group (Ben Jackson, Carissa Bad, Maxim Cuff, Devin Tsuffis)

1-Dimensional Kinematics

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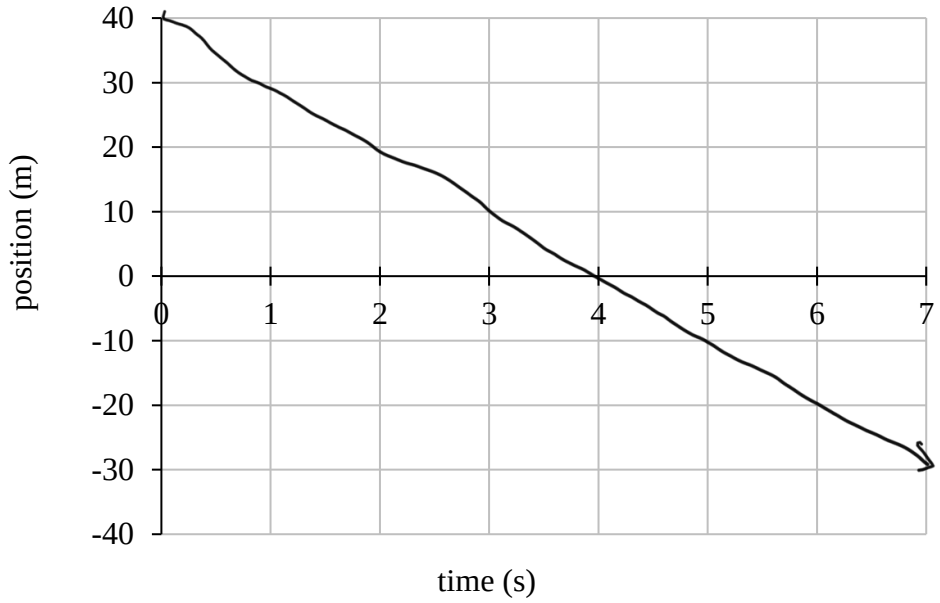
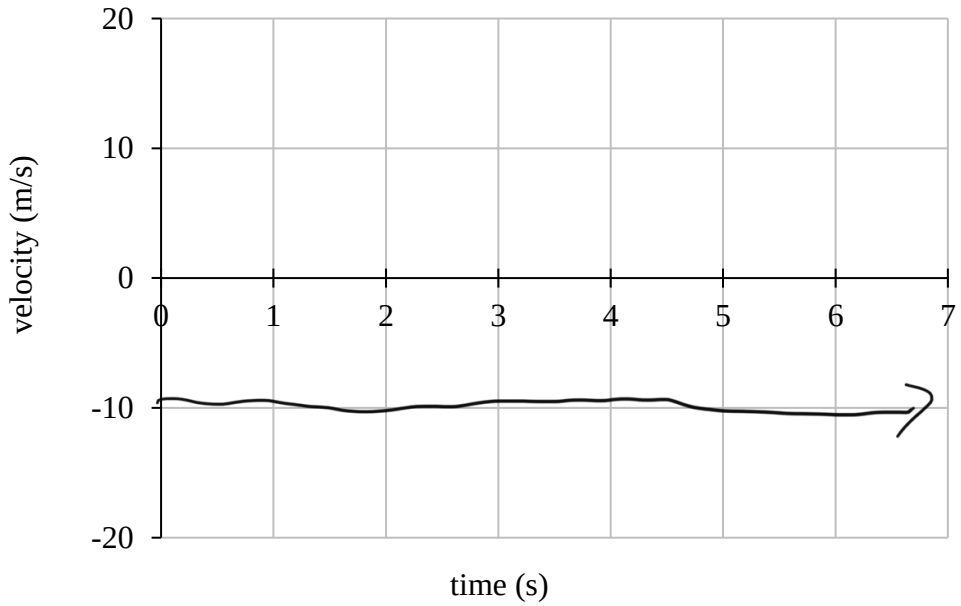
In Questions #1-11, imagine that you are observing two cars (A and B). You define the origin to represent your location. Positive positions represent locations to your right and negative positions represent locations to your left.

