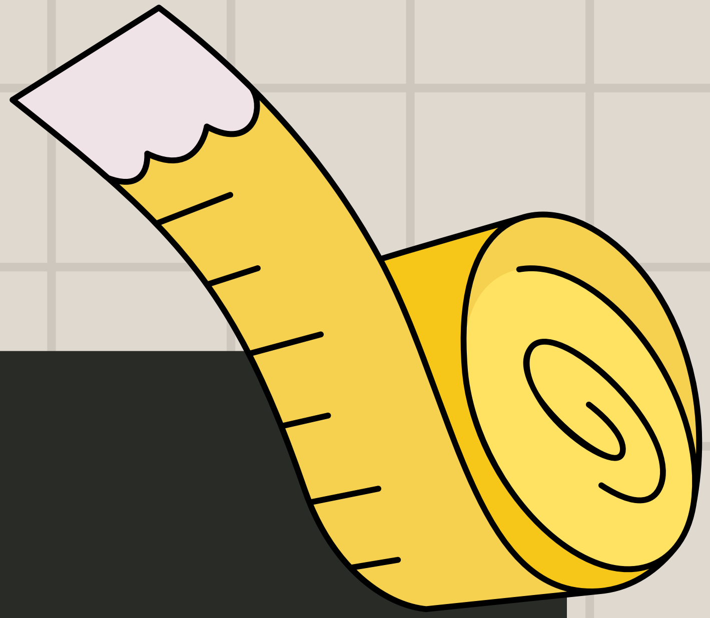
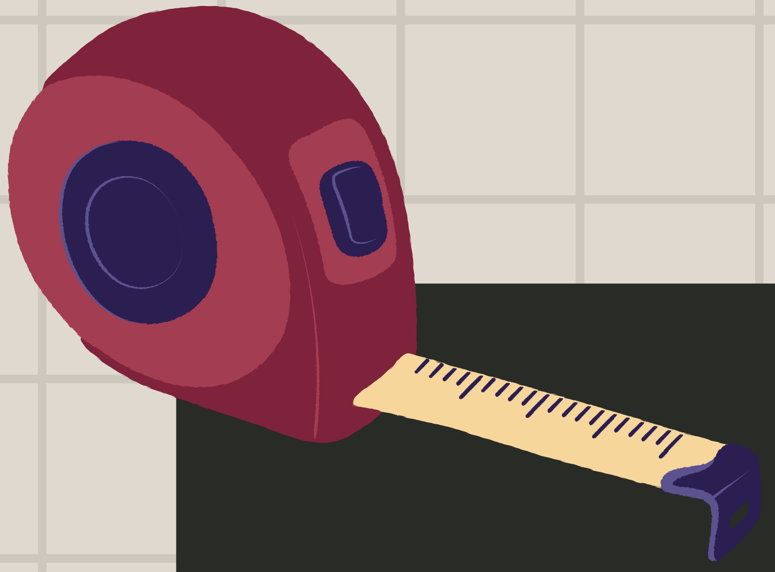
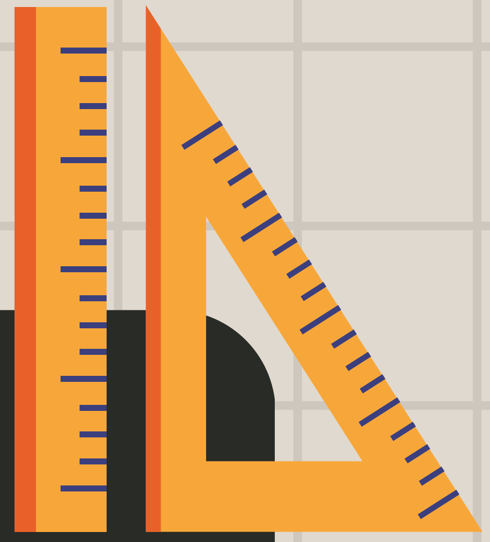
PHYSICS 12

