POSNACK

SCHOOL

Summer Assignment AP Physics 2

The concepts of physics are the most fundamental found in the sciences. By the end of the year, you will have had the opportunity to make and test many hypotheses about the behavior of everyday objects and to design and build some interesting contraptions that will demonstrate the laws of thermodynamics and fluid dynamics. This course will require a serious commitment and independent work on the part of every student in order to ensure a pace by which we can master the material before the AP testing. This preparation packet should assist all of us in achieving that goal.

1. Go to Khan Academy and find the AP Physics 1 series of videos, click here. Watch all the lessons you need to refresh your concepts from Physics H or AP Physics 1. Read the associated text pages to become familiar with the terms and concepts involved in Newtonian Mechanics.

2. Complete the math and physics review below. Show all your work for credit.

3. Go to APlus Physics (click here) and read the associated text pages to become familiar with the terms and concepts involved in Fluid Dynamics (our first chapter). For more help, try some of the supplemental links from here.

All parts of this assignment are to be submitted via Canvas by the end of the first day of school.

The summer assignment is to be one's own work. That does not mean that you cannot help one another when you run into problems, but it DOES mean that copying work is not acceptable and, if discovered, will result in a zero for the assignment.

Part 1: Scientific Notation and Dimensional Analysis

Many numbers in physics will be provided in scientific notation. You need to be able to read and simplify scientific notation. (**This section is to be completed without calculators…all work should be done by hand.)**

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

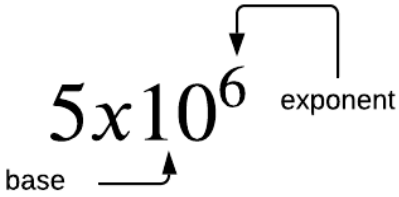
1. 56,840,000 kg

2. 10,854.2 s

3. 0.0000007 m

4. 0.00093 km/s

Oftentimes multiple numbers in a problem contain scientific notation and will need to be reduced by hand. Before you practice, remember the rules for exponents.



Circle the correct answers for each of the following questions (feel free to look them up!):

When numbers are multiplied together, you *(add / subtract)* the exponents and *(multiply / divide)* the bases.
When numbers are divided, you *(add / subtract)* the exponents and *(multiply / divide)* the bases.
When an exponent is raised to another exponent, you *(add / subtract / multiply / divide)* the exponent.

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

5. $(5 \times 10^5) \cdot (3 \times 10^3) =$

6. $(4 \times 10^9) \cdot (5 \times 10^{-4}) =$

7. $(6 \times 10^2) \cdot (2 \times 10^4) =$

8. $(7 \times 10^{-1}) \cdot (9 \times 10^6) =$

9. $(7 \times 10^5)^4 =$

10. $(2 \times 10^{-4})^4 =$

11. $(6 \times 10^3)^{-2} =$

12. $(4 \times 10^{-5})^{-3} =$

13. $\frac{2\times10^{3}}{6\times10^{6}} =$

14. $\frac{1.2\times10^{5}}{6\times10^{-3}} =$

15. $\frac{5.7\times10^{-5}}{4.6\times10^{4}} =$

16. $\frac{8.3\times10^{-2}}{2.7\times10^{-4}} =$

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.

Metric Prefix	Power	Symbol
exa		
peta		
tera		
giga		
mega		
kilo	10^3	k
base unit	10^0	-
centi		
milli		
micro		
nano		
pico	10^{-12}	p
femto		
atto		

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 ($10^0=1$). Remember if there is an exponent on the unit, the conversion should be raised to the same exponent as well.

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

1) 564 g = _____ kg

2) 101.3 MHz = _____ Hz

3) 1.7 Gb = _____ kb

4) 64 nm = _____ m

5) 52 m^2 = _____ cm^2

6) 536 mm^3 = _____ m^3

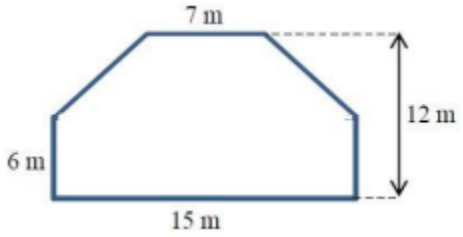
7) 20 cm/g^3 = _____ kg/m^3

8) 1 m/s = _____ km/hr

Part 2: Geometry

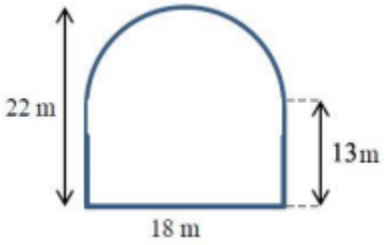
Calculate the area of the following shapes. It may be necessary to break up the figures into common shapes.

