mixing the temperature = T
- The specific heat of water = C
- The specific heat of aluminum = C2

Do the experiment object to measure specific heat of C:

- (t-t1) (m1c1+m2c2)
- You can calculate the C=m(T1-T)

MATTERS NEEDING ATTENTION:

- The experimental process the cylinder water cannot be filled too much, but the metal cylinder above the surface, and the volume of the metal objects to be appropriate, should not be too small, it can increase the experimental effect.
- The object to be measured from the boiling water and put into the calorimeter in the cylinder process faster, thus reducing the emission of heat.

Experiment (2) and Joule heating.

- The first battery or allow voltage power supply, an ammeter, a sliding rheostat and a single-pole switch from a series circuit, the calorimeter terminal connected with a voltmeter, heat scale calorimeter cylinder quality, and poured into the proper amount of oil to half full.

Once again on the scales weighing, and oil quality, loaded into heat exchanger spiral resistance wire, was immersed in oil, and measured the initial temperature, ready after the start of the current access, remember this electrifying time, ammeter and voltmeter are respectively measured by the strength of the current in low voltage, when the power supply from electric start, from time to time, record the voltage and current changes, and then taken their average value to calculate.

- Power 10-15min, to reach a certain temperature, i.e cut off the power supply.
- Once again, measure the oil temperature (temperature)

According to the experimental record, according to W=1vt can calculate the electric energy into heat energy, and the heat from oil and the heat measurement for:

Q + (m1c+m2c2) X (t2-t1)

- According to the thermal equivalent q=Q/W calculates electro thermal equivalent

The above experiments derived values is only into likes values, in order to improve experimental accuracy, mainly to the temperature measurement temperature very carefully, and heating time is not more than 15min.

CUSTODY

- In 1, After the experiment, the conductive rod, blender, inner cylinder and wipe dry, into the barrel.
- In 2, The annex to keep good, avoid loss and weight.

8. TIMER

OPERATION / MAINETENANCE / PRECAUTIONARY MEASURES

Care of Your Stopwatch

- Do not use or store this stopwatch in areas exposed to temperature extremes, strong vibration or strong impact.
- Heat can shorten battery life and cause malfunction. Keep the stopwatch away from heaters and direct sunlight when using it.
- Never use the stopwatch in a bathroom or any area subject to high humidity.
- Never try to take the stopwatch apart. Doing so cause malfunction.
- To clean the stopwatch, use a soft, dry cloth moistened in a solution of water and mild neutral detergent. Wiring out all excess moisture from the cloth. Never use thinner, bezene, alcohol or other similar agents.
- Keep your manual and all information handy for future reference.
- Press this button to start and stop elapsed time measurement.
- Press this button while an elapsed time measurement is in progress to monetarily freeze a SPLIT or LAP time on the display (timing continues internally). Press again to display the ongoing time measurement. You can repeat the SPLIT/LAP time operation as many times as you want. Pressing this button while elapsed time measurement is stopped resets the time to all zeros.
- Press this button to toggle between the split time mode and lap time mode.

The maximum elapsed time that can be measured is 9 hours, 59 minutes, 59.99 seconds.

A **SPLIT** is the time from the start of an event up to any specific point	SPLIT _____
A **LAP** is the time for one segment (lap) of an event.	LAP - - - -

9. DIGITAL MULTIMETER

OPERATION / MAINTENANCE / PRECAUTIONARY MEASURES

DC Voltage Measurement

- Connect the red test lead to "VΩmA "Jack and the black test lead to "COM" jack.
- Set the range switch at desired DCV position. If the voltage to be measured is not known beforehand, set the range switch to the highest range and then reduce it until satisfactorily reading is obtained.
- Connect test probes to device or load being measured.

Read voltage value to the LCD display along with the polarity of red lead connection.

AC Voltage Measurement

- Connect the red test lead to "VΩmA "Jack and the black test lead to "COM" jack.
- Set range switch at desired ACV range position.
- Connect test probes to device or lead being measured.

Read voltage value on the LCD display.

DC Current Measurement

- Connect the red test lead to "VΩmA "Jack and the black test lead to "COM" jack. (for measurement between 200mA and 10A, connect red lead to: 10A" jack).
- Set the range switch desired DCA range position.
- Open the circuit in which the current is to be measured, and connect test probes in series with the circuit.

Read current value on the LCD display along with the polarity of red lead connection.

Resistance Measurement

- Connect the red test lead to "VΩmA "Jack and the black test lead to "COM" jack. (the polarity of the red lead is positive "+")
- Set the range switch at desired resistance range position.
- Connect test probes across the resistor to be measured and read the LCD display.

If the resistor being measured is connected to a circuit, turn off power and discharge all capacitors before measurement.

Transistor Test

- Set range switch at “hPE” position.
- Determine whether the transistor under testing is NPN or PNP type and locate the emitter, base, collector leads. Insert the leads into proper holds of the hFE test socket on the front panel.

The meter will show the approximate hFE value at the condition of base current 10 μ A and Vce 3.0V.

Diode Test

- Connect the red test lead to “VΩmA Jack and the black test lead to “COM” jack.
- Set the range switch at **+** position
- Connect red probe to the anode of the diode to be tested and black probe to the cathode of the diode.

The approximate forward voltage drop of the diode will be displayed in mV. If the connection is reversed; only figure”1” will be shown.

Continuity Test (WDM-463 only)

- Connect the red test lead to “VΩmA “Jack and the black test lead to “COM” jack.
- Set range switch at.))) position.

Connect the test leads to the terminals of circuit. If the resistance is lower than the approximate 50Ω, the buzzer sounds then.

Battery and Fuse Replacement

- If the sign “BAT” appears on the LCD display, it indicates that the battery should be replaced. Remove screws on the back cover and open the case. Replaced the exhausted battery with a new one of the same type.

