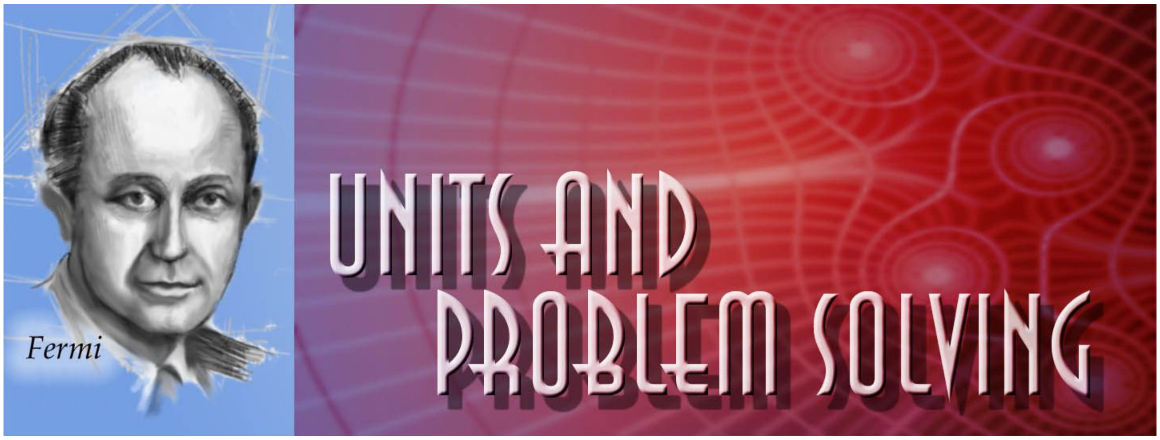
Unit 1 Summer Work: Basic Mathematical Concepts You Need To Know In Physics



The Big Idea

Physics is about understanding the rules that govern the natural world around us, but to understand these rules we have to make measurements. This first unit is about the mathematical rules and concepts that govern those measurements. When you master these, the rest of physics becomes simple. However, like a house built on a weak foundation, if you do not understand these basic rules, you will find your understanding of the rest of physics is a little shaky!

The late, great physicist Enrico Fermi used to solve problems by making educated guesses. For instance, say you want to *guess*timate the number of cans of soda drank by everybody in San Francisco in one year. You'll come pretty close if you guess that there are about 800,000 people in S.F., and that each person drinks on average about 100 cans per year. So, 80,000,000 cans are consumed every year. Sure, this answer is wrong, but it is likely not off by more than a factor of 10 (i.e., an "order of magnitude"). That is, even if we guess, we're going to be in the *ballpark* of the right answer. That is always the first step in working out a physics problem.

The first rules of physics:

- ***You <u>will</u> hit problems where you don't instantly know what to do. DON'T PANIC!!! J.ump in and try something. Anything you can do is better than sitting and staring.***

- ***<u>Don't be afraid to estimate!!! But do think about whether numbers you see and calculate are reasonable!</u>***

In this packet, you will find some background material that it is expected you will be familiar with when you start class in September. Most of it (Hopefully all of it!) is material that you have previously covered in Chemistry and math classes. At the end of the packet is a series of problems and a final set labeled Introductory Math Quiz. Solve all problems on notebook paper and show your work. The problems are excerpted from a larger packet, so Lesson and Problem numbers are not in a strict order. This packet is due on the first day of class in the fall.

Lesson 1: All measurements are estimates!!!! (That's why we use Significant Figures)

1.3 Figuring Out How Precise We Can Be In Our Measurements

Anything you simply count can be thought of as an exact measurement, but anything you measure is always, at some level an estimate. How your write that measurement conveys how carefully the number was measured.

If I quickly measure the width of a piece of notebook paper, I might get 220 mm (2 significant figures). If I am more precise, I might get 216 mm (3 significant figures). An even more precise measurement would be 215.6 mm (4 significant figures).

So what's the big deal?

1. If you write a number, such as the number of hairs on your head, as 23,412.5 hairs, a reader will naturally assume you counted each and every hair to arrive at this number, if you had estimated the number, you had no business writing so many numbers, and could have simply said about 20,000 hairs. In other words, the number of digits (significant digits) in your measurement conveys how precisely a number was measured.

2. It is impossible for a number you calculate from doing math operations on measurements to be more precise than the numbers you started with. So, if you multiply a very precise number (a lot of sig. figs) by a number that was estimated (few sig. figs), your answer must be an estimated one (few sig figs). Its pretty much that simple!

3. Your calculator is blissfully unaware of these rules and will happily spit out long strings of decimal places (sig figs) on any calculation. So, you have to know how to count sig figs and use that count to keep track of how many sig. figs. You should keep in your calculations.

