AP Physics 2 Summer Assignment

Read all information carefully and complete all problems. You must show your work for the problems to receive credit. Work may be shown on a separate sheet of paper if necessary.

Greek Letters

In Physics, we use variables to denote a variety of unknowns and concepts. Many of these variables are letters of the Greek alphabet. If you are not familiar with these letters, you should become so. While there is no practice work for this section and while you do not have to outright memorize these letters at this point, you need to have this exposure so that when class starts and you see this on the board: μ you don't call it, "that funny-looking m-thing".

These variables have specific names and I will be using these names. You need to do this as well.

Greek Letter	**Name**	**Commonly used for**
α	Alpha (lowercase)	Angular acceleration, radiation particle
β	Beta (lowercase)	Radiation particle
Δ	Delta (uppercase)	Showing a change in a quantity
ε	Epsilon (lowercase)	Permittivity
ϕ	Phi (lowercase)	Magnetic Flux, work function
γ	Gamma (lowercase)	Radioactivity, relativity
λ	Lambda (lowercase)	Wavelength
μ	Mu (lowercase)	coefficient of friction
π	Pi (lowercase)	Mathematical constant
θ	Theta (lowercase)	Angle name
ρ	Rho (lowercase)	Density, resistivity
Σ	Sigma (uppercase)	Showing the sum of numbers
τ	Tau (lowercase)	Torque
ω	Omega (lowercase)	Angular velocity
ξ	Xi (uppercase)	Electromotive force; induced voltage

The Metric System

Everything in physics is measured in the metric system. The only time that you will see English units is when you convert them to metric units. The metric system is also called SI (from the French, "Système International"). In the SI system fundamental quantities are measured in meters, kilograms, and seconds.

Here are the metric prefixes that we will use throughout the year:

Name of prefix	Numerical value	Abbreviation
pico-	10^{-12}	p
nano-	10^{-9}	n
micro-	10^{-6}	μ
milli-	10^{-3}	m
centi-	10^{-2}	c
kilo-	10^{3}	k
mega-	10^{6}	M
Giga	10^{9}	G

Answers and Solutions

In physics, the *solution* to a problem is usually more important than the *answer*. An *answer* is the number that you circle at the end of the process of solving a problem. The entire process is called the *solution*. On the free response portion of the AP exam, you can earn most of the credit for a problem with a good solution but the wrong answer, yet a correct *answer* alone with no *solution* will earn you nothing. Throughout the year, we will use the same process for writing a solution. If you exclude any of the steps in the process, you will lose credit. The steps to writing a solution are as follows:

1) Draw a diagram if needed
2) List given variables on far left, include unknown variable
3) Write the full relevant equation.
4) Plug in values **including units.**
5) Solve for an answer (**including units**) and circle/box answer.

   (Note: it is not necessary to show all of the mathematical steps involved in solving an equation)

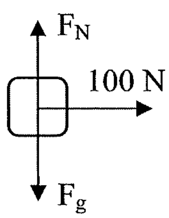
Example of a full solution:

Ex) A 50 kg mass is subject to a horizontal force of 100 N on a frictionless surface. Determine the acceleration of the mass.

F = 100 N
m = 50 kg
a = ?

↑

List of known and unknown variables



↑

diagram

$\mathbf{F_{net} = ma}$ ← *Equation*

100 *N* = (50 *kg*)a ← *Variables with units*

$\boxed{\mathbf{a = 2\ m/s^2}}$ ← *Boxed/circled answer with units*

Note: If you didn't remember the correct units for your variable (acceleration here), it is also acceptable to use dimensional analysis and determine equivalent units directly from the equation; for example in this question you could still receive full credit for:

a = 2 N/kg

You will need to use this process later in this packet…

Significant Figures

Significant figures *(also known as significant digits or sig-figs)* are the numbers in a value which are precisely known. Its importance can be understood with an example:

Billy is using a pair of calipers to determine the volume of a sphere ($V = \frac{4}{3}\pi r^3$) for a physics lab. His calipers can only measure to the nearest millimeter. He measures the radius of the sphere to be 3.5 cm (35 mm) with his calipers. Then he calculates the volume of the sphere in a calculator, which outputs **179.59438 cm^3**. Billy shares this information with his lab group, who then use it in their calculations.

