AP Physics B Summer Assignment – 2010

Your assignment is to solve the problems that follow. These problems deal with topics that were covered in your first year physics course. They are topics that will be on the AP physics test but are not really new, just problems a little harder that what you were used to in your introductory physics course. By covering the material over the summer we will be able to get to the material that is at the core of AP Physics B much more quickly and spend more time on that material.

DUE DATE: The assignment is due at the beginning of class on the first day of school.

SHOW YOUR WORK: To receive credit you must show a logical progression of steps leading to your answers. Just like the AP exam, answers with no work will receive no credit.

NEATNESS COUNTS: Your answer must be neat and easy to follow.

COLLABORATION: You are encouraged to work with other students and to receive help from sources available to you. However, it would be considered cheating if you simply copied another student's work. If you can get the problem explained by another student that's fine, but you must then work through the problem on your own.

REVIEW OF THE TOPICS COVERED IN THESE PROBLEMS

The problems you have to solve in this assignment all involve motion in one dimension. You must use some basic definitions you have learned in your introductory course. Below is an overview of the material.

- Distance is the length measurement of the path the object traveled.
- Displacement is the change in an object's position. It is written as $\Delta x = x - x_0$ where x is a later or final position of the object and x_0 is the starting position of the object.
- Average speed is the total distance traveled divided by the time it took to travel that distance.
- Average velocity is an object's displacement divided by the time it took.
- The acceleration of an object is the rate of change of its velocity. It is written $a = \Delta v/\Delta t$, where $\Delta v = v - v_0$ and v is a later or final velocity and v_0 is the starting velocity of the object.
- If the acceleration is constant you can use the following equations.

$$v = v_0 + at$$
$$\Delta x = v_0 t + \tfrac{1}{2} a t^2$$
$$v^2 = v_0^2 + 2a\Delta x$$
$$\Delta x = \tfrac{1}{2} (v_0 + v)t$$

- Remember that when an object is under the force of gravity alone it is said to be in free fall.
- Remember, for objects in free fall you can use positive or negative "g" where the magnitude of g is 9.8 m/s^2.

MATH REVIEW: Often problems on the AP exam are done with variables only. Solve for the variable indicated. Don't let the different letters confuse you. Manipulate them algebraically as though they were numbers.

1. $v^2 = v_o^{\,2} + 2a(s - s_o)$, $a =$ _____

2. $K = \frac{1}{2}kx^2$, $x =$ _____

3. $T_p = 2\pi\sqrt{\frac{\ell}{g}}$, $g =$ _____

4. $F_g = G\frac{m_1 m_2}{r^2}$, $r =$ _____

5. $mgh = \frac{1}{2}mv^2$, $v =$ _____

6. $x = x_o + v_o t + \frac{1}{2}at^2$, $t =$ _____

7. $B = \frac{\mu_o}{2\pi}\frac{I}{r}$, $r =$ _____

8. $x_m = \frac{m\lambda L}{d}$, $d =$ _____

9. $pV = nRT$, $T =$ _____

10. $\sin\theta_c = \frac{n_1}{n_2}$, $\theta_c =$ _____

11. $qV = \frac{1}{2}mv^2$, $v =$ _____

12. $\frac{1}{f} = \frac{1}{s_o} + \frac{1}{s_i}$, $s_i =$ _____

CONVERSION FACTORS

Science uses the MKS system (SI: System Internationale). MKS stands for kilogram, meter, second. These are the units of choice of physics. The equations in physics depend on unit agreement. So you must convert to MKS in most problems to arrive at the correct answer. These are some common conversions to know!

kilometers (km) to meters (m)
meters to kilometers
gram (g) to kilogram (kg)
centimeters (cm) to meters (m)
meters to centimeters
Celsius (°C) to Kelvin (K)
millimeters (mm) to meters (m)
meters to millimeters
atmospheres (atm) to Pascals (Pa)
nanometers (nm) to meters (m)
meters to nanometers
liters (L) to cubic meters (m^3)
micrometers (μm) to meters (m)

Other conversions will be taught as they become necessary.

What if you don't know the conversion factors? Colleges want students who can find their own information (so do employers). Hint: Try a good dictionary and look under "measure" or "measurement". Or the Internet? Enjoy.

a. 4008 g = _____ kg
b. 1.2 km = _____ m
c. 823 nm = _____ m
d. 298 K = _____ °C
e. 0.77 m = _____ cm
f. 8.8×10^{-8} m = _____ mm
g. 1.2 atm = _____ Pa
h. 25.0 μm = _____ m
i. 2.65 mm = _____ m
j. 8.23 m = _____ km
k. 5.4 L = _____ m^3
l. 40.0 cm = _____ m
m. 6.23×10^{-7} m = _____ nm
n. 1.5×10^{11} m = _____ km

PROBLEMS

1. Starting from your house, you run 200 m east at an average speed of 4 m/s, then run 280 m west at an average speed of 7 m/s ending at school. Calculate your:
    a. Average speed from your house to your school;
    b. Average velocity from your house to your school.