The Atlantic/Pacific Rule for Determining Significant Figures

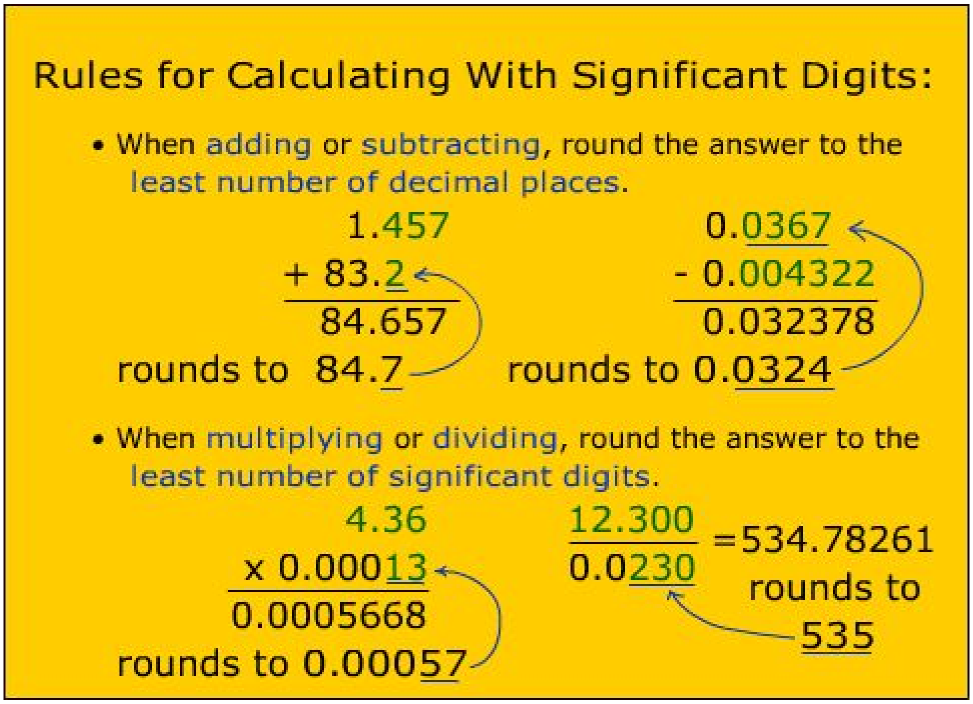
1) Look for the presence, or not, of a decimal point - this will tell you which side to start counting from
- Pacific: left - Atlantic: right

2) If there is a decimal point you start counting from the left side of the number:
- starting from the very left side of the number, look for the first non-zero number
- count the first non-zero number and every number (0-9) after that
- example: 0.00010 meters
- because there is a decimal point, we start from the left side of the equation L0.00010, and look for the first non-zero number 0.00010
- count that number and every number after that regardless of what the number is (0-9)
- in this case there are 2 significant figures

3) if there is not a decimal point you start counting from the right side of the number - starting from the very right side of the number, look for the first non-zero number
- count the first non-zero number and every number (0-9) after that
- example: 721000 jellybeans
- because there is a decimal point, we start from the right side of the equation 721000, and look for the first non-zero number 7.
- count that number and every number after that regardless of what the number is (0-9)
- in this case there are 3 significant figures - 721

So how precise can my answers be?
If you measure something directly, measure to the limit of precision of the instrument. You can estimate to one decimal place beyond the smallest unit indicated on the instrument.

When you do calculations based on these measurements the following rules apply
(http://chemsite.lsrhs.net/measurement/sig_fig.html)



Addition and subtraction example:

Let's say two measurements were taken and they came out to 1.3 cm and 2.54 cm. The last digit of these measurements was estimated so 1.3 cm could be anything from 1.2 - 1.4 cm (or even broader), and 2.54 cm could be anything from 2.53 - 2.55 cm (or even broader). Let's assume we will need to add these measurements together for a calculation.
The lowest possible right answer is: 1.2 cm + 2.53 cm = 3.73 cm
The highest possible right answer is: 1.4 cm + 2.55 cm = 3.95 cm
Notice that the tenths place varies, so it doesn't make any sense to pretend we have any information about the hundredths place and should not report it. We should round this answer to the tenths place.
Using our original measurements we get: 1.3 cm + 2.54 cm = 3.84 cm --- rounded to ---> 3.8 cm

Multiplication and division example:

Let's assume we have the same two new measurements: 12 cm (implied range of 11 - 13 cm) and 1.33 cm (implied range of 1.32 - 1.34 cm). What if we needed to multiply them together to solve a problem.
The lowest possible right answer is: 11 cm x 1.32 cm = 14.52 cm2
The highest possible right answer is: 13 cm x 1.34cm = 17.42 cm2
Notice that the ones place now varies and we really have no idea what the tenths or hundredths place would be, so we should round this answer to the ones place.
Using our original measurements we get: 12 cm x 1.33 cm = 15.96 cm2 --- rounded to ---> 16 cm2

1.4 Calculate using sig. figs.
Your backyard has brick walls on both ends. You measure a distance of 23.4 m from the inside of one wall to the inside of the other. Each wall is 29.4 cm thick. How far is it from the outside of one wall to the outside of the other? Pay attention to significant figures.

1.5 The Usefulness of Scientific Notation

How do we deal with very large or small numbers, and how do I let someone know I measured 30,000 feet to a precision of + or – 100 ft.? The answer to both these questions is scientific notation. Writing number in this format has a number of advantages:

1. It is not practical to use anything else for very large or very small measurements. For example, how many stars are there in the universe? The current estimate is 300 sextillion! How many zeros is that?

2. In scientific notation that would be 3 x 10^{23} stars. The mass of the sun is about 2,000,000,000,000,000,000,000,000,000,000 kg – it's a lot more practical to write 2 x 10^{30} kg.

3. It always lets you know the exact precision of a measurement (the sig. figs. are built in).

4. Estimating answers can be easy with scientific notation. For example, 23,100 people each have about $11.90 in their pockets. What is the approximate total amount of money they have? Whiteboard a method of solving this with your group!

