Scientific Basics Assignment 2018
AP Physics 1
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Dear AP Physics 1 Student, August 30th, 2018

Welcome to AP Physics 1. I'm excited to have you in my class this year!

The purpose of this assignment is to help you learn and/or review some basic skills we will use in this course. This set of assignments will provide resources and practice for units of measurement and dimensional analysis, scientific notation, and graphical interpretation.

Please complete the following packet, watching the videos and answering the video notes questions as you go along, and then working the practice questions. BE SURE TO SHOW ALL WORK in every section in order to earn credit, using the videos and sample problems as models.

I expect completion of this reading and the given problems to take you about **3 hours**. This assignment will be your first homework assignment and you will have a quiz assessing your understanding next Thursday (first E day of the year).

Hope you have had a great summer and I'm looking forward to working with you this year!

Mr. Frost

1.2 Physical Quantities and Units

Figure 1.16 The distance from Earth to the Moon may seem immense, but it is just a tiny fraction of the distances from Earth to other celestial bodies. (credit: NASA)

Learning Objectives

By the end of this section, you will be able to:

- Perform unit conversions both in the SI and English units.
- Explain the most common prefixes in the SI units and be able to write them in scientific notation.

The range of objects and phenomena studied in physics is immense. From the incredibly short lifetime of a nucleus to the age of Earth, from the tiny sizes of sub-nuclear particles to the vast distance to the edges of the known universe, from the force exerted by a jumping flea to the force between Earth and the Sun, there are enough factors of 10 to challenge the imagination of even the most experienced scientist. Giving numerical values for physical quantities and equations for physical principles allows us to understand nature much more deeply than does qualitative description alone. To comprehend these vast ranges, we must also have accepted units in which to express them. And we shall find that (even in the potentially mundane discussion of meters, kilograms, and seconds) a profound simplicity of nature appears—all physical quantities can be expressed as combinations of only four fundamental physical quantities: length, mass, time, and electric current.

We define a **physical quantity** either by *specifying how it is measured* or by *stating how it is calculated* from other measurements. For example, we define distance and time by specifying methods for measuring them, whereas we define *average speed* by stating that it is calculated as distance traveled divided by time of travel.

Measurements of physical quantities are expressed in terms of **units**, which are standardized values. For example, the length of a race, which is a physical quantity, can be expressed in units of meters (for sprinters) or kilometers (for distance runners). Without standardized units, it would be extremely difficult for scientists to express and compare measured values in a meaningful way. (See Figure 1.17.)

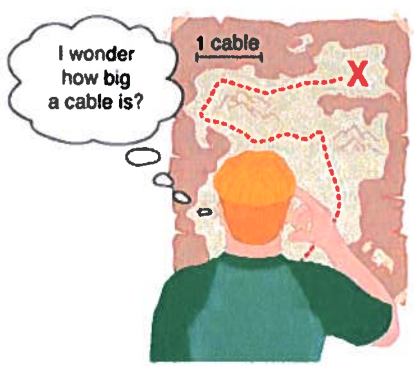


Figure 1.17 Distances given in unknown units are maddeningly useless.

There are two major systems of units used in the world: **SI units** (also known as the metric system) and **English units** (also known as the customary or imperial system). **English units** were historically used in nations once ruled by the British Empire and are still widely used in the United States. Virtually every other country in the world now uses SI units as the standard; the metric system is also the standard system agreed upon by scientists and mathematicians. The acronym "SI" is derived from the French *Système International*.

The Kilogram

The SI unit for mass is the **kilogram** (abbreviated kg); it is defined to be the mass of a platinum-iridium cylinder kept with the old meter standard at the International Bureau of Weights and Measures near Paris. Exact replicas of the standard kilogram are also kept at the United States' National Institute of Standards and Technology, or NIST, located in Gaithersburg, Maryland outside of Washington D.C., and at other locations around the world. The determination of all other masses can be ultimately traced to a comparison with the standard mass.

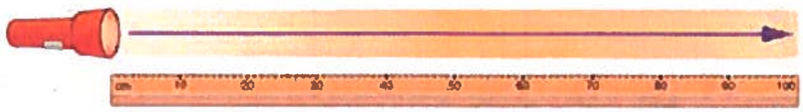


Figure 1.19 The meter is defined to be the distance light travels in 1/299,792,458 of a second in a vacuum. Distance traveled is speed multiplied by time.

Electric current and its accompanying unit, the ampere, will be introduced in Introduction to Electric Current, Resistance, and Ohm's Law when electricity and magnetism are covered. The initial modules in this textbook are concerned with mechanics, fluids, heat, and waves. In these subjects all pertinent physical quantities can be expressed in terms of the fundamental units of length, mass, and time.