Fuse rarely need replacement and blow almost as a result of operator’s error. Open the case mentioned above and replace the blown fuse ratings of 0.5A/250V.

Safety Information:

Follow all safety and operating instructions to ensure the meter is used safely and kept in good condition.

Preliminary

Safety can be guaranteed only with test leads supplied. If necessary, they must be replaced with the same electric ratings. Measuring leads must be in a good conditions.

During use

- Never exceed the protection limit values indicated in the specifications for each range of measurement.
- When the meter is linked to measurement circuit, do not touch the unused terminals.
- Never use the meter to measure voltage that might exceed 500V above earth ground.
- Always be careful when working with voltage above 60V DC or 30V AC rms. Keep fingers behind the probe barriers while measuring.
- Do not perform resistance measurements on live circuits.
- Never test AC current on this tester.

Maintenance

- Before operating the case, always disconnect test leads from all energized circuits.
- For continued protection against fire, replace fuse only with the specified voltage and current ratings: 0.5 A/250V (quick acting).
- Never use abrasives or solvents on the meter, used only a fastened.
- Do not use abrasives or solvents on the meter, use only a damp cloth and mild detergent to clean the meter.

10. MICROMETER SCREW-GAUGE

OPERATION/ MAINTENANCE / PRECAUTIONARY MEASURES

OPERATION

A micrometer reading contains two parts:

1. the first part is contributed by the main scale on the sleeve
2. the second part is contributed by the rotating vernier scale on the thimble

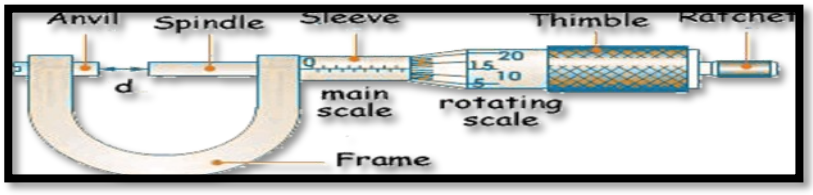
A typical micrometer screw gauge

The above image shows a typical micrometer screw gauge and how to read it. Steps:

- To obtain the first part of the measurement: Look at the image above, you will see a number 5 to the immediate left of the thimble. This means 5.0 mm. Notice that there is an extra line below the datum line, this represents an additional 0.5 mm. So the first part of the measurement is 5.0+0.5=5.55.0+0.5=5.5 mm.
- To obtain the second part of the measurement: Look at the image above, the number 28 on the rotating vernier scale coincides with the datum line on the sleeve. Hence, 0.28 mm is the second part of the measurement.

You just have to add the first part and second part of the measurement to obtain the micrometer reading: 5.5+0.28=5.785.5+0.28=5.78 mm.

Ex. Determination of the diameter'd' of a wire

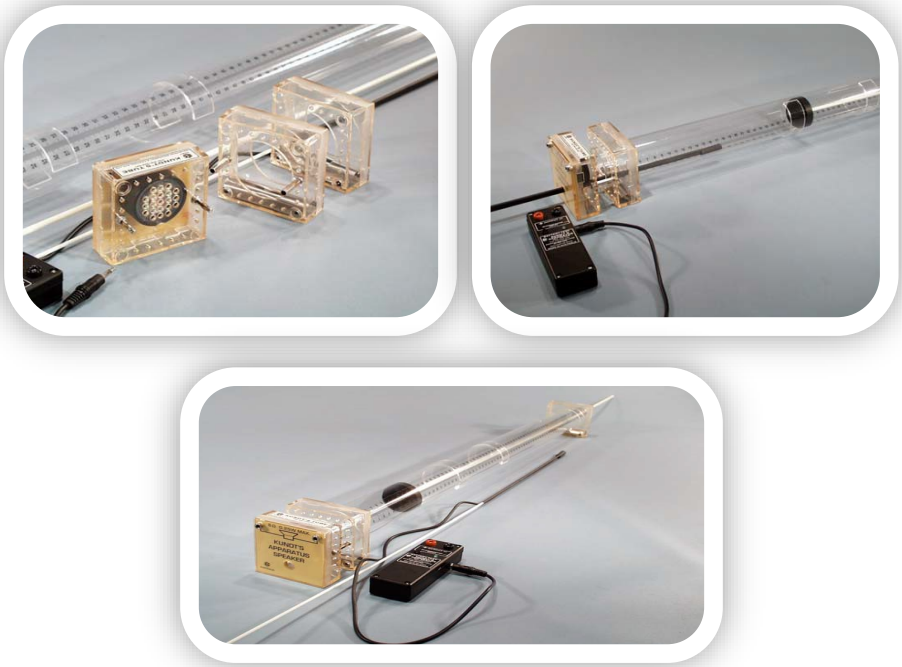


- Place the wire between the anvil and spindle end as indicated in the diagram.
- Rotate the thimble until the wire is firmly held between the anvil and the spindle.
- The rachet is provided to avoid excessive pressure on the wire. It prevents the spindle from further movement - squashing the wire!

To take a reading:

- First look at the main scale. This has a linear scale reading on it.The long lines are every millimetre the shorter ones denote half a millimetre in between.
- On the diagram this reading is 2.5 mm
- Now look at the rotating scale. That denotes 46 divisions - each division is 0.01mm so we have 0.46mm from this scale.
- The diameter of the wire is the sum of these readings: 2.5 + 0.46 = **2.96 mm**

11. KUNDT'S TUBE



Speaker end of the Kundt's tube

OPERATION

ASSEMBLY FOR AN EXPERIMENT:

• Take the plain support block (without the 2 sockets) and slide it on the end of the tube where the scale has finished at 800mm. While sliding the tube into the hole in the support block, allow the tube to slightly deflect the metal curve inside the block so there is a gentle sliding friction between the block and the tube.

• Take the other support block with the 2 sockets and slide it on the other end of the tube where the scale begins at zero. The sockets should be pointing away from the tube.