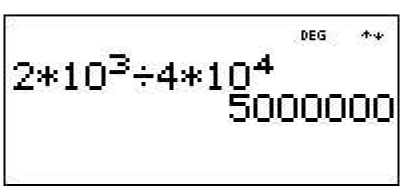
<u>The Bottom Line: You should be able to comfortably put numbers you measure in and out of scientific notation.</u>

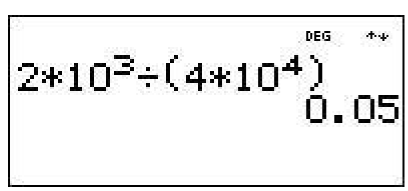
1.6 Scientific Notation on Calculators (http://www.mathsisfun.com/numbers/estimation-game.php)

You will use a calculator to do your many of your calculations. You need to use one that handles scientific notation and learn how to use it properly. The reason for this is that a calculator can treat a number like 1.23 x 10^4 in two different ways. First, it can treat the number as a single numerical value written in a particular format, scientific notation. Second, it can treat the number as two separate numbers multiplied together, (1.23) times (10^4). For our purposes the first approach is better.

To tell if your calculator handles scientific notation, look for an "EE" button or an "EXP" button. When using scientific notation on a calculator, do not type in "x10^", the "EE" or "EXP" button replaces that part of the number. Instead, enter 1.23"EE"4 or 1.23"EXP"4. Also, make note of how that value is displayed in the screen of the calculator.

To make sure you are using your calculator correctly work out the following calculations. The correct answers will be given to you after you submit your answers. If you have errors, don't dismiss them lightly. Find out what is causing the error and correct it. Keep in mind that calculators do not know how to round off to the correct number of significant digits. You have to do that part. For instance, which of the following calculations is correct?





The second answer is obviously correct, but hundreds of times each year, Physics students get problems wrong by entering numbers in their calculators improperly and not realizing their error. Had the student trying the calculation above used the EE key instead of typing "*10exp" there would be no problem.

<u>THOU SHALT USE THE PROPER KEYS ON YOUR CALCULATOR! NEITHER THE MANUFACTURER OR YOUR TEACHER CARE WHETHER YOU PREFER TO DO IT ANOTHER WAY!</u>

Lesson 2: Units and Unit Conversions

2.1 The importance of Units

Units identify what a specific number represents. For example, the number 42 can be used to represent 42 miles, 42 pounds, or 42 elephants! Without the units attached, the number is meaningless. Also, correct unit cancellation can help you find mistakes when you work out problems.

2.2 Key Concepts to know about Units

- Every answer to a physics problem must include units. Even if a problem explicitly asks for a speed in meters per second (m/s), the answer is 5 m/s, not 5.
- When you're not sure how to attack a problem, you can often find the appropriate equation by thinking about which equation will provide an answer with the correct units. For instance, if you are looking to predict or calculate a distance, use the equation where all the units cancel out, with only a unit of distance remaining.
- In physics, *SI units* (Le Système International d'Unités).
- When converting speeds from one set of units to another, remember the following rule of thumb: a speed measured in *mi/hr* is about double the value measured in *m/s* (*i.e.*, 10 m/s is equal to about 20 MPH). Remember that the speed itself hasn't changed, just our representation of the speed in a certain set of units.
- If a unit is named after a person, it is capitalized. So you write "10 Newtons," or "10 N," but "10 meters," or "10 m."

2.3 Some Key Relationships

We use the System Internationale (essentially the metric system) to measure things in physics. You will find it very helpful to know the following relationships. ***KNOW THESE!!!***

- **1 meter = 3.3 feet (so approximately 3 feet)**
- **1 mile = 1.6 kilometers or about 1,600 meters (or about one and a half kilometers)**
- **1 lb. (1 pound) = 4.45 Newtons (so multiply the weight of an object in pounds by 4.5 to get an approximate weight in Newtons)**
- **1 gram is about the mass of a paperclip**
- **1 kilogram (1,000 grams) is about 2.2 pounds (so as an estimate 1 kg weighs roughly 2 pounds!)**

2.4 What quantities will we be measuring?

The three ***fundamental quantities*** we measure in physics are often abbreviated **m-k-s**.

a) What three quantities do you think are being measured and what units are we using?

m - meters
k - kilograms
s - seconds

Just about every other quantity we measure will use ***derived units***; units that are a combination of fundamental units.

b) For instance, what units would you use to measure your ***speed*** in the Imperial (English) system of measurements we use in everyday life?

(miles/hour)

c) What units would you use for speed in the SI system?

(meters/second)

Here is a table of quantities we will be measuring this year, along with the common abbreviations and units.

Type of measurement	*Commonly used symbols*	*Unit and M-K-S unit Combination*
length or position	d, x, L or even s	meters (m)
Time & Period	t and T	seconds (s)
velocity or speed	v	meters per second (m/s)
Mass	m	kilograms (kg)
Force	F	Newtons (N) (kg*m/s)
acceleration	a	meters/sec^2 (meters/second/second)
Energy	e, KE, U, Q	Joules (J) (kg*m^2/s)
Power	P	Watts (W) (kg*m^2/s^2)
electric charge	q	Coulombs (C)
temperature	T	Kelvin (K)
electric current	I	Amperes (A) (C/s)
gravitational field	**g**	Newtons per kg (N/kg), or meters/sec^2
electric field	**E**	Newtons per Coulomb (N/C)
magnetic field	**B**	Tesla (T)

2.5 Greek Symbols

When we run of out English symbols for the things we measure, we use Greek symbols!

