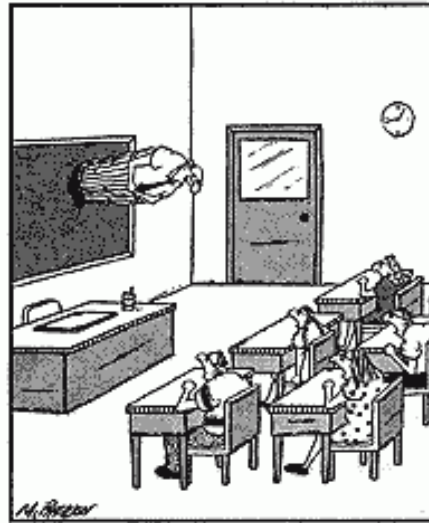


Regular Physics - Notes Ch. 1



"Good morning, and welcome to
The Wonders of Physics."

What is Physics?— the study of matter and energy and their relationships; the study of the basic physical laws of nature which are often stated in simple mathematical equations. Physics is about learning the rules of nature. Once you know the rules that govern anything it is easier to appreciate that thing...like a sport - you can't appreciate the game when you don't know the rules.

I. Scientific Methods – Many discoveries are made purely by chance, BUT even then - the discovery is the result of making careful observations (noticing everything) and recording the observations for further analysis and thought. You must be able to tell the difference between an observation and an inference. An inference is usually a result of observations done and can often be turned into a hypothesis and then tested.

For Example: As you watch the afternoon football practice, each group of players goes to the water fountain in turn. If you said that “The players are thirsty” would that be an observation or an inference?

Can you think of an appropriate test in this case?

It is very important that when an experiment is designed to test a question, inference, or hypothesis, the experiment MUST have only ONE experimental variable (characteristic that changes due to a designed change in another variable). If the other possible variables are not kept constant (controlled), there is no way to show that the observation is due to the variable being tested.

- **Qualitative Data** – observations that generally describe the system in the experiment using words without numbers or measurements. (general behavior, color, texture, position, direction)
- **Quantitative Data** – observations that describe the system numerically (using measurements of size, mass, length, speed, how many, etc)

II. Metric System (SI or System International) – *standard measurement system for science*

- **Fundamental units**—basic
 - time—second (s)
 - length—meter (m)
 - mass—kilogram (kg)
 - temperature—kelvin (K)
 - electric current—ampere (A)
 - amount of substance—mole (mol)

- **Derived units**—combinations of the fundamental units
 speed—m/s acceleration – m/s² density – kg/m³

Dimensional analysis can often be used to check many types of problems. Units must remain consistent if the formula/calculation was correct.

Example p.25 #4

4. Determine the units of the quantity described by the following combinations of units:

a. kg (m/s) (1/s)

b. (kg/s) (m/s²)

c. (kg/s) (m/s)²

d. (kg/s) (m/s)

- **Know the value for these Common Metric prefixes – (Table 1-3 see p.12 in Text)**

pico (p)

Tera (T)

nano (n)

Giga (G)

micro (μ)

Mega (M)

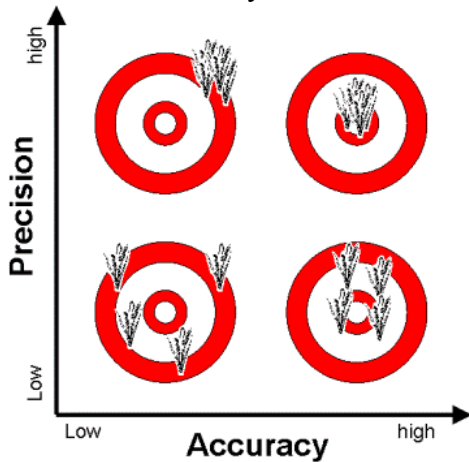
milli (m)

kilo (k)

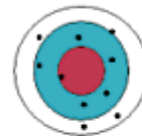
centi (c)

III. Measurements in Experiments

- **Precision**—degree of exactness in a measurement; ex. An analytical balance is much more precise when compared to your bathroom scale. A set of measurements is **precise** if they are all VERY close to the same value.
- **Accuracy**—closeness of a measurement to the accepted value; ex. If the analytical balance is not calibrated correctly, your bathroom scale may be more accurate. A set of measurements is **accurate** if they are all VERY close to the correct or accepted value for that measurement.



