

Physics 111 - Class 3A

Kinematics I

September 19, 2022

Class Outline

- Logistics / Announcements
- Introduction to Chapter 3
- Clicker Questions
- Activity: Calculus and Kinematics
- Debrief: Calculus and Kinematics



Physics 111

Search this book...

Unsyllabus

ABOUT THIS COURSE

Course Syllabus (Official)

Course Schedule

Accommodations

How to do well in this course

GETTING STARTED

Before the Term starts

After the first class

In the first week

Week 1 - Introductions!

PART 1 - KINEMATICS

Week 2 - Chapter 2

Week 3 - Chapter 3

Readings

Videos

Homework

Week 3 Classes

Test 1

Lab

Learning Logs

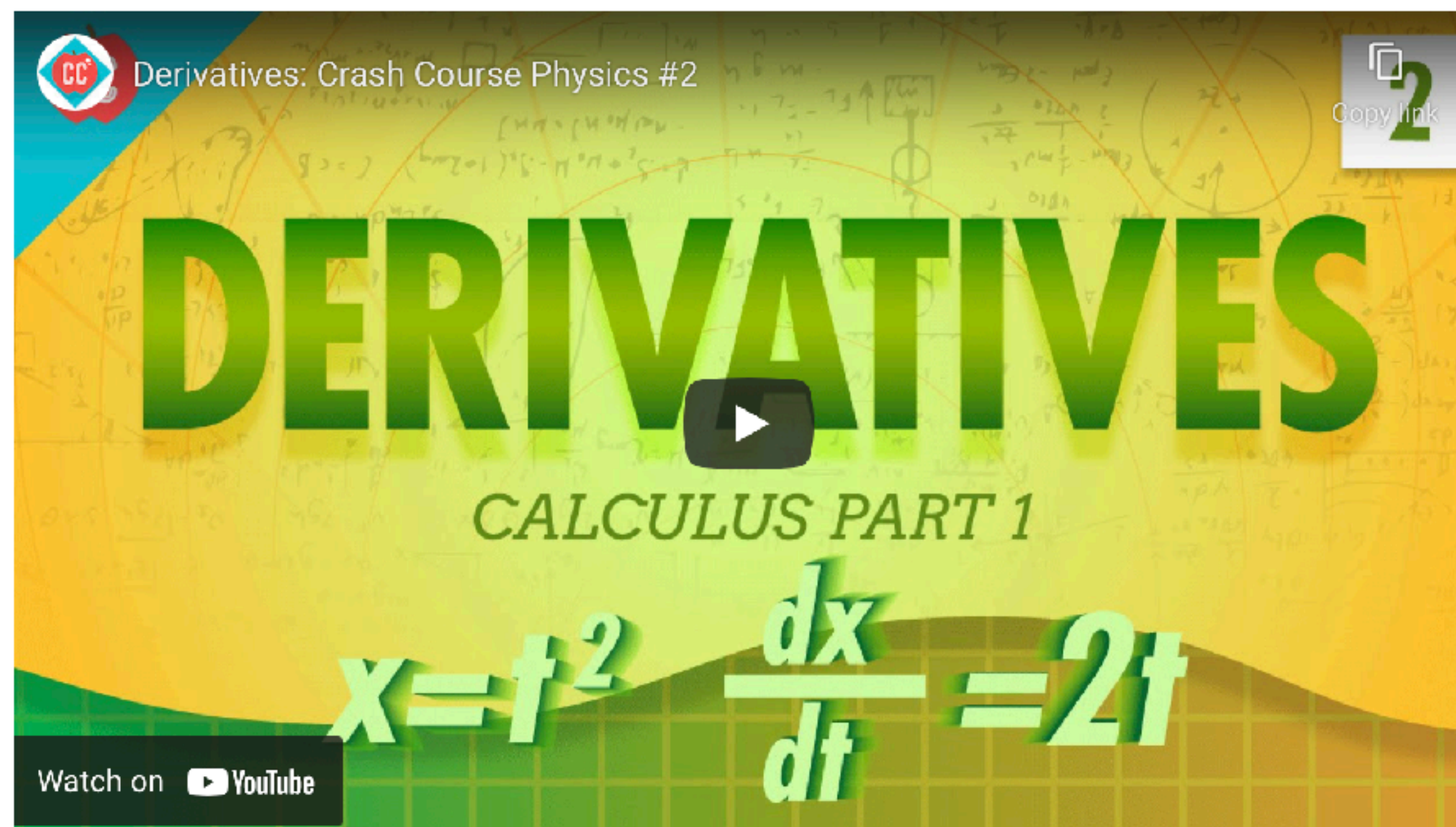


Videos

Below are the assigned videos for this week. The videos are collapsible so once you're done with one, you can move to the next one. In the sidebar on the right, you can use the checklists to keep track of what's done.