• Take the Speaker box and fully plug the 2 banana plugs into the 2 sockets on the support block so the two units are firmly connected together.

• Adjust the position of the support block on the tube so the face of the speaker is about

12mm away from the end of the tube. For normal experiments, the end of the tube must NOT touch against the speaker.

REASON:: The experiments are performed on either an open tube (open both ends) or on a closed tube (tube closed at the end opposite the speaker). When the piston is slid inside the tube, the piston forms the closed end at any position along the tube.

• Rotate the speaker and block assembly so the label is uppermost and the hole for the microphone is under the speaker. Let the assembly rest firmly on the work bench.

• Connect the 2 sockets on the speaker housing to a sine wave signal source (oscillator or similar) with standard 4mm banana plug cables.

SIGNAL SOURCE: Set your oscillator to about 500Hz and check that the speaker works.

- The speaker is protected against too much power from the signal source, but the sine wave signal should be about 1 to 2 volts peak. If your oscillator cannot provide enough power, an amplifier may be required to drive the speaker.

IMPORTANT NOTE:

⇒ If the voltage to the speaker is too high, the wave will be distorted and will no longer be a sine wave shape. If this occurs, the sound from the speaker will be distorted and will not sound 'clean'.

- During an experiment, the sound wave will be detected by the microphone. Slide the mini microphone through the hole under the speaker so that it slides inside the tube.
- The tube can be rotated so the scale is at the bottom and close to the microphone for accurate measurements. Special scale markings are provided so it can be read with the scale on the top or the bottom of the tube.
- During an experiment, the piston can be slid into the other end of the tube to make the closed tube any length desired.
- During certain experiments, the two transparent shutters can be slid from the holes in the tube to open the tube at these places.

MICROPHONE DRIVER:

- Plug the small plug on the microphone cable into the socket provided on the side of the 'Microphone Driver' and, using standard 4mm banana plug cables, connect the 'Driver' to an oscilloscope to see the microphone signal or into an amplifier to hear the microphone signal.
- The battery can be tested by pressing the button provided. If battery is OK, the small LED will light.

BATTERY:

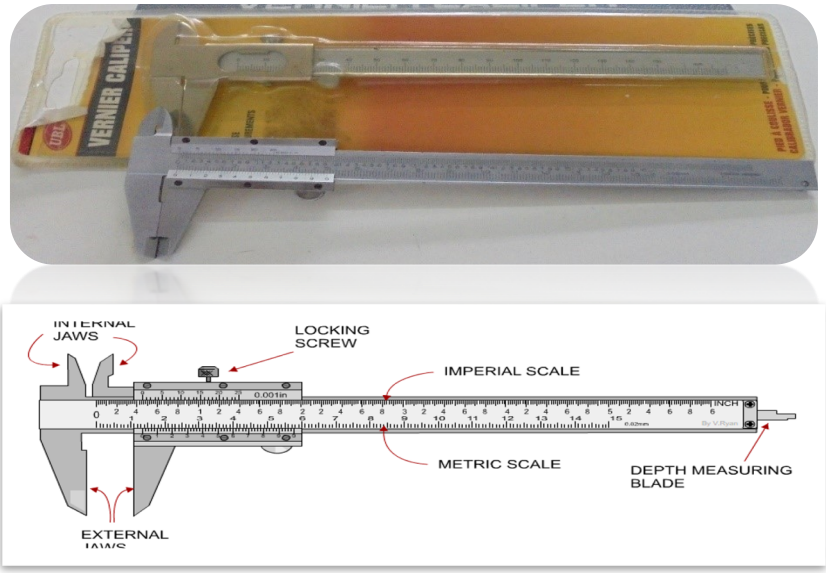
- To replace the standard 9V battery, remove the 4 screws from the housing.
- The battery has a very long life and will last several years providing the microphone is disconnected from the 'Driver' when storing the instrument.

WAVELENGTH AND FREQUENCY CONVERSION:

- To convert Frequency to Wavelength or to convert Wavelength to Frequency, the following formula must be used:

$V = \lambda / f$ where V is speed of sound in air in metres/sec, λ is wavelength in metres and f is frequency in Hz. For school experiments, the speed of sound can be considered to be close to 333 metres per second at sea level.

12. VERNIER CALIPER



OPERATION / MAINETENANCE / PRECAUTIONARY MEASURES

- The Vernier Caliper is a precision instrument that can be used to measure internal and external distances extremely accurately. The example shown below is a manual caliper.
- Measurements are interpreted from the scale by the user.
- This is more difficult than using a digital vernier caliper which has an LCD digital display on which the reading appears.
- The manual version has both an imperial and metric scale. Manually operated vernier callipers can still be bought and remain popular because they are much cheaper than the digital version.

Also, the digital version requires a small battery whereas the manual version does not need any power source.

OPERATION

The basic steps are as follows:

1. Preparation to take the measurement:

- Loosen the locking screw and move the slider to check if the vernier scale works properly.
- Before measuring, do make sure the caliper reads 0 when fully closed. If the reading is not 0, adjust the caliper's jaws until you get a 0 reading. If you can't adjust the caliper, you will have to remember to add to subtract the correct offset from your final reading.

Clean the measuring surfaces of both the vernier caliper and the object, then you can take the measurement.

2. Take the measurement:

- Be careful not to pull on the jaws. Using the screw, close the jaws lightly on the item which you want to measure.
- If you are measuring something round, be sure the axis of the part is perpendicular to the caliper. Namely, make sure you are measuring the full diameter.

3. How to read the measured value:

- Read the centimetre mark on the fixed scale to the left of the 0-mark on the vernier scale. (10mm on the fixed caliper)
- Find the millimetre mark on the fixed scale that is just to the left of the 0-mark on the vernier scale. (6mm on the fixed caliper)
- Look along the ten marks on the vernier scale and the millimetre marks on the adjacent fixed scale, until you find the two that most nearly line up. (0.25mm on the vernier scale)
- To get the correct reading, simply add this found digit to your previous reading. (10mm + 6mm + 0.25mm= 16.25 mm)

4. Maintenance

- Clean the surface of the vernier caliper with dry and clean cloth (or soaked with cleaning oil) and stock in a dry environment if it stands idle for a long time.

