Honors Physics-Summer Assignment

Welcome to Honors Physics! I am looking forward to working with you next year. In order for you to be prepared to take on the challenges of Honors Physics, I have prepared the following assignment for you to complete during the next two months. If you should have any difficulty with any portion of the assignment, please feel free to contact me via email at lisa.cole@bufordcityschools.org

Part 1: Summer Reading

This summer we will be reading *The Instant Physicist* by Richard Muller. This book is available at most local bookstores. You will be answering questions to support the material that is presented in the book. These questions will be available on my website on and after June 13. My website can be accessed at the following address: http://www.bufordcityschools.org/bhs/teachers/lisacole/index.htm.

Part 2: Viewing and Discussion of Podcasts

A list of podcasts will be made available to you on my website on June 13. You will be required to select **three** from the list to watch and then discuss via a blog. Instructions and requirements for your participation in the discussion will be made available to you on my website along with the list of podcasts.

Part 3: Review of Measurement and Basic Math Skills

The text that follows is a review of measurement and basic trigonometry. Please look through the review material and attempt the problems included throughout this handout. If you have questions or difficulty, please feel free to email me at the address above. This material will be collected on the first day of class and will be counted as a grade. You should also be prepared for a short quiz over the basic math skills on the first day of class.

Good luck and I look forward to working with you next year.
Ms. Cole

Units and measurement

SYSTEMS OF UNITS

Physics involves an objective description of the world, so measurement is a crucial tool. In measuring, we make use of a group of **standard units** comprising a **system of units**. The SI system of units, which is the modern version of the metric system, is the primary system of units we will use in this class.

Units in the SI system include **base units**, which are defined by standards, and **derived units**, which are defined in terms of the base units. The base units are:

Quantity	Name of Unit	Abbreviation	Definition
length	**m**eter	m	"…the length of the path traveled by light in a vacuum in 1/299,792,458 of a second." (1983)
mass	**k**ilogram	kg	"…this prototype [a certain platinum-iridium cylinder] shall henceforth be considered to be the unit of mass." (1989)
time	**s**econd	s	"…the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium-133 atom." (1967)
electric current	ampere	A	"…that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross section, and placed 1 meter apart in a vacuum, would produce between these conductors a force equal to 2×10^{-7} newton per meter of length." (1946)
temperature	Kelvin	K	"…the fraction 1/273.16 of the thermodynamic temperature of the triple point of water." (1967)
amount of substance	mole	mol	"…the amount of substance of a system which contains as many elementary entities as there are atoms in 0.012 kilograms of carbon-12." (1971)
luminous intensity	candela	cd	"…the luminous intensity, in the perpendicular direction, of a surface of 1/600,000 square meter of a blackbody at the temperature of freezing platinum under a pressure of 101.325 newtons per square meter." (1967)

This is called the **mks system** (for **m**eter-**k**ilogram-**s**econd)

Some examples of derived units include:

Quantity	Name of Unit	Symbol
area	square meter	m^2
volume	cubic meter	m^3
speed, velocity	meter/second	m/s
acceleration	meter/second/second	m/s^2
frequency	hertz	$Hz = s^{-1}$
force	newton	$N=kg \cdot m/s^2$

You should also be familiar with the SI prefixes:

Multiple	Prefix	Abbreviation
10^{12}	tera-	T
10^{9}	**giga-**	G
10^{6}	**mega-**	M
10^{3}	**kilo-**	k
10^{2}	hecto-	h
10	deka-	da
10^{-1}	deci-	d

Multiple	Prefix	Abbreviation
10^{-2}	**centi-**	c
10^{-3}	**milli-**	m
10^{-6}	**micro-**	μ
10^{-9}	**nano-**	n
10^{-12}	pico-	p
10^{-15}	femto-	f

The prefixes in bold are the most commonly used ones in this class.

Example: How many micrometers are in 3 x 10^{3}kilometers?
3 x 10^{12} micrometers

DIMENSIONAL ANALYSIS & UNIT ANALYSIS

Dimensional analysis is a procedure that you can use to check whether an equation is dimensionally correct or incorrect. You expect the two sides of an equation to be equal; thus they must have the same dimensions.

To perform dimensional analysis, replace each variable with the type of dimensions it measures then algebraically manipulate the dimensions to simplify. If the left hand side and right hand side have the same dimensions, the equation is dimensionally correct.