Metric Prefixes

SI units are part of the **metric system**. The metric system is convenient for scientific and engineering calculations because the units are categorized by factors of 10. Table 1.2 gives metric prefixes and symbols used to denote various factors of 10.

Metric systems have the advantage that conversions of units involve only powers of 10. There are 100 centimeters in a meter, 1000 meters in a kilometer, and so on. In nonmetric systems, such as the system of U.S. customary units, the relationships are not as simple—there are 12 inches in a foot, 5280 feet in a mile, and so on. Another advantage of the metric system is that the same unit can be used over extremely large ranges of values simply by using an appropriate metric prefix. For example, distances in meters are suitable in construction, while distances in kilometers are appropriate for air travel, and the tiny measure of nanometers are convenient in optical design. With the metric system there is no need to invent new units for particular applications.

The term **order of magnitude** refers to the scale of a value expressed in the metric system. Each power of 10 in the metric system represents a different order of magnitude. For example, 10^1, 10^2, 10^3, and so forth are all different orders of magnitude. All quantities that can be expressed as a product of a specific power of 10 are said to be of the *same* order of magnitude. For example, the number 800 can be written as 8×10^2, and the number 450 can be written as 4.5×10^2. Thus, the numbers 800 and 450 are of the same order of magnitude: 10^2. Order of magnitude can be thought of as a ballpark estimate for the scale of a value. The diameter of an atom is on the order of 10^{-9} m, while the diameter of the Sun is on the order of 10^9 m.

The Quest for Microscopic Standards for Basic Units

The fundamental units described in this chapter are those that produce the greatest accuracy and precision in measurement. There is a sense among physicists that, because there is an underlying microscopic substructure to matter, it would be most satisfying to base our standards of measurement on microscopic objects and fundamental physical phenomena such as the speed of light. A microscopic standard has been accomplished for the standard of time, which is based on the oscillations of the cesium atom.

The standard for length was once based on the wavelength of light (a small-scale length) emitted by a certain type of atom, but it has been supplanted by the more precise measurement of the speed of light. If it becomes possible to measure the mass of atoms or a particular arrangement of atoms such as a silicon sphere to greater precision than the kilogram standard, it may become possible to base mass measurements on the small scale. There are also possibilities that electrical phenomena on the small scale may someday allow us to base a unit of charge on the charge of electrons and protons, but at present current and charge are related to large-scale currents and forces between wires.

Part A: Units

Intro to Units Reading Notes.

Complete these questions, using the reading on the previous pages.

1. What are the four fundamental physical quantities referred to in the text?

Length, mass, time, electric charge

2. What are the SI units for each of the four dimensions you wrote above?

m, Kg, S, coulomb (c)

3. How many meters is a kilometer? How many Hertz is a GigaHertz?

1,000 1,000,000,000 1billion — or 10^9

Unit Conversions

Video Notes

4. What is 3.45 pounds expressed in grams? (Show all work, using the method from the first video at http://bit.ly/conversionsvid1)

$$\frac{3.45\ \text{pounds}}{} \times \frac{16\ \text{oz}}{1\ \text{lb}} \times \frac{28.35\ \text{g}}{1\ \text{oz}} = 1{,}565\ \text{grams}$$

5. On a certain day, the exchange rate between US Dollars and Euros is 1 USD = 0.78 Euros. On that day, how much is 125 Euros worth in US Dollars? (Show all work, using the method from the first video)

$$\frac{125}{} \times \frac{1\ \text{USD}}{0.78}$$

$125 \div 0.78 = \$160.26$

6. How many seconds are there in five days? (Show all work, using the method from the second video at http://bit.ly/conversionsvid2)

$$\frac{5\ \text{d}}{} \times \frac{24\ \text{h}}{1\ \text{d}} \times \frac{60\ \text{min}}{1\ \text{h}} \times \frac{60\ \text{sec}}{1\ \text{min}} = 432{,}000\ \text{sec}$$

SAMPLE PROBLEM

Sometimes you start out with a unit that has a numerator and a denominator, like a rate or ratio. Consider a speed of 12 miles/hour. What would this be in meters/minute?

$$\frac{12\ miles}{hour} * \frac{1600}{1\ mile} * \frac{1\ hour}{60\ minutes} = \frac{15*1600\ meters}{60\ minutes}$$

$$= \frac{320\ meters}{minute}$$

12. Convert 5 meters per second to km per hour.

~~5m | 1Km / 1000m = 0.005 Km~~

$$\frac{5m}{sec} \times \frac{0.001\ Km}{1m} \times \frac{60sec}{1min} \times \frac{60min}{1hour}$$

= 18 Km per hour

13. Convert 50 miles per hour to feet per second.

$$\frac{50\ miles}{1\ hour} \left| \frac{5,280ft}{1\ mile} \right| \frac{1\ hr}{60\ min} \left| \frac{1\ min}{60sec} \right.$$

= 73.33 ft/sec

14. Convert 11.3 grams/mL to kg/liter

$$\frac{11.3g}{1mL} \left| \frac{1Kg}{1000g} \right| \frac{1000mL}{1L}$$

= 11.3 kg/liter

15. Challenge: Convert 11.3 grams/mL to kg/m^3

$$\frac{11.3g}{1mL} \left| \frac{1Kg}{1000g} \right| \frac{1000000mL}{1m^3}$$

= 11,300 Kg/m^3

Here is a table to help you get started. Fill in the blanks with the conversions.

