EXPERIMENT 2:
GRAPHING and MEASUREMENTS

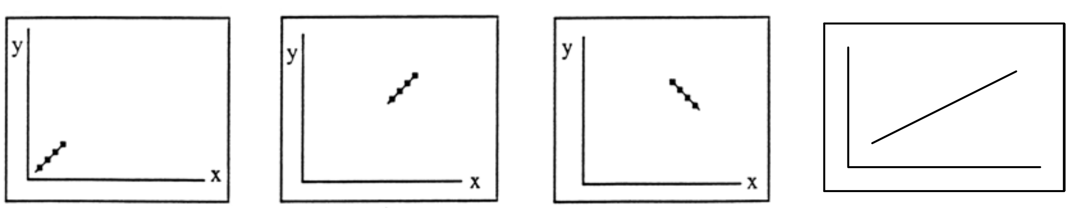
Introduction: Graphs summarize numerical data efficiently and are usually easier to understand and interpret than columns of numbers. In this experiment you will collect data and construct a graph that makes an effective visual presentation. **In advance** before coming to lab, set up a data sheet similar to the report sheet. Include space for calculations.

Part 1: Measurements on rectangular metal pieces.

A kit with four or five rectangular pieces of metal will be provided to you. There will also be an irregular piece in the kit, stamped with a code number. Obtain a ruler where 0.1 cm marks are clearly visible – so you can estimate between the marks. Measure the mass and two dimensions (length, width,) of each of the rectangular pieces **to the nearest 0.01 cm**. Measuring the thickness (height) of the metal piece is tricky – so this third dimension will be provided to you. The metals are finely milled to precise thickness given in English units (inches). For example, 0.0320 inch, 0.0250 inch, or 0.0641 inch. Convert to cm (1 inch = exactly 2.54 cm). **Measure across the middle** since they have been cut by hand and may be slightly irregular. The edges and corners are sharp – so you may want to handle the pieces with a pair of tweezers. Weigh the irregular piece (see part 3). Keep the pieces in a weighing tray to avoid losing them.

Part 2: Graphing linear data

1. Use a piece of graph paper with divisions no larger than 10 per inch, or 5 per cm to graph: Mass (on y-axis) versus Volume (on x-axis). Title the graph and label both axes.
2. Select a scale that includes the range of values. It helps to select units with subdivisions of 10, or 2 or 5 since the masses are in decimal units. Never use divisions of 3 or 4 for instance. The graph should large enough to take up most of the graph paper. In general, the scales on the x-axis and the y-axis do not need to start at 0. The first 3 examples are inappropriately scaled graphs; #4 is best.
   Start by counting 10 squares; make a mark, then mark every 10^{th} square.
   Distribute the units to be plotted as evenly as possible along the entire axis
   and label every tenth square with a 1 or 10 or 0.1 or 2 or 20 of 0.2 or 5 or 50 or 0.50 etc



These three figures represent poor graphing technique — ideal graph

3. Carefully plot the experimental points. Use a sharp ***pencil*** because it is easy to make mistakes in this kind of plotting. Make **small dots, and then draw small circles** around them so that they show up clearly. **Using a ruler or other straight edge, draw the "best" straight line <u>through</u> the data points.** Don't do this too hurriedly – it requires some judgment. If the points are somewhat scattered, there should be equal numbers of them on either side of the line. **<u>Don't connect the dots in a zigzag!!</u>** When you have finished your graph, let your instructor check it and make suggestions for changes and/or additions.

4. Determine the slope of the graph. Use two sets of coordinates from the line which are fairly far apart and do not correspond to the original data points plotted. Remember, your graphed line may or may not touch ANY of your original data points!

