Dear AP Physics Student:

Welcome to AP Physics! You will learn not simply the theory and application of physics; instead, you will learn how to approach the process of problem solving. You will learn how to think like a scientist. Physics is just the medium through which we explore thinking. Any worthwhile endeavor involves some sort of tribulation. Don't be intimidated by a challenge; embrace the opportunity! A few suggestions as you pursue excellence:

Be willing to try, try again. Don't give up after the first attempt did not produce a solution. Never spend more than 10 minutes or so staring at a problem without getting somewhere. If you honestly have no idea what to do at some stage of a problem, STOP. Put the problem away. Physics has a way of becoming clearer after you take a break. On the same note, if you're stuck on some algebra, don't spend forever trying to find what you know is a small mistake, say a missing negative sign or something. Put the problem away, come back in an hour, and start from scratch. This will save you time in the long run. And finally, if you've put forth a real effort, you've come back to the problem many times, and you can't get it: relax. Ask the teacher for the solution, and allow yourself to be enlightened.

When you put are struggling with a problem, it always helps to discuss that problem with others. Form study groups; have a buddy in class with whom you are consistently comparing solutions. Though you may be able to do all your work in every other class without help, it is not shameful to ask for help. Nor is it dishonest to seek assistance – as long as you're not copying, or allowing a friend to carry you through the course, group study is permitted and encouraged in virtually every physics class around the globe. If you don't understand something, don't be afraid to ask. Chances are that the rest of the class has the same question. Sometimes the teacher will not answer you directly, but will give you a hint, something to think about so that you might guide yourself to your own answer. Don't interpret this as refusing to answer your question. You must learn to think for yourself, and your teacher is helping you develop the analysis skills you need for success in physics.

Physics is not about memorization and regurgitation. True, there are some equations you need to memorize. But problem solving skills cannot be learned overnight. Furthermore, physics is cumulative. The topics you discuss in December rely on the principles you learned in September. Spend some time on physics every night, even if that time is only a couple minutes, even if you have no assignment due the next day. Spread your "cram time" over the entire semester. The night before a major exam, I have always told my students not to study after 7 or 8 P.M. The purpose of all these problems, these equations, the exams, is to gain a working knowledge of physics, a deeper understanding of how the natural world works.

Don't be so caught up in the grind of your coursework that you fail to say "Wow!" occasionally. Some of the things you're learning are truly amazing. Physics gives insight into God's glorious creation and the incredible world we live in. Some of the most critical discoveries, our most powerful inventions, our most fundamental technologies originate from an understanding of physics. Enjoy yourself. You have an opportunity to emerge from your physics course with wonderful and useful knowledge, and unparalleled intellectual insight. Do it.

Sincerely,

Your Physics teacher

Prefix	Symbol	Meaning	Scientific Notation
exa-	E	1,000,000,000,000,000,000	10^{18}
peta-	P	1,000,000,000,000,000	10^{15}
tera-	T	1,000,000,000,000	10^{12}
giga-	G	1,000,000,000	10^{9}
mega-	M	1,000,000	10^{6}
kilo-	k	1,000	10^{3}
hecto-	h	100	10^{2}
deka-	da	10	10^{1}
—	—	1	10^{0}
deci-	d	0.1	10^{-1}
centi-	c	0.01	10^{-2}
milli-	m	0.001	10^{-3}
micro-	μ	0.000 001	10^{-6}
nano-	n	0.000 000 001	10^{-9}
pico-	p	0.000 000 000 001	10^{-12}
femto-	f	0.000 000 000 000 001	10^{-15}
atto-	a	0.000 000 000 000 000 001	10^{-18}

Part 1: Scientific Notation and Dimensional Analysis

Many numbers in physics will be provided in scientific notation. You need to be able read and simplify scientific notation. (**This section is to be completed *without* calculators…all work should be done by hand.)** Get used to no calculator! All multiple choice portions of tests will be completed without a calculator.

Express the following the numbers in scientific notation. Keep the same unit as provided. ALL answers in physics need their appropriate unit to be correct.