1 artock = 1 uban	1 tarman = 3 olum
Artock/uban = 1 jal	2 san = 4 artock
1 ubic = 2 uban	0.5 soon = 1 san
1 uber = 0.5 ubic	0.5 leah = 1 soon
1 lumbar = 3 uber	1 gulag = 3 san
1 ballock = 2 artock	2 jal = 1 gallon
1 olum = 4 artock	$1 = 2 uban

5. Did the proprietor try to cheat you (compare your answer from question 4 to your answer in question 1)

Yes because 3 artocks/quart is a worse deal for bananas than half an artock per quart, the initial advertised cost.

6. Compared to American bananas, is the typical price (the flyer price) of bananas in Malloway expensive or cheap?

$\frac{0.5\text{ art}}{1\text{ qt}} \cdot \frac{1\text{ uban}}{2\text{ artock}} \cdot \frac{\$1}{2\text{ uban}} = \$0.25/\text{quart}$

Cheaper than $0.56 per qt

7. How many UBER of ivory are equal to 4 TARMAN of brass?

$4\text{ tarman} \cdot \frac{3\text{ olom}}{1\text{ tarman}} \cdot \frac{4\text{ artock}}{1\text{ olom}} \cdot \frac{1\text{ uban}}{1\text{ artock}} \cdot \frac{1\text{ ubic}}{2\text{ uban}} \cdot \frac{1\text{ uber}}{2\text{ ubic}} = 12\text{ uber}$

8. What is the relationship between an ARTOCK and a TARMAN?

$1\text{ artock} \cdot \frac{1\text{ olum}}{4\text{ artock}} \cdot \frac{1\text{ tarman}}{3\text{ olum}} = \frac{1}{12}\text{ tarman}$

This result can help us make meaning from an unknown equation or check that it is correct. Consider the expression

$$Money\ Earned = Wage + \$40$$

We would expect "money earned" to have units of dollars, but "wage" has units of dollars/hour. We cannot add dollars/hour to 40 dollars, because they have different units. Let's fix it:

$$Money\ Earned = Wage * time + \$40$$

Now our equation works. When we multiply our wage * time, we get units of dollars (hours cancel out). Then we can add $40, and our result is in dollars, which matches what we expected from "money earned" on the lefthand side of the equation. An example where this equation might apply is if you charge a travel fee of $40 and an additional charge of $10 for each hour you work.

One more example, to show how we can use the units to determine the meaning of an unknown equation:

$$Q = \frac{Volume}{Time}$$

Although we may not know exactly what Q measures, we can think about the units of volume (gallons, perhaps) and of time (seconds). So the units of Q would be gallons/second. Gallons/second might measure the flow rate of water from a faucet.

Practice

16. Which of the following are valid expressions? Which could be valid if a unit conversion is done?

$$a.\ 4.2\ hours + 1.2\ hours + 2.2\ hours$$

$$b.\ 9.0\ \frac{dollars}{yard} + 3\ yards$$

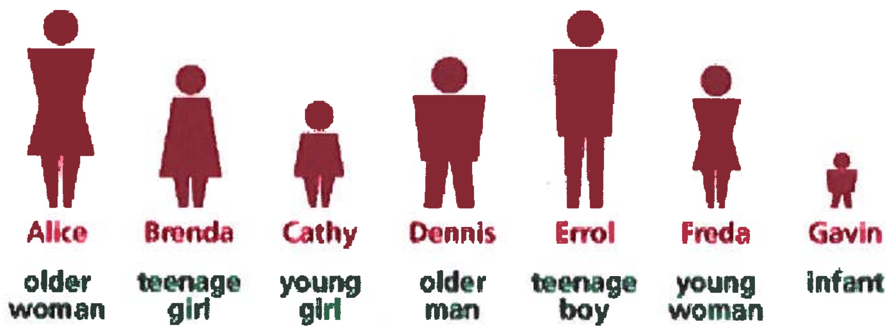
$$c.\ 9.0\ \frac{dollars}{yard} * 3\ yards + \$2$$

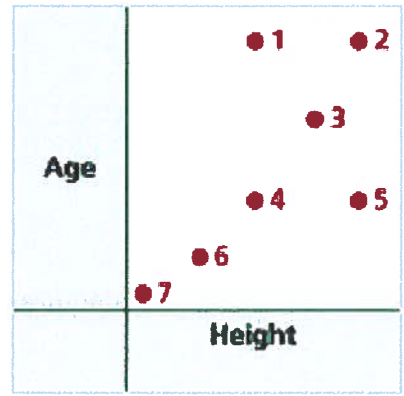
$$d.\ 18\ feet + 6\ inches$$

Part C: Graphical Representations

The exercises below are taken from www.learner.org. Try them on your own without using outside resources. This will be checked for completeness and evidence of effort, but not correctness. This is to help me understand what skills you already have in interpreting graphs.