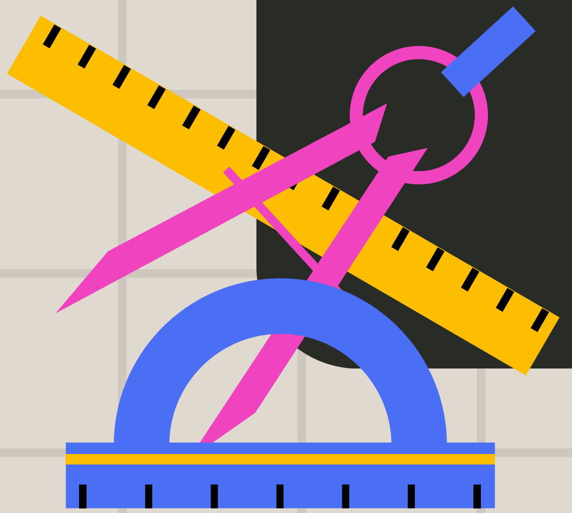


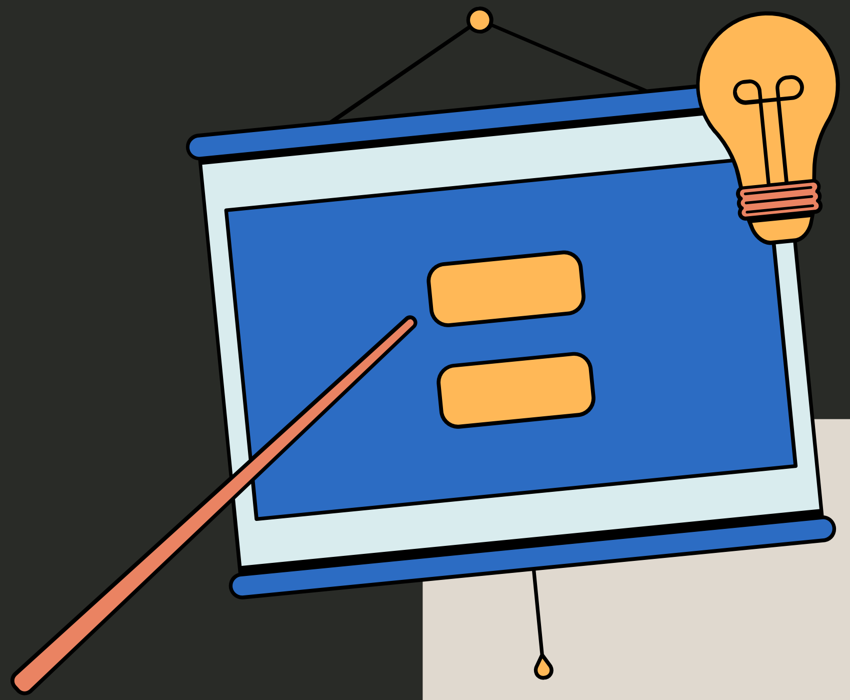
DIGITAL PORTFOLIO TASK 1

PRESENTED BY GROUP 10 FISH CRACKERS

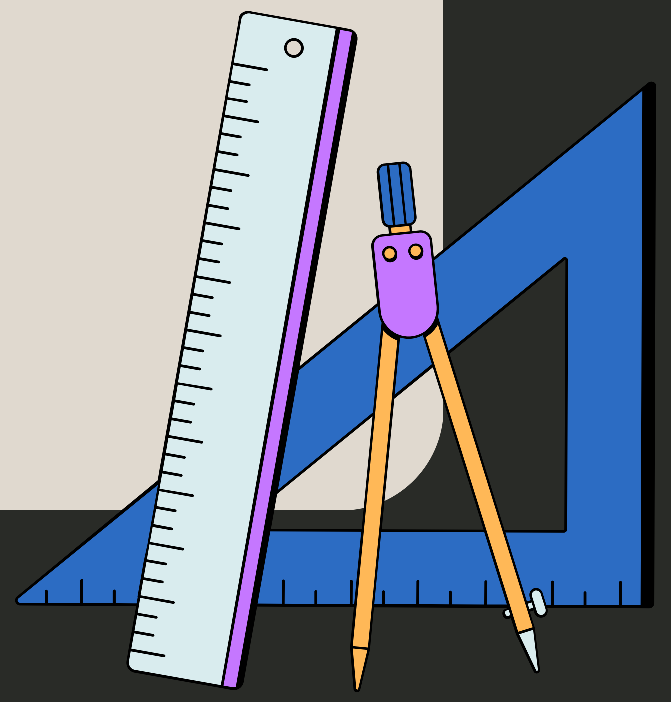
Accuracy and Precision of Measurements using Different Measuring Devices



ACTIVITY NO. 1:

UNCERTAINTY OF MEASUREMENT



OBJECTIVES:

- I dentify the least count of common measuring devices.
- Determine the uncertainty based on least count.
- Write measurements with the correct notation and uncertainty.