1. 7,640,000 kg

2. 8327.2 s

3. 0.000000003 m

4. 0.0093 km/s

Often times multiple numbers in a problem contain scientific notation and will need to be reduced by hand. Before you practice this, remember the **rules for exponents** you learned in algebra:

When numbers with exponents are multiplied together, you _____ the exponents and _____ the bases.

When numbers are divided, you _____ the exponents and _____ the bases.

When an exponent is raised to another exponent, you _____ the exponents and _____ the base.

Using the three rules from above, simplify the following numbers in proper scientific notation:

5. $(3\times10^{6})\cdot(2\times10^{4}) =$

6. $(1.2\times10^{4}) / (6\times10^{-2}) =$

7. $(4\times10^{8})\cdot(5\times10^{-3}) =$

8. $(7\times10^{3})^{2} =$

9. $(8\times10^{3}) / (2\times10^{5}) =$

10. $(2\times10^{-3})^{3} =$

Fill in the power and the symbol for the following unit prefixes. Look them up as necessary. These should be **memorized** for next year. Kilo- has been completed as an example.

Prefix	Power	Symbol
Giga-		
Mega-		
Kilo-	10^3	k
Centi-		
Milli-		
Micro-		
Pico-		

Not only is it important to know what the prefixes mean, it is also vital that you can convert between metric units. If there is no prefix in front of a unit, it is the base unit which has 10^0 for its power, or just simply "1". Remember if there is an exponent on the original unit, the converted unit should be raised to the same exponent.

Convert the following numbers into the specified unit. Use scientific notation when appropriate.

1. 24 g = _____ kg
2. 94.1 MHz = _____ Hz
3. 6 Gb = _____ kb
4. 640 nm = _____ m
5. 3.2 m^2 = _____ cm^2
6. 40 mm^3 = _____ m^3
7. 1 g/cm^3 = _____ kg/m^3
8. 20 m/s = _____ km/hr

For the remaining scientific notation problems you may use your calculator. It is important that you know how to use your calculator for scientific notation. The easiest method is to use the "EE" button. An example is included below to show you how to use the "EE" button.

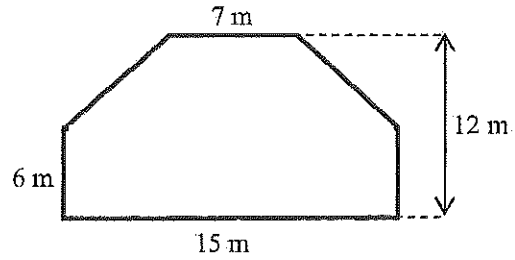
Ex: 7.8×10^{-6} would be entered as 7.8 E -6

9. $(3.67 \times 10^3)(8.91 \times 10^{-6}) =$
10. $(5.32 \times 10^{-2})(4.87 \times 10^{-4}) =$
11. $(9.2 \times 10^6) / (3.6 \times 10^{12}) =$
12. $(6.12 \times 10^{-3})^3$

Part 2: Geometry

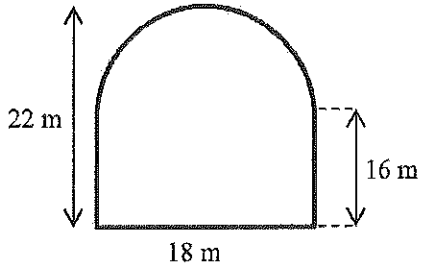
Calculate the area of the following shapes. It may be necessary to break up the figure into common shapes.

1.



Area = _____

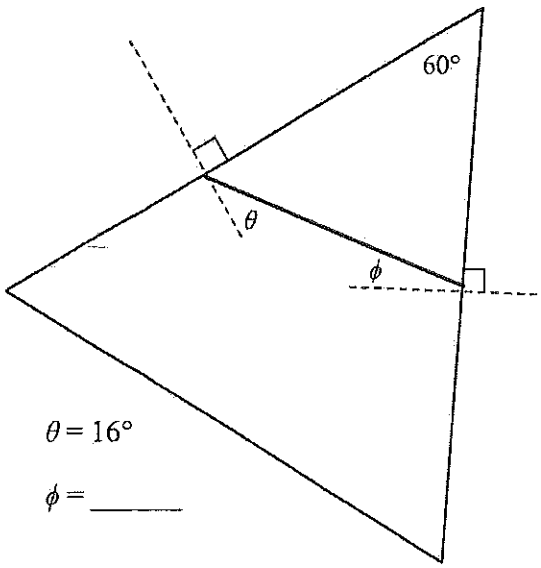
2.