2. A car sits on an entrance ramp to a freeway, waiting for a break in the traffic. The driver sees a small gap between a van and an eighteen-wheeler and accelerates with constant acceleration along the ramp onto the freeway. The car starts from rest, moves in a straight line, and has a speed of 25 m/s when it reaches the end of the 120-m ramp.
    a. What is the acceleration of the car?
    b. How much time does it take the car to travel the length of the ramp?
    c. If the traffic on the freeway is moving at a constant speed of 25 m/s, what distance does the traffic travel while the car is moving down the ramp?

3. At the instant a traffic light turns green, an automobile that has been waiting at an intersection starts to move with a constant acceleration of 2 m/s^2. At the same instant a truck, traveling with a constant speed of 18 m/s, passes the automobile.
    a. How far beyond its starting points does the automobile overtake (pass) the truck?
    b. How fast is the automobile going when it overtakes the truck?
    c. On a single graph, sketch the position of each vehicle as a function of time. Take x = 0 at the intersection.

4. A lunar lander is making its descent to Moon Base I. The lander descends slowly under the retro-thrust of its descent engines. The engine is cut off when the lander is 5 m above the surface of the Moon and has a downward speed of 1.5 m/s at that time. The lander then free falls to the Moon. What is the speed of the lunar lander just as it touches the Moon's surface? The acceleration due to gravity on the moon is 1.6 m/s^2.

5. A brick is dropped (initial velocity zero) from the roof of a building. The brick strikes the ground in 4.5 s. Air resistance can be ignored.
    a. How tall is the building?
    b. What is the magnitude of the brick's velocity just before it reaches the ground?
    c. Sketch an acceleration vs time, velocity vs time, and position vs time graphs for the brick.

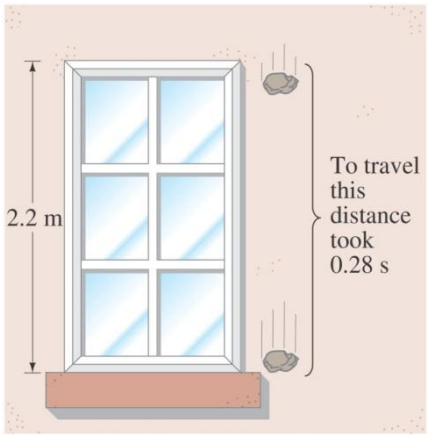
6. On a twenty-mile bike ride, you ride the first 10 miles at an average speed of 10 mi/h. What must your average speed for the next 10 miles be to average 15 mi/h?

7. A typical world-class sprinter accelerates to his maximum speed in 4 s. If such a runner finishes a 100-m race in 9.1 s, what is the runner's average acceleration during the first 4 s? Assume that once he attains his top speed the runner continues at that speed until the end of the race.

8. The engineer of a blue train traveling 25 m/s sights a red train whose caboose is 200 m ahead of him on the same track. The red train is traveling in the same direction as the blue train at 15 m/s. The engineer of the blue train immediately applies the brakes causing a constant acceleration of .1 m/s^2. Will there be a collision? If so, where will it take place?

9. A cannon is positioned on top of a cliff 60 m high. The gun crew spots a boat on the water below 2.2 km away. At the same time, the hooligans on the boat see the gun and start to accelerate directly away from it at 0.9 m/s^2. If the gun is pointing up at an angle of 10° above the horizontal, and it fires a cannonball at 240 m/s, how long should the gunners wait before firing if they are to hit the fleeing boat?

10. A falling stone takes 0.28 s to travel past a window 2.2 m tall. From what height above the top of the window did the stone fall?



11. The first meters of a 100 meter dash are covered in 2 seconds by a sprinter who starts from rest and accelerates with a constant acceleration. The remaining 90 meters are run with the same velocity the sprinter had after 2 seconds.
    a. Determine the sprinter's constant acceleration during the first 2 seconds.
    b. Determine the sprinters velocity after 2 seconds have elapsed.
    c. Determine the total time needed to run the full 100 meters.
    d. Draw the displacement vs time curve for the sprinter.