INTRODUCTION

In an scientific measurement, no value is perfectly exact. Every measurement has a degree of uncertainty, which reflects the limitations of the measuring instrument and the person using it. This uncertainty is not a mistake - it’s a normal and expected part of measuring.

The least count is the smallest division that a measuring device can reliably show. The uncertainty is typically estimated as ± half the least count, unless the instrument specifies otherwise.

Example:

If a ruler's smallest division is 1 mm, the uncertainty is usally ± 0.5 mm. So if the length measured is 12.0 cm, you should write: 12.0 cm ± 0.05 cm

Understanding and writing measurements with uncertainty is essential in physics to show reliability and precision of your data.

MATERIALS:

- Ruler (cm and mm scale)
- Vernier caliper
- Tripple beam balance
- Meter stick
- Stop watch
- Digital Scale
- Objects to measure
  - cylinder
  - your name
  - pen
  - metal ball
  - book
  - coin

PROCEDURE:

- Use the smallest division you can reliably read to determine the least count.
- Uncertainty is usally ± half the least count unless otherwise stated.
- Measure the following objects using appropriate devices. Write each result with the corect measurement ± uncertainty format.

PART 1: Identify Least Count and Estimate Uncertainty

Measuring Device	Least Count	Estimated Uncertainty (±)
Ruler (cm side)	0.05 cm	0.05 cm ± 0.025 cm
Ruler (mm side)	0.5 mm	0.5 mm ± 0.25 mm
Meter stick	0.5 cm	0.5 cm ± 0.25 cm
Digital Scale (kg)	0.0001 kg	0.0001 kg ± 0.0005 kg
Triple beam balance (g)	0.1 g	0.1 kg ± 0.05 g
Stopwatch	0.01 sec	0.01 s ± 0.005 s

PART 2: Take and Report Measurements

Object Measured	Device Used	Measured Value	Proper Notation (with ± uncertainty)
Length of a pen	Ruler (mm side)	15.2 mm	15.2 mm ± 0.25 mm
Mass of a ball	Triple beam balance	233 g	233 g ± 0.05 g
Height of a book	Ruler (cm side)	33.5 cm	33.5 cm ± 0.25 cm
Time to say your name	Stopwatch	1.06 s	1.06 s ± 0.005 s
Width of a coin	Vernier caliper	2.5 cm	2.5 cm ± 0.5 cm
Mass of the cylinder	Triple beam balance	53.3 g	53.3 g ± 0.5 g

GUIDE QUESTIONS:

Why is it important to report uncertainty in measurements ???

Bceause every measurement is not perfect. It may be because of the device used or the way it is executed. This helps avoid misleading conclusions, allows fair comparison of results, and ensures honesty about the limitations of the tools or methods used. In short, uncertainty makes measurements more trustworthy and scientifically valid.

GUIDE QUESTIONS:

What is the difference between precision and accuracy???

Accuracy refers to how close a measurement is to the true or accepted value, while precision refers to how consistent repeated measurements are with each other. A measurement can be precise without being accurate if results are consistent but far from the actual value, and it can be accurate without being precise if results average close to the true value but vary widely. Ideally, good measurements should be both accurate and precise to ensure reliability and correctness.

GUIDE QUESTIONS:

If two students measured the same object but reported slightly different uncertainties, is one of them necessarily wrong? Explain.