Summary of Calculus from Crash Course Physics

Derivatives



Integrals



Contents

Summary of Calculus from Crash

Course Physics

Required Videos

Optional Videos

Checklist of items

- ☐ Calculus: Derivatives
- ☐ Calculus: Integrals
- ☐ Vectors and 2D Motion
- ☐ Introduction to Displacement and the Differences Between Displacement and Distance
- ☐ Introduction to Velocity and Speed and the differences between the two
- ☐ Introduction to Acceleration with Prius Brake Slamming Example Problem
- ☐ Introduction to Free-Fall and the Acceleration due to Gravity

Required Videos

Preface

▼ Mechanics

▶ 1 Units and Measurement

▶ 2 Vectors

▼ 3 Motion Along a Straight Line

Introduction

3.1 Position, Displacement, and Average Velocity

3.2 Instantaneous Velocity and Speed

3.3 Average and Instantaneous Acceleration

3.4 Motion with Constant Acceleration

3.5 Free Fall

3.6 Finding Velocity and Displacement from Acceleration

▼ Chapter Review

Key Terms

Key Equations

Summary

Conceptual Questions

Problems

Additional Problems

Challenge Problems



Figure 3.1 A JR Central L0 series five-car maglev (magnetic levitation) train undergoing a test run on the Yamanashi Test Track. The maglev train's motion can be described using kinematics, the subject of this chapter. (credit: modification of work by "Maryland GovPics"/Flickr)

Chapter Outline

[3.1 Position, Displacement, and Average Velocity](#)

[3.2 Instantaneous Velocity and Speed](#)

[3.3 Average and Instantaneous Acceleration](#)

[3.4 Motion with Constant Acceleration](#)

[3.5 Free Fall](#)

[3.6 Finding Velocity and Displacement from Acceleration](#)

Our universe is full of objects in motion. From the stars, planets, and galaxies; to the motion of people and animals; down to the microscopic scale of atoms and molecules—everything in our universe is in motion. We can describe motion using the two disciplines of kinematics and dynamics. We study dynamics, which is concerned with the causes of motion, in [Newton's Laws of Motion](#); but, there is much to be learned about motion without referring to what causes it, and this is the study of kinematics. Kinematics involves describing motion through properties such

Position Graphs

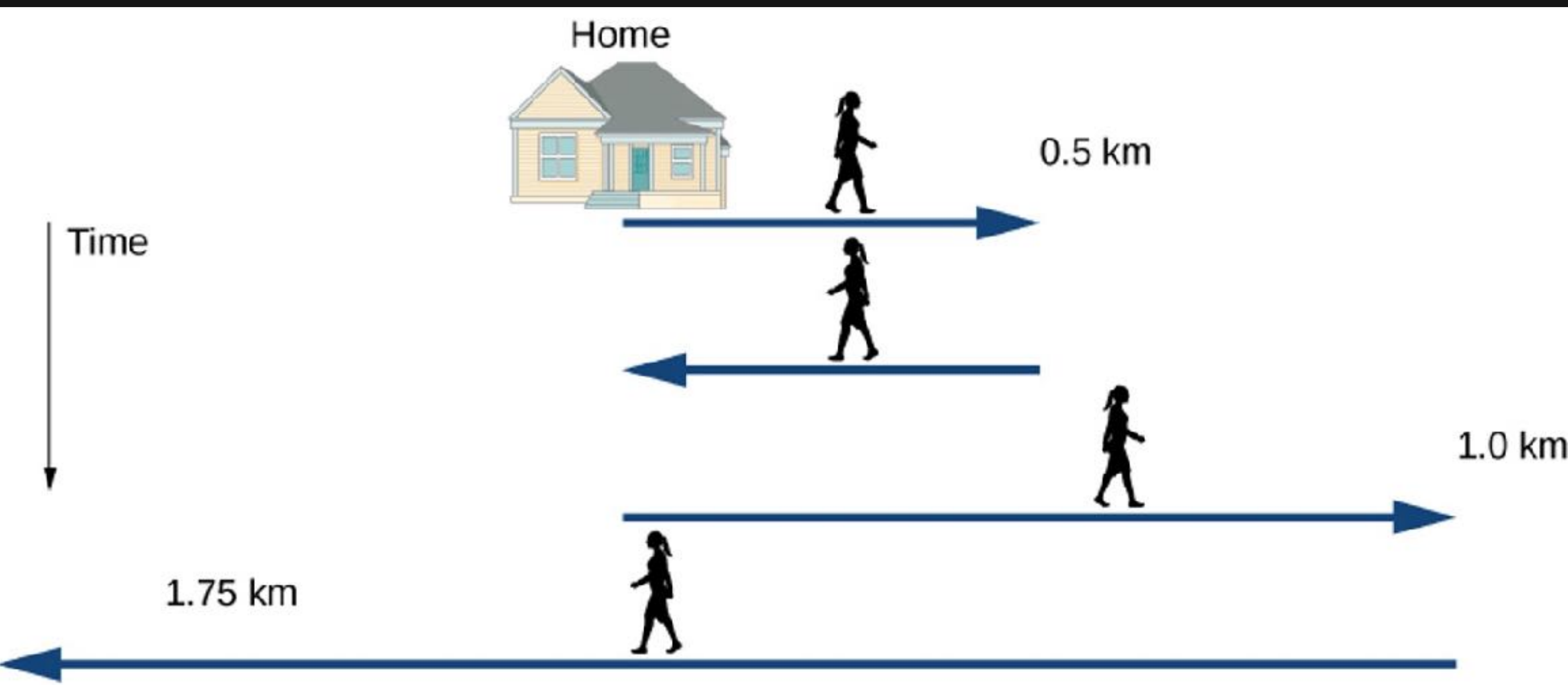
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Jill sets out from her home to deliver flyers for her yard sale.

