

**I. From position to velocity.**

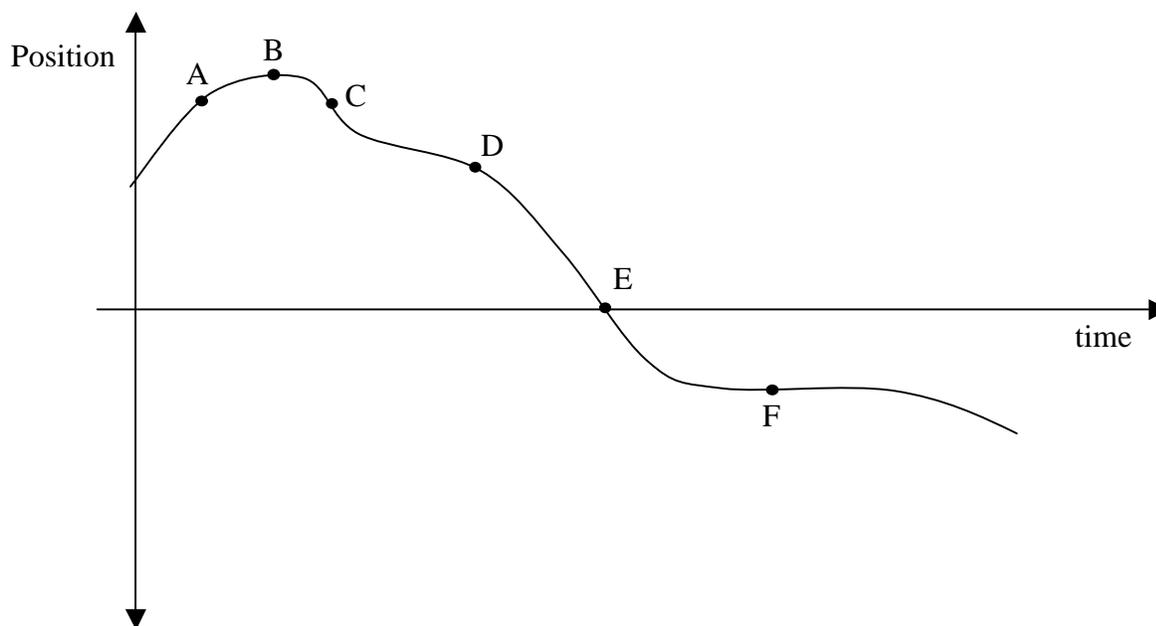
In tutorial, you always walked in front of the motion detector. If you could go *behind* it, your position would become negative. For instance, a position  $x = -2$  meters means you're 2 meters behind the detector instead of 2 meters in front of it.

A. At which of the lettered points on the graph below:

- is the motion slowest?
  
- is the person speeding up?
  
- is the person slowing down?
  
- is the person reversing direction?

For each of your above answers, explain your reasoning. Answer in terms of individual lettered points, not intervals between lettered points.

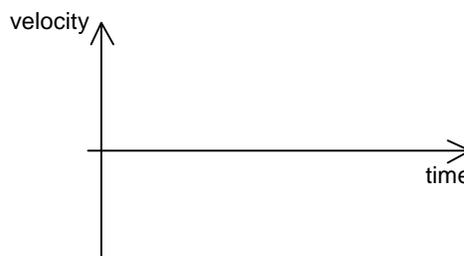
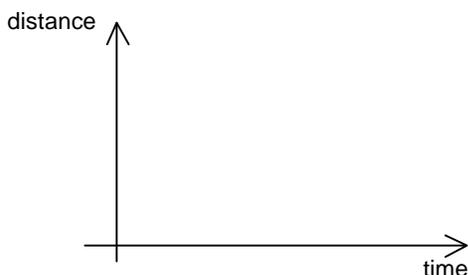
B. A common mistake is to say the person reverses direction at point E. Why do you think a student might make that mistake? What might you say to the student to help him avoid that mistake in the future?



## II. Braking car

From  $t = 0$  to  $t = 5$  s, a car is cruising down a street at steady speed, when suddenly a cuddly puppy runs into the road. So, at  $t = 5$  s, the driver slams the brakes, and the car slows down at a steady rate until stopping 3 seconds later.