Dimensions of common quantities:

Quantity	Dimension	Unit
mass (m)	[M]	[kg]
time(t)	[T]	[s]
length	[L]	[m]
area	[L^2]	[m^2]
volume	[L^3]	[m^3]
velocity (v)	[L]/[T]	[m/s]
acceleration (a or g)	[L]/[T^2]	[m/s^2]

For example, show that the equation for the area of a triangle: $A=1/2\ b \cdot h$ is dimensionally correct:

$A=1/2\ b \cdot h$

$[L^2] = ½\ [L] \cdot [L]$ replace each quantity with the dimension (L=length)

$[L^2] = [L] \cdot [L]$ ½ is dimensionless and can be ignored

$[L^2] = [L^2]$ "length" multiplied by "length" is "length squared"

Notice that this procedure doesn't necessarily tell you that the equation is physically correct, just that the quantities have the correct dimensions.

Unit analysis is very similar, but instead of using the dimensions (e.g. "length"), you use the units of measurement (e.g. "meters).

For examples, show that the equation: $v = v_o + at$ is dimensionally correct.

$v = v_o + at$

$[m/s] = [m/s] + [m/s^2][s]$ replace quantities with units

$[m/s] = [m/s] + [m/s]$ multiply units

$[m/s] = [m/s]$ add units

UNIT CONVERSION

Unit conversion is a vitally important technique in physics. In order to convert a quantity from one unit to another, multiply by the correct **conversion factor**-a state of equivalence in the form of a ratio.

For examples, convert 100 yards into feet (using the conversion 3 ft = 1 yd):

$$100 \text{ yd} \cdot \frac{3 \text{ ft}}{1 \text{ yd}} = 300 \text{ ft}$$

Convert 1 day into seconds:

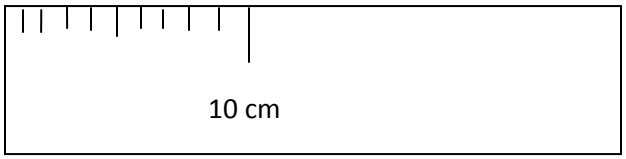
$$1 \text{ day} \cdot \frac{24 \text{ hr}}{1 \text{ day}} \cdot \frac{60 \text{ min}}{1 \text{ hr}} \cdot \frac{60 \text{ s}}{1 \text{ min}} = 86400 \text{ s}$$

SIGNIFICANT FIGURES

Significant figures are one method that physicists can use to convey the uncertainty or error in a measurement. The accuracy of a measurement depends on the measurement scale of the instrument being used – 5.1 m is a less accurate measurement than 5.12 m. "The significant figures in any measurement are the digits that are known with certainty, plus one digit that is uncertain." When taking a measurement, write down the digits that can be read directly from the instrument, and obtain another digit "by estimating the fraction of the smallest division of the instrument's scale."

For example, if you were measuring a piece of paper using a ruler divided into 1 cm increments:

You would start by writing 8. cm because you are certain it is 8 cm, and then estimate another digit based on the fraction. So 8.1 cm would be a valid measurement. It has two significant figures, one that is known with certainty and one that is estimated.



The rules for determining how many significant figures a written number has are:
1. Zeros at the beginning of a number are not significant. They merely locate the decimal point. For example,
   0.0254 m has three significant figures (2,5,4)
2. Zeros within a number are significant. For example,
   104.6 m has four significant figures (1,0,4,6)
3. Zeros at the end of a number after the decimal point are significant. For example,
   2705.0 m has five significant figures (2,7,0,5,0)
4. In whole numbers without a decimal point that end in one or more zeros (trailing zeros)-for example, 500 kg-the zeros may or may not be significant. In such cases, it is not clear which zeros serve only to locate the decimal point and which are actually part of the measurement. To avoid this, use scientific notation.

Exact numbers are numbers without uncertainty or error. For example, there are exactly 60 seconds in a minute. The radius is exactly half the diameter of a circle.

When performing calculations, use the following rules:
1. When multiplying or dividing quantities, leave as many significant figures in the answer as there are in the quantity with the least number of significant figures.
2. When adding or subtracting quantities, leave the same number of decimal places (rounded) in the answer as there are in the quantity with the last number of decimal places.

You can use SI prefixes or scientific notation to control the number of decimal places given in your answer.