Pronunciation table for commonly used Greek letters. The ones in bold will be used this year

μ "mu"	τ "tau"	**Φ "phi"**	ω "omega"	ρ "rho"
θ "theta"	**π "pi "**	**Ω "omega"**	**λ "lambda"**	**∑ "sigma"**
α "alpha"	β "beta"	γ "gamma"	**Δ "delta"**	ε "epsilon"

2.6 Subscripts in Physics

We also use ***<u>subscripts</u>*** often in physics, so that an object's initial position can be described as:

x_i, or x_0 or **d_i, or d_0, etc.**

The subscripts can be invaluable in keeping track of what you are calculating, so pay attention to them! It's a little confusing at first, but you get used to it!

Of these symbols, you should be very comfortable with two in particular.

- **Delta - Δ = change in something you are measuring, like position, or velocity. Mathematically, you find change by subtracting the final amount from the original amount. For example Δposition = change in position = final position – initial position. *Commit this to memory!!!!***

- **Sigma - ∑ = The sum of quantities being measured. Usually in physics these quantities will be forces. So, ∑F = The sum of the forces on an object. These forces will add up to some value – otherwise known as the net. In other words if an object (like a soccer ball) is kicked by three players at the same time, the forces will add up to some net force. This can be written as ∑F = F1 + F2 +F3 = Fnet. *Know this notation as well!***

- ***Average - A quantity with a line over the symbol denotes average.(e.g. $\bar{v}$ means average velocity. If hyou know the starting and ending velocities of an object for a certain period of time, you can calculate its average velocity. average = (initial + final)/2. Commit this to memory!!!!***

2.6 Metric Prefixes you need to know.

There are simply no excuses for not knowing these metric prefixes (think of them as simply abbreviations) You already use them all the time in computing, medicine dosages, and other common life activities. **KNOW THEM!!!**

giga (G) = x 10^9
mega (M) = x 10^6
kilo (k) = x 10^3
centi (c) = x 10^{-2}
milli (m) = x 10^{-3}
micro (μ) = x 10^{-6}
nano (n)= x 10^{-9}

2.7 Factor Label Method of Unit Conversion

Everybody hates unit conversions. Still, they are a practical necessity and they get a whole lot easier once you know a couple of simple steps.

1. To convert units, you need a conversion factor (how many of these are in those, e.g. 2 weeks = 1 fortnight)

2. Any conversion factor can be represented as a fraction.

3. Multiplying your original number by these fractions in the right order will convert units.

Example: How many cm are in 2 miles?

Given: 1 mile= 5,280 ft 1 ft= 12 in 1 in= 2.54 cm

$$2\ \text{miles}\left(\frac{5{,}280\ \text{ft}}{1\ \text{mile}}\right)\left(\frac{12\ \text{in}}{1\ \text{ft}}\right)\left(\frac{2.54\ \text{cm}}{1\text{in}}\right) = \mathbf{321{,}868.8cm}$$

NOTE: This is what your calculator will spit out. Can you spot the error in the above calculation????

As a rule of thumb your problem set up should look like this:

$$\text{Starting Units x } \frac{\text{Desired Units}}{\text{Starting Units}} = \text{Desired Units}$$

Sometimes you will need to multiply by more than one ratio to get to your desired units, you can do this by using linking units. Your setup will look like this:

$$\text{Starting Units} \times \frac{\text{Linking Units}}{\text{Starting Units}} \times \frac{\text{Desired Units}}{\text{Linking Units}} = \text{Desired Units}$$

2.17 Double Factor Label Unit Conversions:

Often, you will be asked to perform conversions of more than one unit at a time

For example: **What speed is greater 40 m/s or 80 mi/hr?**

To compare the numbers we have to convert them to common units. Here we have to convert both the distance unit (miles to meters) and the time units (hours to seconds).

- You can still use the same methodology. Just remember - the order you do conversions in does not matter.
- you must set up the conversion factors to cancel out the unit you are trying to convert (see below)
- You can string multiple conversion factors together and do all you actual calculations at the end (see below)

$$\frac{80\text{ miles}}{\text{hour}} \cdot \frac{1\text{ hour}}{60\text{ mins}} \cdot \frac{1\text{ min}}{60\text{ secs}} \cdot \frac{5280\text{ ft}}{1\text{ mile}} \cdot \frac{12\text{ in}}{1\text{ ft}} \cdot \frac{2.54\text{ cm}}{1\text{ inch}} \cdot \frac{1\text{ meter}}{100\text{ cm}}$$

Cancel off the units:

$$\frac{80\ \cancel{\text{miles}}}{\cancel{\text{hour}}} \cdot \frac{1\ \cancel{\text{hour}}}{60\ \cancel{\text{mins}}} \cdot \frac{1\ \cancel{\text{min}}}{60\text{ secs}} \cdot \frac{5280\ \cancel{\text{ft}}}{1\ \cancel{\text{mile}}} \cdot \frac{12\ \cancel{\text{in}}}{1\ \cancel{\text{ft}}} \cdot \frac{2.54\ \cancel{\text{cm}}}{1\ \cancel{\text{inch}}} \cdot \frac{1\text{ meter}}{100\ \cancel{\text{cm}}}$$

Since the units cancel, leaving me with the "meters per second" that I need, I know the numbers must then be in the right places. So to get my answer, all I have to do is grab a calculator and simplify:

$$\frac{80}{1} \cdot \frac{1}{60} \cdot \frac{1}{60} \cdot \frac{5280}{1} \cdot \frac{12}{1} \cdot \frac{2.54}{1} \cdot \frac{1}{100} \approx 35.7632$$

This says that 80 miles per hour is equivalent to just under 36 meters per second, so:

Lesson 3: Visualizing Proportions in Numbers and Graphs.

