AP Physics C

Summer Assignment 2019

Welcome to AP Physics C: Mechanics! This packet serves as a self assessment, a skills review and in some places a rigorous algebraic challenge. These problems are designed to take no more than 5 hours of work in total. Problems that are preceded by an asterisk would be considered more challenging and may require multiple equations as well as systems of equations and/or the quadratic equation to solve. Enjoy! I look forward to working with you all next year.

Kinematics

$\Delta x = v_x t$ This is the constant velocity equation.

$v = v_0 + at$ These four equations are the constant acceleration equations.
$x = x_0 + v_0 t + \frac{1}{2} at^2$ You will need three quantities to solve for the fourth and sometimes more
$v^2 = v_0^2 + 2a(x - x_0)$ than one equation
$F_{net} = ma$ x_0 (initial position) x (Final position)
v_0 (initial velocity) v (Final velocity)

$v^2 = v_x^2 + v_y^2$ Equations for Projectile motion
$v_x = v \cos \Theta$
$v_y = v \sin \Theta$
$\Theta = \tan^{-1}(v_y / v_x)$

Directions: For each of the following questions, using the equations provided above, solve for the working equation ***first***. Box the equation, then substitute with units and solve. To prepare for the AP Physics course, please use the variables as they appear in the equations provided.

1. Example: A car that is capable of braking with an acceleration of magnitude 12 m/s^2 leaves skid marks that are 36m long while braking to a stop. What was the initial speed of the car before it hit the brakes?

$a = -12 m/s^2$ $v^2 = v_0^2 + 2a(x - x_0)$ $\sqrt{((0 m/s)^2 - 2(-12 m/s^2)(0 m 36 m))} = v_0$ $v_0 =$
$x = 36$ $v^2 - 2a(x - x_0) = v_0^2$
$x_0 = 0$ $\sqrt{(v^2 - 2a(x - x_0))} = v_0$ ← Working equation
$v = 0 m/s$

2. A rock is dropped at the same instant that a ball, at the same initial elevation, is thrown horizontally.
    a. Which will have a greater speed when it reaches the ground: The rock, the ball or neither?

    b. Explain your answer in words.

c. Which will reach the ground first: the rock, the ball, or neither?

d. Explain your answer in words.

3. A ball is thrown upward from y= 0m with an initial velocity of 7 m/s.
    a. What maximum height does the ball reach?

    b. How long does it take the ball to reach this height?

4. A rock is thrown downward with an initial speed of 5 m/s from a height of 12 . After what time interval does the rock strike the ground?

5. A bowling ball rolls off a 0.8 m high table with an initial velocity of 0.7m/s.
    a. How much time does the ball take to hit the ground?

    b. How far from the base of the table does the ball land?

6. If an arrow is released with a speed of 80 m/s at an angle of 30 degrees above the horizontal.
    a. What is the horizontal component of the arrows velocity?

    b. What is the vertical component of the arrows velocity?

    c. What is the arrows total air time?

Forces

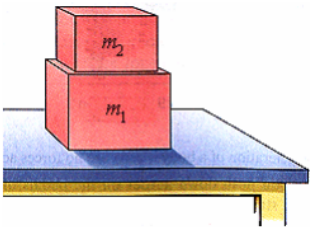
7. *A student is pushing a crate up a 20° incline at a constant speed. The crate has a mass of 20 kg, and a coefficient of friction between the crate and the incline is 0.25.
    a. Draw a free-body diagram of the crate.

    b. Calculate the magnitude of the normal force between the crate and the incline.

    c. Calculate the magnitude of the friction force between the crate and the floor.

8. A 28.5 kg box (m_1) rests on a table. A 13.5 kg box (m_2) is placed on top of the 28.5 kg box, as shown.
    a. Draw the Free body diagram for the whole system (both blocks).

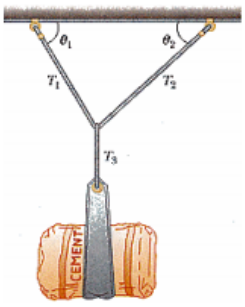
    b. Determine the normal force that the table exerts on the 28.5 kg box.



    c. Draw a free body diagram for just m_1.

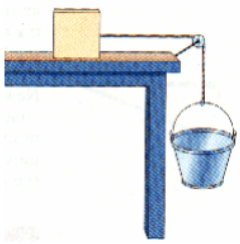
    d. Determine the normal force that the 28.5 kg box exerts on the 13.5 kg box.

9. *A bag of cement of weight 325 N hangs from three wires as shown in the diagram. Two of the wires make angles Θ_1 =60° degrees and Θ_2 = 30° degrees with the horizontal. If the system is in equilibrium, find the tension in each wire. (hint: solve for T_3 first by summing the forces on the bag of cement. You will need a system of equations to solve for the other two.)



