PRACTICAL 1 – Measurement and Estimation

Name:	ID Number:
Class:	Lab Group:
Date:	

1.1. LABORATORY EQUIPMENT & SAFETY /55

In the science laboratory, you will find many different pieces of equipment. Before you can begin experimenting, you need to be able to identify these items and learn how to safely use them. You also need to be able to spell their names correctly, and to draw them when you write reports of experiments.

Safety statement:
The experiments described here may involve the use of breakable glassware and sharp edged equipment. Careless and/or ignorant use of such equipment could result in serious injuries. Do not hesitate to ask your instructor if you are in doubt. Report any damage caused to the equipment during your experiment to the instructor immediately.

Acknowledged

……

"I pledge that I have neither given nor received any unauthorized assistance on this practical worksheet."

_____

Student Signature

1.2 Measuring Lengths

(8 marks)

Measuring Tape

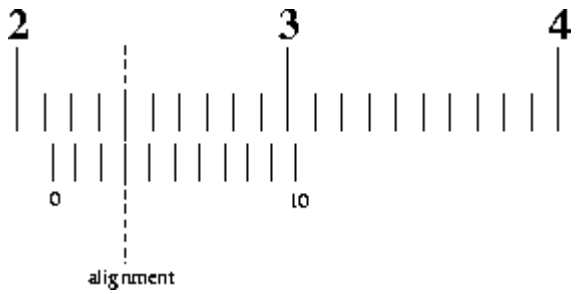
Use the measuring tape to measure the length and the width of your work bench, and then calculate its area. (Area of a rectangle = Length × Width)

- Length = …….. m Width = ……. m Area …….. m^2,
- Length = ……..... cm Width = ……. cm Area …….. cm^2
- Length = …….. ft Width = ……. ft Area …….. ft^2
- Length = …….. in Width = ……. in Area …….. in^2

Notes on using the Vernier Caliper

Many of you have experience using the Vernier Caliper. Below are notes on using the Vernier Caliper. Ask for help if you do not know how to use the instrument.

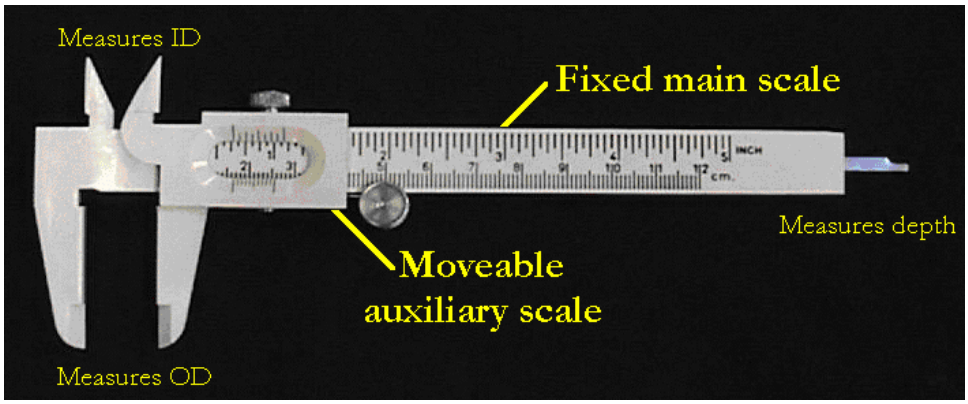
- The Vernier caliper is an extremely precise measuring instrument; the reading error is 1/20 mm = 0.05 mm.
- Close the jaws **lightly** on the object to be measured.
- Use the bottom scale, which is in metric units.
- Notice that there is a fixed scale and a sliding scale.
- The boldface numbers on the fixed scale are centimeters.
- The tick marks on the fixed scale between the boldface numbers are millimeters.
- There are ten tick marks on the sliding scale. The left-most tick mark on the sliding scale will let you read from the fixed scale the number of whole millimeters that the jaws are opened.



