Summer Assignment Packet

AP Physics C: Mechanics **Mr. Withers**

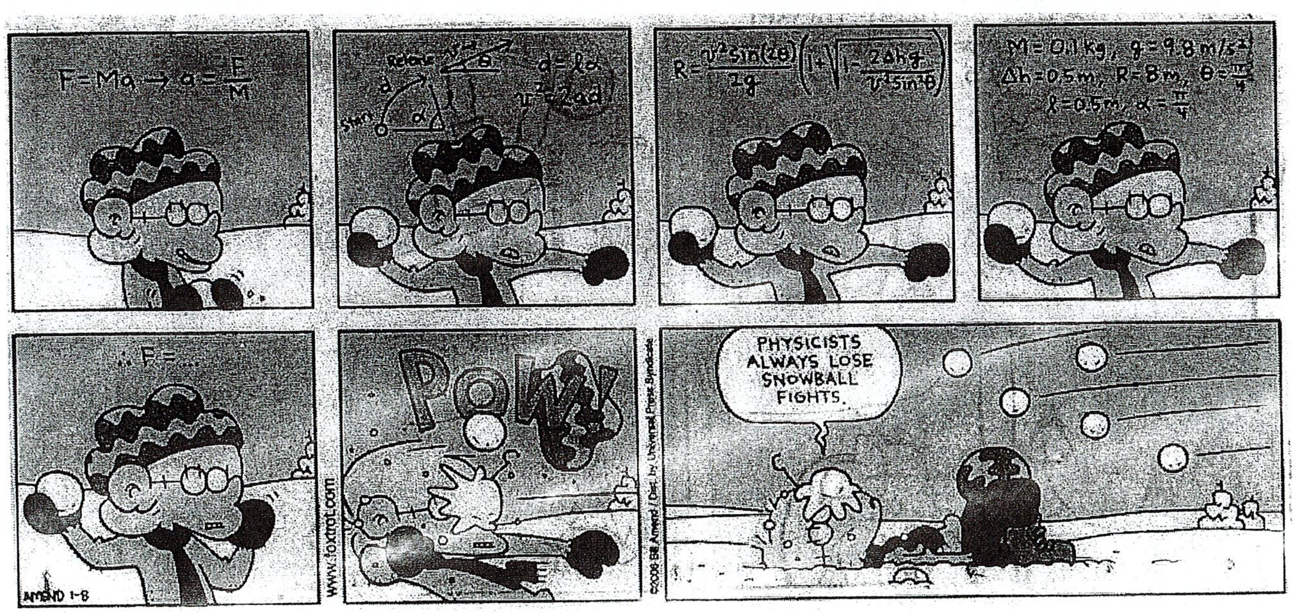
Name:__________________________________

AP Physics C: Mechanics requires an exceptional proficiency in algebra, trigonometry, and geometry. In addition to the science concepts, AP Physics C: Mechanics often seems like a course in applied mathematics. The following assignment includes mathematical problems that are considered routine in AP Physics C: Mechanics. This includes knowing several key metric system conversion factors and how to employ them. Another key area in AP Physics C: Mechanics is understanding vectors. The purpose of this summer assignment is to fight your "couch inertia" and get you on the right path to success in the fall.

The attached pages contain a brief review, hints, and example problems. It is hoped that combined with your previous math knowledge this assignment is merely a review and a means to brush up before school begins in the fall. Please read the text and instructions throughout. If you use any extra paper for scratch work, please attach it to the packet before you turn it in.

The completed packet is due the first day of class in August.

Q: *What if I don't get all the problems or don't understand the instructions?*
A: *Simply do the best you can, but show some work or effort in order to receive credit.*



AP Physics C: Mechanics Summer Assignment

NAME: ________________________________

SOLVING EQUATIONS FOR VARIABLES

Solve the following equations for the specified variable. Show all steps on a separate sheet of paper!

1. $\Delta y = \frac{1}{2} g t^2$ for t
2. $\Delta x = v_o t + \frac{1}{2} a t^2$ for v_o
3. $v = \sqrt{2a\Delta x}$ for Δx
4. $a = \frac{\Delta v}{t}$ for v_f
5. $a = \frac{\Delta v}{t}$ for t
6. $F = G\frac{m_1 m_2}{r^2}$ for m_2
7. $F = G\frac{m_1 m_2}{r^2}$ for r
8. $T = 2\pi\sqrt{\frac{L}{g}}$ for L
9. $T = 2\pi\sqrt{\frac{L}{g}}$ for g

UNIT CONVERSIONS

Convert the units from the unit given to the unit requested. Use "Factor Label Method", Show all steps!