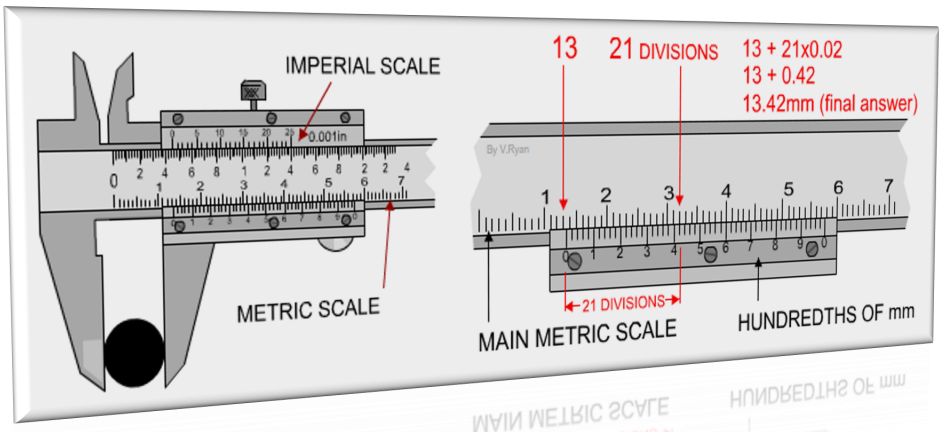
How to Read a Measurement from the Scales:

EXAMPLE 1: The external measurement (diameter) of a round section piece of steel is measured using a vernier caliper, metric scale.

MATHEMATICAL METHOD

A. The main metric scale is read first and this shows that there are 13 whole divisions before the 0 on the hundredths scale. Therefore, the first number is 13.
B. The' hundredths of mm' scale is then read. The best way to do this is to count the number of divisions until you get to the division that lines up with the main metric scale. This is 21 divisions on the hundredths scale.
C. This 21 is multiplied by 0.02 giving 0.42 as the answer (each division on the hundredths scale is equivalent to 0.02mm).
D. The 13 and the 0.42 are added together to give the final measurement of 13.42mm (the diameter of the piece of round section steel).

Alternatively, it is just as easy to read the 13 on the main scale and 42 on the hundredths scale. The correct measurement being 13.42mm.



Sensitivity of the reading:

- You can read to half a rotating scale division - to within 0.005mm - but no more than that. That assumes you have experience and confidence in using the instrument +/- one division is more realistic!

Practical Notes:

- SWG (Standard Wire Gauge) 32 wire has a manufacturer diameter value of 0.274 mm. If you measure it with a micrometer in school you could only say it was 0.275mm - that last digit of '4' would be impossible to measure with a micrometer.
- Always check carefully for a zero error before using the micrometer!

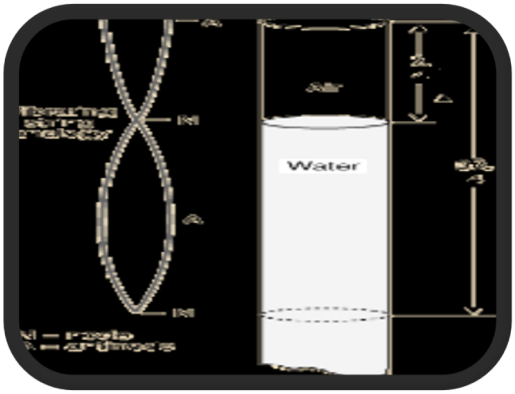
Here is a vid clip with an animation that takes you through how the micrometer works and how to read it.

13. RESONANCE APPARATUS

OPERATION/ MAINTENANCE / PRECAUTIONARY MEASURES

INTRODUCTION

- A tuning fork of known frequency is made to vibrate at the mouth of a vertical column of air. The column of air is located in a clear graduated tube that is partially filled with water.
- The length of the air column is adjusted by regulating the water level in the tube until the column of air resonates with the same frequency as the sounded tuning fork.
- By locating several resonance positions and measuring their average distance apart, it is possible to compute the wavelength of sound in air, as well as its velocity.
- The velocity with which sound travels in any medium may be determined if the frequency and the wavelength are known.
- Our resonance apparatus consists of a clear cylindrical tube, mounted on a metal base. A water reservoir is clamped on near the top of the cylinder with a flexible tube leading to the bottom of the cylinder. The cylinder has a 90cm scale affixed along its length and marked off in 1cm increments. .
- The length of the water column may be changed by raising or lowering the water level while the tuning fork is held over the open end of the tube. Resonance is indicated by the sudden increase in the intensity of the sound when the column is adjusted to the proper length.
- The water surface constitutes a node of the standing wave since the air is not free to move longitudinally. The open end provides the conditions for an antinode, but the actual antinode has been found to occur outside the tube at a distance of about 0.6 r from the end, where r is the tube radius.



OPERATION

- If not assembled already, mount the resonance tube to the tripod base by inserting it into the two black clamps on the support stand. Next, connect the length of rubber hose between the resonance tube and the water reservoir.
- Move the reservoir can to a height just below the top of the resonance tube. Then fill the water reservoir container with water until the level settles about 1cm above the bottom of the container.
- The water level in the clear tube should be about 20cm from the top of the tube.

This level lets the container travel the full length of the scale without overflowing.

Procedure:

1. Fill partially the resonance tube with water.
2. Make a sound using a tuning fork of known frequency at the tube's open upper end.
3. The length of the air column in the tube is adjusted by raising or lowering the water level until the column of air resonates at the same frequency as the vibrating tuning fork.
4. The wavelength of sound in air and its velocity can be computed by locating several resonance positions and determining the distances between them.