- In the example above, the leftmost tick mark on the sliding scale is between 21 mm and 22 mm, so the number of whole millimeters is 21.
- Next we find the tenths of millimeters. Notice that the ten tick marks on the sliding scale are the same width as nine tick marks on the fixed scale. This means that at most one of the tick marks on the sliding scale will align with a tick mark on the fixed scale; the others will miss.
- The number of the aligned tick mark on the sliding scale tells you the number of tenths of millimeters. In the example above, the 3rd tick mark on the sliding scale is in coincidence with the one above it, so the caliper reading is (21.30 ± 0.05) mm.
- If two adjacent tick marks on the sliding scale look equally aligned with their counterparts on the fixed scale, then the reading is half way between the two marks. In the example above, if the 3rd and 4th tick marks on the sliding scale looked to be equally aligned, then the reading would be (21.35 ± 0.05) mm.

For more practice on using the Vernier Caliper go to http://www.phy.ntnu.edu.tw/java/ruler/vernier.html

Vernier Caliper



1- Use the Vernier Caliper to measure the three dimensions of the given rectangular piece of metal in centimeters to the second decimal place, and then calculate its volume in cubic centimeters. (Volume of a rectangular solid = Length × Width × Height).

- Length = …… cm
- Width = …….. cm
- Height = …….. cm
- Volume = …….. cm^3

2- Use the Vernier Caliper to measure the inside diameter, the outside diameter and the length of the given piece of plastic pipe in centimeters to the second decimal place, and then calculate the volume of the plastic material in cubic centimeters.
The volume of a right circular cylinder = $\pi \times (\text{radius})^2 \times (\text{height})$.

- Inside diameter = …… cm , inside radius = …… cm
- Outside diameter = …….. cm , outside radius = …… cm
- Height of the pipe = …….. cm
- $Volume = \pi \times (outside\ radius)^2 \times (height) - \pi \times (inside\ radius)^2 \times (height)$
- Volume = …….. cm^3
- Volume rounded to the second decimal place = …….. cm^3
- For what purpose are the Vernier Calipers used in science labs?

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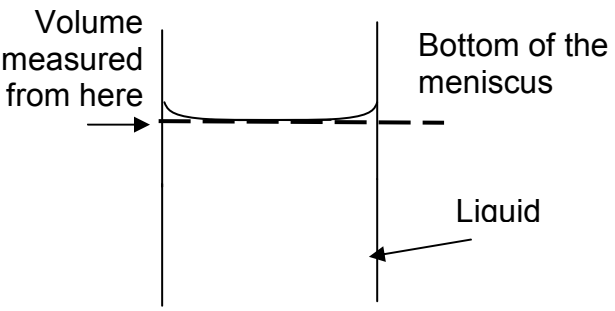
(12 marks)

1.3 Measuring Volumes of Liquids and solids

Measuring Cylinder



1 – Use the measuring cylinder to measure 50 ml of water (V_1). Dip the given rectangular piece of metal into the water and read the new volume (V_2). The difference between the two volumes is the displaced water volume, and is equal to the volume of the metal piece.

- Volume (V_1) = …50……ml
- Volume (V_2) = …… ml
- Volume of the displaced water = (V_2) – (V_1) = …….. __ …….. ml = …… ml
- Volume of the metal piece = ……. cm^3
- Compare the volume of the metal piece with that calculated from the previous measurements you took with the Vernier Caliper at the end of section 1.2.

(5 marks)

1.4 Measuring Mass and Weight

Beam Balance

The triple beam balance is a rugged, inexpensive weighing instrument. It is named for the three beams which carry weights.

A. The middle beam reads only in 100 g increments.

B. The far beam reads only in 10 g increments.

The weights in each of these must always sit in a "notch". They cannot be placed at arbitrary points on the beam.

C. The weight on the front beam can be placed to read continuously from 0 to 10 grams.

The triple beam balance has a little knob under the pan which you screw in or out to set the empty balance to read exactly 0.00 g.