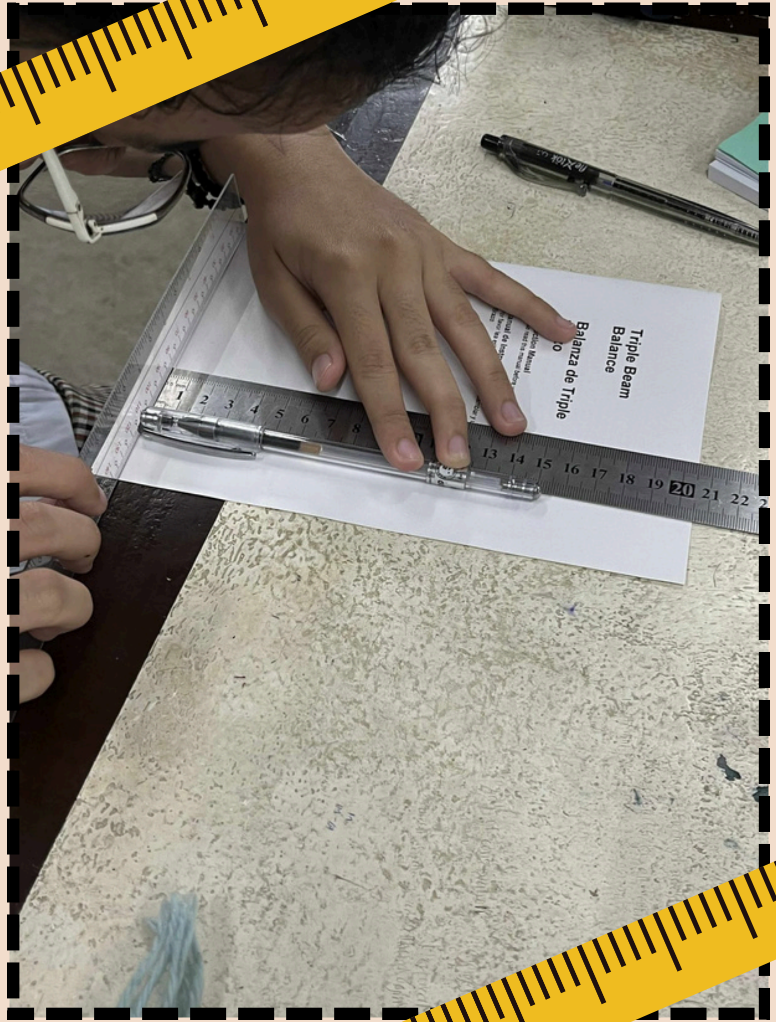
Not necessarily, it doesn't always mean one of them is wrong. Uncertainty depends not only on the object being measured but also on the measuring tool, the method used, and even the judgment of the person doing the measurement. For example, one student might use a ruler that measures to the nearest millimeter, while another might estimate between lines and give a smaller uncertainty. As long as both follow logical reasoning and clearly explain how they determined their uncertainties, both results can be valid. The key is that uncertainty should honestly reflect the limitations of the measurement.

GUIDE QUESTIONS:

How can using better instruments reduce uncertainty ???

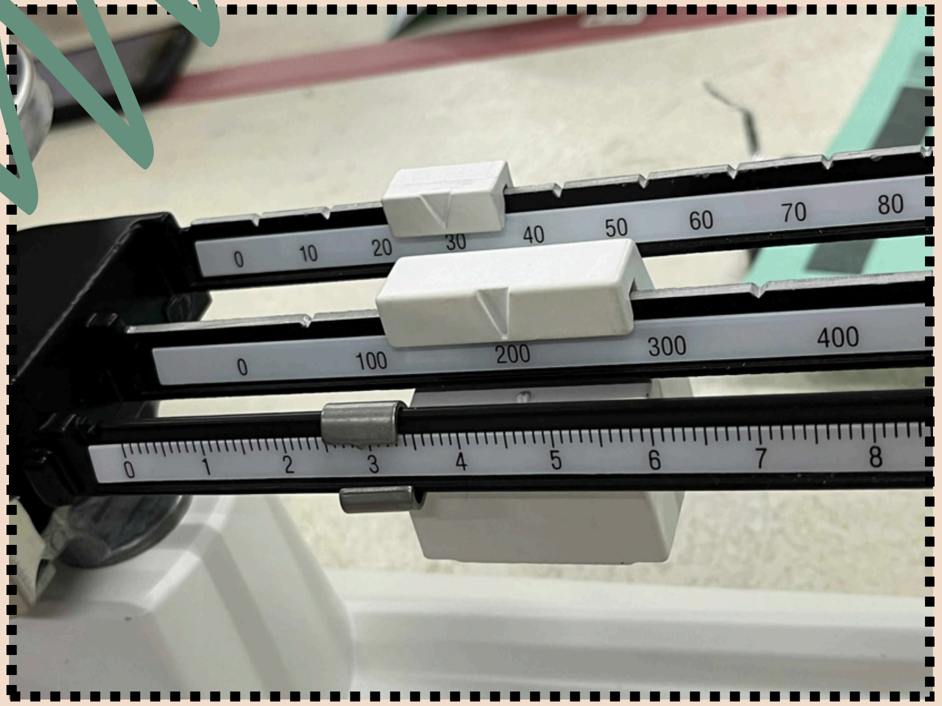
Using better instruments can reduce uncertainty because they are designed to measure more precisely and accurately. High-quality instruments usually have finer scales, better sensitivity, and less error, which allow for smaller divisions and more exact readings. For example, a digital caliper that measures to the nearest 0.01 mm will give a much smaller uncertainty than a regular ruler that only measures to the nearest millimeter. By minimizing limitations of the measuring tool, better instruments reduce the possible range of error and make results more reliable and trustworthy.

