AP Physics-B **Kinematics - Part I -- Graphical Analysis of Motion**

Kinematics - The study of the motion of objects without regard to the causes of this motion.

1.) The speed of sound in air is ~331 m/s. During the next thunderstorm, try to estimate your distance from a lightning bolt by measuring the time lag between the flash and the thunderclap. You can ignore the time for the light flash to reach you. Why?

2.) Average velocity and instantaneous velocity are generally different quantities. Can they ever be equal for a specific type of motion?

3.) Can the instantaneous velocity of an object ever be greater in magnitude than the average velocity? Can it ever be less?

4.) If a car is traveling eastward, can its acceleration be westward? Explain.

5.) If an object is stationary at some instant, is its acceleration necessarily zero at this time?

6.) A football player makes a touchdown run of 100 yards in a time of 15 seconds. What was his average velocity in m/s during his run?

7.) Car A traveling form New York to Walt Disney World has a speed of 25 m/s. Car B traveling form New York to Chicago also has a speed of 25 m/s. Are their velocities equal? Explain.

8.) A person makes a trip by car between two cities. A record of the trip is as follows: 30.0 min at 80.0 km/hr, 12.0 min at 100.0 km/h, 15.0 min for a lunch break, 45.0 min at 40.0 km/h.

a.) Determine the average speed for the trip.
b.) Determine the distance between the cities.

9.) A person takes a trip, driving with a constant speed of 89.5 km/h except for a 22.0 min rest stop. If the person's average speed is 77.8 km/h, how far is the trip?

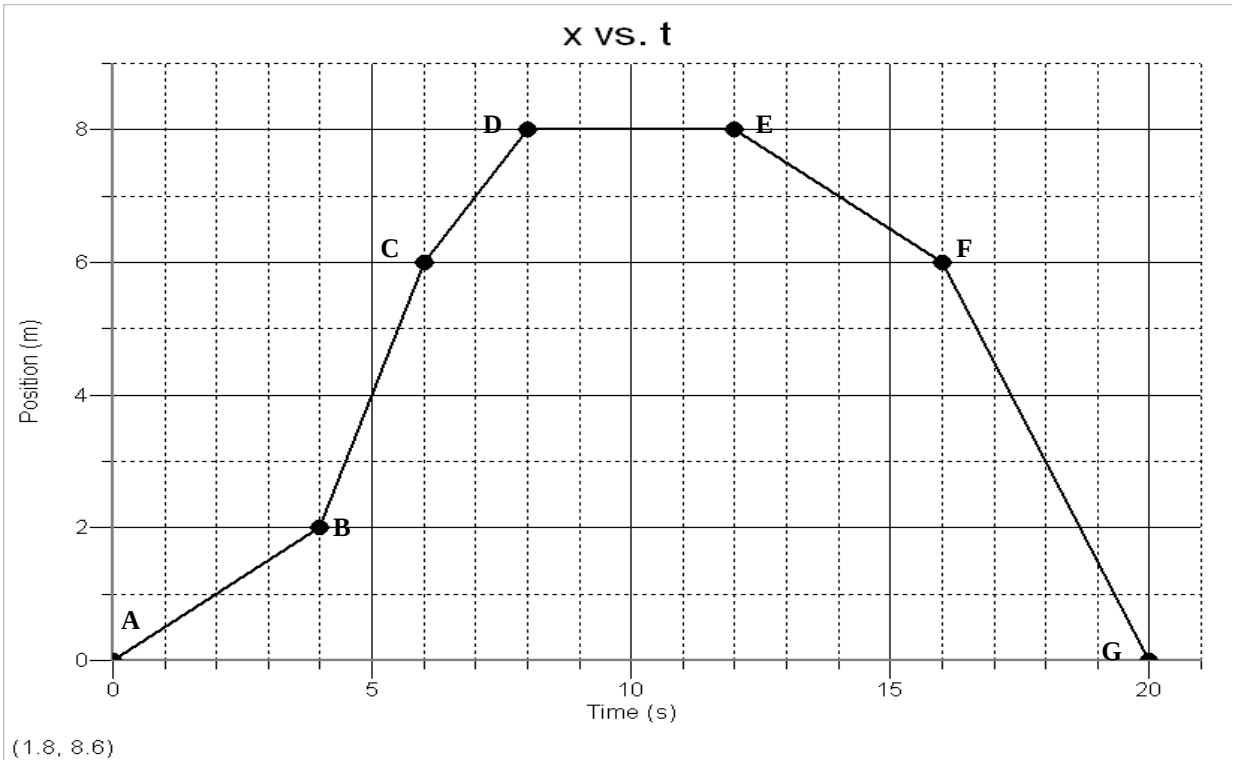
10.) Sketch a velocity-time graph for a shuttle train which runs between cities A and C with an intermediate stop at city B. All cities are on a straight line.