1.



Area = _____

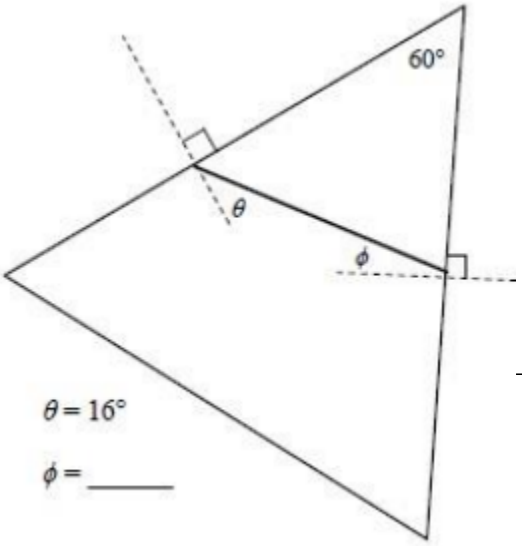
2.



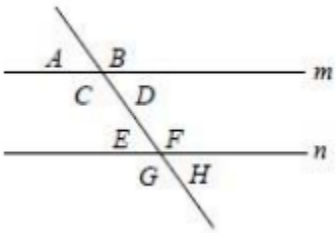
Area = _____

Calculate the unknown angle values for questions 3-6.

3.



4.

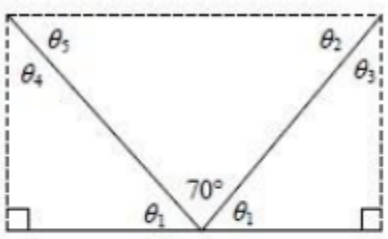


Lines *m* and *n* are parallel.

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

E = _____ *F* = _____ *G* = _____ *H* = _____

5.



θ_1 = _____

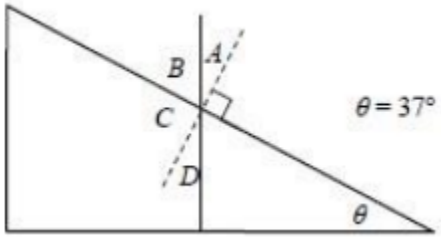
θ_2 = _____

θ_3 = _____

θ_4 = _____

θ_5 = _____

6.



A = _____ *B* = _____

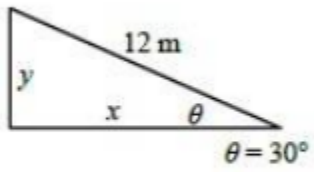
C = _____ *D* = _____

Part 3: Trigonometry

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

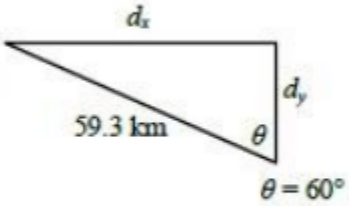
sinθ = cosθ= tanθ =

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. 

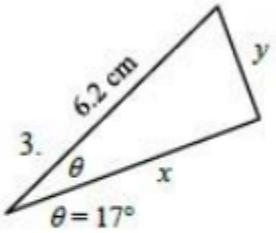
$y =$ _____

$x =$ _____

2. 

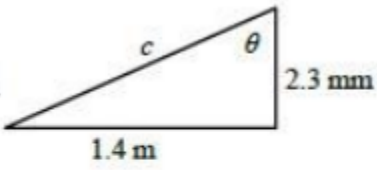
$d_x =$ _____

$d_y =$ _____

3. 

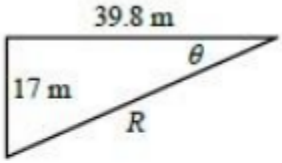
$x =$ _____

$y =$ _____

4. 

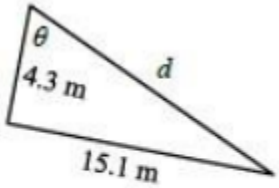
$c =$ _____

$\theta =$ _____

5. 