DOCUMENTATIONS:



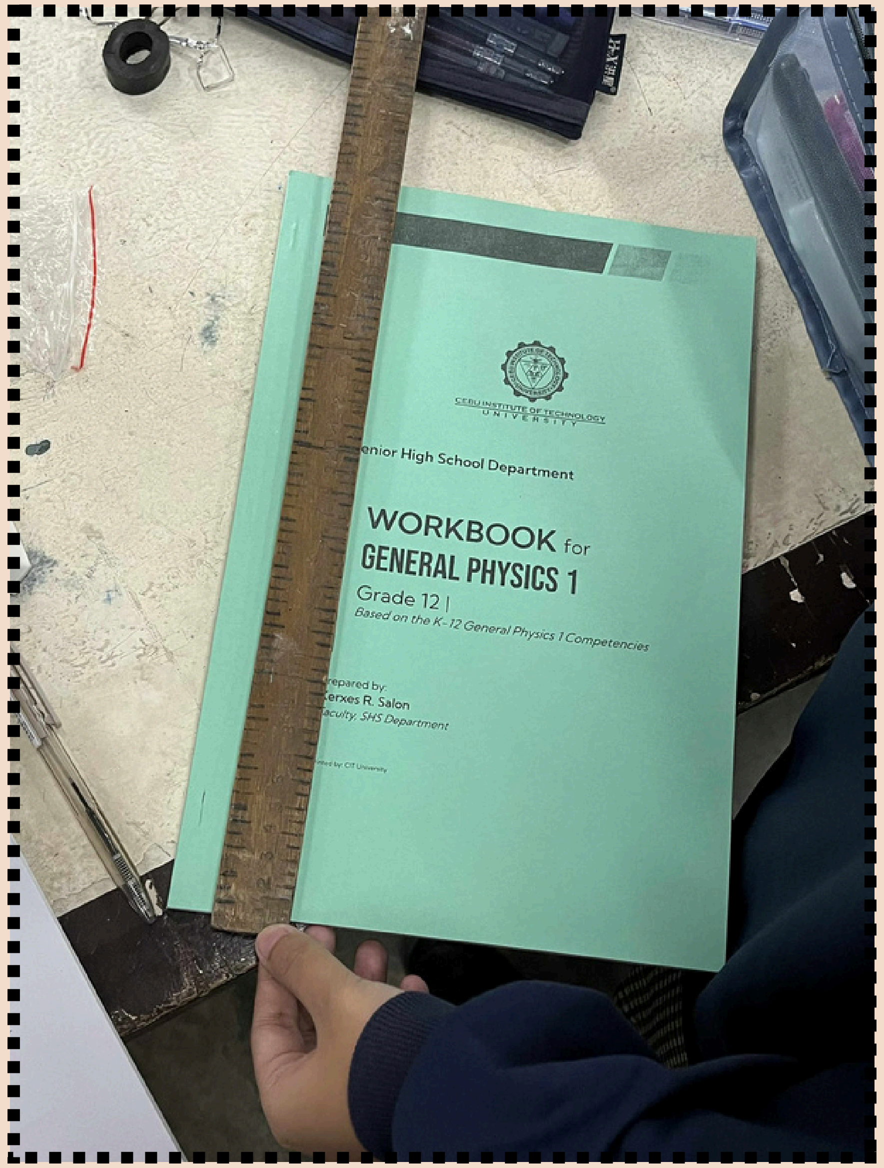
We're measuring the pen's length using a ruler, it measures 15.2 mm. And the uncertainty result is 15.2 mm ± 0.25 mm.