Use these rules for rounding:
1. If the first digit to be dropped is less than 5, leave the preceding digit as is.
2. If the first digit to be dropped is 5 or greater, increase the preceding digit by one.

For example,
$(6.12\ \text{m}) * (2.9\ \text{m}) = 17.748\ \text{m}^2 = 18\ \text{m}^2$
(3 sig figs) (2 sig figs) (round to 2 sig figs)

$(1054.00\ \text{m}^2) / (0.0910\ \text{m}) = 11582\ \text{m} = 1.16 \times 10^4\ \text{m}$ or $11.6\ \text{km}$
(6 sig figs) (3 sig figs) (round to 3 sig figs)

Trigonometry
Remember the trigonometric ratios for right triangles:

$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$ $\cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$ $\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$

The Pythagorean theorem is very useful: $a^2 + b^2 = c^2$

For a nonright triangle, you can use the Law of Sines:

$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$ a, b, c are sides; A, B, C are the opposite angles

or the Law of Cosines:

$c^2 = a^2 + b^2 - 2ab\cos C$ or $\cos C = a^2 + b^2 - c^2 / 2ab$

Additional Math Review

Using powers of ten to describe very big and very small numbers.

Remember this stuff.

$10{,}000 = 10^4$
$1{,}000 = 10^3$
$100 = 10^2$
$10 = 10^1$
$1 = 10^0$
$0.1 = 10^{-1}$
$0.01 = 10^{-2}$
$0.001 = 10^{-3}$
$0.0001 = 10^{-4}$

$30{,}000 = 3x\ 10{,}000 = 3x10^4$
$30{,}000 = 30x\ 1000 = 30x10^3$
$30{,}000 = 30{,}000\ x\ 1 = 30{,}000x10^0$
$30{,}000 = 3{,}000{,}000x\ 0.01 = 3{,}000{,}000x10^{-2}$
All of the above are correct. They all describe 30,000.

Which is correct…..?

1.	300 is	a) 3×10^1	b) 3×10^2	c) 3×10^3	d) 3×10^4
2.	420 is	a) 4.2×10^1	b) 4.2×10^2	c) 4.2×10^3	d) 4.2×10^4
3.	0.34 is	a) 3.4×10^{-1}	b) 3.4×10^{-2}	c) 3.4×10^{-3}	d) 3.4×10^{-4}
4.	0.00034 is	a) 3.4×10^{-1}	b) 3.4×10^{-2}	c) 3.4×10^{-3}	d) 3.4×10^{-4}
5.	0.000000000034 is	a) 3.4×10^{-10}	b) 3.4×10^{-11}	c) 3.4×10^{-12}	d) 3.4×10^{-13}
6.	490000000000000000000000 is	a) 4.9×10^{21}	b) 4.9×10^{24}	c) 4.9×10^{25}	

Adding Exponents

$(4 \times 10^3) + (5 \times 10^2) = 4000 + 500 = 4500$
$(4.3 \times 10^4) + (4.3 \times 10^{-2}) = 43000 + 0.043 = 43000.043$
$(5.3 \times 10^3) - (2 \times 10^2) =$
$(6.72 \times 10^2) + (4.3 \times 10^{-1}) =$

Multiplying Exponents

$(4 \times 10^3) \times (5 \times 10^2) = 4 \times 5 \times 10^3 \times 10^2 = 20 \times 10^5 = 2 \times 10^6 = 0.2 \times 10^7$
$(4.3 \times 10^4) \times (4.3 \times 10^{-2}) = 4.3 \times 4.3 \times 10^4 \times 10^{-2} = 18.99 \times 10^2$
$(5.3 \times 10^3) \times (2 \times 10^2) =$
$(6.72 \times 10^2) \times (4.3 \times 10^{-1}) =$

Dividing Exponents

$(4 \times 10^3) \div (5 \times 10^2) = (4 \div 5) \times (10^3 \div 10^{2)} = 20 \times 10^5 = 0.8 \times 10^1 = 8$
$(4.3 \times 10^4) \div (4.3 \times 10^{-2}) = (4.3 \div 4.3) \times (10^4 \div 10^{-2)} = 1 \times 10^6$
$(5.3 \times 10^3) \div (2 \times 10^2) =$
$(5.3 \times 10^3) \times (2 \times 10^2) =$

Entering very big and very small numbers into your calculator.

