Week 3 Tutorial

Tutorial Section
Tutorial Time
Tutorial TA Name

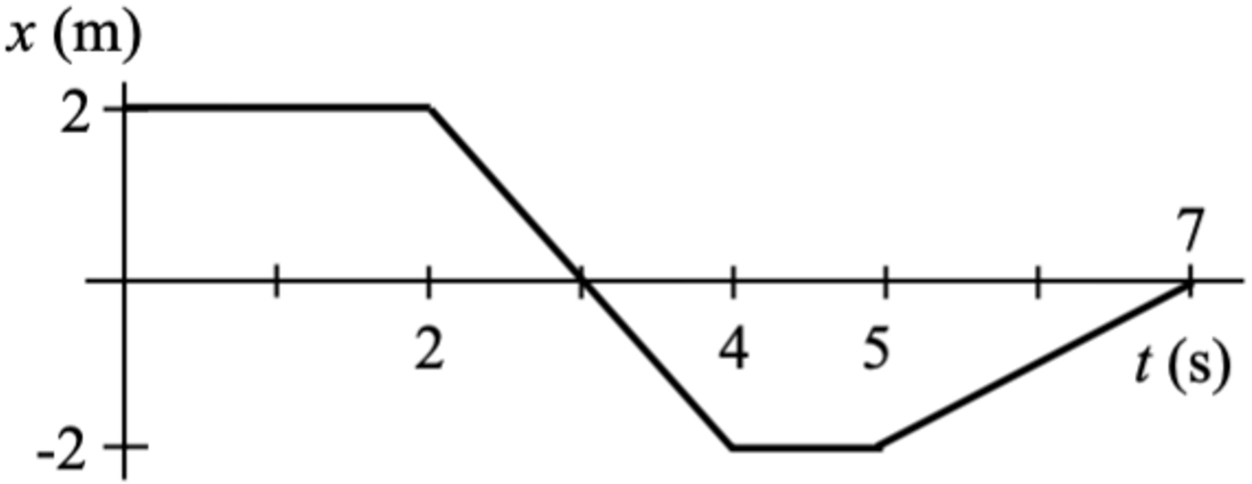
About Me

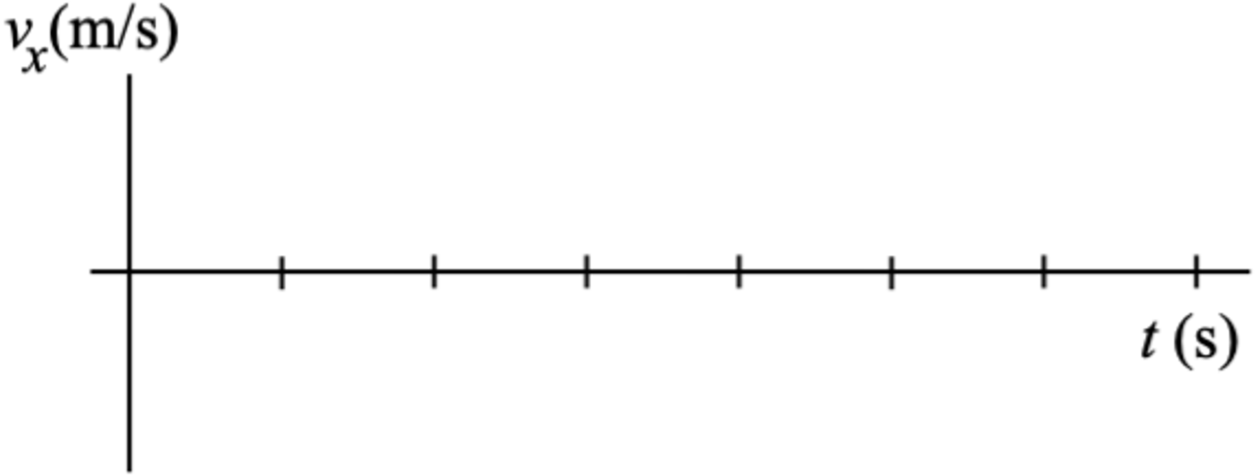
Tutorial Structure

- Introduction
- Question 1
- Problem Solving Framework
- Question 2
- Problem Solving Framework
- Q&A

Question 1

A position vs. time graph is shown. On the velocity versus time graph below it sketch the corresponding velocity as a function of time. Show all calculations, and label the axes appropriately. /9