A Both accuracy and precision



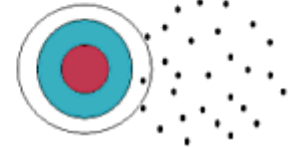
B Accuracy only



C Precision only



D Neither accuracy nor precision



Example Problem P. 19 #3

3. The following students measure the density of a piece of lead three times.

The density of lead is actually 11.34 g/cm³. Considering all of the results,

which person's results were accurate? _____ Which were precise? _____ Were any both accurate and precise?

a. Rachel: 11.32 g/cm³, 11.35 g/cm³, 11.33 g/cm³

b. Daniel: 11.43 g/cm³, 11.44 g/cm³, 11.42 g/cm³

c. Leah: 11.55 g/cm³, 11.34 g/cm³, 11.04 g/cm³

IV. Significant digits—tools used for measurement have limitations on how precisely they can reliably measure so only the reliable digits are reported in a measurement. The number of significant digits reported in a measurement or calculation must not imply more precision than what was used to make the measurements or calculations.

When physicists report findings to the scientific community, they need rules about how precision can be understood by others... **this is why we must learn and follow the rules for significant digits! All numbers directly readable from the instrument used PLUS one estimated digit are all significant.**

~Zeros used solely for showing the position of the decimal point are **not significant**.

Rules for significant digits

Rule 1- which digits are significant: *The digits in a measurement that are considered significant are all of those digits that represent marked calibrations on the measuring device plus one additional digit to represent the estimated digit (tenths of the smallest calibration).*

The zero digit is used somewhat uniquely in measurements. A zero might be used either as an indication of uncertainty or simply as a place holder. For example, the distance from the earth to the sun is commonly given as 1,500,000,000 km. The zeroes in this measurement are not intended to indicate that the distance is accurate to the nearest km, rather these zeroes are being used as place holders only and are thus not considered significant.

Rules for zeros:

1. All non-zero digits in a measurement **are** considered to be significant.
2. Zeroes **are** significant if bounded by non-zero digits; e.g., the measurement 4003 m has four significant figures.
3. If a decimal point is expressed, all zeroes following non-zero digits **are** significant; e.g., the measurement 30.00 kg has four significant figures.
4. If a decimal point is not explicitly expressed, zeroes following the last non-zero digit **are not** significant, they are **place holders only**; e.g., the measurement 160 N has two significant figures.
5. Zeroes preceding the first non-zero digit **are not** significant, they are **place holders only**; e.g., the measurement 0.00610m has three significant figures.

Rules for addition and subtraction with significant figures:

1. Change the units of all measurements, if necessary, so that all measurements are expressed in the same units (kilograms, meters, degrees Celsius, etc.).
2. The sum or difference of measurements may have **no more decimal places** than the least number of places in any measurement.

For example:

$$\begin{array}{r} 11.44 \text{ m} \\ 5.00 \text{ m} \\ 0.11 \text{ m} \\ \hline 13.2 \text{ m} \\ 29.750 \text{ m} \end{array}$$

But since the last measurement (13.2 m) is expressed to only one decimal place, the sum may be expressed to only one decimal place. Thus 29.750 m is rounded to 29.8 m.

Students typically make one of two mistakes: **1.** either they keep *too few figures by rounding off too much* and lose information, or **2.** they keep *too many figures by writing down whatever the calculator displays*. Use of significant figure rules helps us express values with a reasonable amount degree of precision.

Rules for multiplication and division with significant figures:

When multiplying or dividing, the number of significant figures retained may not exceed the least number of digits in either of the factors.

Example: $0.304 \text{ cm} \times 73.84168 \text{ cm}$. The calculator displays 22.447871. A more reasonable answer is 22.4 cm^2 . This product has only three significant figures because one of the factors (0.304 cm) has only three significant figures, therefore the product can have only three.

Another example: $0.1700 \text{ g} \div 8.50 \text{ L}$. The calculator display of 0.02 g/L, while numerically correct, leaves the impression that the answer is not known with much certainty. Expressing the density as 0.0200 g/L shows the reader that very precise measurements were made.

Example: Consider the quotient: $294,921 \text{ cm}^2 \div 38.0 \text{ cm}$. Calculator displays 7761.07895. What is the correct answer?

See example problems p. 19 #'s 2 and 4

2. Express the following measurements as indicated.

a. 6.20 mg in kilograms

b. $3 \times 10^9 \text{ s}$ in milliseconds

c. 88.0 km in meters

4. Perform these calculations, following the rules for significant figures.

a. $26 \text{ cm} \times 0.02584 \text{ cm} = ?$

b. $15.3 \text{ m}^3 \div 1.1 \text{ m} = ?$

c. $782.45 \text{ kg} - 3.5328 \text{ kg} = ?$

d. $63.258 \text{ nm} + 734.2 \text{ nm} = ?$

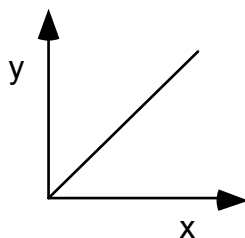
V. Plotting Graphs (p. 20-25 in text)

These conventions must be followed for all graphs in this course.