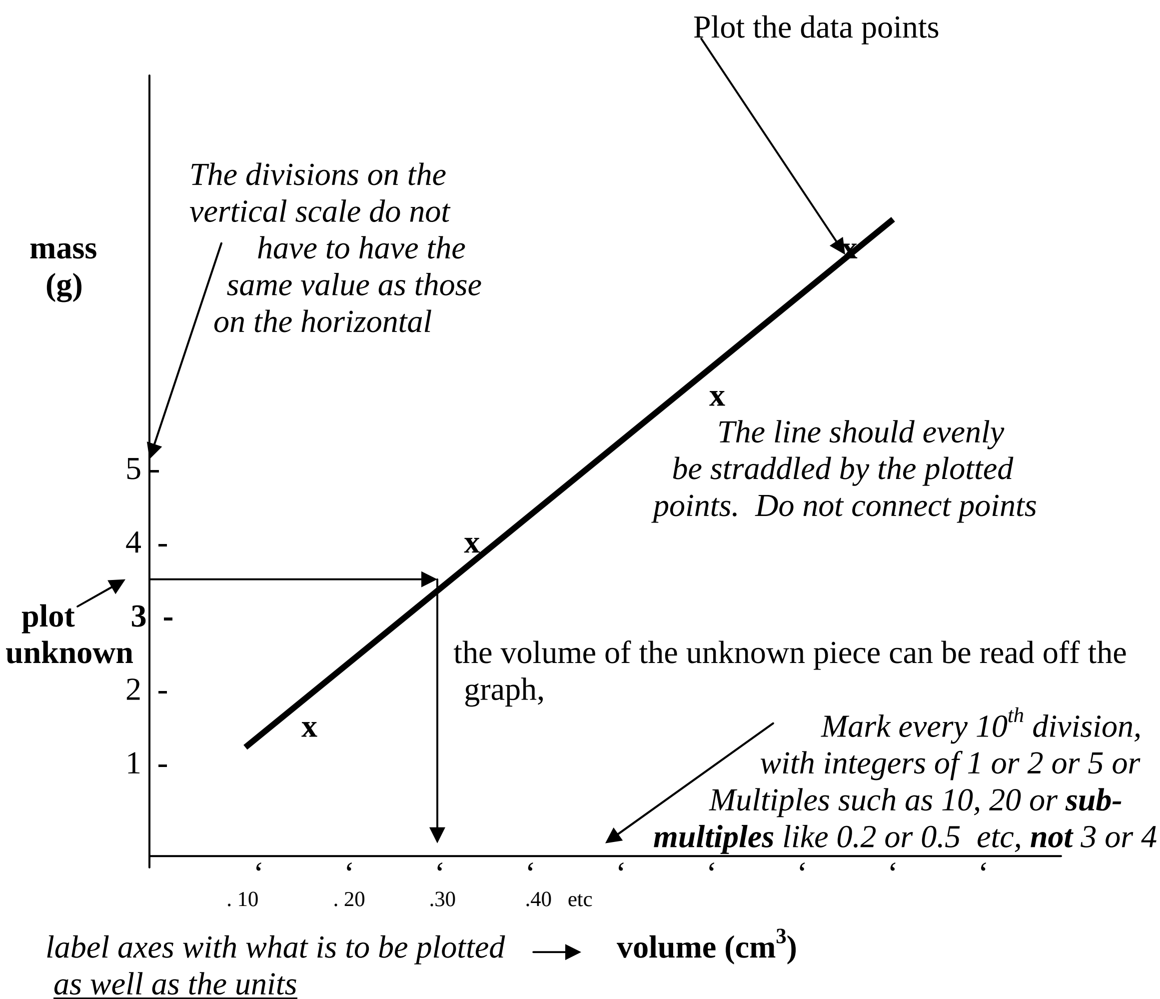
Remember that the slope is "rise over run", or the difference between two y values divided by the difference between two x values.

Use the slope formula: slope = $\frac{y_2 - y_1}{x_2 - x_1}$

Part 3. The mass and volume of an irregular shaped piece of metal

Weigh this piece; do not make any measurements on it with a ruler. **Use your graph** (read the mass on the vertical axis) to determine the volume of this piece. Be sure to record the code number of the irregularly shaped piece.

Select a proper scale – mark every 10th small division, label axes as shown



EXPERIMENT 2: Report Sheet Name: ______________________
GRAPHING AND MEASUREMENTS section: __________

Part 1: Data **show units**				**Calculated values (show units)**
Mass and dimensions of metal pieces				
Mass	**Length**	**Width**	**Height (given)**	**Volume**
1 ________	________	________	________	________
2.________	________	________	________	________
3.________	________	________	________	________
4.________	________	________	________	________

Show set-up of one of the volume calculations.

Calculate the density (with units) of each piece.
Show setup for one calculation.
(Watch sig figs and show units.)

1. __________________
2. __________________
3. __________________
4. __________________

Calculate the mean (average) of the 4 density values. ___________

Part 2. **Calculate the slope of the graph.**

Show set-up:

Question: What does the slope of the graph represent in this experiment? _________

Compare the slope of the graph with the mean value of the densities you calculated!
Are the values similar?

Calculate the % difference:

$$\% \text{ difference} = \left[\frac{\text{calculated value} - \text{value from graph}}{\text{calculated value}} \right] \times 100$$

_______ %

Part 3. Data:

Metal code # ____________ mass of the metal: _________________

volume of metal: __________ (read off the graph)

Attach the graph. If your instructor allows you to use a graphing program such as Excel, you'll need the equation of the straight line, from which you can get the slope and calculate the volume of the metal (the x value).

Be sure to attach the copy sheet from your notebook, which the instructor signed.