Problem Solving Framework

PHYSICAL REVIEW PHYSICS EDUCATION RESEARCH **16,** 010123 (2020)

Template for teaching and assessment of problem solving in introductory physics

E. W. Burkholder,[1,*] J. K. Miles,[2] T. J. Layden,[2] K. D. Wang,[3]
A. V. Fritz,[4] and C. E. Wieman[1,3]

1. Framing

- Visual Representation
- Assumptions and Simplifications
- Relevant Concepts
- Information Needed
- Similar Problems

2. Planning

- Solution Plan
- Rough Estimate

3. Execution

Carry-out Plan for solving
- Work in algebra/symbols until the BITTER end
- Plug in numbers at the LAST step

4. Answer Checking

- Compare to Estimate
- Units Check
- Limits Test
- Getting (UnStuck)

Reference: Template for teaching and assessment of problem solving in introductory physics

1. Framing

2. Planning

3. Execution

4. Answer Checking

1. Framing

- Visual representation: describe the motion based on position vs time graph; i.e., from 0-2s, position x stays the same at 2m.
- Assumptions and simplifications: Only consider this motion in 1D.
- Relevant concept: the relationship between position x, velocity Vx: Vx=dx/dt
- Information needed: position change during certain time period
- Similar problems: given Vx vs t graph, draw ax vs t graph; given Vx vs t graph, draw x vs t graph, etc.

2. Planning

- Rough estimate: It's hard to estimate how a graph should look like but we know that once the slope of x vs t graph changes the velocity would change. So, in this problem we need to calculate velocity for each time section separately. Also, roughly we can estimate the sign of velocity (positive/negative/0) from visually viewing the graph. We can do that for final double check.

- Solution plan: First divide 0-7s into several time section for separate velocity calculation. Then calculate velocity using Vx=dx/dt for each time section. Finally draw line to represent velocity during each period of time.

3. Execution

- See solution on slide 10. Carry out the calculation, plug in the numbers at the last step.

4. Answer Checking

Compare to estimates: compare the calculation results to your rough estimates see whether the sign matches.

Units: Think about what unit we use for Vx in this problem and add them in your final answer.

Limits: Think about how x vs t graph looks like with 0 velocity? How increasing or decreasing the velocity change x vs t graph?

Getting (UnStuck)? Not sure what it means…

Solution

2. A position vs. time graph is shown. On the velocity versus time graph below it sketch the corresponding velocity as a function of time. Show all calculations, and label the axes appropriately.