But what if the actual radius was 3.51 cm but Billy couldn't get that precision with his calipers? Using 3.51 cm, the volume would be calculated as **181.138 cm^3**. Clearly a different answer than before. For this reason, it would be incorrect to report an answer with that many digits, since most of them cannot be known that precisely. He can only accurately report the volume to two significant figures (since he only measured 2 digits, 3.5) and so he would report that the volume is **180 cm^3**, as precise as he can get.

When you report a value based on measurements, it is understood by everyone reading it that you know that number to be precise, so you would essentially be lying if you didn't take significant figures into account.

On the AP Physics exam, you are expected to report your final answers on the free response with the correct number of significant figures. Failure to do so will lose you points. There are very specific rules for doing calculations with significant figures. Fortunately, the AP graders are not terribly strict with this and you can simply use the same number of sig figs as the **given value that has the least amount**. For example, if you were given the following values and asked to calculate a final velocity:

$v_0 = 3.55$ m/s ⟶ 3 sig figs

$a = 2.0$ m/s^2 ⟶ **2 sig figs** ⟶ **Report your answer with 2 sig figs**

$\Delta x = 2052$ m ⟶ 4 sig figs

$$v_f^2 = v_0^2 + 2(a)(\Delta x)$$

$$\mathbf{v_f = 91\ m/s}$$

So all we really need to be able to do is determine the **total number** of sig figs.

<u>Rules for determining the number of sig. figs:</u>

Rule	Example	# of sig figs
1) All non-zero numbers are significant.	33,451	5
2) Any zeros in between non-zero numbers are significant.	7052	4
3) All zeros shown at the end of a number AND to the right of a decimal point are significant.	30.00	4
4) Zeros to the left of non-zero numbers in a number smaller than one are NOT significant.	0.0000000053	2
5) All zeros to the left of a written decimal point are significant. If there is no decimal, they are not.	3000. 3000	4 1
Use scientific notation for clarity. If you can get rid of zeros and write a number in sci. notation, they are NOT significant.	0.0000034 = 3.4 x 10^{-6}	2

Significant Figure Practice:

1. Indicate how many significant figures there are in each of the following measured values.

246.32	______	1.008	______	700000	______
107.854	______	0.00340	______	350.670	______
100.3	______	14.600	______	1.0000	______
0.678	______	0.0001	______	320001	______

2. Convert the following numbers into scientific notation, and also indicate how many significant figures there are in each.

	Scientific Notation	# Sig. Figs
1) 5,690	______	______
2) 1,200,000	______	______
3) 832	______	______
4) 0.00459	______	______
5) 0.0000116	______	______
6) 3,200,000,000	______	______
7) 0.123	______	______
8) 103,000,000	______	______
9) 4.05	______	______
10) 0.093	______	______

Metric Conversions

Physics makes heavy use of the wonderfully simple *metric system* in which large and small numbers can be expressed with ease through use of a prefix. All of our variables (such as distance, acceleration, force, etc) may sometimes have metric prefixes. In order to use them in an equation, it is often best to convert it to the base unit without a prefix.

Express the following distances in terms of the base unit for distance, the *meter*. Express the answer in scientific notation if it is larger than 100 or smaller than 0.01. The first one has been done for you. Refer back to the metric system reference page if needed.

Kilo = 10^3 so...

1) 65 km --------> 65×10^3 m = $\boxed{6.5 \times 10^4 \text{ m}}$

2) 126 cm

3) 500 cm

4) 1,000 cm

5) 0.05 km

6) 0.10 km

7) 550 nm

8) 12 km

9) 3.8 nm

10) 84 mm

11) 2.1 Gm

12) 50 μm

13) 4000 nm

14) 50,000,000 pm

Algebraic Solutions

(For help see <http://www.khanacademy.org/math/algebra/solving-linear-equations-and-inequalities>)

In AP Physics it is always helpful and often required to solve algebraic equations in the terms of variables, rather than with given values or numbers. This involves basic addition, subtraction, multiplication, and division of coefficients and variables as seen in the example below. Please solve each equation or expression for the desired coefficient. **Doing this quickly and efficiently is a critical skill required for this class.** It is very helpful to think of this process as "rearranging" an equation to make it more useful for a specific purpose. Do not worry if you have no idea what any of these equations mean, this is only a mathematical exercise.