1. Look at the graph below. Who is represented by each point?



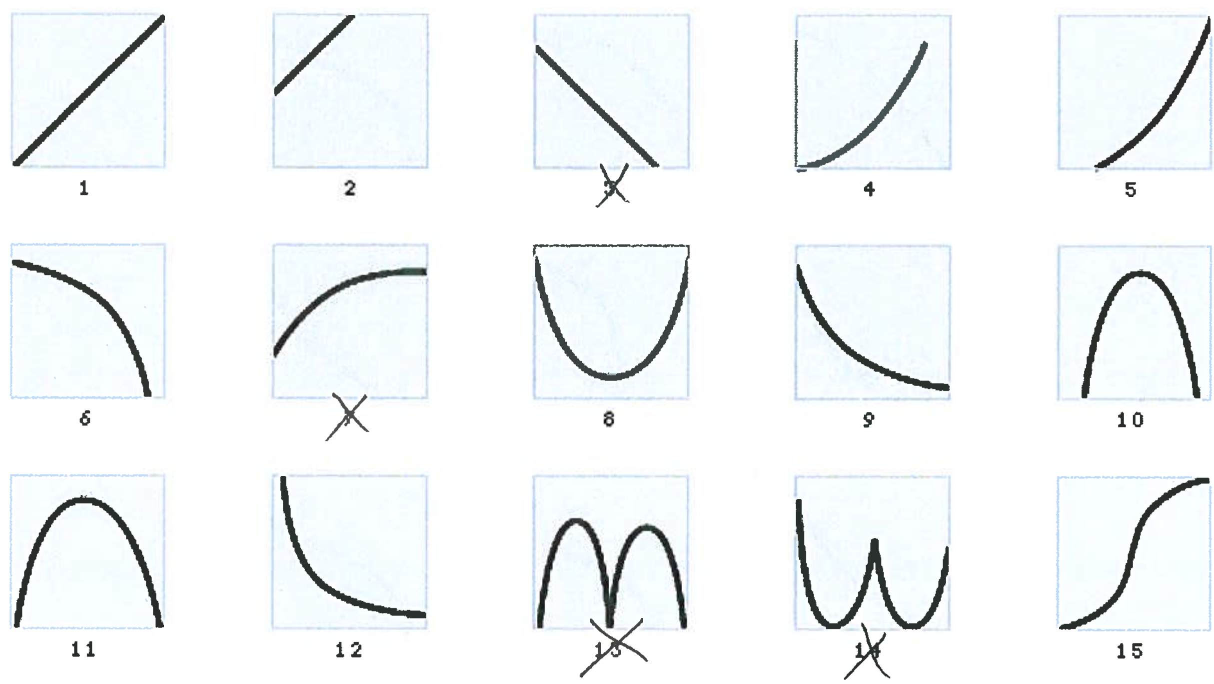


Point 1:	Dennis	Point 5:	Errol
Point 2:	Alice	Point 6:	Cathy
Point 3:	Freda	Point 7:	Gavin
Point 4:	Brenda		

Briefly explain **how** you know:

I Know because the relation of height and age are shown in 2 ways, by a chart and a model. I can determine their placement on the chart by comparing the visual models to their own descriptions then their spot on the graph.

3. Often we are asked to sketch graphs from words or descriptions. Choose the best graph to fit each of the situations described below. Also, state what the LABELS of the horizontal and vertical axes would be



Description	Which Graph?	Horizontal Axis	Vertical Axis
a. I really enjoy cold milk or hot milk, but I hate lukewarm milk.	13	Temperature (°F)	favorability (mhm's)
b. Prices are now rising more slowly than at any time during the last five years.	7	Time (years)	Prices ($)
c. The smaller the boxes are, the more boxes we can load into the van.	3	size of load (# of boxes)	Size of boxes (in^3)
d. After the concert there was a stunned silence. Then one person in the audience began to clap. Gradually, others joined in, and soon everyone was applauding and cheering.	4	time (sec)	clappers (people)
e. If the price for movie admission is too low, then the owners will lose money. If prices are too high, then few people will attend, and again the owners will lose.	14	Price of ticket ($)	Revenue ($)