Kinematics -- Conceptual Questions

Note: Remember, you aren't expected to know the answers to the conceptual questions that follow. All you are expected to do is to keep them in the back of your mind while you go through the material involved in this chapter.

1.) Without using a formal presentation of formulas, determine the following in your head:

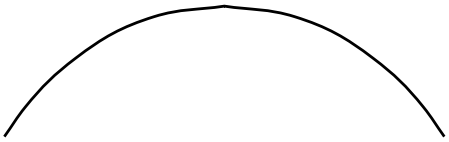
a.) The units you get when you multiply velocity and time.

b.) The distance an object travels in 8 seconds when moving with a velocity magnitude of 6 m/s.

c.) The units you get when you multiply acceleration and time.

d.) The velocity an object will *pick up* in 7 seconds when moving under an acceleration magnitude of 5 m/s^2, assuming the velocity and acceleration are in the same direction.

2.) True or False: An object that negatively accelerates slows down.



3.) Think about a two dimensional projectile situation (someone throws a baseball in from the outfield). Once the ball has become free, and ignoring friction:

a.) Is there a point in the flight where the acceleration is perpendicular to the velocity? Explain.

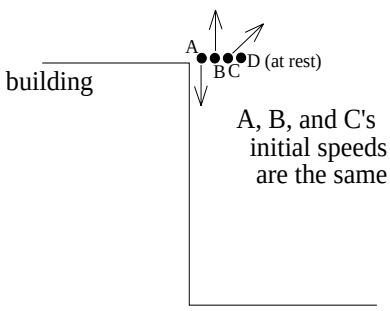
b.) Is there a point in the flight where the velocity is zero but the acceleration is non-zero? Explain.

c.) Is there a point in the flight where a *component* of the flight's motion has zero velocity with a non-zero acceleration? Explain.

d.) Is there a point in the flight where a *component* of the flight's motion has non-zero velocity with zero acceleration? Explain.

e.) Is there more than one point that fits the description outlined in *Part d*? Explain.

f.) Is there anywhere in the flight where the ratio of the acceleration in the *x direction* to the acceleration in the *y direction* is zero? Explain.



4.) *Rock A* is thrown vertically downward from a rooftop. *Rock B* is thrown vertically upward. *Rock C* is thrown at an angle relative to the horizontal. *Rock D* drops from rest. All four are released from the same spot with those initially moving having the same velocity magnitude v_o. Assume we can neglect friction.

a.) Considering *Rock A* and *Rock B*, which of the following quantities is the same for both rocks: i.) the time of

flight to the ground; ii.) the velocity just before hitting the ground; iii.) the magnitude of the velocity just before hitting the ground; iv.) the acceleration during the flight; v.) the net displacement; vi.) the average speed to the ground; vii.) the average velocity to the ground.

b.) Considering *Rock B* and *Rock C*, which of the following quantities is the same for both situations: i.) the time of flight to the ground; ii.) the velocity just before hitting the ground; iii.) the magnitude of the velocity just before hitting the ground; iv.) the acceleration during the flight; v.) the net displacement; vi.) the average speed to the ground; vii.) the average velocity to the ground.

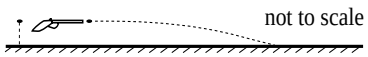
c.) What is common to the flight of *Rock A* and *Rock D*?

d.) If rock *C's* angle had been zero degrees (that is , if it had been thrown horizontally), what would have been common to the flight of *Rock C* and *Rock D*?

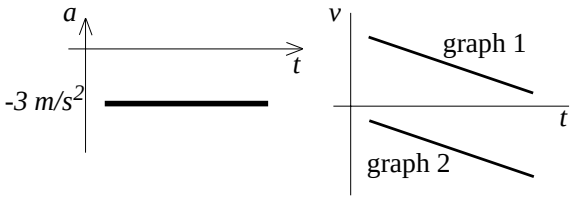
5.) An object accelerates from rest at a constant rate a. In time t, it travels d units. If the acceleration is doubled, how much time will it take to travel the same distance d?

6.) What's a jerk? (No, it's not the guy sitting next to you.)