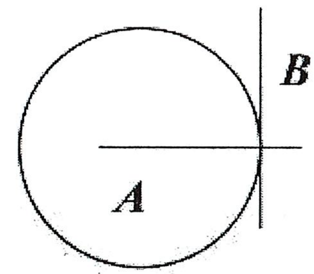
Factor Label Method Video: https://youtu.be/49TUDZ8t9N8

10. The number of seconds in a year:
11. $28\ km\ to\ cm$
12. $45\ kg\ to\ mg$
13. $85\ \frac{cm}{min}\ to\ \frac{m}{s}$
14. $3 \times 10^8\ \frac{m}{s}$ to $\frac{km}{day}$
15. $823\ nm\ to\ m$
16. $8.8 \times 10^{-8} m\ to\ mm$
17. $1.5 \times 10^{11} m\ to\ \mu m$
18. $7.6\ m^2\ to\ cm^2$

5. Solve the following geometric problems.

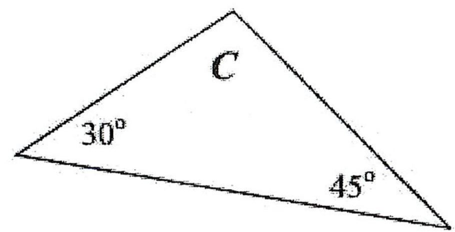
a. Line **B** touches the circle at a single point. Line **A** extends through the center of the circle.

i. What is line **B** in reference to the circle?

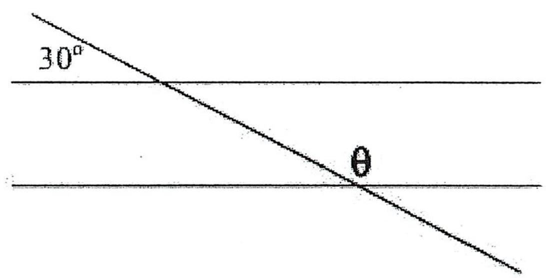


ii. How large is the angle between lines **A** and **B**?

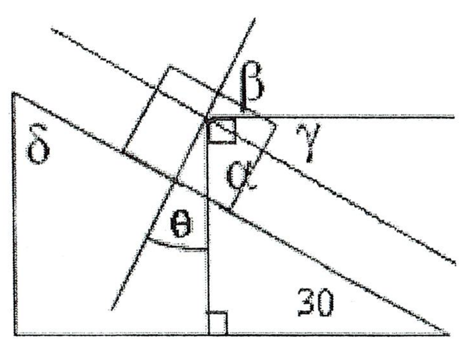
b. What is angle **C**?



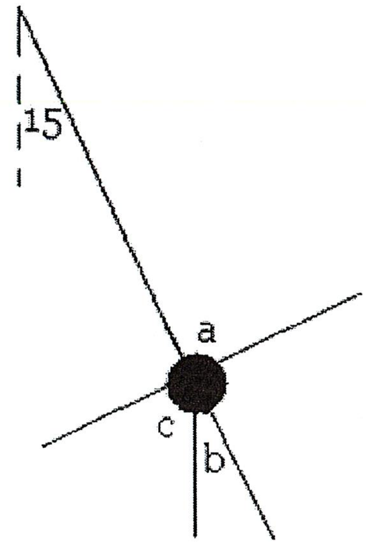
c. What is angle **θ**?



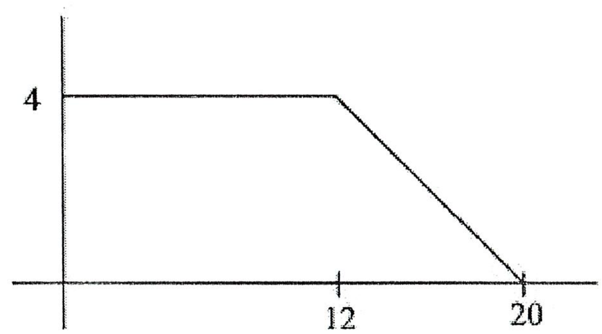
d. How large are angles **α**, **β**, γ, **δ**, and **θ**?



e. How large are angles **a**, **b**, and **c**?



f. What is the area under the curve at right?

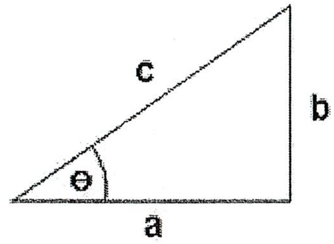


g. The radius of a circle is 5.5 cm

i. What is the circumference in <u>meters</u>?

ii. What is its area in <u>square meters</u>?

6. Use the generic triangle shown below, right-triangle trigonometry, and the Pythagorean theorem to solve the following problems. Your calculator <u>must</u> be set to degree mode.



a. **θ** = 55° and **c** = 32 m, solve for **a** and **b**.

b. **θ** = 45° and **a** = 15 m/s, solve for **b** and **c**.

c. **b** = 17.8 m and **θ** = 65°, solve for **a** and **c**.

d. **a** = 250 m and **b** = 180 m, solve for **θ** and **c**.

e. **a** = 25 cm and **c** = 32 cm, solve for **b** and **θ**.