Area = _____

Calculate the unknown angle values for questions 3-6.

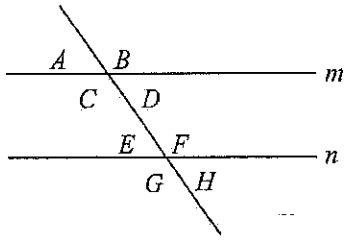
3.



$\theta = 16°$

$\phi =$ _____

4.

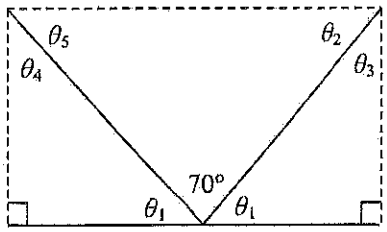


Lines m and n are parallel.

$A = 75°$ $B =$ _____ $C =$ _____ $D =$ _____

$E =$ _____ $F =$ _____ $G =$ _____ $H =$ _____

5.



$\theta_1 =$ _____

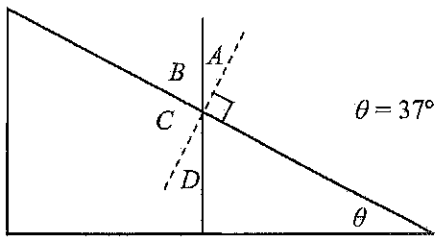
$\theta_2 =$ _____

$\theta_3 =$ _____

$\theta_4 =$ _____

$\theta_5 =$ _____

6.



$A =$ _____ $B =$ _____

$C =$ _____ $D =$ _____

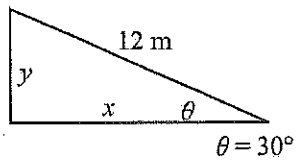
Part 4: Trigonometry

Write the formulas for each one of the following trigonometric functions. Remember SOHCAHTOA!

$\sin\theta =$ $\cos\theta =$ $\tan\theta =$

Calculate the following unknowns using trigonometry. Use a calculator, but show all of your work. Please include appropriate units with all answers. (Watch the unit prefixes!)

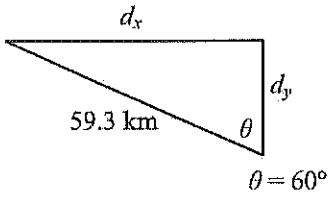
1.



$y =$ _____

$x =$ _____

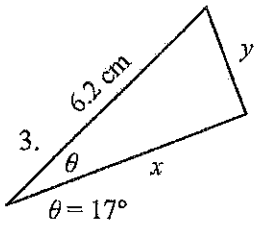
2.



$d_x =$ _____

$d_y =$ _____

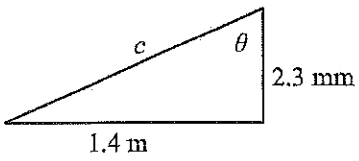
3.



$x =$ _____

$y =$ _____

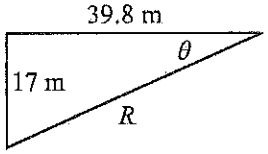
4.



$c =$ _____

$\theta =$ _____

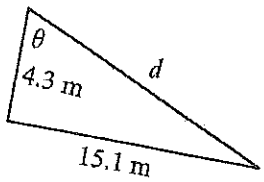
5.



$R =$ _____

$\theta =$ _____

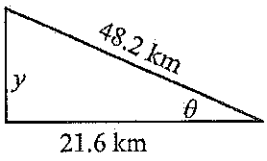
6.



$d =$ _____

$\theta =$ _____

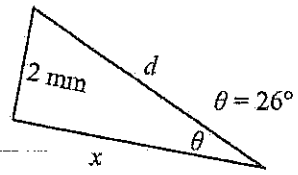
7.