7.) The muzzle velocity of a gun is 100 m/s. A bullet is fired horizontally from the gun when it is 2 meters off the ground. At the same time, a second bullet held next to the gun is dropped from rest. It takes the dropped bullet .64 seconds to hit the ground. Ignoring friction and assuming the terrain is flat, how far will the fired bullet travel before hitting the ground? (This is almost all conceptual--use your head a lot with only a little bit of math).



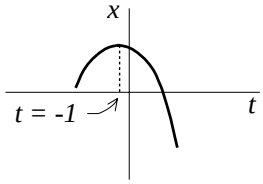
8.) A graph of the negative acceleration applied to two equal masses is shown. Mass A moves in the *+x direction* while mass B moves in the *-x direction*.



a.) Are either of the *velocity versus time* graph shown associated with either particle? Explain.

b.) How would things change if the acceleration had been positive?

9.) A body moves along the *x axis* as depicted by the graph



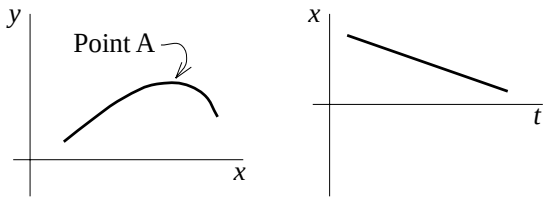
a.) In what direction is the body moving at *t = -1 seconds*?

b.) In what direction is it moving at *t = +1 seconds*?

c.) Is this a constant velocity situation? Explain.

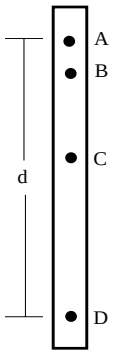
d.) Is this a constant acceleration situation? Explain.

10.) The two graphs depict different characteristics of the motion of a mass. In what direction is the mass's velocity when at Point A? In what direction is the motion's acceleration?



11.) Make up a conceptually based graphical question for a friend. Make it a real stinker, but give enough information so the solution *can* be had (no fair giving an impossible problem).

12.) There is a classic experiment in which a tape freefalls through a timer that impresses a mark on the tape every 60^{th} of a second (see sketch). As the tape picks up speed, the marks become farther apart (note that the sketch is not necessarily to scale). Assuming you can ignore friction:



a.) What is the ratio between the distance AB and the distance AD?

b.) You measure the total distance between the four dots and call it *d*. What is the time duration over this interval? If you divide *d* by that time, what kind of quantity will it give you (think about its units . . .)?

c.) At what point in the AC interval is the average velocity and instantaneous velocity the same?

13.) Two buildings stand side by side. The taller is 20 meters higher than the shorter. Rocks are dropped from rest from both roofs at the same time. When the rock from the taller building passes the top of the shorter building, the rock from the shorter building will be (a.) 20 meters below its start point; (b.) less than 20 meters below its start point; (c.) farther than 20 meters below its start point.

14.) A brick is thrown upward with velocity v_1. Two bricks stuck together are thrown upward with three times that velocity. If the first brick reaches a maximum height of *H*, how high will the two bricks go?

15.) An idiot drops a coke bottle out of the window of a Cesna aircraft flying in the horizontal. Ignoring air friction, what will determine how long it takes for the bottle to hit the ground? That is, what parameters (i.e., mass, height, velocity, what?) would you need to calculate the time of freefall?

16.) Two identical guns are fired from the same place at ground level on a horizontal range. One is angled at 20^o whereas the second is angled at 40^o. Ignoring friction:

a.) Which bullet would you expect to be in the air the longest?

b.) Which would go the farthest?

c.) Which would go the highest?

d.) Which would be traveling the fastest as it hits the ground?

e.) Which would have experienced the greatest *maximum* acceleration during the flight?

17.) Answer all of *question 16* assuming air friction exists.

18.) As a projectile passes through its maximum height, little Mr. Know-It-All says, "Right now, the dot product of the velocity and the acceleration is zero." What do you think about that statement (aside from the possibility that little Mr. Know-It-All needs to get a life)?