Now that we have explored the basic rules governing our measurements, it is time to explore the tools we have to visualize measurements and determine if there is a relationship between the things we measure.

3.1 Relationsnips between variables

(http://www.glynn.k12.ga.us/~pmcveigh/COURSES/PHYSICS/NOTES/graphing.html)

Data collected during a experiment should be recorded in a table.

- The first column of the table contains the independent variable (or manipulated variable).
- The second column contains the dependent variable(or responding variable).

Independent Variable	Dependent Variable

When a graph is made the independent variable is plotted on the x-axis and the dependent variable is plotted on the y-axis. If a pattern is present, it signifies a relationship between the two variables.

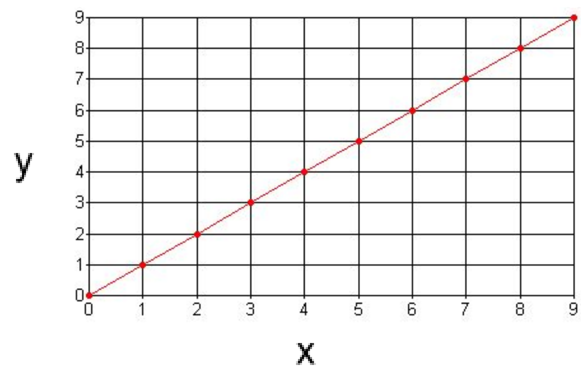
Having done this, your first question should be: *Is there any relationship (in other words, ratio or proportion) between the two things measured?*

3.2 There are only three common types of relationships you need to understand most of first year Physics!

After data is collected, the graph is then analyzed. There are many graphical relationships that may exist between sets of data. The following are only 3 common examples that are often found in physics.

Direct (Linear) Proportions

If the two measurements are directly proportional, the plotted graph results in a straight line as shown.



The equation for this graph is:

$y = mx + b$

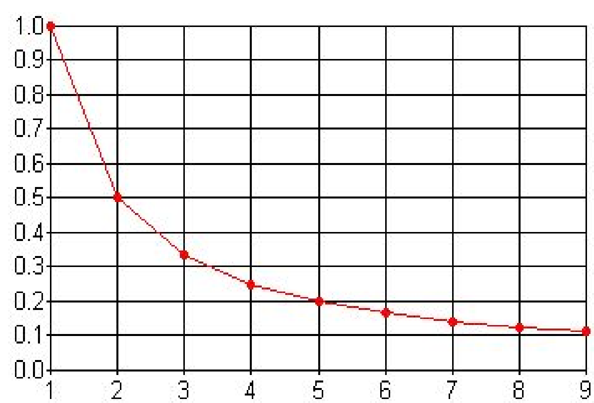
m is the slope of the line, $m = \Delta y/\Delta x$, b is the y intercept

Two variables that are in direct proportion will follow an y_1:x_1 as y_2:yx_2 pattern.

In other words, if you double one variable, the other has to double in response. Direct proportions are very common in physics (e.g. doubling an objects mass will double its weight). But, be careful about proportional relationships. This is not the only type of proportional relationship you will encounter this year!!!

Inverse Proportions

If the two variables form a graph looks like the one below, then an inverse relationship exists between the variables. This means as x increases, y decreases.



The equation for this type of graph is:

$y = k/x$ or $y = kx^{-1}$

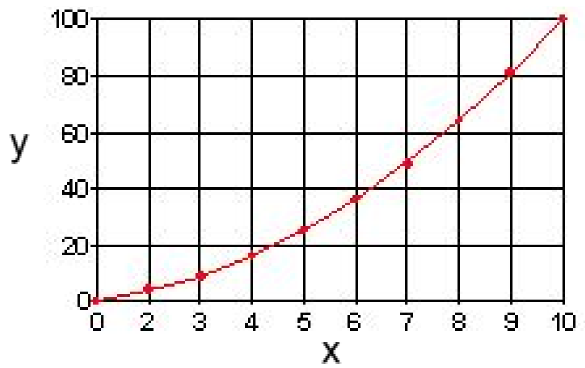
A second, common type of inverse relationship will look similar on a graph, but with the line dropping off more steeply. In the physical world, many times there is an ***inverse square relationship*** between the variables measured.

The equation for such a relationship follows the pattern:

$y = k/x^2$ or $y = kx^{-2}$

Inverse square proportional relationships are common in physics. They do not follow a simple a:b relationsip! Instead, they follow a proportionality relationship that would look more like this:

Polynomial (Parabolic) Proportions



If the graph of the data looks like the one below, then the relationship is likely a power relationship. This means as x increases, y increases as a factor of x raised to a power other than 1. The relationship is stated as y is proportional to x to the nth power. The most common one we see is a squared relationship.