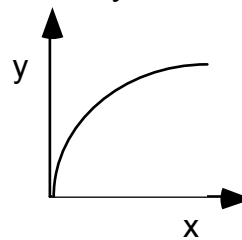
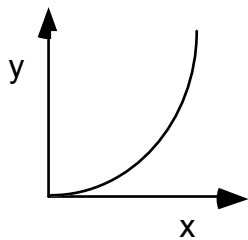
- independent variable (the one controlled by the experimenter) is on X axis (Unless specifically told otherwise for a particular situation)
- dependent variable (the one that responds to changes in the independent variable) is on Y axis
- determine the appropriate range to fit the data points
- determine if the origin (0,0) is a valid data point
- draw best **straight line or smooth curve** to fit the data points; **if slope of a line is to be calculated, use two points from the line that are NOT two of the original data points**

Linear relationship—straight line: shows y is directly proportional to x and as one of them increases, the other does also. The equation for a straight line is:

$$y = mx + b$$



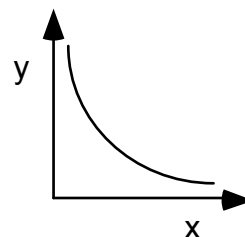
Quadratic relationship—parabola: y is proportional to the square of x $y = kx^2$



OR -- y^2 is proportional to x $y^2 = kx$
where k is constant in both cases.

Inverse relationship—hyperbola: y is inversely proportional to x, so as one of them increases the other decreases

$$xy = k \text{ or } y = k/x \text{ and } k \text{ is the constant}$$



The Physics reference sheet “Graphical Methods – Summary” (available on Quia class website <http://www.quia.com/pages/kjlphysics.html>) reminds you of what you can do in order to make the data become linear (called linearization) depending on what the original graph looks like. Once you have a linear graph you can write an equation that fits the data.

When you are asked to state the relationship between two variables in an experiment/Lab Report, your answer will be determined by what the curve (*even straight lines on graphs are called curves*) looks like when the data is graphed correctly. **You should answer with a proportionality statement.

For example: “y is proportional to k/x.” as shown above by a hyperbolic curve!

Example problems p. 25 #'s 1 and 2

1. Which of the following graphs best matches the data shown below?

Volume of air (m³)

0.50
1.50
2.25
4.00
5.50

Mass of air (kg)

0.644
1.936
2.899
5.159
7.096

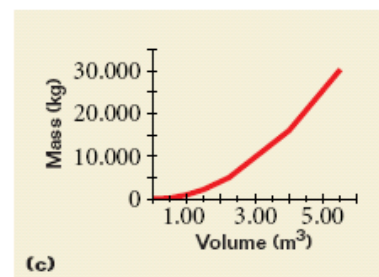
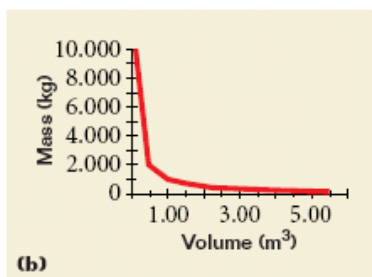
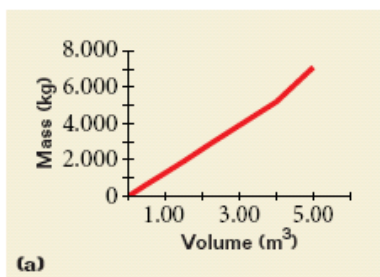


Figure 1-15

2. Which of the following equations best matches the data from item 1?

a. $(\text{mass})^2 = 1.29 (\text{volume})$

b. $(\text{mass})(\text{volume}) = 1.29$

c. $\text{mass} = 1.29 (\text{volume})$

d. $\text{mass} = 1.29 (\text{volume})^2$

In the graphs above BE SURE TO NOTICE THE AXES' numbers and labels and units!! All are important parts of a proper graph and will be checked for on quiz and test.

Regular physics practice homework Ch. 1 p. 27-31 #'s: 2, 5-7, 10-12, 15, 16, 18, 27, and 28. These should be worked out before the quiz over the chapter...you can check your work and answers with the teachers' book/work. On quizzes you will need to Show all work for calculations in order to get credit...This means all formulas, numbers input correctly, the correct answer with the right significant figures, and the correct units!