- A) The table describes her movements. Draw a sketch of her movements.
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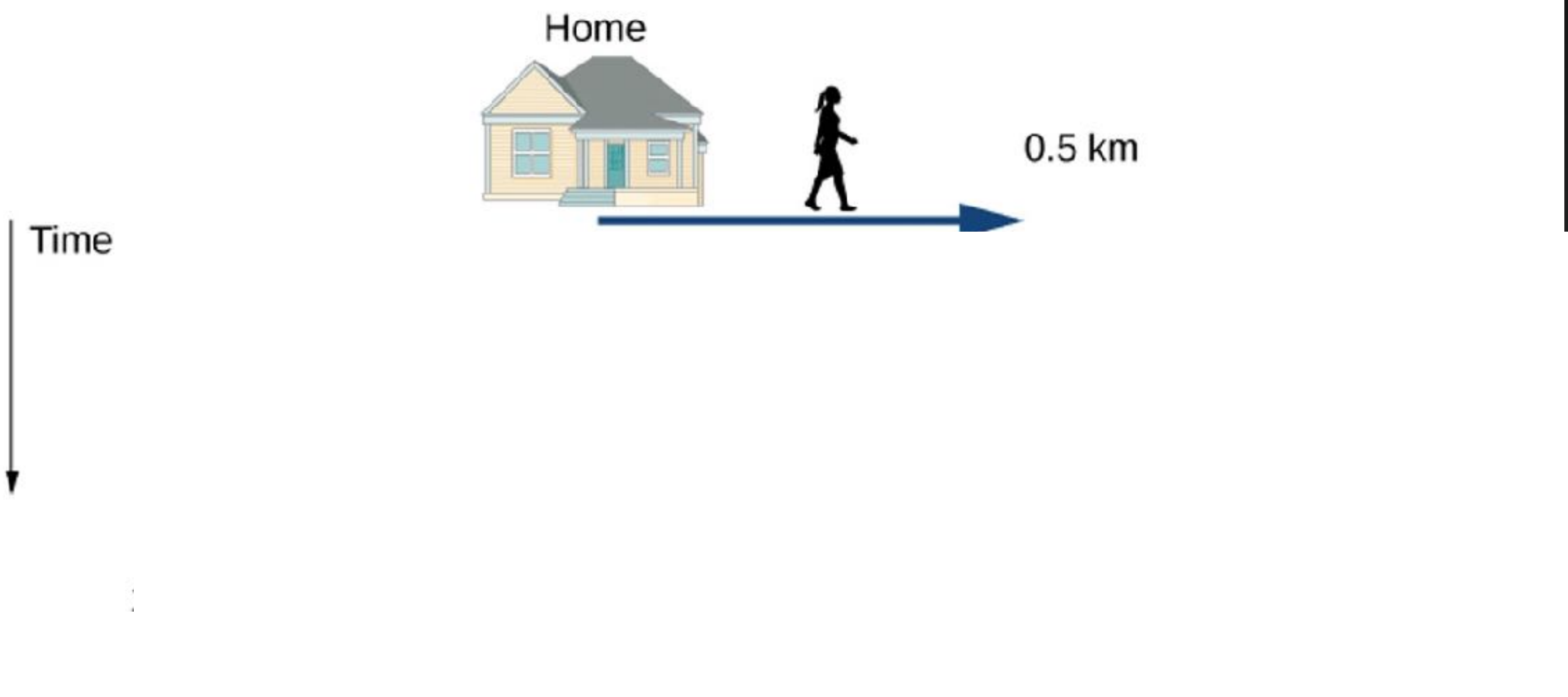