- The equation for this type of graph is: $y = ax^2 + bx+c$
- **a** indicates how much the y values growth is increasing or decreasing by. If it is zero then the slope is constant (a straight line!). If it is not zero then the slope is changing. .
- **b** is the original rate the y value is changing by (or original slope).
- **c** is the original y axis value at x = zero - or where you start from.

Aren't there other Types of Relationships?

Of Course there are other common relationships as well such as exponential $y = e^x$, and logistic (S-curves) but these types are found more often found in Biology (population ecology) and/or finance (like saving account growth) than in Physics.

Lesson 4: Trigonometry

You should already be familiar with basic trigonometry.

SOH stands for Sine equals Opposite over Hypotenuse.
CAH stands for Cosine equals Adjacent over Hypotenuse.
TOA stands for Tangent equals Opposite over Adjacent.

SOH $\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$

CAH $\cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$

TOA $\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$

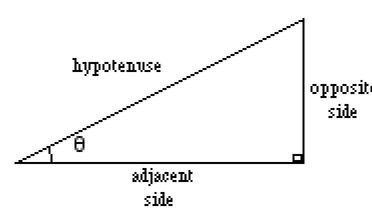


Table of Trigonometric Ratios

Trigonometry is not really a mystery. Its simply a table or ratios that are true for any triangle of certain angles. Before scientific calculators came along, we used tables like this to do trigonometry. If you are having any trouble understanding basic sine, cosine and tangent functions, you may find using the table helpful!

m° ∠A	sin A	cos A	tan A	m° ∠A	sin A	cos A	tan A
1	0.0175	0.9998	0.0175	46	0.7193	0.6947	1.0355
2	0.0349	0.9994	0.0349	47	0.7314	0.6820	1.0724
3	0.0523	0.9986	0.0524	48	0.7431	0.6691	1.1106
4	0.0698	0.9976	0.0699	49	0.7547	0.6561	1.1504
5	0.0872	0.9962	0.0875	50	0.7660	0.6428	1.1918
6	0.1045	0.9945	0.1051	51	0.7771	0.6293	1.2349
7	0.1219	0.9925	0.1228	52	0.7880	0.6157	1.2799
8	0.1392	0.9903	0.1405	53	0.7986	0.6018	1.3270
9	0.1564	0.9877	0.1584	54	0.8090	0.5878	1.3764
10	0.1736	0.9848	0.1763	55	0.8192	0.5736	1.4281
11	0.1908	0.9816	0.1944	56	0.8290	0.5592	1.4826
12	0.2079	0.9781	0.2126	57	0.8387	0.5446	1.5399
13	0.2250	0.9744	0.2309	58	0.8480	0.5299	1.6003
14	0.2419	0.9703	0.2493	59	0.8572	0.5150	1.6643
15	0.2588	0.9659	0.2679	60	0.8660	$0.5\overline{0}$	1.7321
16	0.2756	0.9613	0.2867	61	0.8746	0.4848	1.8040
17	0.2924	0.9563	0.3057	62	0.8829	0.4695	1.8807
18	0.3090	0.9511	0.3249	63	0.8910	0.4540	1.9626
19	0.3256	0.9455	0.3443	64	0.8988	0.4384	2.0503
20	0.3420	0.9397	0.3640	65	0.9063	0.4226	2.1445
21	0.3584	0.9336	0.3839	66	0.9135	0.4067	2.2460
22	0.3746	0.9272	0.4040	67	0.9205	0.3907	2.3559
23	0.3907	0.9205	0.4245	68	0.9272	0.3746	2.4751
24	0.4067	0.9135	0.4452	69	0.9336	0.3584	2.6051
25	0.4226	0.9063	0.4663	70	0.9397	0.3420	2.7475
26	0.4384	0.8988	0.4877	71	0.9455	0.3256	2.9042
27	0.4540	0.8910	0.5095	72	0.9511	0.3090	3.0777
28	0.4695	0.8829	0.5317	73	0.9563	0.2924	3.2709
29	0.4848	0.8746	0.5543	74	0.9613	0.2756	3.4874
30	$0.5\overline{0}$	0.8660	0.5774	75	0.9659	0.2588	3.7321
31	0.5150	0.8572	0.6009	76	0.9703	0.2419	4.0108
32	0.5299	0.8480	0.6249	77	0.9744	0.2250	4.3315
33	0.5446	0.8387	0.6494	78	0.9781	0.2079	4.7046
34	0.5592	0.8290	0.6745	79	0.9816	0.1908	5.1446
35	0.5736	0.8192	0.7002	80	0.9848	0.1736	5.6713
36	0.5878	0.8090	0.7265	81	0.9877	0.1564	6.3138
37	0.6018	0.7986	0.7536	82	0.9903	0.1392	7.1154
38	0.6157	0.7880	0.7813	83	0.9925	0.1219	8.1443
39	0.6293	0.7771	0.8098	84	0.9945	0.1045	9.5144
40	0.6428	0.7660	0.8391	85	0.9962	0.0872	11.4301
41	0.6561	0.7547	0.8693	86	0.9976	0.0698	14.3007
42	0.6691	0.7431	0.9004	87	0.9986	0.0523	19.0811
43	0.6820	0.7314	0.9325	88	0.9994	0.0349	28.6363
44	0.6947	0.7193	0.9657	89	0.9998	0.0175	57.2900
45	0.7071	0.7071	1	90	1	0	Undefined

4.4 The Bottom Line about Trigonometry in Physics Class:

- When you know any two sides of a right triangle, you can use the Pythagorean theorem to find the third side, and trigonometry to find the angle.
- If you know the angle of a triangle and any one side, you can use trigonometry to find the others.
- We will often start with knowing the angle and hypotenuse, and will use sine and cosine to find the horizontal and vertical sides.
- We will often also use the length of the horizontal and vertical sides to find the angle using the tangent function.

