

AP Physics 1: Summer Support Task

Hello and welcome to AP Physics 1! My name is Mr. Molony and I will be your teacher this year. For our course, we have a lot to get through, so this assignment below is just to help you prepare for the common math that we do throughout the year. *If you would like to get a head start on content, I suggest that you read our textbook [linked here](#), or watch flipping physics videos [linked here](#). This is not required but some people are interested and want to get ahead.*

This assignment will be completed on a separate piece of paper and submitted in person when we come back to school.

Part 1: Scientific Notation and Dimensional Analysis (10 to 20 minutes)

In science, we can work with large numbers when looking at things like planets. To help make the numbers easier to process, we use something called **scientific notation**. Here is a video of me going over how to write in scientific notation, along with how to multiply and divide using that notation.

[Video 2: Scientific Notation](#)

Express the following numbers in scientific notation. Keep the same unit as provided.

1. 563,000 kg

3. 8731 m

2. 0.000007 s

4. 0.00650 km/s

Simplify the following expressions using the properties of exponents. Use the “EE” button to solve these questions on your calculator.

5. $(3 \times 10^4) \cdot (7 \times 10^2)$

8. $\frac{(4 \times 10^4)}{(8 \times 10^{-7})}$

6. $(4 \times 10^{-3}) \cdot (6 \times 10^5)$

9. $(9 \times 10^3)^2$

7. $\frac{(3 \times 10^4)}{(7 \times 10^2)}$

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

Unit prefixes & conversions

During our class, we will need to do different conversions, the most basic is using the metric system scale listed below. This is the one provided to you on the exam. In this section, you will work on understanding how to use this information properly to easily convert between different metric values.

PREFIXES		
Factor	Prefix	Symbol
10^{12}	tera	T
10^9	giga	G
10^6	mega	M
10^3	kilo	k
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p

Unit conversions

[Video 3: Unit conversions](#)

Physics has standard units, such as Newtons (N) for force, which are comprised of other units, $1N = \frac{1kg}{m/s}$. You must ensure you are using the correct units. Therefore, you must be able to perform dimensional analysis if the units you are given are not in the proper format. **This will be especially useful when graphing data.** As we linearize data we must determine what the units of the slope of the line represent regularly in this class.

Example:

If you are traveling at 50.0 kph (kilometers per hour), what is your speed in m/s (meters per second)?

$$\frac{50 \text{ km}}{1 \text{ hr}} \cdot \frac{1000 \text{ m}}{1 \text{ km}} \cdot \frac{1 \text{ hr}}{60 \text{ min}} \cdot \frac{1 \text{ min}}{60 \text{ s}} = 13.9 \text{ m/s}$$

*We will do this conversion frequently. As a shortcut, I have this conversion memorized: Divide the speed kph by 3.6 to get the speed in m/s.

11. 46 g = _____ kg

12. 123 MHz = _____ Hz

13. 440 nm = _____ m

14. 200 Km= _____ cm

15. 100 km/min = _____ m/s

16. 20 km/hr = _____ m/s

Part 2: Variations and Solving Equations (20 to 25 minutes)

Direct and Inverse Variation

[Video 4: Direct and Inverse Variation](#)

The second most common thing you must understand in physics, is how different variables relate to each other. In math, there are three types of variations (I use the word relationship more than variation), Direct, inverse, and joint relationship. Each of the following terms are defined in the video linked above and briefly below.

1. A direct relationship means as x increases, so will y .
2. An inverse relationship is when x increases, y will decrease.
3. A joint relationship is when x increases, y & z can either increase or decrease, as long as everything works out in the end.

Direct Variation

$$y = kx$$

Inverse Variation

$$y = \frac{k}{x}$$

Joint Variation

$$x = kyz$$

Consider the equations below. These are all equations that you will use during this course (except for the second equation). When the question states that a variable stays constant, you can treat it as “ k ” from the variation equations you learned to solve in Algebra II. In fact, you can “lump” all constant values into “ k ”. Based on the video, answer whether the value increases or decreases.

$$a = \frac{F}{m}$$

$$V = IR$$

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

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

17. As F increases and m stays constant, a _____.
18. As m decreases and F stays constant, a _____.
19. As R decreases and I stays constant, V _____.
20. As l increases and g stays constant, T _____.
21. As v increases and m stays constant, K _____.