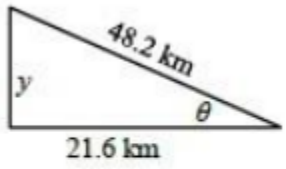
$R =$ _____

$\theta =$ _____

6. 

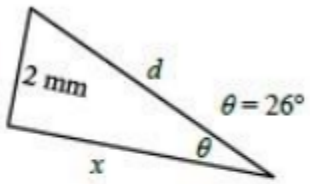
$d =$ _____

$\theta =$ _____

7. 

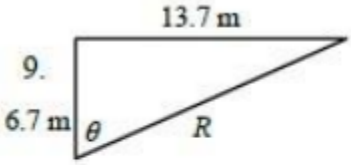
$y =$ _____

$\theta =$ _____

8. 

$x =$ _____

$d =$ _____

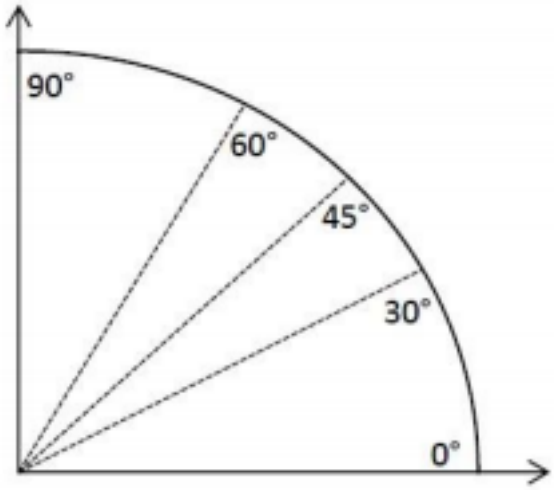
9. 

$R =$ _____

$\theta =$ _____

You will need to be familiar with trigonometric values for a few common angles. Memorizing this unit circle diagram in degrees or the chart below will be very beneficial for next year in both physics and pre-calculus. How the diagram works is the cosine of the angle is the x-coordinate and the sine of the angle is the y-coordinate for the ordered pair. Write the ordered pair (in fraction form) for each of the angles shown in the

table below.



θ	$\cos\theta$	$\sin\theta$
0°		
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 maximum?

13. At what angle is cosine at a minimum?

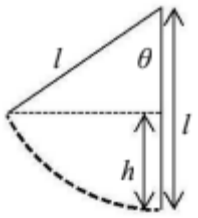
14. At what angle are the sine and cosine equivalent?

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 below 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 4: Algebra

Please show your work for this part on separate sheets of paper and put your final answer in the boxes below, there is not enough room on this sheet to show all of your work. Solve the following (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. Don't let the subscripts on the variables confuse you. v_f, for example is just a single variable.

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

(1) $v_f = v_0 + at$ (2) $x_f = x_0 + v_0 t + \frac{1}{2}at^2$ (3) $v_f^{\,2} = v_0^{\,2} + 2a(x_f - x_0)$

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.

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

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

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

Section II: *For problems 6 – 10, use the four equations below. Don't let the Greek letters confuse you, they're just like any other letter used for variables.*

$\Sigma F = ma$ $f_s \leq \mu_s F^N$

$f_k = \mu_k F^N$ $F^s = -kx$

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

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

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

8. 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 $F^N = 5$ N.

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

10. Use the last equation to solve for F^s if k = 900 N/m and x = 0.15 m.

Section III: *For problems 11-13 use the two equations below.*

$a = \frac{v^2}{r}$ $\tau = rFsin\theta$

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

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

13. Use the second equation to find θ when τ = 4 Nm, r = 2 m, and F = 10 N.

Section IV*: For problems 14 – 21, use the equations below.*

$K = \frac{1}{2}mv^2$ $W = F(\Delta x)cos\theta$ $P = \frac{W}{t}$

$\Delta U_g = mgh$ $U_s = \frac{1}{2}kx^2$ $P = Fv_{avg}cos\theta$

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

15. If ΔUg = 10 J, m = 10 kg, and g = 9.8 m/s^2, find h using the fourth equation.

16. K = ΔUg, g = 9.8 m/s^2, and h = 10 m. Find v.

17. Use the second equation to find W if you know that F is 10 N, Δx is 12 m, and θ is 180°.

18. Given Us = 12 joules, and x = 0.5 m, find k using the fifth equation.

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

Section V: *For problems 20 – 22, use the equations below.*

$p = mv$ $F\Delta t = \Delta p$ $\Delta p = m\Delta v$

20. Find v using the first equation if p is 12 kg · m/s and m is 25 kg.

21. "Δ" means "final state minus initial state". So, $\Delta v = v_f - v_i$ and $\Delta p = p_f - p_i$. Find v_f using the third equation if p_f = 50 kg · m/s, m = 12 kg, and v_i and p_i are both zero.