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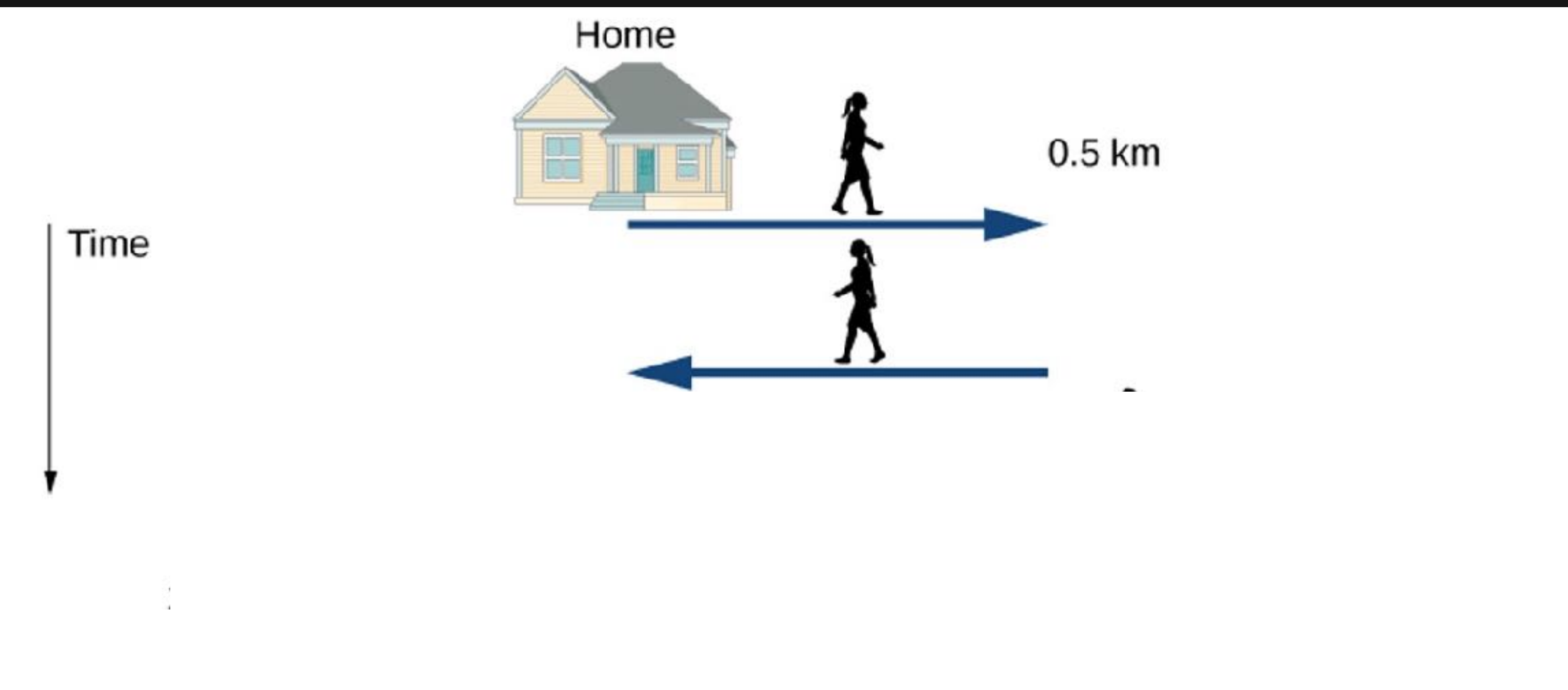
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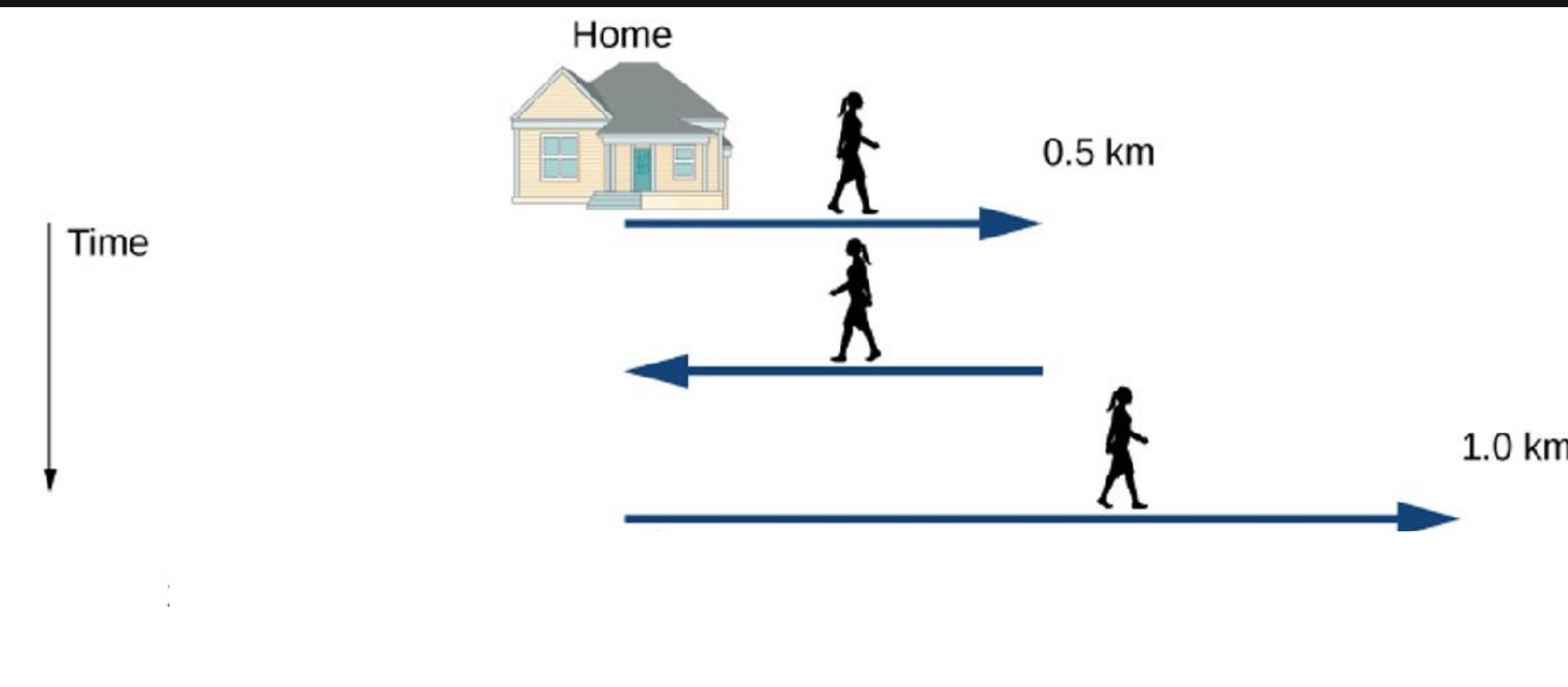


