Experiment 1: Measurement & Analysis

Figure 1.1: Measurement Materials

EQUIPMENT

Triple Beam Balance
Ruler
Metal Cylinder
Digital Caliper
Cylinders (Plastic, Wood)
String

Objective

Enhance measurement and graphing skills; introduce error analysis.

Theory

The fundamental quantities of mechanics are length, mass, and time. The SI units for these quantities are the meter (m), kilogram (kg), and second (s), respectively. All other mechanical quantities can be stated in terms of these quantities. For example, the unit of force in the SI system is the newton (N):

$$1 \text{ N} = 1 \text{ kg}\cdot\text{m/s}^2.$$

In terms of fundamental quantities, a newton is [mass]·[length]/[time^2].

In this experiment, you will use a variety of instruments to measure the fundamental quantities of length, mass, and time (see Fig. 1.1). You will then use these measurements to calculate other quantities and perform error analysis (refer to *Appendix B*).

All measurements have uncertainty; they can only be so precise. The precision of the measuring instrument used determines the uncertainty of a measurement. The size of the smallest scale division (the **resolution**) of an instrument determines the **uncertainty** of measurements obtained with that instrument. Uncertainty, δ (Greek letter *delta*), is either equal to the resolution or equal to $\frac{1}{2}$ the resolution of the measuring instrument, depending on how the instrument is designed.

Digital Instrument:	$\delta =$ the resolution
Analog Instrument:	$\delta = \frac{1}{2}$ the resolution

Analog instruments, such as rulers, are read by eye and can be estimated within ± half of a "tick" mark. Digital instruments can be as imprecise as a full digit in either direction. A digital reading of "5.2 g" might be obtained for masses ranging between (5.100...1) g and (5.2999...) g, so their uncertainty is fully equal to the resolution of the instrument.

Measurements of time on a typical analog clock or watch are considered digital, due to the manner in which they are read; the second hand moves in increments of full seconds, and an estimation cannot be made between seconds.

Name: _____

1. What are the fundamental quantities of mechanics, their symbols, and their respective units? (25 pts)

2. State the symbol and value for the following prefixes: (5 pts ea.)

Prefix	Symbol	Value
mega		
kilo		
centi		
milli		
micro		

3. Convert the following: (10 pts ea.)

- 1.00 in. = _____ cm
- 6.10 in. = _____ cm
- 4 cm^2 = _____ m^2

Material	***Density (g/cm³)***
Solids	
Metal:	
Aluminum	2.70
Stainless Steel	7.8
Brass	8.44 - 8.75
Bronze	8.74 - 8.89
Copper	8.96
Lead	11.3
Mercury	13.5336
Rock:	
Granite	2.64 - 2.76
Slate	2.6 - 3.3
Diamond	3.51
Garnet	3.15 - 4.3
Corundum	3.9 - 4.0
Wood:	
Pine (Yellow)	0.37 - 0.60
Oak	0.60 - 0.90
Ebony	1.11 - 1.33
Misc.:	
Ice	0.917
Bone	1.7 - 2.0
Chalk	1.9 - 2.8
Glass (Lead)	3 - 4
Fluids	
Atmosphere (STP)	0.001225
Water (20°C)	0.99821
Water (0°C)	0.99984
Mercury (20°C)	13.546

Table 1.1: Density of Selected Materials