Unit 1 Summer Work Problems.

Complete all problems neatly on notebook paper and show work as appropriate. For instance, you should explicitly show your factor label method in unit conversion problems.

Warmup Exercise #1: Your First Physics Problems!

See if you can come up with a reasonable estimate for the following. Start with a simple piece of information, like how much a typical student weighs, and then see what you can figure out.

a) What do you think the weight of the entire senior class is?

b) How many blades of grass are there on our football field?

c) How many breath's does an average person take in their lifetime?

Lesson 1 Homework

How Many Significant Digits for Each Number?

1)	0.06260	= _____	11)	8.30×10^{-1}	= _____
2)	0.0501	= _____	12)	9308	= _____
3)	9.80×10^{5}	= _____	13)	0.000600	= _____
4)	0.0305	= _____	14)	5050	= _____
5)	9.68×10^{2}	= _____	15)	1030	= _____
6)	0.0003	= _____	16)	40	= _____
7)	502	= _____	17)	7×10^{-8}	= _____
8)	1318	= _____	18)	0.0800	= _____
9)	5032	= _____	19)	1.900×10^{-3}	= _____
10)	1.15×10^{8}	= _____	20)	9.64×10^{-4}	= _____

Lesson 2 Homework - Single and Double Unit Conversions

2.8 Convert the French speed limit of 140 km/hr into mi/hr using the factor label method – show your work!

2.9 A student weighs 160 pounds. Perform the following conversions using the factor label method. Show all work. See section 2.3 for conversion factors.

i. Convert this weight into a mass in kg
ii. Convert your mass from kg into μg
iii. Convert your weight into Newtons

2.10 An English lord says he weighs 12 stone.

a. Convert his weight into pounds (you may have to do some research online)
b. Convert his weight in stones into a mass in kilograms

2.11 If the speed of your car increases by 10 mi/hr every 2 seconds, how many mi/hr is the speed increasing every second? State your answer with the units mi/hr/s.

2.12 The speed of light is 3.0×10^8 m/s. Convert this to furlongs per fortnight. A furlong is 220 yards, and a fortnight is 14 days. An inch is 2.54 cm.

2.13 Estimate or measure your height.

i. Convert your height from feet and inches to meters
ii. Convert your height from feet and inches to centimeters (100 cm = 1 m)

2.14 Estimate or measure the amount of time that passes between breaths when you are sitting at rest.

i. Convert the time from seconds into hours
ii. Convert the time from seconds into milliseconds (ms)

2.15 Express each of the following quantities in micrograms:

(a) 10 mg, (b) 104 g, (c) 10 kg, (d) 100×10^3 g, (e) 1000 ng.

2.16 Convert 134 mg to units of kg, writing your answer in scientific notation.

2.18 The density of copper is 0.386 grams per milliliter. Find the density of copper in kg per cubic meter.

2.19 The speed of light is 300,000,000 meters per second. How many miles per hour is this?

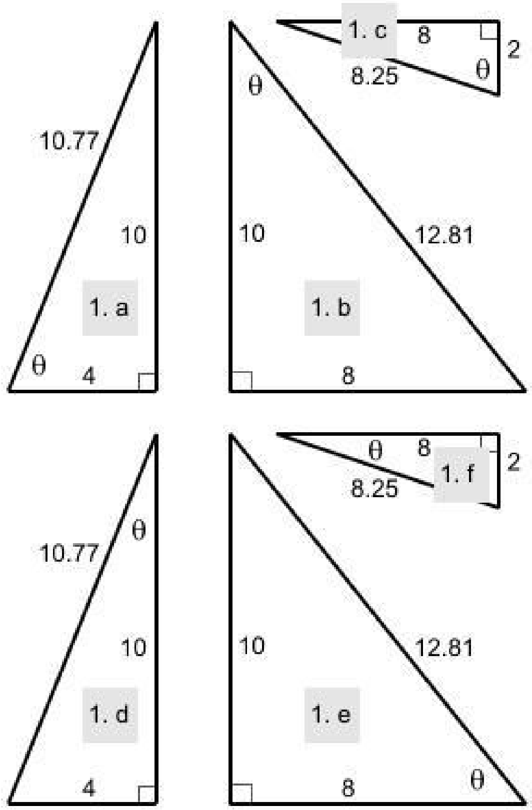
2.21 The speed limit on many roads in Canada is 90 kilometers per hour. What is the speed in centimeters per second?

2.22 My new car gets 10.2 kilometers per liter. What is my gas mileage in kilometers per kiloliter?

2.24 Spinal bifida, a birth defect can be prevented if expectant mothers take 1000 milligrams of folic acid per day. How many kilograms would these women need if they took it for 40 weeks? (Hint: find kilograms per week).