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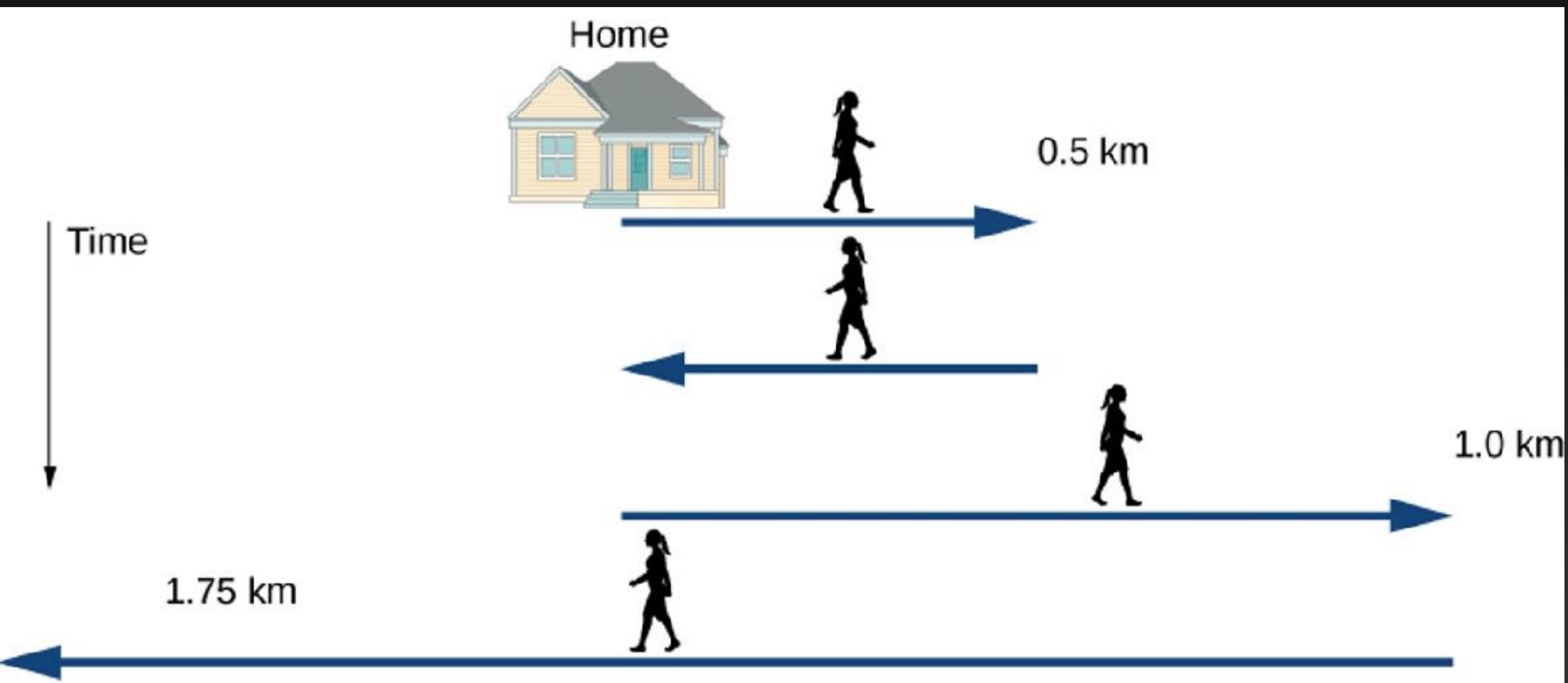