DOCUMENTATIONS:



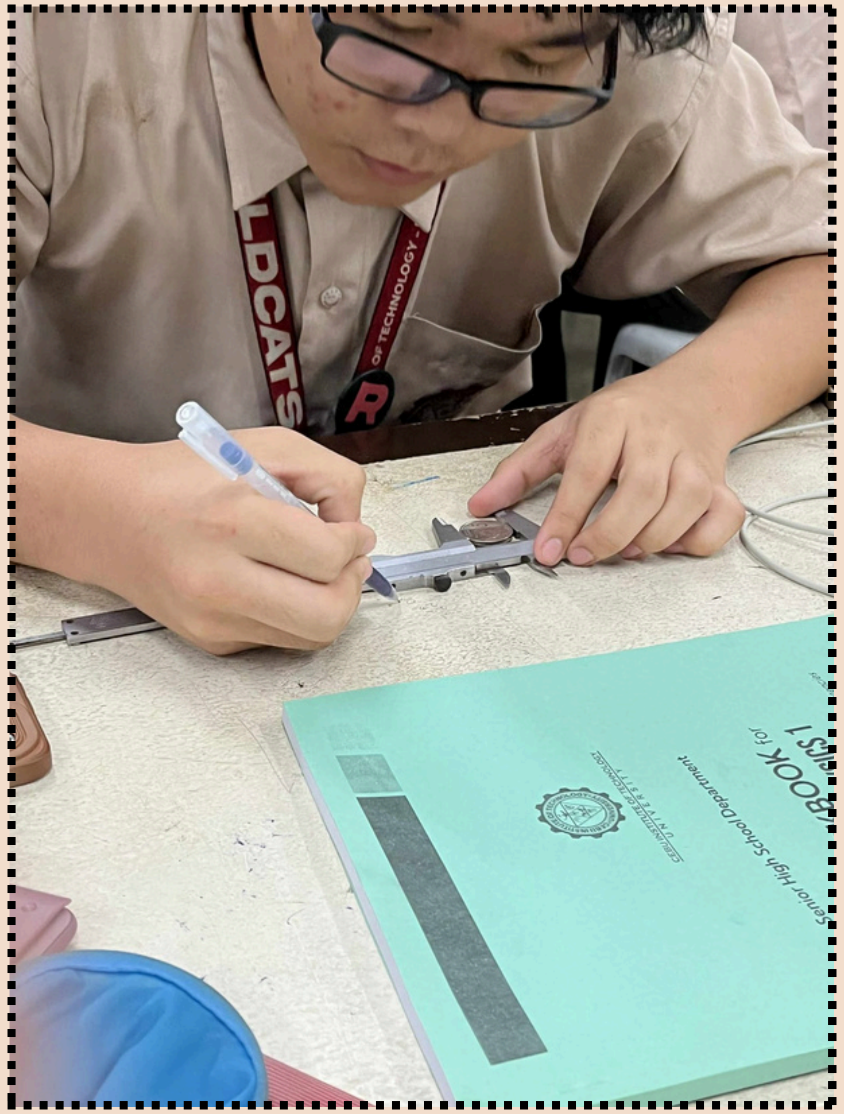
We’re measuring the mass of the metal ball using triple beam balance, it measures 233 g. And the uncertainty result is 233 g ± 0.05 g.

DOCUMENTATIONS:



We're measuring the height of the book using meter stick, it measures 33.5 cm. And the uncertainty result is 33.5 cm ± 0.25 cm.