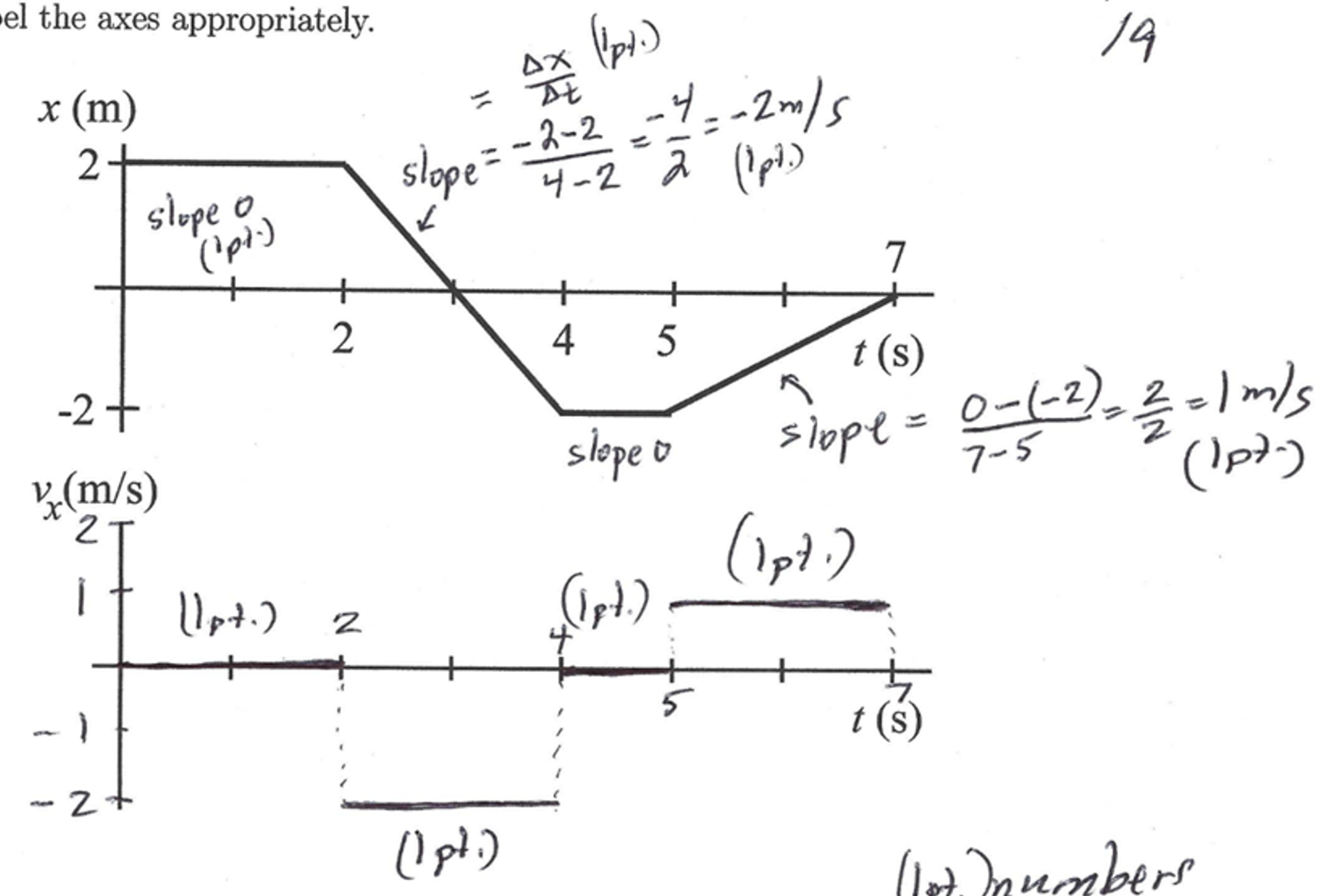


FIG. 1:

Question 2

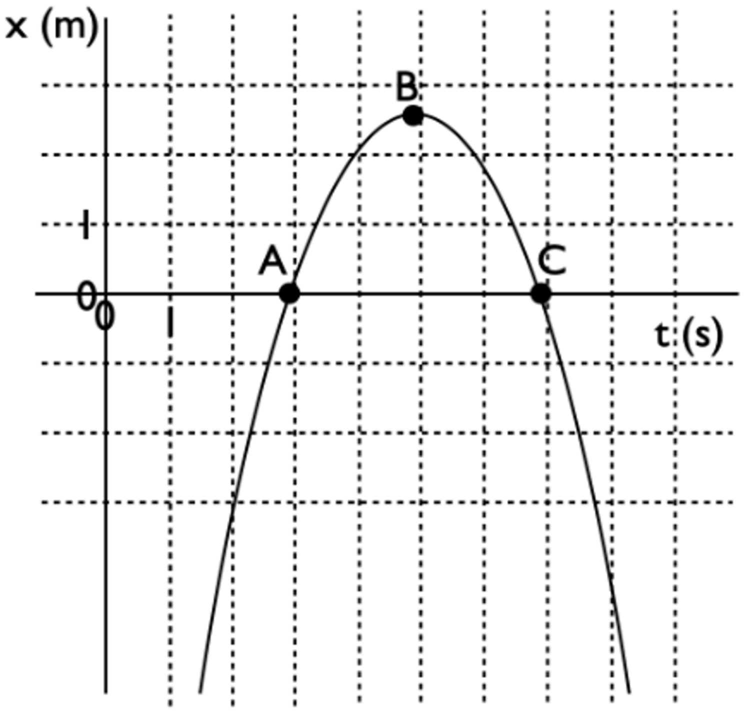


FIG. 1:

3. (a) At each of A, B and C on Fig. 1, estimate the x-component of the velocity vector, v_x from the position vs. time graph (/3) . Draw a tangent line to the graph at each location (/3) and show the calculation of its slope (/3).

(b) What sign, if any, does the x-component of the acceleration vector, a_x, have at point B (/2)?