VECTORS

Most of the quantities in physics are vectors. This makes proficiency in vectors extremely important.

Scalar
A physical quantity described by a single number and units. A quantity described by magnitude only. (Examples: time, mass, and temperature)

Vector
A physical quantity with both a magnitude and a direction. A directional quantity. (Examples: velocity, acceleration, force)

Magnitude
Size or extent. The numerical value of the physical quantity represented by the vector.

Direction
The alignment or orientation of the vector with respect to a coordinate system.

Notation
In your textbook, vector quantities are always indicated by bold type, like this: **A**
In your notes simply put an arrow over the letter representing the vector, as shown below.

Vectors are drawn as arrows:

The length of the arrow is proportional to the vectors magnitude.
The direction the arrow points is the direction of the vector.

Negative Vectors
Negative vectors have the same magnitude as their positive counterpart. They are just pointing in the opposite direction.

HOW ARE VECTORS USED IN PHYSICS?

They are used everywhere!

Speed

Speed is a scalar. It only has magnitude (numerical value). v = 10 m/s means that an object is going 10 meters every second. But we do not know where it is going.

Velocity

Velocity is a vector. It is composed of both magnitude and direction. Speed is the magnitude of velocity. $\mathbf{v}$ = 10 m/s north, or $\mathbf{v}$ = 10 m/s in the +x direction, etc.

There are three types of speed and three types of velocity

- Instantaneous speed / velocity: The speed or velocity at an instant in time. You look down at your speedometer and it says 20 m/s. You are traveling at 20 m/s at that instant. Your speed or velocity could be changing, but at that moment it is 20 m/s.

- Average speed / velocity: If you take a trip you might go slow part of the way and fast at other times. If you take the total distance traveled divided by the time traveled you get the average speed over the whole trip. If you looked at your speedometer from time to time you would have recorded a variety of instantaneous speeds. You could go 0 m/s in a gas station, or at a light. You could go 30 m/s on the highway, but only go 10 m/s on neighborhood streets. But, while there are many instantaneous speeds, there is only one average speed for the whole trip.

- Constant speed / velocity: If you have cruise control you might travel the whole time at one constant speed. If this is the case then you average speed will equal this constant speed.

A trick question

Will an object traveling at a constant speed of 10 m/s also always have constant velocity? Not always. If the object is turning around a curve or moving in a circle it can have a constant speed of 10 m/s, but since it is turning, its direction is changing. And if direction is changing then velocity must change, since velocity is made up of speed and direction.

Constant velocity must have both constant magnitude and constant direction.

Rate

Speed and velocity are rates. A rate is a way to quantify anything that takes place during a time interval. Rates are easily recognized. They always have time in the denominator. Examples: 10 m/s, 10 meters / second

THE VERY FIRST PHYSICS EQUATION

Velocity and speed both share the same equation. Remember speed is the numerical (magnitude) part of velocity. Velocity only differs from speed in that it specifies a direction.

$$v = \frac{x}{t}$$

v stands for velocity, *x* stands for displacement, and *t* stands for time

Displacement is a vector for distance traveled in a straight line. It goes with velocity. Distance is a scalar and goes with speed.

Displacement is measured from the origin. It is a value of how far away from the origin you are at the end of the problem. The direction of a displacement is the shortest straight line from the location at the beginning of the problem to the location at the end of the problem.

How do distance and displacement differ? Supposes you walk 20 meters down in the + x direction and turn around and walk 10 meters in the – x direction. The distance traveled does not depend on direction, so you walked 20 + 10 = 30 meters. Displacement only cares about your distance from the origin at the end of the problem, so your displacement is +20 – 10 = 10 meters.

12. Solve the following problems. Take heed of the following.

- Always use the **MKS** system: units must be in meters, kilograms, and seconds.
- On the all tests, including the AP exam you must:
    1. List the original equation used
    2. Show correct substitution
    3. Arrive at the correct answer with correct units
- Distance and displacement are measured in meters (m)
- Speed and velocity are measured in meters per second (m/s)
- Time is measured in seconds (s)

Example: A car travels 1000 meters in 10 seconds. What is its velocity?

$v = \frac{x}{t}$ $\quad$ $v = \frac{1000\,m}{10\,s}$ $\quad$ $v = 100\,m/s$

a. A car travels 35 km west and 75 km east. What distance did it travel?

b. A car travels 35 km west and 75 km east. What is its displacement?

c. A car travels 35 km west, 90 km north. What distance did it travel?

d. A car travels 35 km west, 90 km north. What is its displacement?

e. A bicyclist pedals at 10 m/s in 20 s. What distance was traveled?

f. An airplane flies 250.0 km at 300 m/s. How long does this take?

g. A skydiver falls 3 km in 15 s. How fast are they going?

h. A car travels 35 km west, 90 km north in two hours. What is its average speed?

i. A car travels 35 km west, 90 km north in two hours. What is its average velocity?

Congratulations, you're done!