1. Car A starts at x = 40 m and moves at a constant velocity of 10 m/s to the left for 7 s. Draw the position versus time graph, the velocity versus time graph, and the acceleration versus time graph for Car A on the appropriate axes below.





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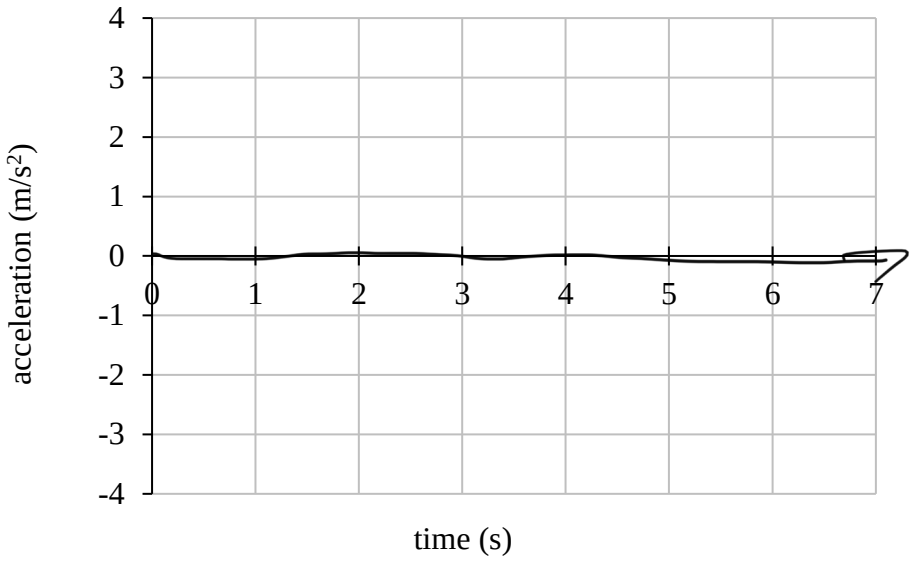
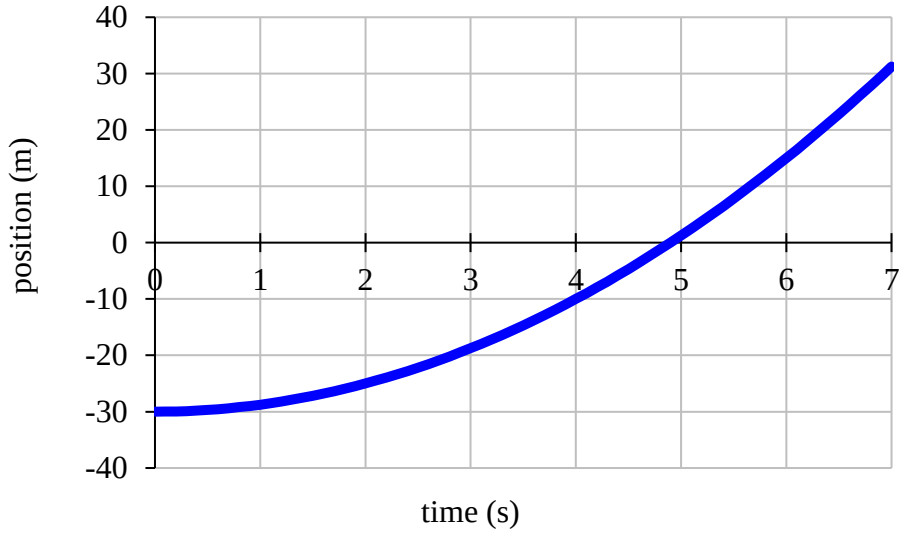


2. Complete the following sentences by circling the correct response in the parentheses:

   At t = 0 s, Car A is located to your (left/right). *From t = 0 s until t = 4 s, Car A is moving to the* (left/right). *From t =4 s until t = 7 s, Car A is moving to the* (left/right).