A. Using a dashed line, sketch rough graphs of the car's position vs. time and its velocity vs. time.

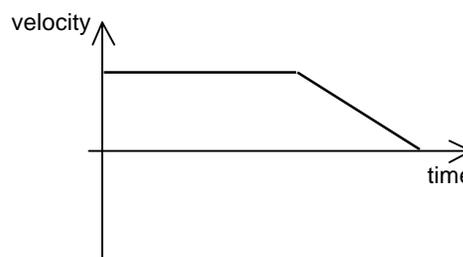
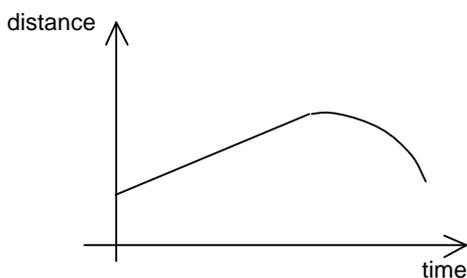


B. *Check for coherence* between the two graphs. If you make any corrections, draw them with a solid line; don't erase your original answers. (You'll get full credit if your revised answer is correct.)

1. If you make corrections, explain why.

2. Did *checking for coherence* help you avoid or catch an error, or in this particular case did you get it right the first time without thinking about how the two graphs fit together?

C. Answering part A, a student drew the following graphs:



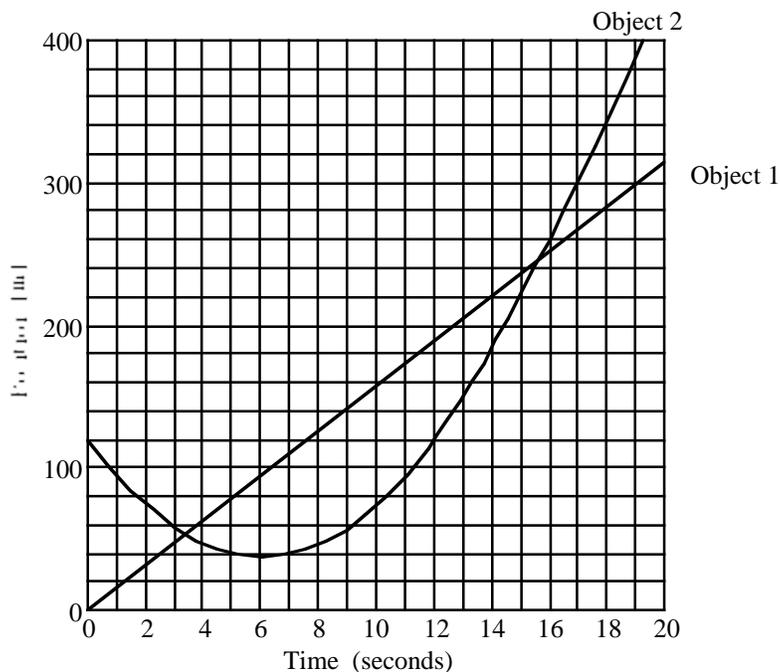
1. Explain how *Checking for coherence* could help the student realize she had made a mistake.

2. Why might a smart student make the mistake evident in the position graph? What might you say to the student to help her avoid or catch that mistake in the future?

**III. Dueling position graphs**

Answer the following questions by carefully examining the graph at right.

- A. Which object's speed is larger at  $t = 13$  sec? What makes you think so?
- B. Which object's position is greater at  $t = 13$  sec? What makes you think so?



- C. Sometimes, answering part B causes a student to go back and change his or her answer to part A. Why do you think this is? What reasoning error that a student might make in part A is likely to be caught when the student then does part B?
- D. At approximately what time do the objects have the same velocity? How do you tell from the graph?
- E. How far apart are the objects when they have the same velocity? Explain how you know.

**Tutorial 2 Homework**

Name \_\_\_\_\_

**Catching mistakes: Motion graphs**

Tutorial section \_\_\_\_\_

- F. Sketch a rough graph of Object 2's velocity vs. time from  $t = 0$  to  $t = 12$ , and explain your reasoning. Hint: It might help to use *Checking for Coherence* while you're thinking through your answer, not just as a double-check afterwards.