Lesson 4 Homework

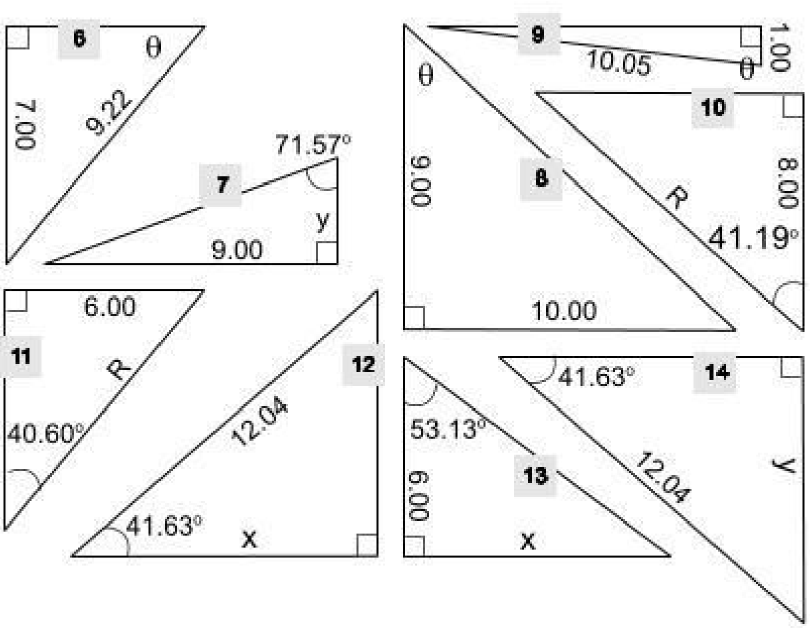
(http://www.physics247.com/physics-homework-help/trigonometry.php)



4.1 For each of the triangles labeled 1.a to 1.f, calculate the sine of the indicated angle (show your work). Use the inverse sine function of your calculator or the trig tables to determine the angle.

4.2 For each of the triangles labeled 1.a to 1.f, calculate the cosine of the indicated angle (show your work). Use the inverse cosine function of your calculator or the trig tables to determine the angle.

4.3 For each of the triangles labeled 1.a to 1.f, calculate the tangent of the indicated angle (show your work)). Use the inverse tangent function of your calculator or the trig tables to determine the angle.



Use the diagram to the right for problem 4.4.

4.5 For each triangle #6 through #14, find the missing side (x, y, or R) or the missing angle (θ).

Homework #5: Putting it All Together: Sig Figs, Units, Scientific Notation, Graphical Relationships, Proportion/Scaling and Trigonometry Problems

5.1 How many significant figures do you usually use for

a) air temperature,
b) a gallon of gas,
c) your weight

5.2 If you use a meter stick to measure something (in meters), what is the maximum number of decimal places you could measure to.

5.3 Describe an example of a situation or job in which keeping track of significant figures is important (be specific in your example)

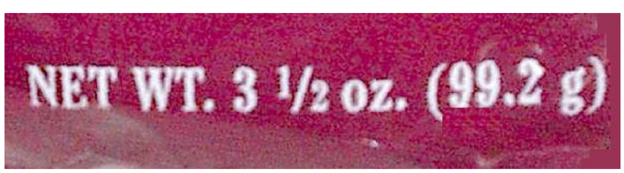
5.4 Nice even measurements are often written like this in American textbooks – 20 meters. From a significant figures standpoint, what is problematic about knowing how precise this measurement is?

5.5 Why are significant digits usually not considered important in math class? What is different about the number 3 used in math class and a measurement of 3 liters?

5.6 In the last century, the average age of the onset of puberty for girls has decreased by several years. Urban folklore has it that this is because of hormones fed to beef cattle, but it is more likely to be because modern girls have more body fat on the average and possibly because of estrogen-mimicking chemicals in the environment from the breakdown of pesticides. A hamburger from a hormone-implanted steer has about 0.2 ng of estrogen (about double the amount of natural beef). A serving of peas contains about 300 ng of estrogen. An adult woman produces about 0.5 mg of estrogen per day (note the different unit!). (a) How many hamburgers would a girl have to eat in one day to consume as much estrogen as an adult woman's daily production? (b) How many servings of peas?

5.7 In an article on the SARS epidemic, the May 7, 2003 New York Times discusses conflicting estimates of the disease's incubation period (the average time that elapses from infection to the first symptoms). "The study estimated it to be 6.4 days. But other statistical calculations ... showed that the incubation period could be as long as 14.22 days." What's wrong here?

5.8 The photo shows the corner of a bag of pretzels. What's wrong here?



Extra Practice with Double Conversions: <u>Show all work setting up the factor label method</u>. If you need a conversion factor, look it up!

5.9 Convert 33mi/hr to cm/week.

5.10 Convert 109g/L to Newtons/gallon.

5.11 Convert 16m/s to yards/hour

5.12 Convert 98mm/s to mi/year.

5.13 Convert 45m/s to mi/hr.

5.14 Convert 63mi/hr to m/s.

5.15 Convert 28 pounds/week to grams/day.

5.16. 80 m + 145 cm + 7850 mm = *X* mm. What is *X in the correct number of sig figs*?

5.17 As you know, a cube with each side 4 m in length has a volume of 64 m^3. Each side of the cube is now doubled in length. What is the *ratio* of the new volume to the old volume? Why is this ratio **not** simply 2? Include a sketch with dimensions.

5.18 A spacecraft can travel 20 km/s. How many km can this spacecraft travel in 1 hour (h)?

5.19 A dump truck unloads 30 kilograms (kg) of garbage in 40 s. How many kg/s are being unloaded?

5.20 The lengths of the sides of a cube are doubling each second. At what rate is the ***<u>volume</u>*** increasing