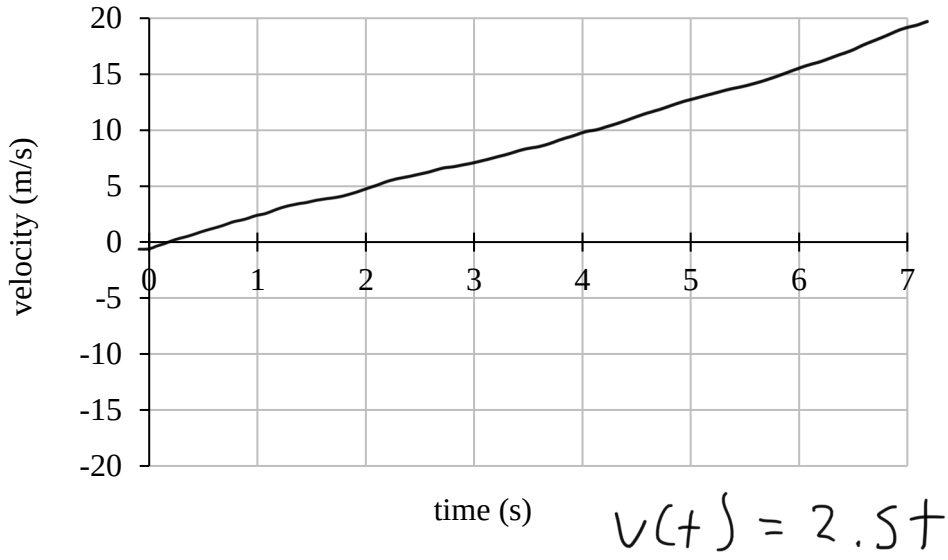
Car B starts from rest and speeds up at a constant rate. The graph below shows the position versus time graph for Car B.



3. Is Car B moving faster at t = 2 s or at t = 5 s? Explain your reasoning.

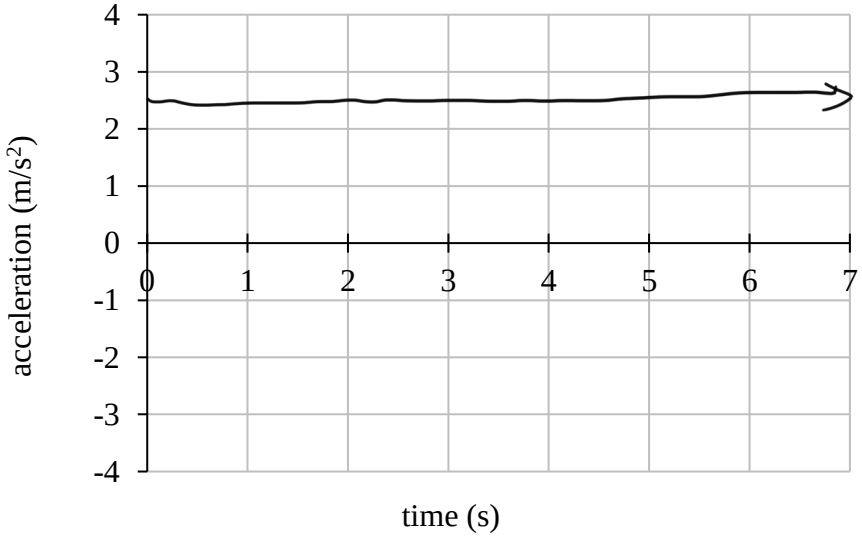
at $t = 5$ s b/c the slope of the line is more positive at $t = 5$ s than at $t = 2$ s

4. Calculate $v(t)$ for Car B and graph it below. The position $x(t)$ of Car B in meters is described by $x(t) = 1.25\ t^2 - 30$ when t is entered in seconds.