11.) A man walks to the corner to mail a letter and comes back. Sketch graphs showing his velocity and position plotted against time.

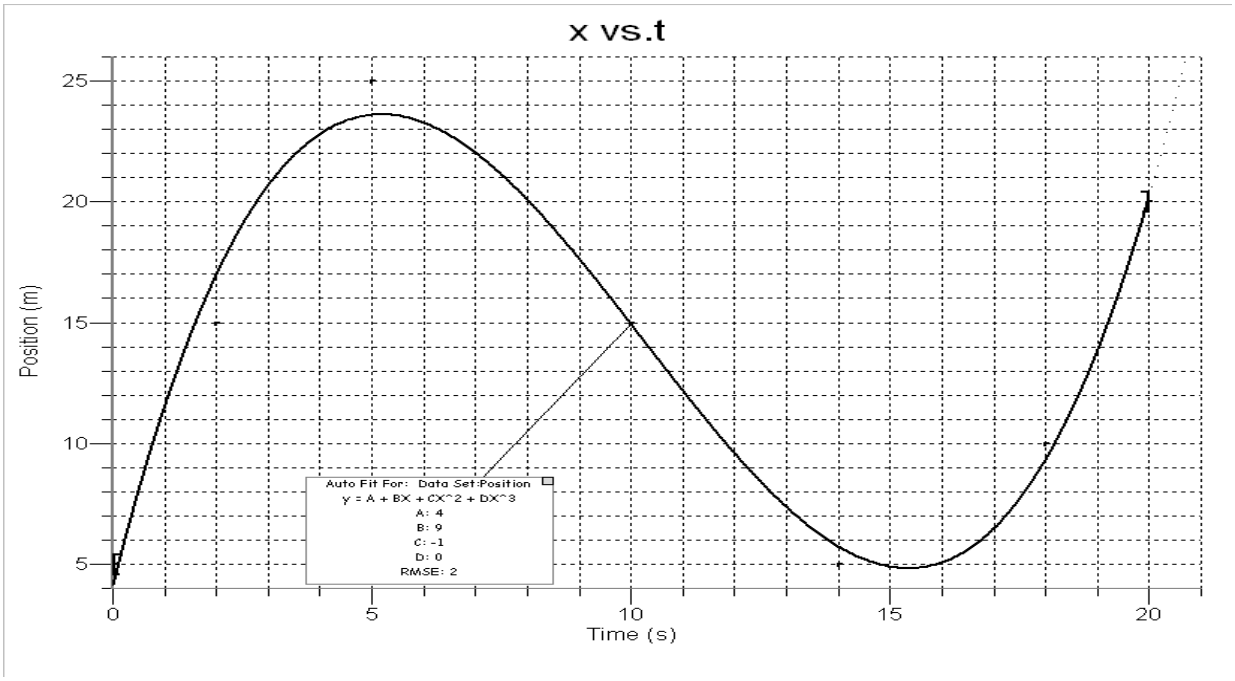
12.) A car driving along a highway slows down as it enters a small village. It is stopped by a traffic light in the center, goes on to the edge of the village, and then speeds up again. Sketch graphs, on above the other, showing its velocity, and its position plotted against time.

13.) A car is traveling along a road at constant velocity. It passes an unmarked police car parked beside the road. The police car accelerates, overtakes the speeding car, passes it, and signals it to stop. Sketch a graph showing the velocities of the two cars plotted against time.

14.) Calculate the average velocity a.) from B to C b.) from E to F c.) from D to E
What might this moving object be?



15.) Calculate the instantaneous velocity at t = 2 s, t = 6 s, and t = 10 s.



16.) Use the graph from Problem 14 to calculate the average velocity between
a.) A and C b.) A and D c.) C and F d.) A and G

17.) Use the graph from Problem 14 to calculate the average speed between A and G.