Say this… " …times ten to the…".
Pressing | 2nd | EE | on your calculator is the equivalent of saying " times ten to the".

So, how do you enter 4×10^5 into your calculator.
You would say this in the following way " 4 times ten to the 5".
You would enter into your calculator the following….

4	2nd	EE	5

Enter these problems into your calculator…

$(3.9 \times 10^7) \times (2 \times 10^2)$

3	.	9	2nd	EE	7	x	2	2nd	EE	2	enter

Your answer should be…. ?

$(3.9 \times 10^{-7}) \times (2 \times 10^2)$

3	.	9	2nd	EE	(-)	7	x	2	2nd	EE	2	enter

Your answer should be…. ?

$(-3.9 \times 10^{-7}) \times (2 \times 10^2)$

(-)	3	.	9	2nd	EE	(-)	7	x	2	2nd	EE	2	enter

Your answer should be…. ?

Use your calculator to answer the following….

$(3 \times 10^3) \times (2 \times 10^2) =$

$(3 \times 10^3) + (2 \times 10^{-2}) =$

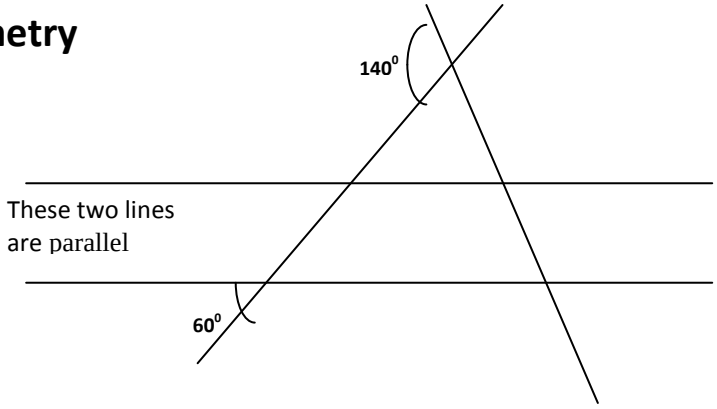
$(-3 \times 10^{-3}) / (2 \times 10^2) =$

$(3 \times 10^3) - (2 \times 10^2) =$

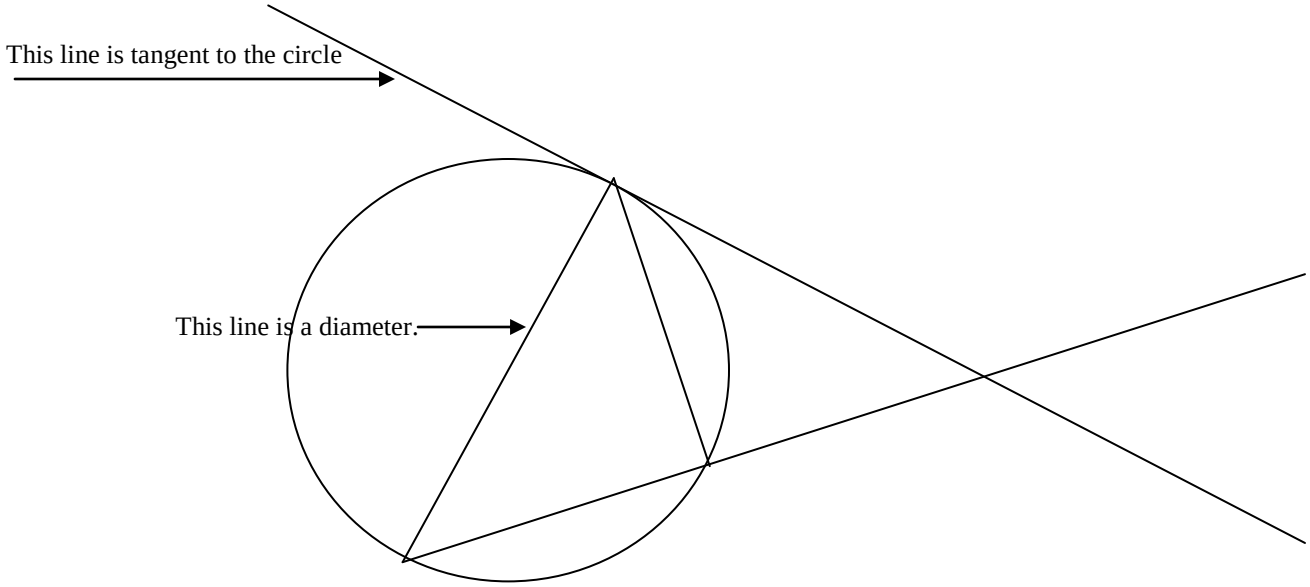
$(3 \times 10^3) \times (2 \times 10^{-2}) =$

$(-3 \times 10^{-3}) \times (2 \times 10^2) =$

Geometry



On both pictures, write down the value of every angle.