Example) ***Solve for v***

$$a = \frac{v^2}{r} \longrightarrow ra = v^2 \longrightarrow \boxed{v = \sqrt{ra}}$$

Multiply both sides by 'r' *square root both sides*

Note: It is not necessary to show your mathematical work or to explain in words what you did. You only need to show the individual steps you took to arrive at your final expression.

Problems:

1) Solve for v

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

---

2) Solve for a

$$v_f^2 = v_0^2 + 2(a)(\Delta x)$$

---

3) Solve for x

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

---

4) Solve for Θ_2

$$n_1 \sin(\theta_1) = n_2 \sin(\theta_2)$$

---

5) Solve for T_2

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

---

6) Solve for v

$$\frac{GMm}{r^2} = \frac{Mv^2}{r}$$

7) Solve for r in terms of ONLY **B, L, 2π, F_B, μ_0**. (In other words, you cannot have an **I** in your expression).

$$F_B = BIL$$

$$B = \frac{\mu_0 I}{2\pi r}$$

---

8) Solve for g

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

---

9) Solve for v_f

$$m_1 v_1 + m_2 v_2 = m_1 v_f + m_2 v_f$$

---

10) Solve for x

$$m_1(x) = m_2(3 - x)$$

---

11) Solve for r

$$\frac{m_1 v^2}{r} = m_2 gh$$

---

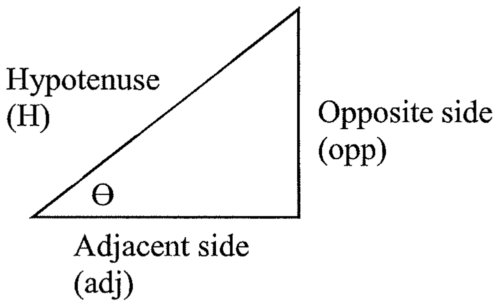
12) Solve for F_A in terms of m, g, and θ. (You cannot have a T in your expression)

$$T\sin(\theta) = F_A$$

$$T\cos(\theta) = mg$$

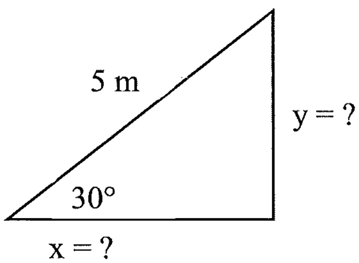
Right Triangle Trigonometry
(Calculator allowed)

Since many chapters in this course deal with two dimensions, it is crucial that you can break vectors into their horizontal (left-right) and vertical (up-down) components with ease. This means using basic trigonometry (SOH CAH TOA). However, it is often more useful to just memorize the results of using SOH CAH TOA (see below) to determine the sides of a right triangle. **The side *opposite* the given angle is always H·sin(Θ) and the side *adjacent* to the given angle is always H·cos(Θ)** (where H is the hypotenuse).



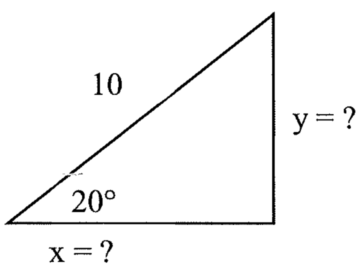
Opp = H·sin(Θ)

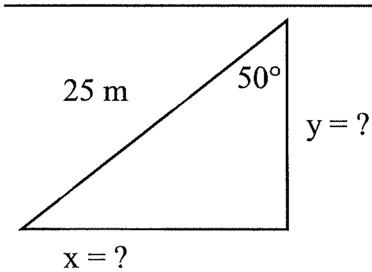
Adj = H·cos(Θ)

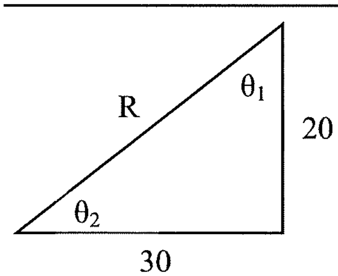


y = 5sin(30) = 2.5 m

x = 5cos(30) = 4.33 m







Determine the magnitudes of θ_1, θ_2, and R.