

E. Time Measurement

1. Fill one test tube with *Solution A* and a second test tube with *Solution B*. Pour both solutions simultaneously into a 250 mL beaker. Record the number of seconds for a reaction to occur; this is indicated by a color change.

F. Mass and Volume of an Unknown Rectangular Solid

1. Obtain a rectangular solid and record the unknown number in the Data Table. Find the mass of the unknown solid using a decigram, centigram, and milligram balance.
2. Measure the length, width, and thickness of the rectangular solid unknown using Ruler A in Figure 2-3. Calculate the volume.
3. Measure the length, width, and thickness of the rectangular solid unknown using Ruler B in Figure 2-3. Calculate the volume.

G. Metric Estimations

1. Estimate the mass of a nickel. Weigh the nickel on any balance and record the mass ± 1 g.
2. Estimate the diameter of a nickel. Measure the nickel with any metric ruler and record the length ± 1 cm.
3. Estimate the volume of 20 drops of water. Using a dropper pipet, add 20 drops of water into a graduated cylinder and record the volume ± 1 mL.

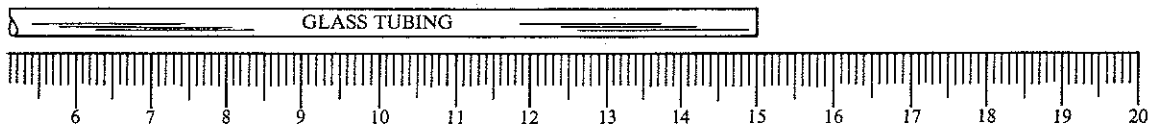
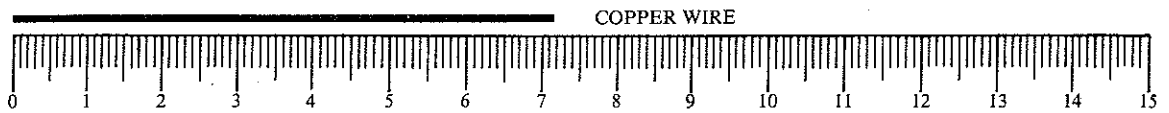
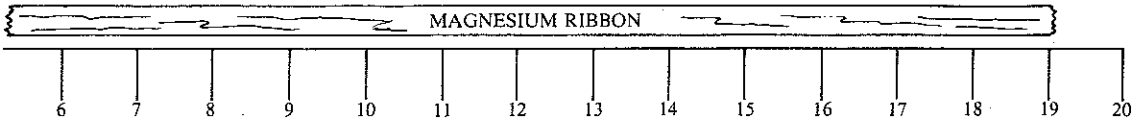
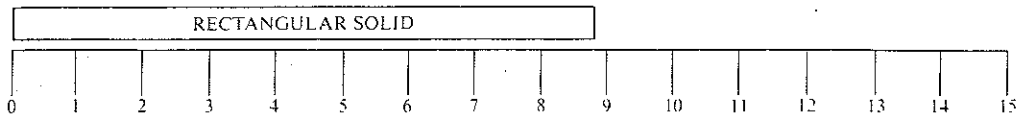
PRELABORATORY ASSIGNMENT*

1. In your own words, define the following terms: balance, mass, meniscus, metric system, parallax, uncertainty, weight.
2. Identify the following laboratory equipment from the diagrams on pages 4-5: beaker, crucible and cover, watchglass, evaporating dish, graduated cylinder, test tube, thermometer.
3. State the quantity expressed by each of the following units.
 - (a) gram — g
 - (b) centimeter — cm
 - (c) milliliter — mL
 - (d) degree Celsius — $^{\circ}\text{C}$
 - (e) second — s
4. State the uncertainty in the measurements obtained from the following metric instruments.
 - (a) decigram balance
 - (b) centigram balance
 - (c) milligram balance
 - (d) metric Ruler A
 - (e) metric Ruler B
 - (f) graduated cylinder
 - (g) thermometer
 - (h) sweep-second clock

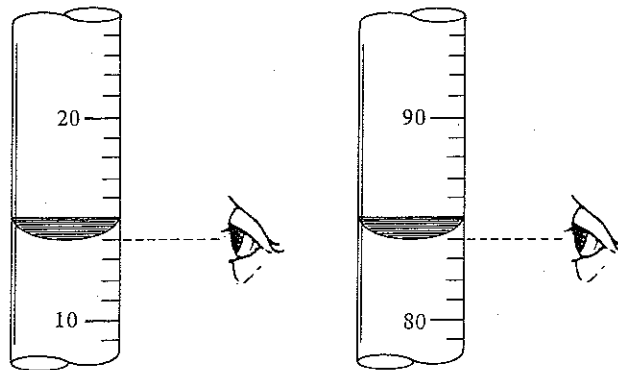
*Answers in Appendix II.

5. Record the measurement indicated by each of the following instruments. The reading must be consistent with the uncertainty of the instrument.