HONORS PHYSICS-SUMMER PROBLEM SET

Basic Math Skills for Physics

1. $x^{12}x^{13}$ =

2. $\frac{x^{13}}{x^{12}}$ =

3. $3^2\ 2^{-3}$ =

4. $2^{3/2}$ =

5. $3^2 + 2^{-3}$

6. $(2.5 \times 10^3) + (2.7 \times 10^2)$ =

7. $(2.5 \times 10^3)\ (2.7 \times 10^2)$ =

8. $(2.5 \times 10^3)(10^2)$ =

Rearrange the following formulas…

a = c/d

9. c =

10. d =

a = cd + g

11. c =

12. g =

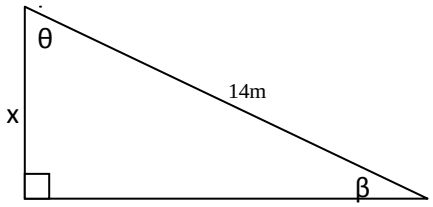
c= $\sqrt{a^2 + b^2}$

13. a =

s= (vt) +(½ at^2)

14. a =

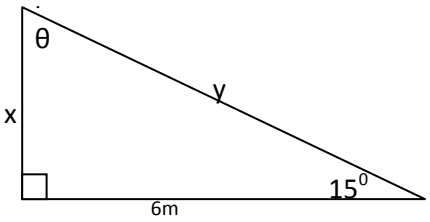
15. v =



16. x =

17. θ =

18. β =



19. x =

20. θ =

21. y =

What do these symbols mean in math?...

22. Δ

23. ≤

24. ≠

25. ≈

26. ∞

27. ∑

HONORS PHYSICS-SUMMER PROBLEM SET

MEASUREMENT

1.) The only SI standard represented by an artifact is the (a) meter, (b) kilogram, (c) second, or (d) electric charge.

2.) Which of the following is *not* an SI base unit? (a) length, (b) mass, (c) weight, or (d) time

3.) Which one of the following is the SI unit of mass? (a) pound, (b) gram, (c) kilogram, or (d) ton

4.) Can dimensional analysis tell you whether you have used the correct equation in solving a problem? Explain.

5.) If x refers to distance, v_o and v to speeds, a to acceleration, and t to time, which of the following equations is dimensionally correct?
(a) $x = v_o t + at^3$, (b) $v^2 = v_o^2 + 2at$, (c) $x = at + vt^2$, or (d) $v^2 = v_o^2 + 2ax$

6.) Is the equation $v = v_o \sin\theta - gt^2$ dimensionally correct? Use SI unit analysis to find out. (v and v_o are velocities, θ is an angle, t is time, and g is acceleration.)

7.) Newton's second law of motion is expressed by the equation F = ma, where F represents force, m is mass, and a is acceleration. (a) The SI unit of force is, appropriately, called the newton (N). What are the units of the newton in terms of base quantities? (b) An equation for force associated with uniform circular motion is $F=mv^2 / r$, where v is speed and r is radius of the circular path. Does this equation give the same units for the newton?

8.) Standing at 452 m, the Petronis Twin Towers in Malaysia is one of the tallest buildings in the world. What is its height in feet?

HONORS PHYSICS-SUMMER PROBLEM SET

9.) If blood flows with an average speed of 0.35 m/s in the human circulatory system, how many miles does a blood cell travel in 1 h?

10.) The density of metal mercury is 13.6 g/cm^3. (a) What is this density as expressed in kg/m^3? (b) How many kilograms of mercury would be required to fill a 0.250 L container?

11.) Which of the following has the greatest number of significant figures? (a) 103.07, (b) 124.5, (c) 0.09916, or (d) 5.408×10^5.