10. A 26.0 kg block is connected to an empty 1.0 kg bucket by a cord running over a frictionless pulley. The coefficient of static friction between the table and the block is 0.48 and the coefficient of kinetic friction between the table and the block is 0.30. Sand is gradually added to the bucket until the system just begins to move.
    a. Draw a free body diagram of the block

    b. Calculate the normal force on the block by the table.



    c. Calculate the maximum frictional force that can be applied by the table to the block.

    d. Draw a free body diagram of the bucket

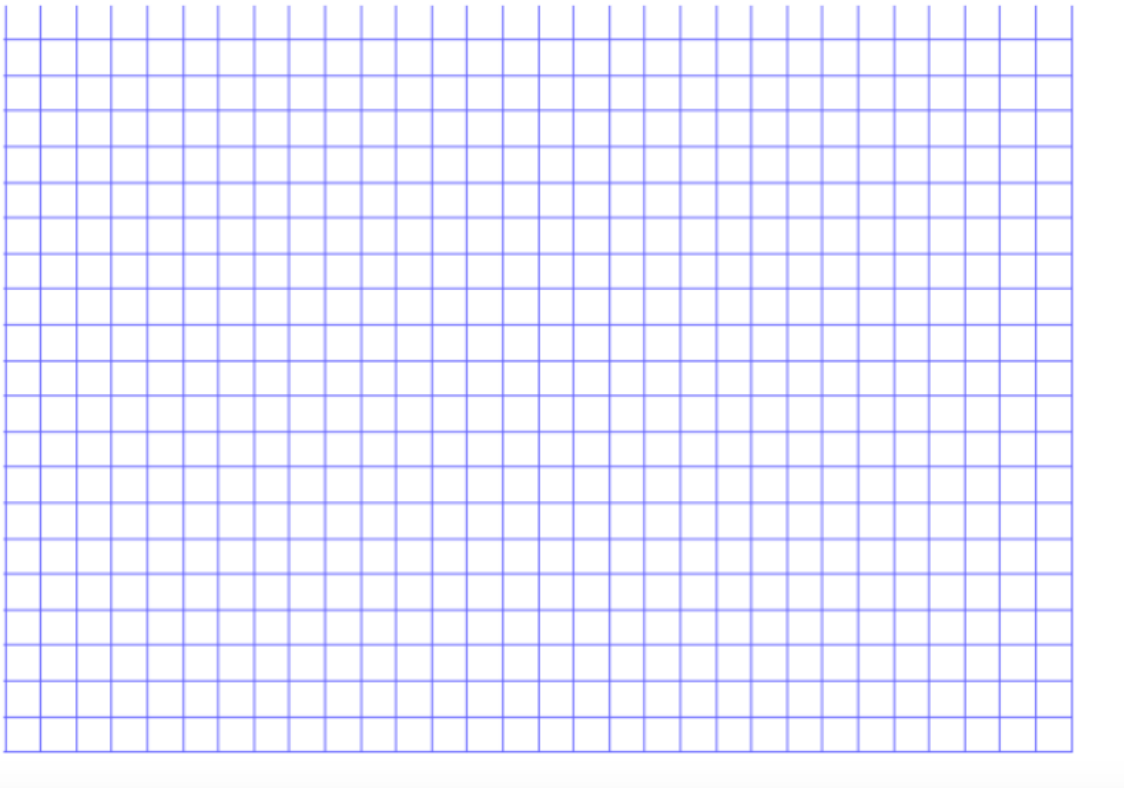
    e. Calculate the mass of sand added to the bucket.

    f. What mass of sand in the bucket would cause the bucket to descend at a constant speed?

Graphing

11. The following data shows the distance an object travels in certain time periods. Prepare a graph of the data below. (graph paper provided on the next page.

Time (s)	Distance (m)
0	0
1	3
2	12
3	27
4	48



a) Describe the relationship between x and y as shown by your graph and write a general equation for the curve.

b) Is the distance traveled greater between 0s and 1s or between 3s and 4s? Explain

c) Is the slope of the curve greater between 1s and 2s or between 3s and 4s? Explain

d) What is the slope of the curve between 1s and 2s? Remember to include units with your slope. Show your work.

e) What is the slope of the curve between 3s and 4s? Remember to include units with your slope. Show your work.

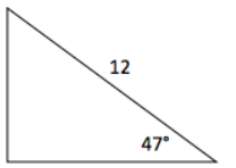
f) What physical quantity does the slope represent? (Hint: look at the units)

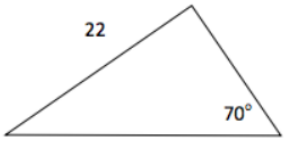
g) What generalization can you make about the meaning of the slope of the line on this graph (ex: The steeper the slope the ……)?

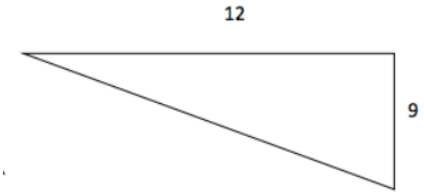
12. Using dimensional analysis convert the following
    a. Convert 4.4 km/hr to m/s
    b. Convert $8.7z10^{-7}$ MW to GW
    c. Convert 22mg to kg
    d. Convert 3.5 hr to s

PREFIXES		
Factor	Prefix	Symbol
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

13. Find the missing sides and angles in the following triangles.







14.

$$f(x) = -x^4 + 4x^2 + 2x$$

a. $\frac{d\,f(x)}{dx} =$

b. $f''(x) =$

15.

$$f(x) = 2x^5 + 4x^2 + 2x$$

a. $\frac{d\,f(x)}{dx} =$

b. $\frac{d^2 f(x)}{dx^2} =$