1- Identify the maximum mass that can be detected by this instrument (…… g).

2- Measure the mass of the given metal piece (……g)

3- Measure the mass of the given piece of plastic pipe(……g)

4- Find the **density** of the above two materials.

Density of metal = $\rho = \frac{m}{V} =$ ———— = …….. g/cm^3

Density of plastic = $\rho = \frac{m}{V} =$ ———— = …….. g/cm^3

Density of metal = _____ kg/m^3

(7 marks)

Electronic Balance

The electronic balance has an easy to read LED display. The On, Off, Zero, and Tare Function Keys are all soft-touch and easy to operate.

What is the range of the electronic balance you use? (…… **)**

What is the precision of the electronic balance you use? (…… **)**

1- Measure the mass of the empty beaker provided (……g)
2- Use the measuring cylinder to measure a 25 ml volume of water.
3- Measure the mass of the beaker and water (……g)
4- What is the mass of 25 ml of water? (……g)
5- Calculate the density of the water using the above two values.

ρ = ---------- = ---------- g/cm^3

ρ = ----------kg/m^3

(7 marks)

1.5 Measuring the Density of Irregular-shape Solids

Apparatus: Measuring Cylinder, Electronic Balance & Stone

- The volume of an irregular-shaped solid could be determined by measuring the volume of liquid it would displace, if it was completely immersed in the liquid.
- Estimate the volume of the given stone (V_E) = …….. cm^3
- Use a measuring cylinder and a suitable volume of water to measure the volume of the stone.
- Volume of water before immersing the stone (V_1) = …….. cm^3
- Volume of water after immersing the stone (V_2) = …….. cm^3
- Volume of the stone (V) = Volume of the displaced water = (V_2) - (V_2)

V = ……. - …… = …….. cm^3

- Estimate the mass of the stone
- Estimated mass of the stone (m_E) = ……

- Use the electronic balance to measure the mass of the stone.
- Measured mass of the stone (m) = ……

- Calculate the density of the stone from the following relation:

- $\rho = - = \frac{.....}{.....} = ...$ g/cm^3

- Use the estimated volume and mass to calculate the density

- $\rho_E = \frac{m_E}{V_E} = \frac{.....}{.....} = ...$ g/cm^3

- Calculate the percentage error in your estimate using the following formula:

- $Percentage\ Error = \frac{Estimated\ Value - Actual\ Value}{Actual\ Value} \times 100$

- $Percentage\ Error = \frac{\rho_E - \rho}{\rho} = \frac{..... - .....}{.....} \times 100$

= ……

(8 marks)

1.4 Measurement of Temperature using the CBL 2 Unit

CBL UNIT WITH CALCULATOR

TEMPERATURE PROBE

Apparatus:

CBL 2 (= Calculator Based Laboratory), Link cable, Calculator cradle, Temperature sensor, Beaker containing water

Instructions:

- Estimate the temperature of the room = _____ ^{0}C
- Estimate the temperature of the water = _____ ^{0}C
- Measure the temperature of the room and water using a glass thermometer, and record it in the table.

- **Follow the instructions below**
- Place the calculator in the cradle.

- Connect link cable into back of CBL and cradle.
- Link **Temperature sensor** to **CH 1**

- Press start/stop on cradle
- Press ON
- Press APPS
- Scroll down to CBL/CBR, press ENTER
- Press ENTER three times.
- Scroll down ▼ to GO……
- Press ENTER
- Measure the temperature of the room and water in degrees Centigrade, and record it in the table
- Press CLEAR
- Scroll down ▼ to UNITS and across ► to ^{o}F
- Press ENTER
- Scroll down ▼ to GO and press ENTER
- Read the temperature of the room and hot water in degrees Fahrenheit, and record it in the table

  Press CLEAR

Write down your results in the table below

Temperature of	Estimated Temperature	Temperature using glass thermometer	Temperature using the probe		%^{0}C error
			^{0}C	^{0}F	
The room					
The water					

(8 marks)