12.) In a multiplication and/or division operation involving the numbers 15437, 201.08, and 408.0×10^5, the result should be rounded to how many significant figures? (a) 3, (b) 4, (c) 5, or (d) any number.

13.) If a measured length is reported as 25.483 cm, could this length have been measured with an ordinary meterstick whose smallest division is millimeters? Discuss in terms of significant figures.

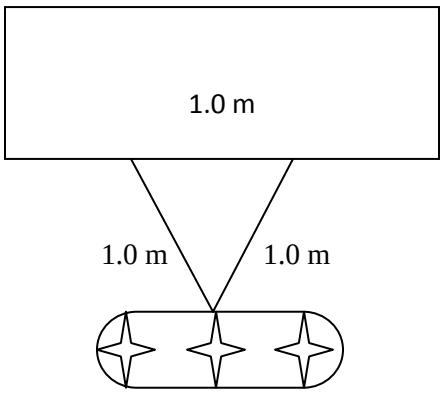
14.) A compact disc (CD) has a diameter of approximately 12 cm. What is its area in m^2?

15.) In doing a problem, a student adds 46.9 m and 5.72 m and then subtracts 38 m from the result. (a) How many decimal places will the final answer have, (1) zero, (2) one, or (3) two? (b) What is the final answer?

HONORS PHYSICS-SUMMER PROBLEM SET

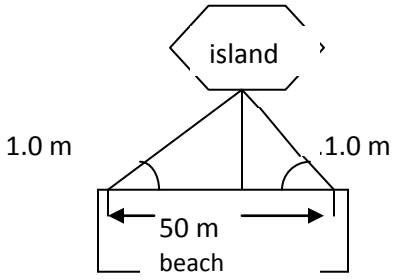
TRIGONOMETRY

1.) Two chains of length 1.0 m are sued to support a lamp, as shown in Fig. 1.21. The distance between the two chains is 1.0 m along the ceiling. What is the vertical distance from the lamp to the ceiling?



2.) The shortest distance between the bases on a baseball field is 90 ft. What is the straight-line distance in meters between first base and third base?

3.) A student wants to determine the distance of a small island from the lakeshore (Fig. 1.23). He first draws a 50 m line parallel to the shore. Then, he goes to the ends of the line and measures the angles of the lines of sight from the island relative to the line he has drawn. The angles are 30^{o} and 40^{o}. How far is the island from the shore?



4.) A car is driven 13 miles east and then a certain distance due north and ends up at a position 25^{O} north of east. (a) The distance traveled by the car due north is (1) less than, (2) equal to, or (3) greater than 13 miles. Why? (b) What distance does the car go due north?

5.) A ladder was standing perfectly upright against a wall. Suddenly the foot of the ladder slid away from the wall and came to a stop 15 feet from the wall. The top of the ladder had moved only 1/5 of the ladder's length before it came to rest firmly on a window sill. Do you have enough information to calculate the length of the ladder? If so, what is it?

6.) There are 10 krits in a flig, 6 fligs in a crat, 5 crats in a wirp, and 7 wirps in a nood. What is the number of krits in a nood divided by the number of fligs in a wirp?

7.) The Genesee Flyer leaves the station at 60 mph. After three hours, the Seneca Streamer leaves the same station at 75 mph, moving in the same direction on an adjacent track. Both trains depart the station at milepost 0. At what milepost will the Streamer draw equal with the Flyer?

Apothecaries (druggists) use the following set of measurements in the English system. Use the following conversions to answer **questions 8-10**.

20 grains ap = 1 scruple (exact)
3 scruples = 1 dram ap (exact)
8 dram ap = 1 oz ap (exact)
1 dram ap = 3.888 g

8.) How many troy ounces are equal to 1 oz ap. (Use the conversions from problems 7-9)

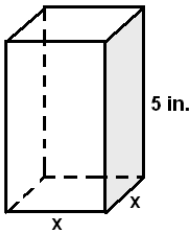
9.) An aspirin tablet contains 5.00×10^{2} mg of active ingredient. What mass in grains ap of active ingredient does it contain? What mass in scruples?

10.) What is the mass of 1 scruple in grams?