Finding the nodes:

1) Choose a tuning fork and mark its frequency in the table below.

2) Mount the tuning fork with the higher frequency in its clamp so its tines vibrate vertically over the mouth of the resonance tube.

3) Strike the tuning fork with the rubber hammer.

4) Slowly lower the reservoir chamber and listen carefully for an increase in the intensity of sound as the resonance chamber is lengthened.

5) Locate the position where the sound is most intense by moving the reservoir chamber up and down and marking the loudest position with a rubber band on the outside of the tube.

6) Next, try to find another position where the sound intensifies. When found, mark this second spot with another rubber band.

7) Lower the water further to find the next resonant length. Continue in this manner as far as the length of the tube will permit.

8) Obtain the lengths □/4, 3□/4, etc. in meters from your measurements. You will need to check to see if your column lengths follow the progression 1, 3, 5, 7, -- since you may have missed a resonance or counted one of the fainter resonances which sometimes occur. Calculate the wavelength and velocity of sound.

9) Measure the distance between the nodes and compute an average value in meters.

10) Repeat the procedure for the other tuning forks you have supplied. The velocity in miles per hour may be found by multiplying the velocity in m/sec by the factor 2.24. Please record the room temperature for reference since the velocity of sound increases with increasing air temperature.

11) Compare to the accepted value of 343m/s at 20°C (68°F).

14. DIGITAL FORCE GAUGE

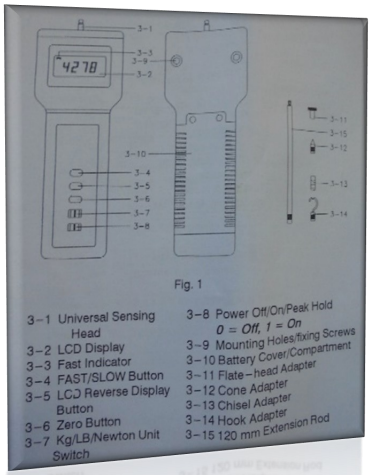


Fig. 1

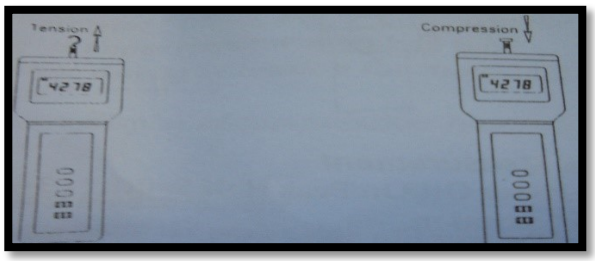
3–1 Universal Sensing Head
3–2 LCD Display
3–3 Fast Indicator
3–4 FAST/SLOW Button
3–5 LCD Reverse Display Button
3–6 Zero Button
3–7 Kg/LB/Newton Unit Switch
3–8 Power Off/On/Peak Hold *0 = Off, 1 = On*
3–9 Mounting Holes/fixing Screws
3–10 Battery Cover/Compartment
3–11 Flate–head Adapter
3–12 Cone Adapter
3–13 Chisel Adapter
3–14 Hook Adapter
3–15 120 mm Extension Rod

OPERATION / MAINTENANCE / PRECAUTIONARY MEASURES

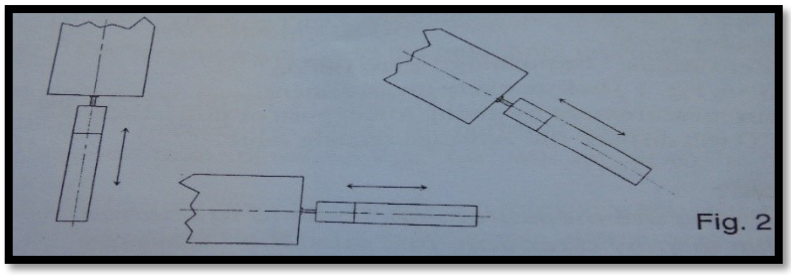
OPERATION

a. Measuring Consideration

1. The Tension & Compression measuring function is executed automatically. When make the compression measurement, the display will show the ‘“ - “ mark automatically.



2. When make the measurement, the SENSING HEAD along the adapter has to be on a line with measuring object. (ref. Fig. 2)



3. Rotating the sensing head is prohibited. Some certain angles between SENSING HEAD and measuring object are not allowed (ref. Fig. 3)

b. Normal Measurement

1. Slide the “Power Off/On/Peak Hold Switch” (3-8, Fig.1) to the “On” position.

0 = Off, 1 = On

2. Determine display unit of Kg, LB or Newton by selecting “Kg/LB/Newton Unit Switch “ (3-7, Fig. 1)

3. Connect “Sensing Head” (3-1, Fig. 1) with proper “Adapter” (3-11 to 3-14, Fig. 1) and the “Measuring Object” should be in straight line. Don’t give any force in standby mode.

4. “Zero Adjust” by pushing “Zero Button”

(3-6), Fig.1) before every measurement.

5. Start measurement by giving force (push/pull), then the LCD will display the Average reading value.

Note:

- During the measurement, if intend to change the display direction, just push the “Reverse Button” (3-5, Fig. 1) once.
- If the upper left corner of LCD not show the “Fast Indicator” (3-3,Fig. 1), the display reading is under the slow sampling time.
- Over range display of tension function, LCD will show “------“

Over the range display of compression function, LCD will show “---------“

c. Peak Hold Measurement

- The meter can measure the peak value of force both of tension & compression operation. The operation procedures of Peak Hold Measurement are same as above”
- Normal Measurement “but should slide the “Power Off/On/Peak Hold Switch “ (3-8, Fig. 1) to the “PEAK H.” position.