Answer possibilities:

Increases

Increases as the square

Increases as the square root

Decreases

Decreases as the square

Decreases as the square root

Solving equations for a specific variable

[Video 5: Solving Equations without & with numbers](#)

Another common aspect of AP Physics 1 is solving equations, but with no numbers dun dun duuuuunnn!!!! This usually does scare some students at first, but once you get used to the process, it does actually make more sense! Solving with no numbers allows us to better understand the relationship between these variables, and create useful graphs to represent this information. Rearrange each of the equations below to solve for the indicated variable.

Example:

$$\Delta V = IR, \text{ solve for } I. \quad \text{dividing both sides by } R \text{ yields } I = \frac{\Delta V}{R}$$

Just as I treated ΔV as one variable in the problem above, treat terms like v_f , v_0 , x_f , and x_0 as one variable below. **Show all work for these questions.**

22. $a = \frac{F}{m}$, solve for F .

26. $T = 2\pi\sqrt{\frac{l}{g}}$, solve for g .

23. $v_f = v_0 + at$, solve for a

27. $v_f^2 = v_0^2 + 2a(x_f - x_0)$, solve for a .

24. $U = \frac{1}{2}kx^2$, solve for x .

25. $mgh = \frac{1}{2}mv^2$, solve for v .

Solving an Equation Using Substitution

The problems above will help you with conceptual questions on the multiple choice of the AP exam, along with the FRQ questions. In FRQ questions, you will be asked to “derive” an equation based on a situation given to you without numbers. Along with this, you will need to plug in numbers to do computational problems and determine the correct equation to use based on given info (and concepts once we are in class learning). Below, you are given three equations. Decide which equation is best based on the knowledge given to you. **For now**, we will leave out the units. Once we are in school, you will need to include units and have the correct final units for your answers. **Show all your work**

1) $v_f = v_0 + at$

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

3) $x_f = x_0 + v_0t + \frac{1}{2}at^2$

Example: Solve for t , given that: $v_0 = 5, v_f = 25, a = 10$

Rearranging the first equation to solve for t , $t = \frac{v_f - v_0}{a} = \frac{25 - 5}{10} = 2$

28. Solve for t , given that: $v_0 = 25, x_f = 120, x_0 = 0, a = 0$

29. Solve for a , given that: $v_0 = 5, v_f = 25, x_f = 100, x_0 = 0$

30. Solve for x_0 , given that: $v_0 = 5, v_f = 0, x_f = 75, a = -10$

31. Simplify all three of the equations (#1-3 above), given $a = 0, x_0 = 0$

Part 3: Trigonometry (10 to 15 minutes)

[Video 6: Trig Review](#)

Right triangles

You will need to solve problems involving right triangles in this course. Vectors, a fundamental concept in this course, are based on right triangles. Remember SOH-CAH-TOA from geometry class? It's back! The image to the right is a snapshot from the equation sheet you will have when you take the AP exam. Please use SOH-CAH-TOA to solve the following problems.

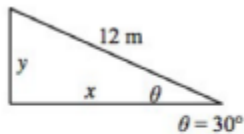
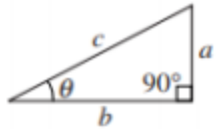
Right triangle

$$c^2 = a^2 + b^2$$

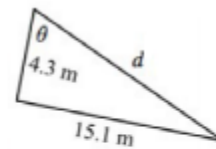
$$\sin \theta = \frac{a}{c}$$

$$\cos \theta = \frac{b}{c}$$

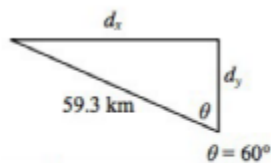
$$\tan \theta = \frac{a}{b}$$



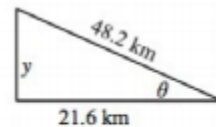
32. $x =$ _____
 $y =$ _____



34. $d =$ _____
 $\theta =$ _____



33. $d_x =$ _____
 $d_y =$ _____

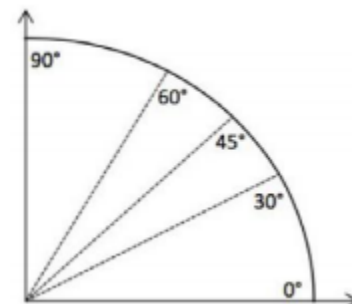


35. $\theta =$ _____
 $y =$ _____

The Unit Circle

This table is also given to you on the equation sheet. You will notice that most of the angles provided are related to the special right triangles, 45-45-90 and 30-60-90. The other two angles, 37° and 53° are the values for a 3-4-5 triangle. In trigonometry, you should have also seen these values in relation to the unit circle where $\cos \theta$ applied to the x and y coordinates, respectively.