1. Framing

2. Planning

3. Execution

4. Answer Checking

1. Framing

- Visual representation: describe the motion based on position vs time graph; i.e., from 0-2s, position x stays the same at 2m.
- Assumptions and simplifications: Only consider this motion in 1D.
- Relevant concept: the relationship between position x, velocity Vx: Vx=dx/dt
- Information needed: position change during certain time period
- Similar problems: given Vx vs t graph, draw ax vs t graph; given Vx vs t graph, draw x vs t graph, etc.

2. Planning

- Rough estimate: We can estimate the sign of velocity (positive/negative/0) from visually viewing the graph, and relative change velocity based on the slope.
- Solution plan: For a, at each point, draw the tangent line and calculate velocity using V=dx/dt. For b, use a=dV/dt to estimate the sign.

3. Execution

- See solution above. Carry out the calculation, plug in the numbers at the last step.

4. Answer Checking

Compare to estimates: compare the calculation results to your rough estimates see whether the sign matches.

Units: Think about what unit we use for Vx in this problem and add them in your final answer.

Limits: Think about how x vs t graph looks like with 0 velocity? How increasing or decreasing the velocity change x vs t graph?

Getting (UnStuck)? Not sure what it means…

Solution

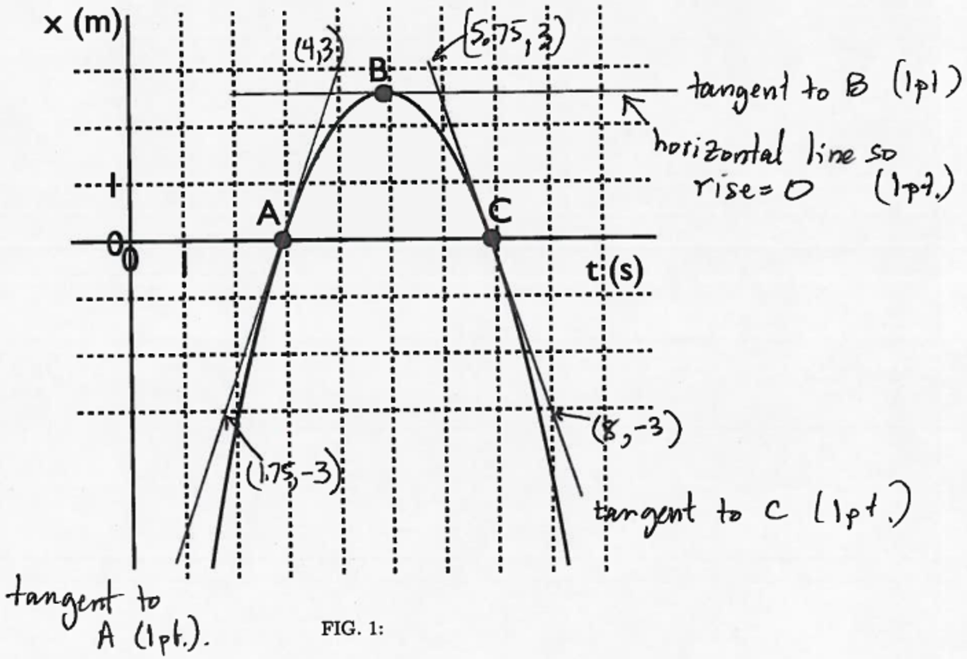


FIG. 1:

3. (a) At each of A, B and C on Fig. 1, estimate the x-component of the velocity vector, v_x from the position vs. time graph (/3) . Draw a tangent line to the graph at each location (/3) and show the calculation of its slope (/3).

$V_{Ax} = \frac{\Delta x}{\Delta t}$ (rise / run) $= \frac{3-(-3)}{4-1.75}$ m/s (1pt.) $= \frac{6}{2.25}$ m/s $= 2.7$ m/s (1pt.)

$V_{Bx} = \frac{0}{\text{run}} = 0$ m/s (1pt.)

$V_{Cx} = \frac{\Delta x}{\Delta t}$ (rise / run) $= \frac{-3-3}{8-5.75}$ m/s (1pt.) $= \frac{-6}{2.25} = -2.7$ m/s (1pt.)

note: looks symmetric – be lenient with values accepted

(b) What sign, if any, does the x-component of the acceleration vector, a_x, have at point B (/2)?

a_x has a negative sign (1pt.) (at B) since V_x is positive just before B and negative just after B.

either (1pt.)

ie. $a_x \approx \frac{V_{Cx} - V_{Ax}}{t_C - t_A} < 0$