Slide the “Power Off/On/Peak Hold Switch “ (3-8, Fig. 1) to the “On” position will cancel the peak hold function.

d. Battery Replacement

- When it is necessary to replace the battery (battery voltage less than appox. 6.8 V), “Lo” will appear on the display.
- Remove battery cover (3-10, Fig. 1) to expose batteries.

Install the batteries correctly into the case. Permanent damage to the circuit may result from incorrect installation.

e. Mounting Holes

- Due to the FORCE GAUGE is a precise instrument best results are obtained when the gauge is fitted to a test stand. Mounting holes are provided on the back of the gauge for easy stand mounting.

Optional Test Stand & Accessory:

TEST STAND, Model : FS-1001

Test stand, cooperate with force gauge, whole system will become the useful tool for material’s tension& compression analysis.

Size: 630 x 250 x 230 mm. Weight: 7.02 Kg (15.4 LB).

WEDGE GRIP, Model: WG - 01

Wedge grip, the optional accessory to install to the base of FS - 1001 be used to hold the tested material.

Applications:

1. Electronics

- Test strength of solder points and spot welds on circuit boards.
- Pull test external leads bonded to ceramic substances.
- Test wire wraps on clip connection.
- Test pull strength of modified wire wrap connection on posts
- Test spring clip insertion and withdrawal forces.
- Pull test weds in micro-electronic devices.
- Measure torque, timing belt tension, sliding friction, etc., on computer peripheral equipment.

- Test P.C board insertion force.
- Test insertion and withdrawal forces of various circuit components such as transistors and integral circuits.

Test actuating force of snap action switches.

2. Business Management

- Measure force required to perforate cards.
- Measure load on slitter knives.
- Measure actuating requirements of typewriter.
- Test clutch release force.
- Measure torque, timing belt tension (by deflection), sliding friction, etc., on computer peripheral equipment.
- Test adhesion strength of labels and stickers.
- Test load on paper thickness gages.
- Measure tension of pencils.
- Test actuating requirements on push buttons and flip switches.

3. Chemical & Plastics

- Test film bond strengths.
- Tensile test rubber, fibers and filaments.
- Measure firmness of polyurethane foam.
- Test crush strength of pills (medicine)
- Test peel strength of adhesives.
- Measure compression of ceramic compounds.
- Test vacuum take - down pressure on process machines.

4. Machinery and Manufacturing

- Test load on wire feel.
- Test force to open cabinet doors.
- Test sprocket chain tension.
- Test pull-out forced of drive shaft.
- Rate testing of springs in systems.
- Calibrate a cantilever beam-type Apparatus to obtain a force/deflection relationship.

5. Automotive

- Measure force of seat belt retractors.
- Measure arm pressure of windshield wipers.
- Measure flip force in mechanical snap action switches.
- Test effort to operate hand tool.
- Test forces required to move linkages and tension cables.
- Measure force of odometer pulls.
- Test peel strength of vinyl insert bonded to body side moldings.
- Evaluate physical efforts (door, look, hood, glove, compartment, brake pedal.

6. Other Industries

- Measure pedal depression force in aircraft.
- Test hardness of gypsum wallboard.
- Test keyboard and pedal contact force of organs and pianos.
- Test force to remove cover tops of aerosol cans.
- Measure trigger pulling forces on firearms, hand tools.
- The firmness of sausages in casings.
- Test integrity of seals on blister packages and plastic bags.
- Test pressure of surgical instruments (forceps, scissors).
- Test fruit removal force and fruit firmness.
- Measure force on spindles of photographic equipment.

15. LENSES

- A lens is a transparent piece of glass or plastic with at least one curved surface.
- A lens works by **refraction**: it bends light rays as they pass through it so they change direction. That means the rays seem to come from a point that's closer or further away from where they actually originate—and that's what makes objects seen through a lens seem either bigger or smaller than they really are.

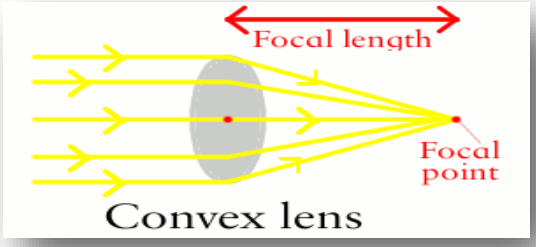


Photo: A convex lens makes light rays converge (come together) at the focal point or focus. The distance from the center of the lens to the focal point is the focal length of the lens.

- Convex lenses are used in things like telescopes and binoculars to bring distant light rays to a focus in your eyes.

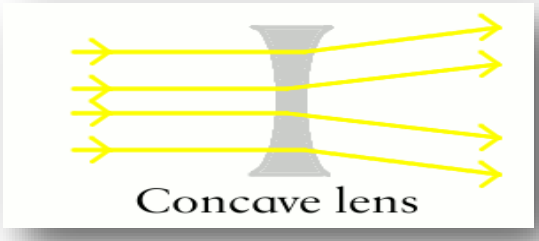
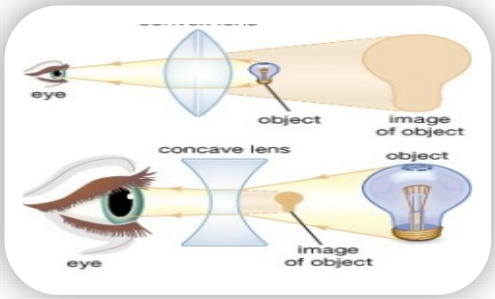


Photo: A concave lens makes light rays diverge (spread out).

- A **concave lens** is exactly the opposite with the outer surfaces curving inward, so it makes parallel light rays curve outward or diverge. That's why concave lenses are sometimes called diverging lenses. (One easy way to remember the difference between concave and convex lenses is to think of con*cave* lenses *caving* inwards.)
- Concave lenses are used in things like TV projectors to make light rays spread out into the distance. In a flashlight, it's easier to do this job with a mirror, which usually weighs much less than a lens and is cheaper to manufacture as well.