VALUES OF TRIGONOMETRIC FUNCTIONS FOR COMMON ANGLES							
θ	0°	30°	37°	45°	53°	60°	90°
$\sin \theta$	0	$1/2$	$3/5$	$\sqrt{2}/2$	$4/5$	$\sqrt{3}/2$	1
$\cos \theta$	1	$\sqrt{3}/2$	$4/5$	$\sqrt{2}/2$	$3/5$	$1/2$	0
$\tan \theta$	0	$\sqrt{3}/3$	$3/4$	1	$4/3$	$\sqrt{3}$	∞



36. For which angle is sine at a maximum? _____
37. For which angle is cosine at a maximum? _____
38. For which angle are sine and cosine Equivalent? _____
39. As the angle increases (in Quadrant I), how does the cosine (x coordinate value on the unit circle) change? _____
40. As the angle increases (in Quadrant II), how does the sine (y coordinate value on the unit circle) change?

Part 4: Graphing and Curve Fits (10 to 15 minutes)

Graphing the results of an experiment is an integral part of this course. We will start by reviewing shapes that you (hopefully) have seen before: **linear**, **inverse** (reciprocal function), **inverse square** (also a reciprocal function), and a **power function**. Most of the power functions you will see in this course will be quadratic functions. Below, you will graph the “parent” function. When you analyze real data, you will need to be able to identify the curve of best fit (or at least narrow the possibilities) and apply it to analyze your graph.

In the questions below, graph what the function would look like, along with labeling the graph as either **linear**, **inverse**, **inverse square**, or **power**.

41. $y = \frac{1}{x}$

42. $y = x^2$

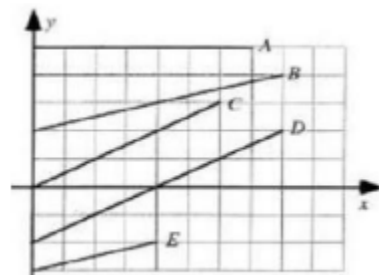
43. $y = \frac{1}{x^2}$

44. $y = x$

[Video 7: Comparing graphs](#)

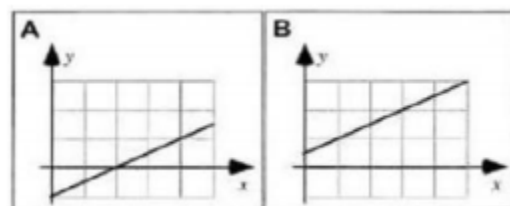
45. Rank the slopes from greatest to least based on the graph to the right. *Greatest at the top, least at bottom*

- _____
- _____
- _____
- _____
- _____



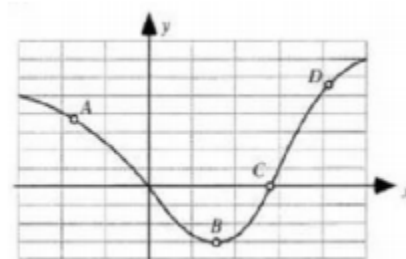
46. Which graph has the greater slope, A or B? Circle your answer.

- A has a greater slope
- B has the greater slope
- The slope is the same for both graphs
- The slope of the graphs cannot be determined



47. For the curve, such as the one on this graph, you can find the slope at any point by drawing a tangent line on the graph. Draw a tangent line for each of the four points. Then rank the slopes of the tangent lines from **greatest to least**.

- _____ > _____ > _____ > _____



That is it! You're done! This is the type of math that you will see throughout our AP Physics 1 course. There are a few more mathematical concepts we will learn in class as the year progresses. This assignment was built as a review, as we will be building on these concepts throughout the school year. Some of you may wonder why we take math in school and where some of those ideas are used in real life. Most of the math you learn is applied right here in physics! Fun fact, Sir Isaac Newton's main reason to create calculus was to help defend his physics research, which eventually became Newton's Laws. This course will be challenging, but remember: The only things in life that are worthwhile require hard work and commitment. I look forward to meeting you in August! ~Mr. Molony