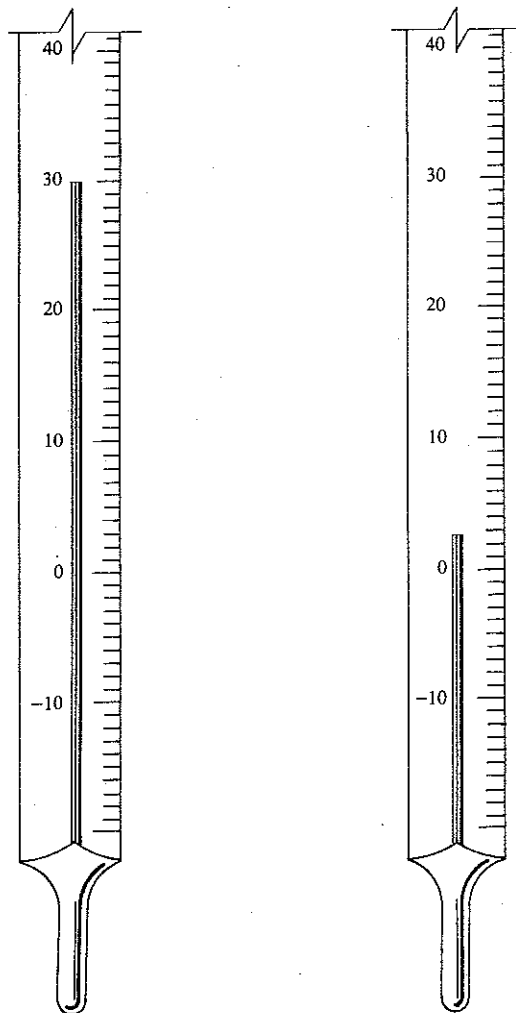
(a) metric rulers



(b) graduated cylinders



(c) thermometers



6. An unknown rectangular solid has the following measurements: 3.70 cm by 2.45 cm by 1.25 cm. Calculate the volume in cubic centimeters.
7. What safety precautions must be observed in this experiment?

POSTLABORATORY ASSIGNMENT

NAME _____

1. State the metric system *reference standard* for the following quantities.

- (a) mass _____ (b) length _____
 (c) volume _____

2. State the metric system *basic unit* for each of the following quantities.

- (a) mass _____ (b) length _____
 (c) volume _____

3. Give the *physical quantity* associated with the following measurements.

- (a) 10.0 mL _____ (b) 10.0 cm³ _____
 (c) 1.25 g _____ (d) 7.50 cm _____
 (e) 22.5°C _____ (f) 75.4 s _____

4. Circle the measurement that is consistent with the uncertainty of each instrument.

- (a) decigram balance: 135.0 g, 135.01 g, 134.966 g
 (b) centigram balance: 84.4 g, 84.50 g, 84.495 g
 (c) milligram balance: 27.5 g, 27.49 g, 27.500 g
 (d) metric Ruler A: 6.5 cm, 6.45 cm, 6.450 cm
 (e) metric Ruler B: 1.5 cm, 1.50 cm, 1.550 cm
 (f) graduated cylinder: 20 mL, 20.0 mL, 20.05 mL
 (g) thermometer: 21°C, 21.5°C, 21.45°C
 (h) sweep-second clock: 45 s, 45.0 s, 45.00 s

5. State the number of significant digits in each of the following measurements.

- (a) 35 s _____ (b) 30°C _____
 (c) 1.05 cm _____ (d) 20.5 cm³ _____
 (e) 23.0 g _____ (f) 10.00 mL _____
 (g) 21.50 cm _____ (h) 0.015 g _____
 (i) 500 cm³ _____ (j) -40.0°C _____

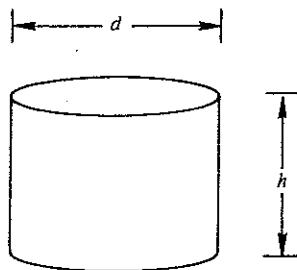
6. Perform the indicated math operation and round off the answer to the proper significant digits.

- (a)
$$\begin{array}{r} 50.6 \text{ g} \\ 50.05 \text{ g} \\ + 50.231 \text{ g} \\ \hline \end{array}$$
 (b)
$$\begin{array}{r} 56.05 \text{ cm} \\ - 11.4 \text{ cm} \\ \hline \end{array}$$

7. Perform the indicated math operation and round off the answer to the proper significant digits.

- (a) (41.50 cm) (0.20 cm) (b)
$$\frac{739.5 \text{ mm}^3}{25.5 \text{ mm}}$$

8. After recording data from an instrumental measurement, is the experimental value rounded off? Explain.
9. After recording data from a calculator operation, is the calculated value rounded off? Explain.
10. (optional) The international reference kilogram is a solid cylinder made from a platinum-iridium alloy. Its diameter is equal to its height. What is the cubic centimeter volume if the height is 3.90 cm?



(The volume of a cylinder equals $\pi d^2 h/4$; where π is 3.14, d is the diameter, and h is the height.)