$y =$ _____

$\theta =$ _____

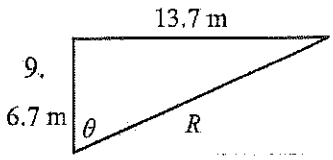
8.



$x =$ _____

$d =$ _____

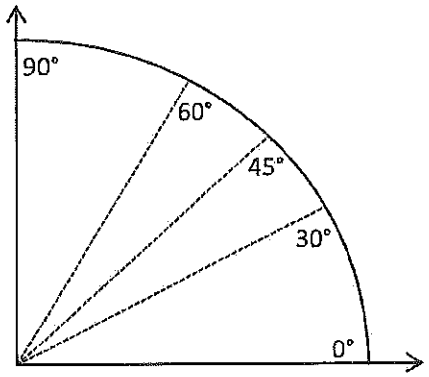
9.



$R =$ _____

$\theta =$ _____

You will need to be familiar with trigonometric values for a few common angles. Memorizing this diagram in degrees or the chart below will be very beneficial for next year (in math and physics!). In the diagram, the *cosine* of the angle is the *x-coordinate* and the *sine* of the angle is the *y-coordinate* (in other words, each radius of the circle shown is the hypotenuse of a right triangle). Write the ordered pair (in fraction form) in the table below for each of the angles shown on the quarter-circle.



θ	$\cos\theta$	$\sin\theta$
0°		
15°		
30°		
45°		
60°		
90°		

Refer to your completed chart to answer the following questions.

10. At what angle is sine at a maximum?

11. At what angle is sine at a minimum?

12. At what angle is cosine at a minimum?

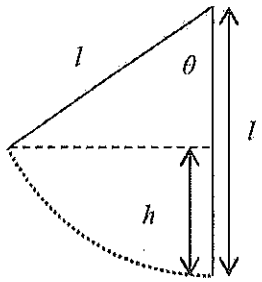
13. At what angle is cosine at a maximum?

14. At what angle are the sine and cosine equivalent?

15. As the angle increases in the first quadrant, what happens to the cosine of the angle?

16. As the angle increases in the first quadrant, what happens to the sine of the angle?

Use the figure at right to answer problems 17 and 18.



17. Find an expression for h in terms of l and θ.

18. What is the value of h if $l = 6$ m and $\theta = 40°$?

Part 5: Algebra

Solve the following (almost all of these are extremely **easy** – it is *important* for you to work *independently*). Units on the numbers are included because they are essential to the concepts, however they do not have any *effect* on the actual numbers you are putting into the equations. In other words, the units do not change how you do the algebra. Show every step for every problem, including writing the original equation, all algebraic manipulations, and substitution! You should practice doing all algebra *before* substituting numbers in for variables.

Section I: *For problems 1-5, use the three equations below:*

$$v_f = v_0 + at$$

$$x = x_0 + v_0 t + \frac{1}{2}at^2$$

$$v_f^2 = v_0^2 + 2a(x_f - x_0)$$

1. Using equation (1) solve for t given that $v_0 = 5$ m/s, $v_f = 25$ m/s, and $a = 10$ m/s^2.

3. $a = 10$ m/s^2, $x_0 = 0$ m, $x_f = 120$ m, and $v_0 = 20$ m/s. Use the second equation to find t.

4. $v_f = -v_0$ and $a = 2$ m/s^2. Use the first equation to find $t/2$.

5. How does each equation simplify when $a = 0$ m/s^2 and $x_0 = 0$ m?

Section II: *For problems 6 – 9, use the four equations below.*

$$\Sigma F = ma$$
$$f_k = \mu_k N$$

$$f_s \leq \mu_s N$$

$$F_s = -kx$$

6. If $\Sigma F = 10$ N and $a = 1$ m/s^2, find m using the first equation.

7. Given $\Sigma F = f_k$, $m = 250$ kg, $\mu_k = 0.2$, and $N = 10m$, find a.

8. $\Sigma F = T - 10m$, but $a = 0$ m/s^2. Use the first equation to find m in terms of T.