DOCUMENTATIONS:



We're measuring the width of the 5 peso coin using vernier caliper, it measures 2.5 cm. And the uncertainty result is 2.5 cm ± 0.5 cm.

DOCUMENTATIONS:

We’re measuring the mass of the cylinder using triple beam balance, it measures 53.3 g. And the uncertainty result is 53.3 g ± 0.5 g.

ACTIVITY NO. 2:

Measurements using Vernier Caliper & Micrometer

(Laboratory)

OBJECTIVES:

- Become familiar with the measuring instrument commonly used in Physics Laboratory: the vernier caliper and micrometer

- Determine the densities of various objects.

INTRODUCTION

In the world of science, accurate and precise measurements are crucial. To achieve this level of precision, scientists rely on specialized tools like vernier calipers and micrometers. In this activity, you will explore the capabilities of these instruments and delve into the concepts of accuracy and precision. Follow the procedures provided and answer the questions at the end of this activity

MATERIALS

- vernier caliper
- micrometer
- metal cylinder
- triplebeam balance
- metal ball
- 50 mL graduated cylinder

P R O C E D U R E S

1. Measure the length and diameter of each of the given objects using the three measuring instruments with accuracy.

2. Record the values on the preliminary written report sheet. Take five trials. Get the average.

3. Calculate the volume of each object using the formulas below. Use the average values of length and diameter.

PROCEDURES

4. Weigh each object using the triple beam balance.

5. Calculate the density of each object using the formula:

PROCEDURES

6. Compute the calculated values with for the standard values of densities of each object and calculate the percentage error usingV

FORMULA

$$V_{cylinder} = \frac{\pi}{4} d^2 L \qquad V_{sphere} = \frac{\pi}{6} d^3$$

where: *V = volume* *d = diameter* *L = length*

Note: π = 3.1416 (express your answers with π for accuracy)

FORMULA

$$\rho = \frac{m}{v}$$

where: ρ = *density* m = *mass* V = *volume*

density of metal ball and cylinder = 7.8 g/cm^3

FORMULA

$$\%E = \left| \frac{\textit{Standard value} - \textit{Calculated value}}{\textit{Standard value}} \right| x100$$

DATA RESULTS

Table 1
Length and Diameter in centimeter of Different Objects

a. Metal Cylinder

Trial	Length (cm)	Diameter (cm)
1	2.3 cm	1 cm
2	2.2 cm	1.3 cm
3	2.4 cm	1.1 cm
Average	2.3 cm	1.1 cm

b. Metal Ball (sphere)

Trial	Length (cm)	Diameter (cm)
1	2 cm	2 cm
2	1.8 cm	1.8 cm
3	1.9 cm	1.9 cm
Average	1.9 cm	1.9 cm

Table 2
Mass, Volume, and Density of Different Objects

Object	Mass (m) in grams	Volume (V) in cm^3	Density (ρ) in g/cm^3	Standard Value of ρ	Percentage Error (%E)
Metal cylinder	22.4 g	2.3 cm	9.73 g/cm^3	8.91 g/cm^3	9.20%
Metal Ball	28.7 g	3.6 cm	7.97 g/cm^3	7.64 g/cm^3	4.35%

COMPUTATIONS

Cylinder's Density

$$D_c = \frac{22.4}{2.6}$$

$$D_c = 8.615384615$$

$$D_c \approx 8.6 \text{ g/cm}^3$$

Cylinder's Error

$$\% E_c = \left| \frac{8.91 - 9.739130435}{8.91} \right| \times 100\%$$

$$\% E_c = 3.306569978\%$$

$$\% E_c \approx 3.3\%$$

COMPUTATIONS

Metal ball's Density

$$Db + \frac{28.7}{3.6}$$

$$Db = 7.97\overline{222}$$

$Db \approx 8.0\ g/cm^3$

Metal ball's Error

$$\% Eb = \left| \frac{7.64 - 7.97222}{7.64} \right| \times 100\%$$

$$\% Eb = 4.348429319\%$$

$\% Eb \approx 4.4\%$

QUESTIONS

What determines the accuracy with which you can make measurements using the Vernier caliper and micrometer?