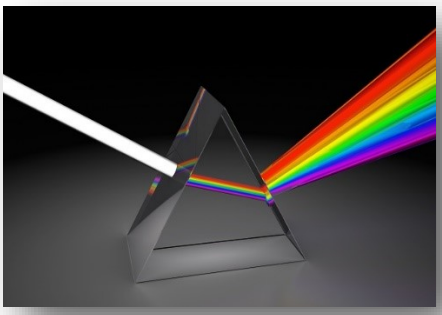
Maintenance of Lenses

- All lens cleaning should be done *very* carefully. Use only photographic lens cleaning fluid, Windex or one of a select group of alcohols, and optical tissue or white, unperfumed facial or toilet tissue. Remove fingerprints as quickly as possible. Never use any kind of abrasive on a lens.
- Begin by brushing off dust with very soft lens brush. Clean compressed air can be used. Moisture condenses in air-compressors, however, causing rust, and using air from such sources has the potential of depositing debris on lens surfaces.
- If you can't get your lens sparkling clean with air and brushing, then dampen a piece of lens cleaning tissue with lens cleaning fluid and gently wash the surface of the lens. Lay a piece of lens cleaning paper or tissue on the lens and squeeze one or two drops of fluid on the paper, then pull the wet paper across the lens. Use a mopping rather than a scrubbing technique, repeating this operation with clean paper and fluid.
- Methanol or pure grades of alcohol can be used as a solvent to remove oily residue; you may have to repeat this with clean tissue and more liquid.
- Do not use tissue without liquid.

16. PRISMS

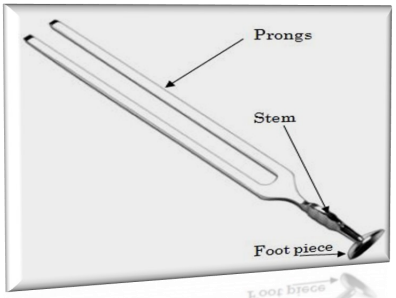
- A prism is a transparent, geometric, optical object with a minimum of two polished plane faces inclined relative to each other, from which light is reflected or refracted. Prisms are made from transparent materials such as glass, plastic and fluorite.
- The angle, position, and number of surfaces help define the type and function. One of the most recognizable uses of prisms, as demonstrated by Sir Isaac Newton, consists of dispersing a beam of white light into its component colours.
- These uses are common in applications with telescopes, binoculars, surveying equipment, and a host of others.

- This application is utilized by refractometer and spectrographic components. Since this initial discovery, prisms have been used in "bending" light within a system, "folding" the system into a smaller space, changing the orientation (also known as handedness or parity) of an image, as well as combining or splitting optical beams with partial reflecting surfaces.



Dispersion through a Prism

18. TUNING FORK



- A **tuning fork** is an acoustic resonator in the form of a two-pronged fork with the prongs (tines) formed from a U-shaped bar of elastic metal (usually steel). It resonates at a specific constant pitch when set vibrating by striking it against a surface or with an object, and emits a pure musical tone once the high overtones die out.
- The pitch that a particular tuning fork generates depends on the length and mass of the two prongs. It is frequently used as a standard of pitch to tune musical instruments.

Parts of a tuning fork

1. Foot piece
2. Stem
3. Prongs

How to use tuning fork?

- Hold the stem of the tuning fork between the index finger and thumb of your right hand without touching the prongs.
- Strike the junction of superior 1/3 and inferior 2/3 of the prongs (area of maximum vibration) on a rubber pad or elbow.

Tuning Fork and Test:

The three tuning forks generally used include:

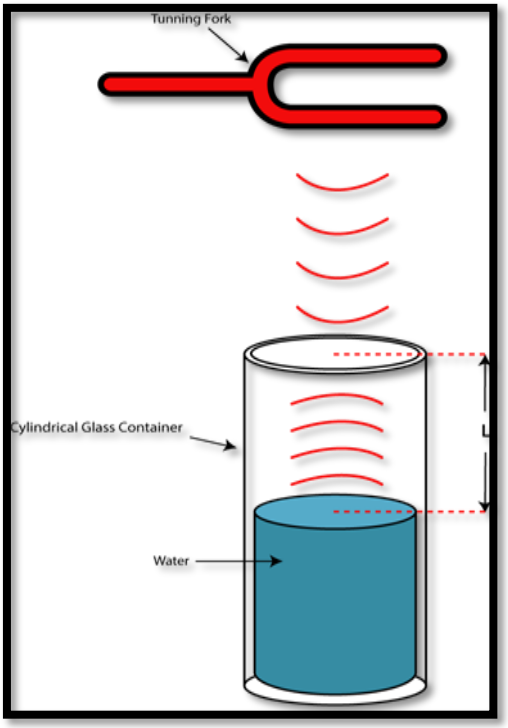
- 256 Hz, 512 Hz, 1024 Hz. Most common being 512 Hz.
- 512 Hz - because it has appropriate decay time. Less overtones and lies in speech frequency. Compressing the prongs with fingers produces around 70 dB sound and hitting against knee or elbow 90 dB.
- A prediction of air-bone gap can be made if tuning forks of 256, 512 and 1024 Hz are used.

