Chapter 2 XtraWrk – 1D motion

Multiple Choice/Conceptual questions:

MC#4. A baseball player hits a ball straight up into the air. While the ball is in the air (after it leaves the bat), which statement is true?

a) The velocity of the ball is always opposite the direction of the acceleration
b) The acceleration of the ball is zero
c) The velocity of the ball is never in the same direction of the acceleration
d) The velocity and the acceleration are opposite on the way up

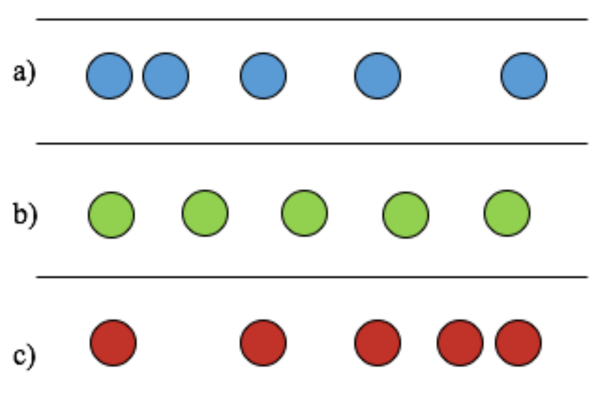
MC#6. A rocket traveling in a straight line fires its thrusters in reverse, creating a backwards acceleration. Assume the thrusters continue to fire constantly. What happens to the rocket?

a) It eventually stops and remains stopped in place
b) It eventually stops and then speeds back up in the forward direction
c) It eventually stops and then speeds up in the backwards direction
d) It never stops but loses speed more and more slowly forever

CQ#1. If an object has a nonzero velocity, can it have zero acceleration? Explain.

CQ#2. If an object has zero velocity, can it have a nonzero acceleration? Explain.

CQ#6. The following images show drops from an oil pan of a car moving from left to right. Assuming the oil drips at a constant rate (so the time interval between each dot is the same), and taking the positive direction to the right, describe the motion of the car for each case. For which option is the acceleration positive? Negative? Constant?



Problems:

2.10) Car A travels at 55 mph. Car B travels at 70 mph in the same direction. Assume they start at the same time at the same location.

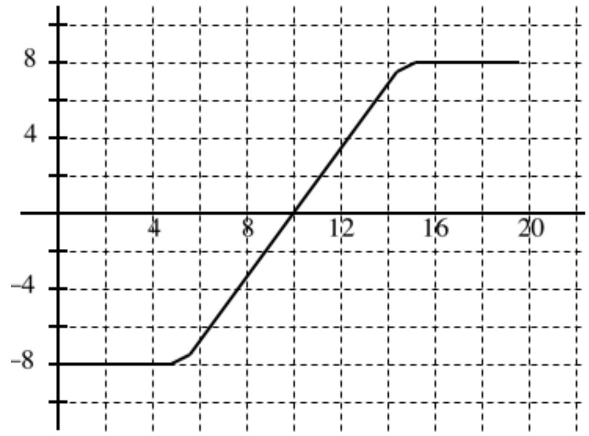
a) What's the difference in arrival time for a destination 10 miles away?
b) How far must car B travel to be 15 minutes ahead of A?

2.24) What would the body's motion look like if the graph to the right was:

a) a position vs. time graph?

b) a velocity vs. time graph

c) an acceleration vs. time graph?



2.28) A mad genius builds a human cannon that is 220 m long and launches the human at a final speed of 10.97 km/s. What is the unrealistically large acceleration this human cannonball will experience during their launch? What is this in "g's? (For reference, humans can only withstand up to 15*g* for short periods of time.)

2.34) A racecar finishes a race with a speed of 100 m/s and can accelerate at a maximum rate of -5.00 m/s^2 as it comes to rest along a straight track.

a) From the instant the driver applies constant braking, what is the minimum time needed before the car can come to rest?
b) Can the car stop safely if the runout lane available is 0.800 km long?

2.50) A sandbag is released from a hot-air balloon that is descending at a constant 1.5 m/s. After 2.0 seconds,

a) How fast is the sandbag traveling?
b) How far below the hot-air balloon is the mailbag?
c) How would parts (a) and (b) change if the balloon had been <u>rising</u> at 1.5 m/s?

2.51) A tennis player throws a ball straight up. It leaves the hand 2.0 m above the ground and takes 4.0 seconds to return to the starting height. (note: remember sign and units for all numeric answers!)

a) What is the ball's acceleration on the way up?
b) What is the ball's acceleration at the top of its flight?
c) What is the ball's acceleration on the way down?
d) What is the velocity of the ball when it reaches its maximum height?
e) What is the initial velocity of the ball?
f) What is the ball's maximum height?

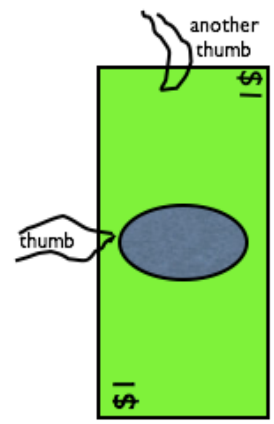
New set-up: The ball is again thrown upward. At a particular point in time, the velocity is registered at +12 m/s upward. If the stopwatch starts at that point:

g) How fast is it moving after 0.3 seconds?
h) How fast is it moving after it has traveled 0.2 meters?
i) How long will it take to get to the point where it is moving at -4 m/s?
j) Where will it be after the first 0.7 seconds?

2.53) A rocket is launched with 50 m/s of initial velocity straight upwards. It continues to accelerate at 2 m/s^2 until it reaches a height of 150 m.

a) What happens after the propulsion cuts out at 150 m height?
b) What is the rocket's maximum height above the ground?
c) How much time does it take to reach that height?
d) What is the total time of flight for the rocket?

2.69) The *dollar bill drop* is a classic physics experiment: one person holds a dollar bill vertically between another person's open index finger and thumb. The first person releases the bill and the second person must catch it as quickly as possible. If the second person holds their fingers exactly in the middle of the dollar bill, and their reaction time is 0.2 seconds, will they successfully catch the dollar bill?



Other problems:

1. Classic Free-fall problem

A mass located at 1.5 m above the ground is thrown upwards with velocity 10 m/s.

a) Where will the mass be at t = 0.2 seconds?
b) At what time will the mass be at 4.0 m high?
c) What will be the velocity at t = 0.15 seconds?
d) What will be the velocity when the mass is at 1.25 m above the ground?
e) How high (maximum relative to the ground) will the mass go?

2. Pebble into the well problem

Annabelle drops a pebble from rest into a deep wishing well. It takes 8 seconds for the sound of the splash to get back to her. Assuming the speed of sound is 330 m/s, how deep is the well?
(Hint: The problem has two parts – what are they, and why?)

3. Elevator and bolt problem

A 3 meter tall elevator moving at 2 m/s upward has a bolt in its ceiling come loose at $t = 0$ seconds. The bolt "freefalls" for a period of time and finally hits the elevator's floor. How far has the elevator's floor moved during the time the bolt free fell?

4. How high is the building?

You are sitting in a room on an unknown floor of a high, multiple-story building, looking out a 1.5-m tall window. Someone drops a ball from rest from the rooftop above. It falls, and when it gets to your window, the ball takes 0.20 seconds to pass from the top of your window to the bottom of the window. It proceeds on, hits the ground, bounces elastically (meaning no energy is lost) and reappears at your window 12 seconds later. How high is the building?

> (Hint: You will need a carefully labeled picture to keep track of all of the variables involved in this problem!!)