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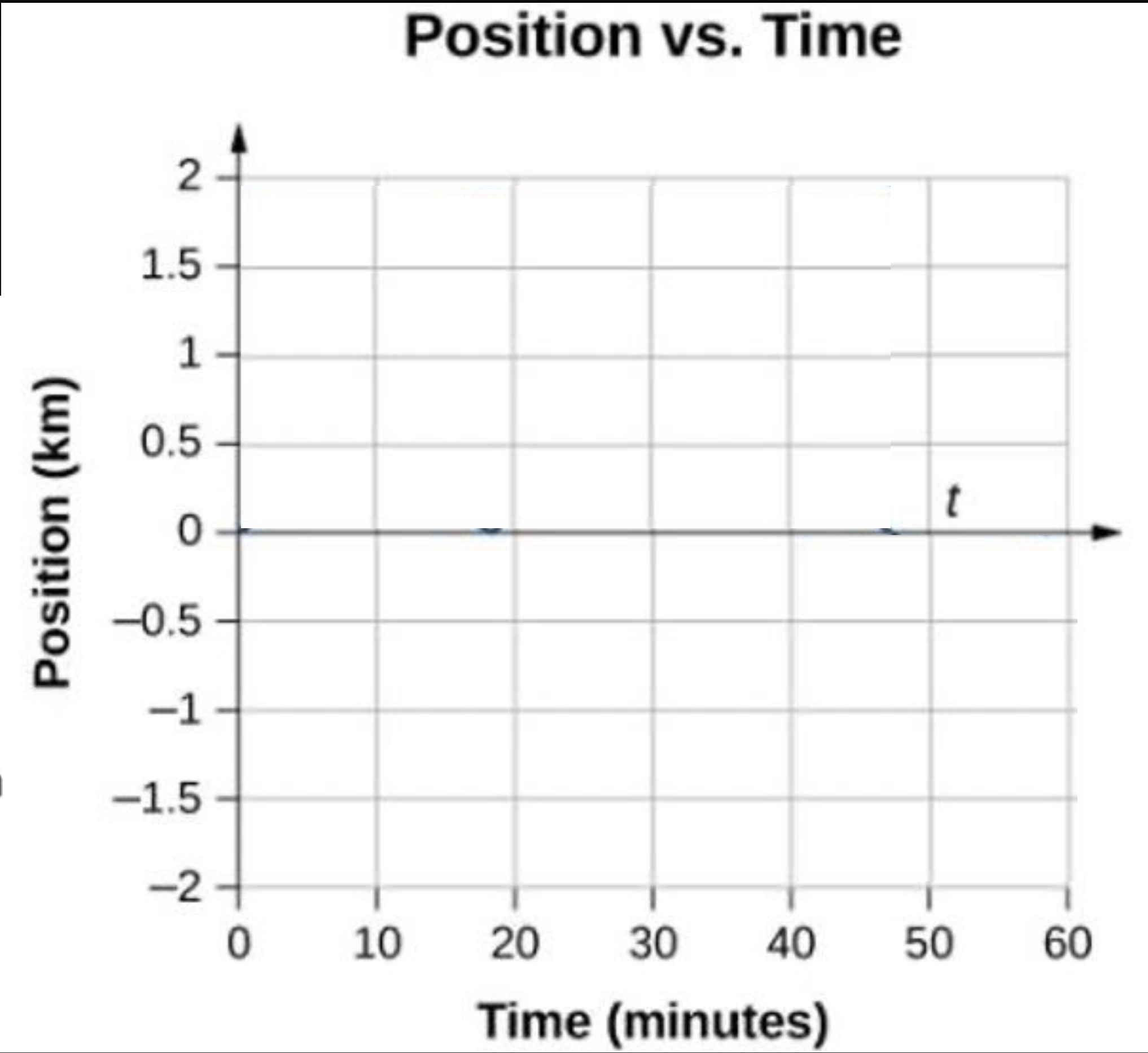
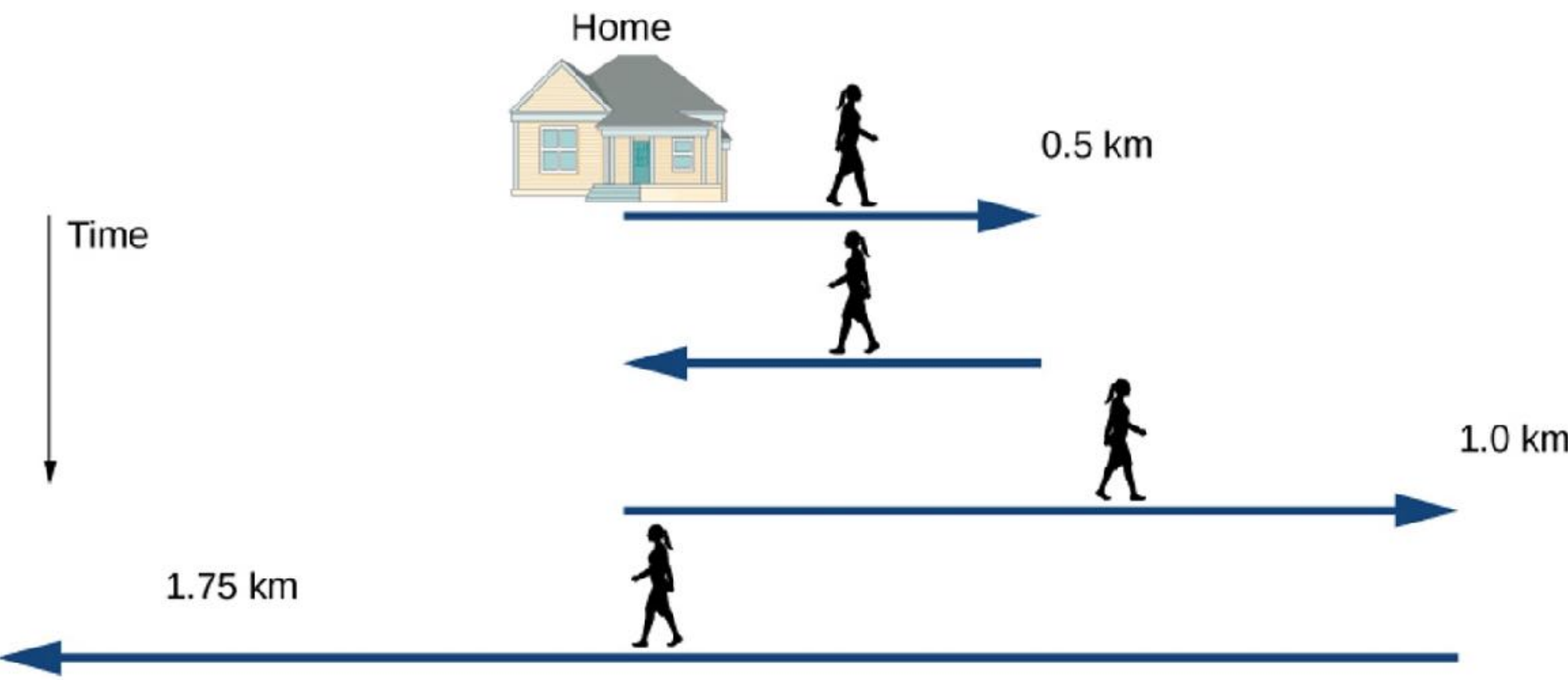