$v(t) = 2.5t$

5. Calculate $a(t)$ for Car B and graph it below.



6. Complete the following sentences by circling the correct response in the parentheses:

   At t = 0 s, Car B is located to your (left/right). *From t = 0 s until t = 4.9 s, Car B is moving to the* (left/right). *From t = 4.9 s until t = 7 s, Car B is moving to the* (left/right).

7. Are Cars A and B ever at the same position at the same instant? If the answer is yes, then calculate the time and position. If the answer is no, then explain why not.

$40 - 10t = 1.25t^2 - 30$

$1.25t^2 + 10t - 70$

$t = 4.485$

$40 - (10 \cdot 4.485)$

Position $= -4.85\,m$

8. Which car is moving faster at $t = 1$ s? Explain your reasoning.

$V_B(1) = 1.25(1) = 1.25\,m/s$ so the speed of

$V_A(1) = -10(1) = -10\,m/s$ car A is faster than car B

$||V_B(1)|| = 1.25\,m/s$

$||V_A(1)|| = 10\,m/s$

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9. Two students are discussing their answers to Question #8.

   Student 1: *I think Car A is moving faster at t = 1 s. It's at a much higher point on its position versus time graph, so it must be moving faster.*

   Student 2: *I disagree. You need to look at the slope of the position versus time graph to determine how fast the car is moving. Car B has a positive slope at t = 1 s while Car A has a negative slope, so Car B must be moving faster.*

   Do you agree or disagree with either or both of the students? Explain your reasoning.

I disagree with both students, Student 1 is mixing up their position and velocity graphs and Student 2 is calculating velocity instead of speed.

10. Are there any times at which Car A and Car B have the same speed? If the answer is yes, calculate the time(s). If the answer is no, then explain why not.

$$||v_B|| = ||2.5t|| = ||-10|| = ||v_A||$$

$$2.5t = 10$$

$$t = 4\ s$$

11. Two students are discussing their answers to Question #10.

Student 1: *At t = 4.49 s, both cars are at the same location. In order for them to be at the same location, they must have the same speed, even if it is just for that instant in time.*

Student 2: *I disagree. If you look at the graph of x(t) for Car A and the graph of x(t) for Car B, you see that the magnitude of their slopes are different at that time. Since the slope magnitudes are different, their speeds must be different. Just because one car passes another doesn't mean they have the same speed.*

Do you agree or disagree with either or both of the students? Explain your reasoning.

I disagree with student 1 b/c he is confused about position and speed. Student 2 is right.

12. On a different planet, a missile is fired straight into the air. The diagram shows its location at six different times. At $t_0 = 0$ s, it leaves the ground with speed v_0 and it reaches its highest point above the ground at t_5. The only other information you have is that $t_1 = 2$ s and $t_4 = 8$ s and that the corresponding heights at those times are $y_1 = 720$ m and $y_4 = 1920$ m. Determine the initial speed of the missile and the magnitude of the constant gravitational acceleration on that planet.

t_5 ●
t_4 ●
t_3 ●
t_2 ●
t_1 ●
t_0 ●

$y_1 = v_0 t + \frac{1}{2} a t^2$

$720 = v_0 2 + \frac{1}{2} a 4$

$1920 = v_0 8 + \frac{1}{2} a 64$

$360 = v_0 + a$

$240 = v_0 + 4a$

$v_0 = 360 - a$

$240 = 360 + 3a$

$a = -40\ m/s^2$

$360m = v_0 - 40m$

$v_0 = 400\ m/s$

13. A car initially at rest speeds up at a rate of $3\frac{m}{s^2}$ for 10 s. After that, it continues at a constant velocity for 20 s more. Assuming that it was travelling east, determine its average velocity for that entire 30 s.

14. Graph the velocity versus time for the entire 30 s period for the car described in Question #13. Your graph should be qualitatively correct and you should be able to explain why you've drawn it the way you have.