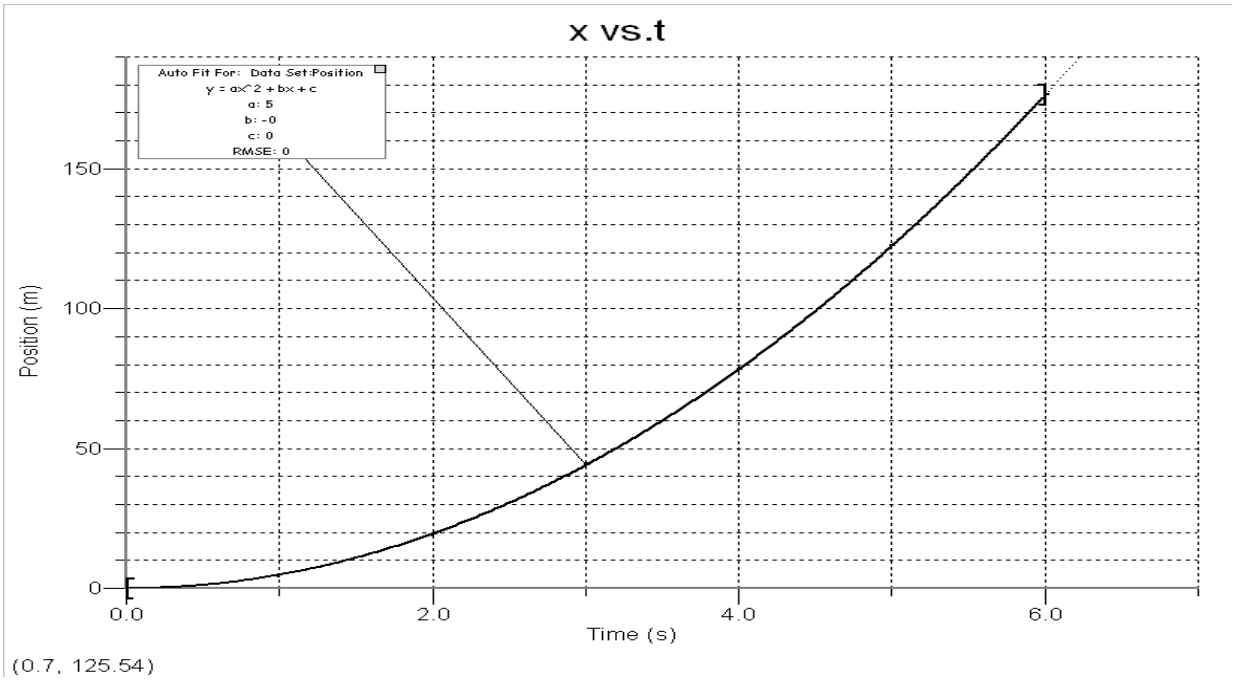
18.) Use the graph in Problem 15 to calculate the average velocity between
a.) t = 2 s and t = 6 s b.) t = 2 s and t = 10 s c.) t = 0 s and t = 18 s

19.) Using the graph below:

a.) Find the average velocity for the intervals: 0s to 6s, 1s to 5s, 2s to 4s.

b.) Find the instantaneous velocity at t = 3.0s.

c.) In one sentence, sum up what you can conclude from this exercise.



20.) Using the graph from problem 19:

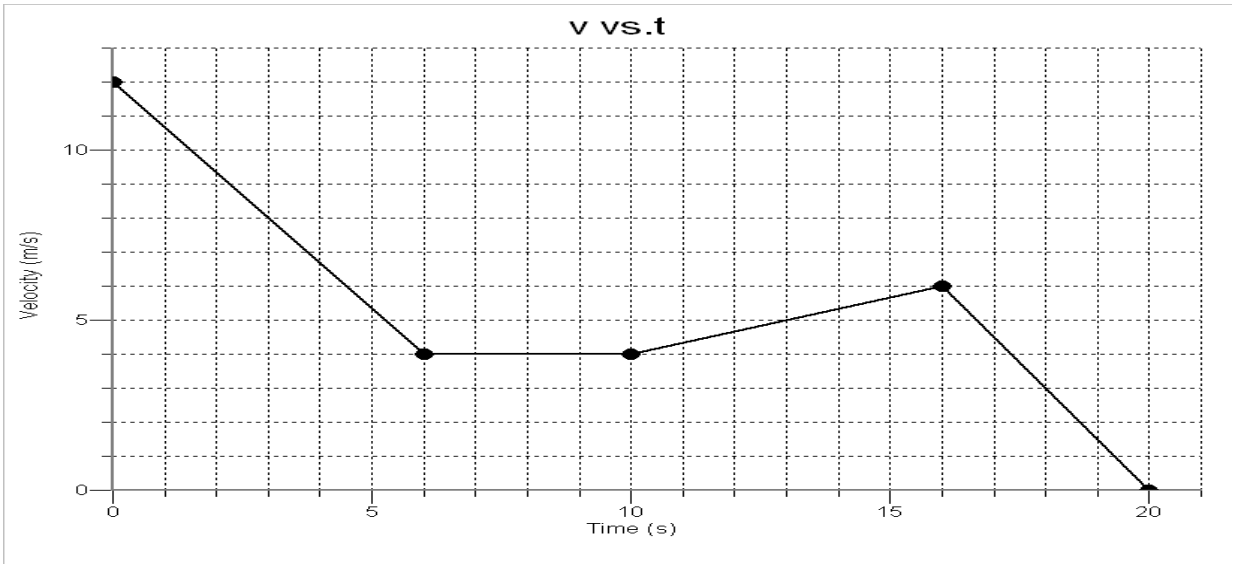
a.) Use the slope of the tangent line to find the instantaneous velocity at the midpoint of each time interval (at t = 1.5 sec, t = 2.5 sec, and so on).

b.) Find the average velocity in each 1-second interval (t from 1 to 2 sec, t from 2 to 3 sec, and so on).

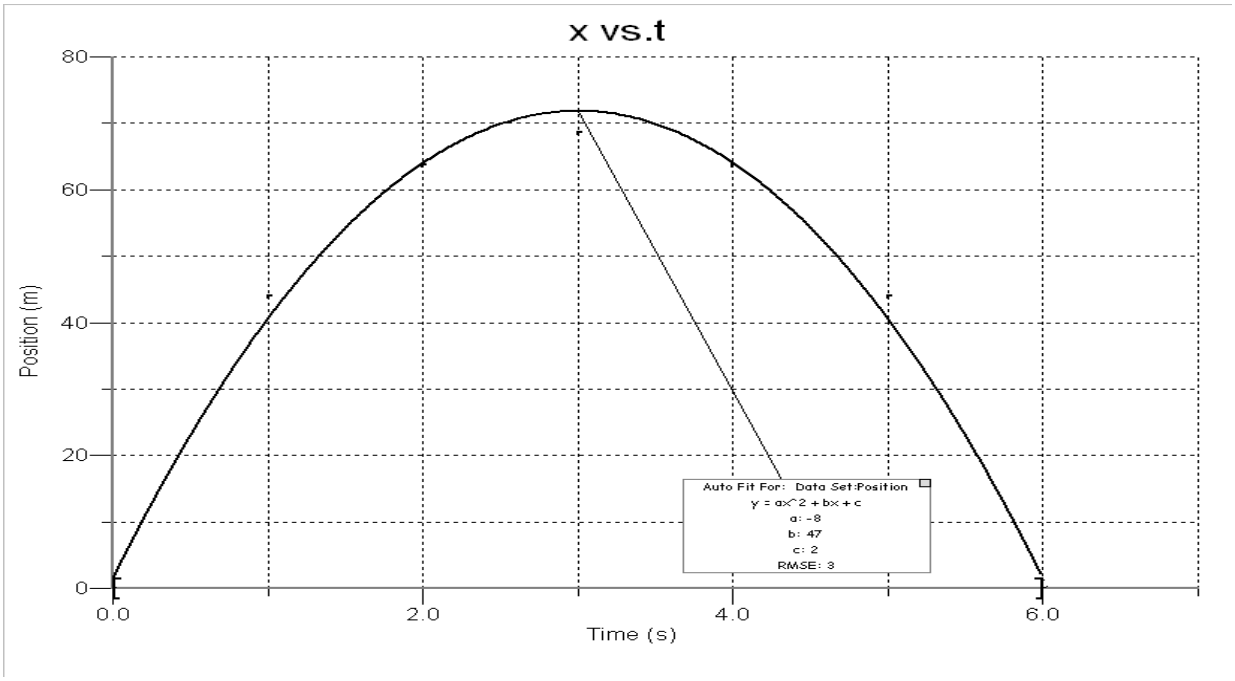
c.) How could you find the instantaneous velocities at 2 sec, 3 sec, 4 sec, and 5 sec?

d.) In one sentence, sum up what you can conclude from this exercise.