The accuracy of measurements using a Vernier caliper and micrometer depends on the instrument's resolution, its calibration, and the user's technique. A Vernier caliper can typically measure to the nearest 0.01–0.02 mm, while a micrometer can measure even smaller values, up to 0.001 mm, making it more accurate. However, if the instrument is worn out, not properly zeroed, or poorly calibrated, errors can occur. In addition, the skill of the user plays an important role, since factors like applying too much pressure, misalignment, or parallax error can affect the reading. Therefore, both the quality of the instrument and the care taken by the user determine the accuracy of measurements.

QUESTIONS

Which of the three objects used, metal cylinder, the wire, and the metal ball, has the greatest error in its density? Why?

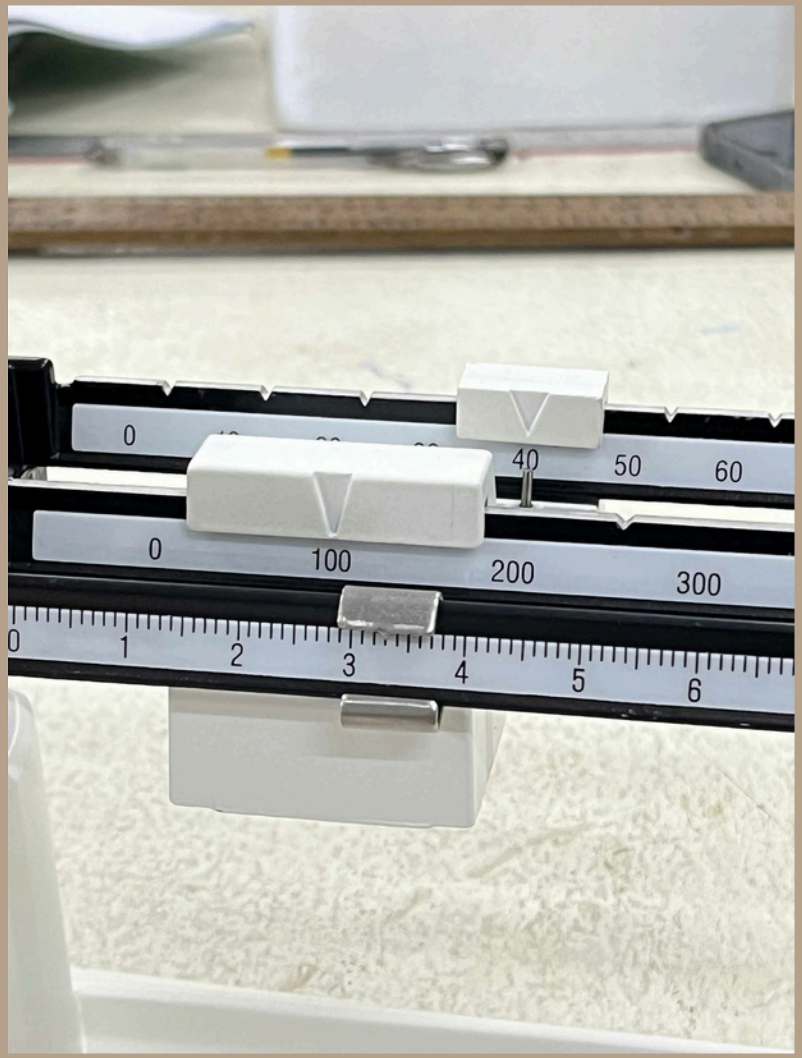
The metal ball has the greater error in its density because even a small uncertainty in measuring its diameter greatly affects the calculation of its volume, since volume depends on the cube of the radius. This larger uncertainty in volume leads to a greater overall error in the density compared to the metal cylinder.

CONCLUSION

In this activity, we learned how to accurately measure objects using the Vernier caliper, micrometer, and ruler. By performing multiple trials, we reduced random errors and obtained more reliable average measurements. From these values, we calculated the volume, density, and percentage error of different objects. The results showed that small mistakes in measuring dimensions, especially diameter, can cause significant errors in density calculations. This highlights the importance of careful handling of instruments, precise readings, and repeated trials to minimize uncertainty and improve accuracy.

DOCUMENTATION

DOCUMENTATION



THANK YOU!

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