22. Use the second and third equation together to find v_i if v_f = 0 m/s, m = 95 kg, F = 6000 N, and Δt = 0.2 s.

Section VI*: For problems 23 – 25 use the three equations below.*

$T_s = 2\pi\sqrt{\frac{m}{k}}$ $T_p = 2\pi\sqrt{\frac{l}{g}}$ $T = \frac{1}{f}$

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

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

25. 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 26 – 29, use the equations below.*

$F^G = -G\frac{Mm}{r^2}$ $U_G = -G\frac{Mm}{r}$

26. Find F_g if G = 6.67 × 10^{-11} m^3/kg · s^2, M = 2.6 × 10^{23} kg, m = 1200 kg, and r = 2000 m.

27. What is r if U_g = -7200 J, G = 6.67 × 10^{-11} m^3/kg · s^2, M = 2.6 × 10^{23} kg, and m = 1200 kg?

28. Use the first equation in Section IV for this problem. K = -U_g, G = 6.67 × 10^{-11} m^3/kg · s^2, and M = 3.2 × 10^{23} kg. Find v in terms of r.

29. Using the first equation above, describe how F_g changes if r doubles.

***Section VIII:** For problems 30 – 35 use the equations below.*

$V = IR$ $R = \frac{\rho l}{A}$

$I = \frac{\Delta Q}{t}$ $R_s = (R_1 + R_2 + R_3 + \ldots + R_i) = \sum_i R_i$

$P = IV$ $\frac{1}{R_p} = (\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots + \frac{1}{R_i}) = \sum_i \frac{1}{R_i}$

30. Given V = 220 volts, and I = 0.2 amps, find R (the units are ohms, Ω).

31. If ΔQ = 0.2 C, t = 1s, and R = 100 Ω, find V using the first and third equations.

32. R = 60 Ω and I = 0.1 A. Use these values to find P using the first and fifth equations.

33. Let R_s = R. If R_1 = 50 Ω and R_2 = 25 Ω and I = 0.15 A, find V.

34. Let R_p= R. If R_1 = 50 Ω and R_2 = 25 Ω and I = 0.15 A, find V.

35. Given R = 110 Ω, l = 1.0 m, and A = 22 × 10^{-6} m^2, find ρ.

Part 5: Graphing and Functions

A greater emphasis has been placed on conceptual questions and graphing on the AP exam. Below you will

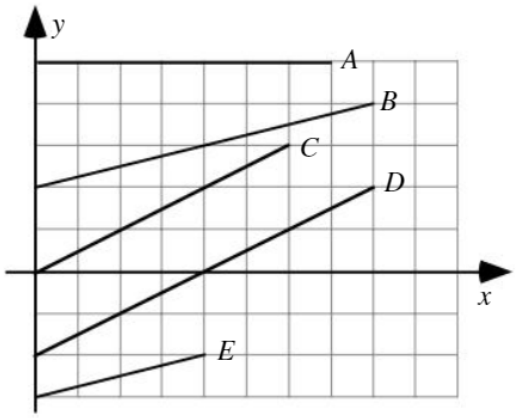
find a few example concept questions that review foundational knowledge of graphs. Ideally you won't need to review, but you may need to review some math to complete these tasks. At the end of this part is a section covering graphical analysis that you probably have not seen before: *linear transformation*. This analysis involves converting any non-linear graph into a linear graph by adjusting the axes plotted. We want a linear graph because we can easily find the slope of the line of best fit of the graph to help justify a mathematical model or equation.

Key Graphing Skills to remember:

1. Always label your axes with appropriate units.
2. Sketching a graph calls for an estimated line or curve while plotting a graph requires individual data points AND a line or curve of best fit.
3. Provide a clear legend if multiple data sets are used to make your graph understandable.
4. Never include the origin as a data point unless it is provided as a data point.
5. Never connect the data points individually, but draw a single smooth line or curve of best fit
6. When calculating the slope of the best fit line you must use points from your line. You may only use given data points IF your line of best fit goes directly through them.