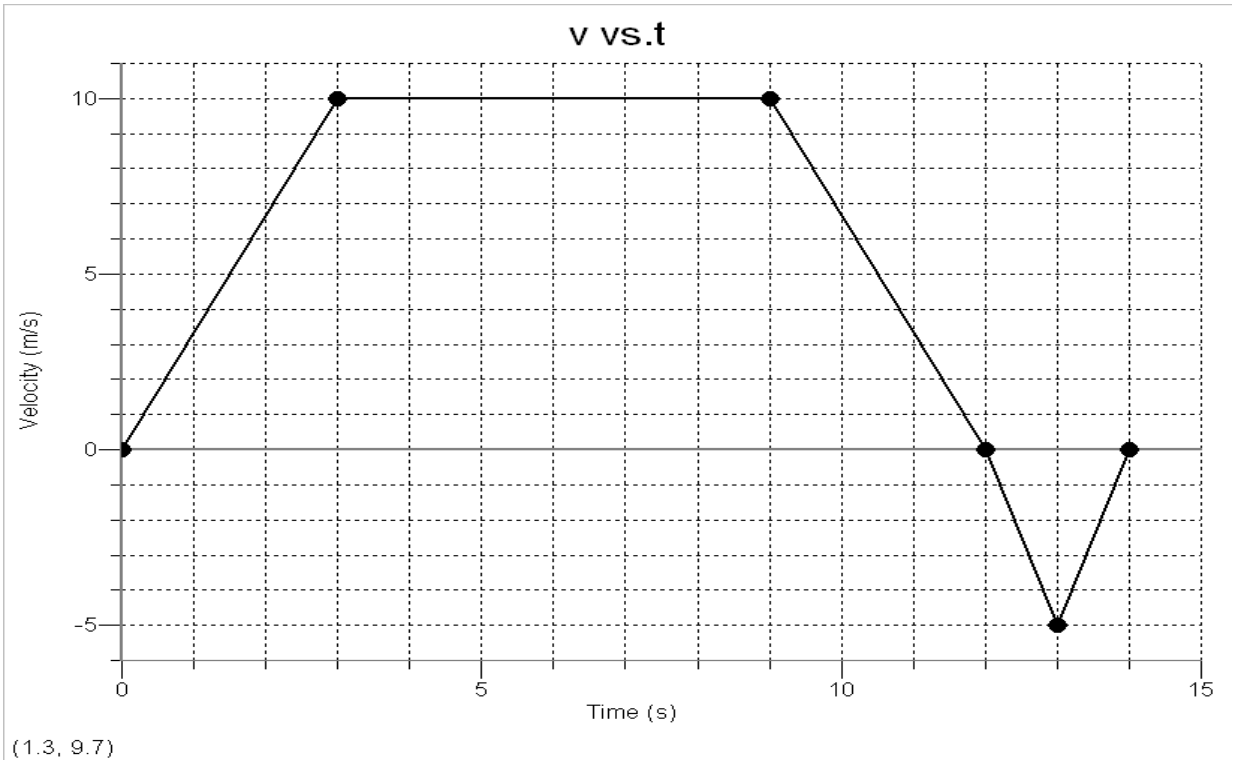
21.) Construct a graph of position vs. time from the graph below.



22.) Construct a graph of velocity vs. time from the graph below.



23.) Construct graphs of position vs. time and of acceleration vs. time from the graph below.



24.) Sketch a velocity-time graph for a ball thrown straight up from the time it is still at rest in the hand until it is momentarily at rest on the ground.

b.) Should the area between the curve and the time axis above the time axis be equal to the corresponding area below the time axis?

c.) Use the graph in (a) to sketch the acceleration-time graph for the same motion.

25.) Car A is stopped at a traffic light. The light turns green and A starts moving forward. Just as it does so, car B passes it going at a steady velocity. Their velocity-time curves are shown in the figure below:

a.) How long does it take car A to be going as fast as car B?

b.) At that time, how much is car B ahead of car A?

c.) Which car is ahead, and by how much, at the end of 0.012 hours?

d.) At what time does car A catch up with car B?

e.) How far have they traveled from the traffic light by the time car A catches up?