Quadratic Formula Word Problems

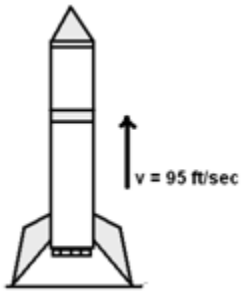
The following quadratic problems are similar to those we will be solving in our physics class. You have already seen many of these in Math II. Let's see what you remember.

1. The surface area of a rectangular box with a square base is 112 square inches. The surface area is given by $A = 2x^2 + 4xh$. Find x.



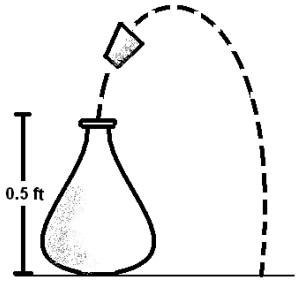
For problems #2 – 7, use the motion model $h = -16t^2 + v_0t + h_0$, where *h* is the height, *t* is the time, v_0 is the initial velocity and h_0 is the initial height.

2. You launch a model rocket from ground level with an initial velocity of 95 feet per second. After how many seconds will the rocket have an altitude of 114 feet?

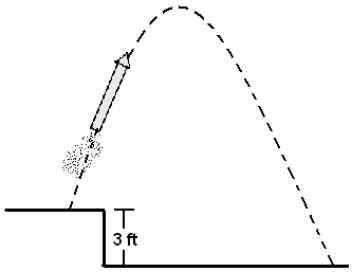


3. You throw a baseball in the air with a starting velocity of 28 feet per second. The baseball is 5 feet high when it leaves your hand. After how many seconds will it hit the ground?

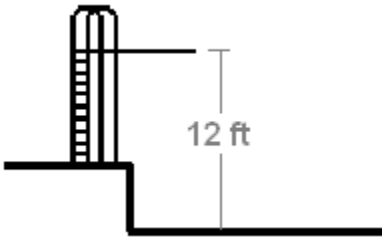
4. During a chemistry experiment, the cork in a 0.5-foot tall beaker with an effervescent solution pops off with an initial velocity of 20 feet per second. How many seconds does it take for the cork to hit the table?



5. Fireworks are shot upward with an initial velocity of 125 feet per second from a platform 3 feet above the ground. How long will it take the rocket to hit the ground?



6. A person steps off a 12-foot high diving board with 0 initial velocity. How many seconds does it take the person to hit the water?



7. A person springs off a 12-foot high diving board with an initial velocity of 15 feet per second. How many seconds does it take the person to hit the water?

LOGIC PROBLEMS

Physics is a branch of science that involves the study of the physical world: energy, matter, and how they are related. The goal of this course is to help you understand the physical world. Problem solving and the use of mathematics are important components to the study of physics. To expand your mind, you need to learn new facts and develop new ways of thinking that will make the information that you already know more useful. Try to solve the following problems using a combination of world knowledge, mathematics, common sense, logic, and science.

1. A chicken farmer also has some cows for a total of 30 animals, and the animals have 74 legs in all. How many chickens does the farmer have?

2. A scientist is experimenting with cubic bacteria that are one micrometer in length and that reproduce by dividing every minute into two bacteria. At 12:00 p.m., he puts a single organism in a container. At precisely 1:00 p.m., the container is full. At what time was the container half full? How big (in liters) was the container?

3. You start walking north and you walk in a straight line for two kilometers. When you look at the map, you discover that you actually walked one kilometer north and one kilometer south. How is this possible?

4. My sister has six red stamps and three blue stamps. In her collection, seven stamps are from Mexico and six stamps are from France. One stamp is purple and it is not from Mexico or France. Two of her Mexican stamps are red and one is blue. Two of her French stamps are blue and three are red. How many stamps does she have?

5. At an eBay auction, a woman's ring and jewelry box are on sale for $200.00. The jewelry box is valued at $190.00 more than the ring. How much is the ring worth?

6. The government pays farmers a specific fee for each row of four trees that they plant. An enterprising farmer found a way of planting five rows of four trees using only ten trees. How did he do it?

7. All students in the physics class also study mathematics. Half of those who study literature also study mathematics. Half of the students in the mathematics class study physics. Thirty students study literature and twenty students study physics. Nobody who studies literature studies physics. How many students in the mathematics class study neither physics nor literature?

8. You have to measure exactly 4 liters of water, but you only have a 3 liter bottle and a 5 liter bottle. How do you do it?