9. Given the following values, determine if the third equation is valid. $\Sigma F = f_s$, $m = 90$ kg, and $a = 2$ m/s^2. Also, $\mu_s = 0.1$, and $N = 5$ N.

10. Use the first equation in Section I, the first equation in Section II and the givens below, find ΣF. $m = 12$ kg, $v_0 = 15$ m/s, $v_f = 5$ m/s, and $t = 12$ s.

11. Use the last equation to solve for F_s if $k = 900$ N/m and $x = 0.15$ m.

Section III: *For problems 12, 13, and 14 use the two equations below.*

$$a = \frac{v^2}{r}$$

$$\tau = rF\sin\theta$$

12. Given that v is 5 m/s and r is 2 meters, find a.

13. Originally, $a = 12$ m/s^2, then r is doubled. Find the new value for a.

14. Use the second equation to find θ when $\tau = 4$ Nm, $r = 2$ m, and $F = 10$ N.

Section IV: *For problems 15 – 23, use the equations below.*

$$K = \frac{1}{2}mv^2$$

$$\Delta U_g = mgh$$

$$W = F(\Delta x)\cos\theta$$

$$U_s = \frac{1}{2}kx^2$$

$$P = \frac{W}{t}$$

$$P = Fv_{avg}\cos\theta$$

15. Use the first equation to solve for K if $m = 12$ kg and $v = 2$ m/s.

16. If $\Delta U_g = 10$ J, $m = 10$ kg, and $g = 9.8$ m/s^2, find h using the second equation.

17. $K = \Delta U_g$, $g = 9.8$ m/s^2, and $h = 10$ m. Find v.

18. The third equation can be used to find W if you know that F is 10 N, Δx is 12 m, and θ is 180°.

19. Use the value for W you found in the previous question to find P if $t = 2$ s. Which equation do you need?

20. Given $U_s = 12$ joules, and $x = 0.5$ m, find k using the fourth equation.

21. For the same value of x as given in problem 20 and the k value you just found, use the last equation in Section II to find F_s.

22. Assuming $\theta = 0°$ and $F = F_s$, use the third equation listed above along with the numbers found and given in the previous two questions to find W.

23. For $P = 2100$ W, $F = 30$ N, and $\theta = 0°$, find v_{avg} using the last equation in this section.

Section V: *For problems 24 – 26, use the equations below.*

$$p = mv$$

$$J = F\Delta t = \Delta p$$

$$\Delta p = m\Delta v$$

24. p is 12 kgm/s and m is 25 kg. Find v using the first equation.

25. "Δ" means "final state minus initial state". So, Δv means $v_f - v_i$ and Δp means $p_f - p_i$. Find v_f using the third equation if $p_f = 50$ kgm/s, $m = 12$ kg, and v_i and p_i are both zero.

26. Use the second and third equation together to find v_i if $v_f = 0$ m/s, $m = 95$ kg, $F = 6000$ N, and $\Delta t = 0.2$ s.

Section VI: *For problems 27 – 29 use the three equations below.*

$$T_s = 2\pi\sqrt{\frac{m}{k}}$$

$$T_p = 2\pi\sqrt{\frac{l}{g}}$$

$$T = \frac{1}{f}$$

27. T_p is 1 second and g is 9.8 m/s^2. Find l using the second equation.

28. $m = 8$ kg and $T_s = 0.75$ s. Solve for k.

29. Given that $T_p = T$, $g = 9.8$ m/s^2, and that $l = 2$ m, find f (the units for f are Hertz).

Section VII: *For problems 30 – 33, use the equations below.*

$$F_g = -\frac{GMm}{r^2}$$

$$U_g = -\frac{GMm}{r}$$

30. Find F_g if $G = 6.67 \times 10^{-11}$ m^3 kg^{-1} s^{-2}, $M = 2.6 \times 10^{23}$ kg, $m = 1200$ kg, and $r = 2000$ m.

31. What is r if $U_g = -7200$ J, $G = 6.67 \times 10^{-11}$ m^3 kg^{-1} s^{-2}, $M = 2.6 \times 10^{23}$ kg, and $m = 1200$ kg?