Conceptual Review of Graphs

1. In the image below, there are several lines plotted on a graph. In the space below, rank the slopes of the lines from greatest to least.



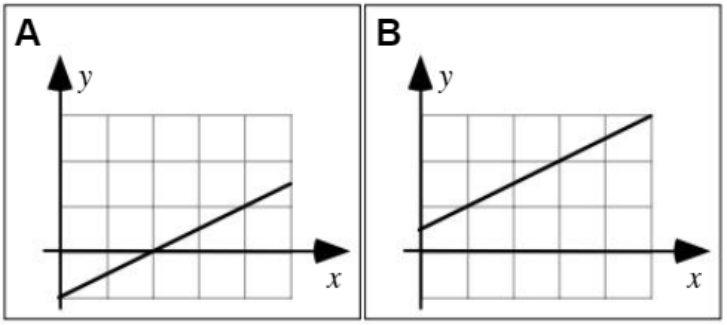
Greatest -----> Least

_____ , _____ , _____ , _____ , _____

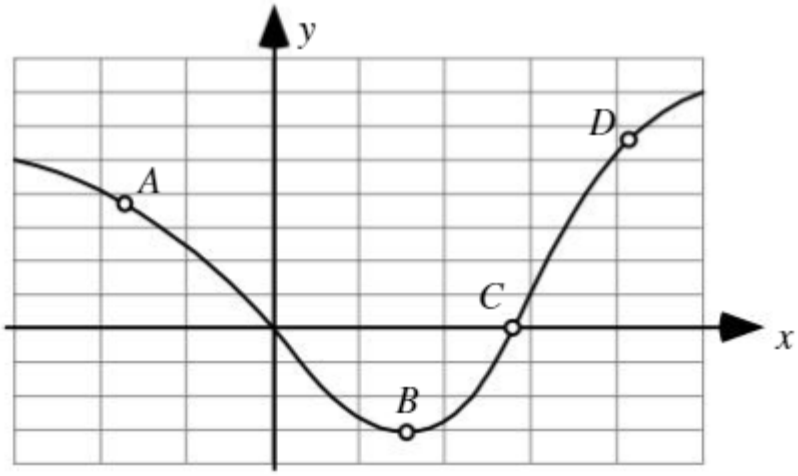
Explain your reasoning.

2. Compare the slopes in the graphs below. Is the slope of the graph greater in Case A, Case B, or the same in both cases? _____

Explain your reasoning.



3. Compare the slopes of the line at the four points shown in the graph below. Rank the slopes at each point from greatest to least.



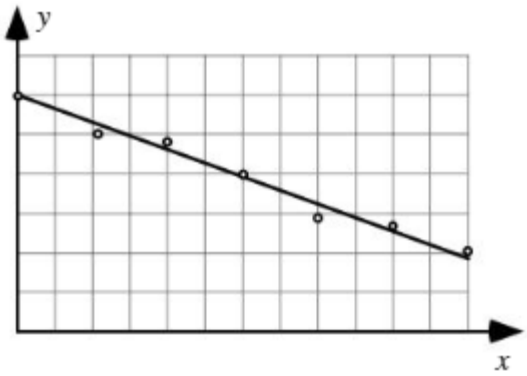
Greatest -----> Least

_____ , _____ , _____ , _____

Explain your reasoning.

4. Below is a graph showing the data that two students collected. Based on the data, one student claims that their data shows that as the y-value decreases, the x-value increases. They state that y is inversely proportional to x.

What, if anything, is wrong with the student's claim? Explain your answer, and correct anything that is incorrect.



Part 6: Fluids Preview

Using the APlus Physics link (https://www.aplusphysics.com/courses/honors/fluids/fluids_intro.html) to Fluids notes, read the section, become familiar with the terms, and answer the following questions.

1. What is fluid dynamics?

2. What is density? If there is an equation that corresponds to it, include it, and describe it.
3. What is buoyancy?

4. What is buoyant force? If there is an equation that corresponds to it, include it, and describe it.

5. What is Pressure and how does it relate to fluids? If there is an equation that corresponds to it, include it, and describe it.

6. Compare the pressure on the surface of a box when it is on land versus when it is completely submerged under water. Is it different or the same? Explain.

7. Describe what happens when you partially put your finger on a hose that has water coming out of it. Think about what happens to the water when your finger is not over the hole versus when your finger is partially over (covering) the hole. It may help to use the law of continuity for fluids to explain the physics/math behind what is going on.