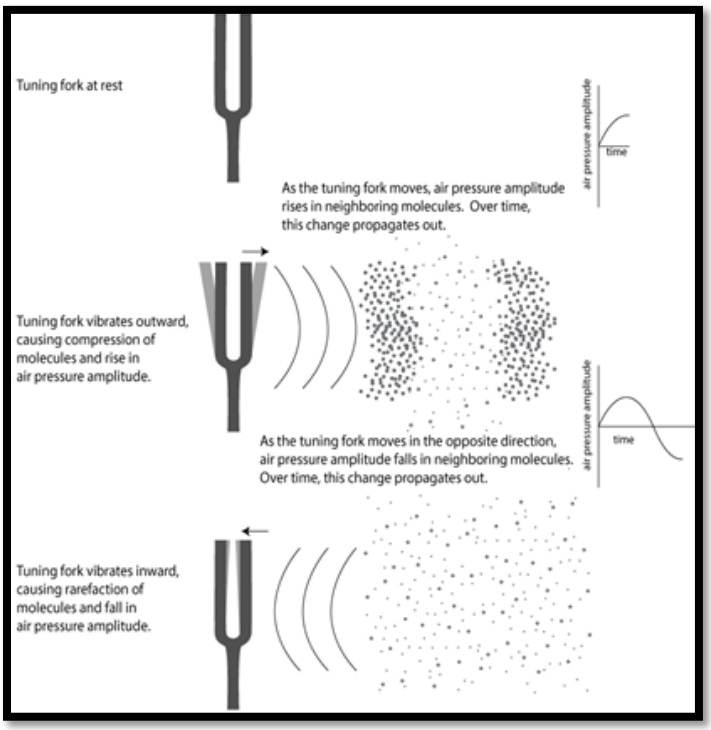
Pre-requisites for an ideal tuning fork:

1. It should be made of a good alloy.
2. It should vibrate at the specified frequency.
3. It should be capable of maintaining the vibration for one full minute.
4. It should not produce any overtones.

Methodology of using tuning forks:

- The tuning fork must be struck against a firm surface (rubber pad/ elbow of the examiner). The fork should be struck at the junction of upper 1/3 and lower 2/3 of the fork. It is this area of the fork which is capable of maximum vibration.
- The vibrating fork should be held parallel to the acoustic axis of the ear being tested.





19. SPRING BALANCE

1. Definition:

- A spring balance shall mean an instrument which on the application of the load to be weighed indicates the whole weight by the extension or compression of a spring, such extension or compression being indicated by means of a pointer or dial.

2. Capacities:

- Suspended spring balances shall have capacities ranging from 1kg to 500kg.
- Pedestal spring balances capacities range from 1kg to 20kg.
- Capacities or denominations must be clearly marked on the instrument.

3. General Requirements:

(a) Dimensions of indicator must not exceed 1mm in width and must not be more than 3mm from the chart or dial.

(b) Dimensions of graduation will have a minimum width apart of not less than 1.5mm for capacities up to 20 kg and not less than 2.5mm for capacities above 20kg.

(c) If the indicator is adjustable the range of adjustment will not exceed 1% of the capacity of the spring balance

(d) In spring balances of hanging type, the spring shall be suspended from a stand, support or bracket.

(e) The body of the spring balances shall be constructed of aluminium, brass, bronze, cast iron, mild steel or any other suitable material and shall be sufficiently robust in construction.

(f) If receptacles or pans are provided for the balance, they shall be made of aluminium brass, bronze, cast iron, mild steel or stainless steel. Metal chains or metal support shall be provided if the pans are suspended. When the pans are manufactured from mild steel, it shall be suitably protected. Against corrosion.

(g) In case of removable receptacle or pan, it shall be numbered or otherwise identified with the machine to which it belongs, and every such part shall be so made and fitted that its operating position remains unchanged. For the purpose of this requirement the part or the receptacle shall be deemed to be readily removable if it can be removed without the use of a tool.

(h) successive graduations on the scale shall correspond to the weights in the following table:

Capacity of instrument	Maximum weight corresponding to successive graduations
500g but not exceeding 2.0 kg	5g
Exceeding 2.0kg but not exceeding 6 kg	10g
Exceeding 6 kg but not exceeding 20 kg	20g
Exceeding 20kg but not exceeding 30 kg	50g
Exceeding 30kg but not exceeding 50 kg	100g
Exceeding 50kg but not exceeding 100 kg	200g
Exceeding 100 kg	1/250 of capacity

CHAPTER 8

Inventory of Laboratory Equipment/Tools/Instruments

- **The process of listing equipment/tools/supplies/materials with the description, quantity and value of each is performed to keep track of multiple items and ensure that all laboratory equipment/materials/ supplies in the laboratories are in a complete or itemized list with the indicated quantity on hand.**

Procedure of Inventory of Laboratory Equipment/Tools/Instruments

FLOWCHART	RESPONSIBLE	DETAILS
Conduct inventory of items available in the laboratories	Laboratory Custodian	The laboratory custodian shall conduct inventories of items and conduct records to ensure accuracy. Inventory duties shall
Create reports of lost and damaged items	Laboratory Custodian	The laboratory custodian shall create reports of lost and damaged items. If there are discrepancies, she must
Print duly accomplished inventory for the quarter to be signed by the immediate supervisor	Laboratory Custodian	The laboratory custodian shall print the duly accomplished inventory to be noted by the immediate supervisor.
File final copy of the inventory	Laboratory Custodian	The laboratory custodian shall keep a file of the duly signed inventory for the quarter.

APPENDIX A

SCIENCE LABORATORY HOURS OF OPERATION

DAY	TIME
ROOM 207	
Monday, Wednesday, Friday	**8:00 a.m. - 12:00, 1:00-7:00 p.m.**
Tuesday, Thursday	**8:00 a.m. - 12:00, 1:00-7:00 p.m.**

- The science laboratories observe the College holidays, breaks or schedule of no classes.
- The scheduled indicated are valid for most of the semester. Hours may vary during holidays, school breaks and/or no classes. Changes shall be posted in bulletin boards as needed.

Separability Clause

If any part of this manual is held invalid, the other revisions not affected thereby shall remain in force and effect.

Repealing Clause

All pictures, operation procedures of newly procured equipment, policies in the laboratory rooms, rules and regulations inconsistent with the revisions of this operation manual are hereby repealed or amended accordingly.

Effectivity Clause

This operation manual shall take effect this day upon approval of the Boards of Trustees.

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