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Key Equations

Displacement	$\Delta x = x_f - x_i$
Total displacement	$\Delta x_{\text{Total}} = \sum \Delta x_i$
Average velocity (for constant acceleration)	$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{x_2 - x_1}{t_2 - t_1}$
Instantaneous velocity	$v(t) = \frac{dx(t)}{dt}$
Average speed	Average speed = $\bar{s} = \frac{\text{Total distance}}{\text{Elapsed time}}$
Instantaneous speed	Instantaneous speed = $ v(t) $
Average acceleration	$\bar{a} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_0}{t_f - t_0}$
Instantaneous acceleration	$a(t) = \frac{dv(t)}{dt}$
Position from average velocity	$x = x_0 + \bar{v}t$

Key Equations

Average velocity	$\bar{v} = \frac{v_0 + v}{2}$
Velocity from acceleration	$v = v_0 + at$ (constant a)
Position from velocity and acceleration	$x = x_0 + v_0 t + \frac{1}{2}at^2$ (constant a)
Velocity from distance	$v^2 = v_0^2 + 2a(x - x_0)$ (constant a)
Velocity of free fall	$v = v_0 - gt$ (positive upward)
Height of free fall	$y = y_0 + v_0 t - \frac{1}{2}gt^2$
Velocity of free fall from height	$v^2 = v_0^2 - 2g(y - y_0)$
Velocity from acceleration	$v(t) = \int a(t)dt + C_1$
Position from velocity	$x(t) = \int v(t)dt + C_2$

Another perspective on Kinematics

Equation

Calculus

Graphical

Displacement

Velocity

Acceleration

Equation

$$x(t) = x_0 + v \cdot t$$

Displacement

$$v(t) = v_0 + a \cdot t$$

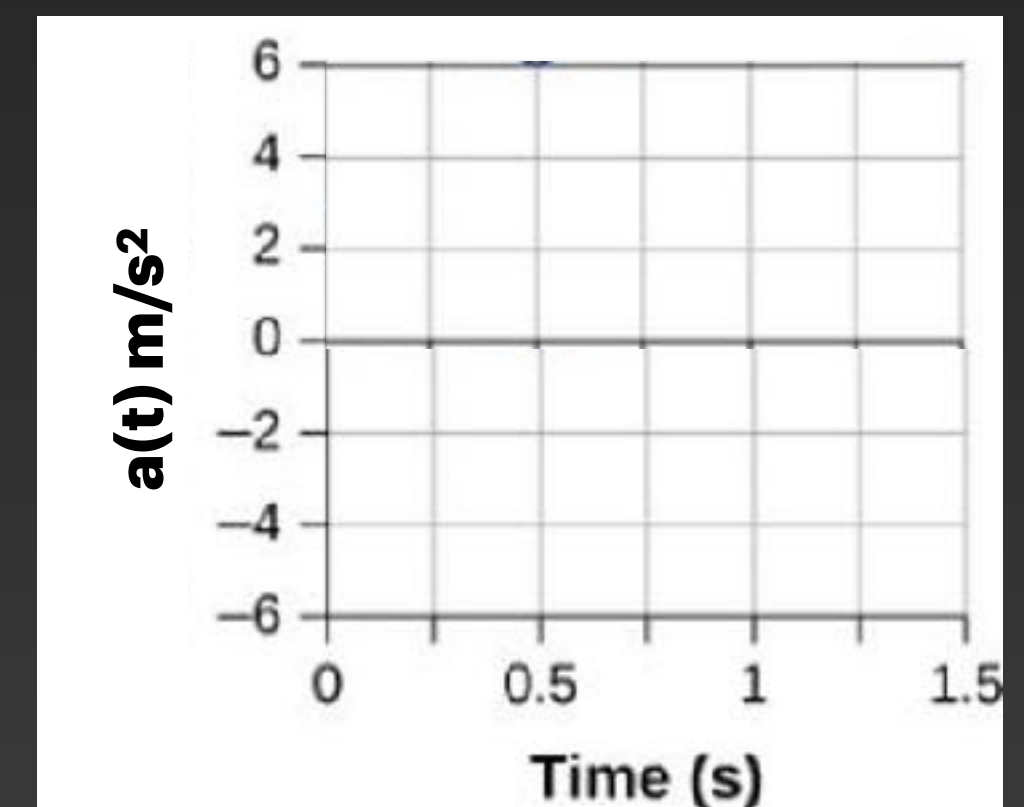
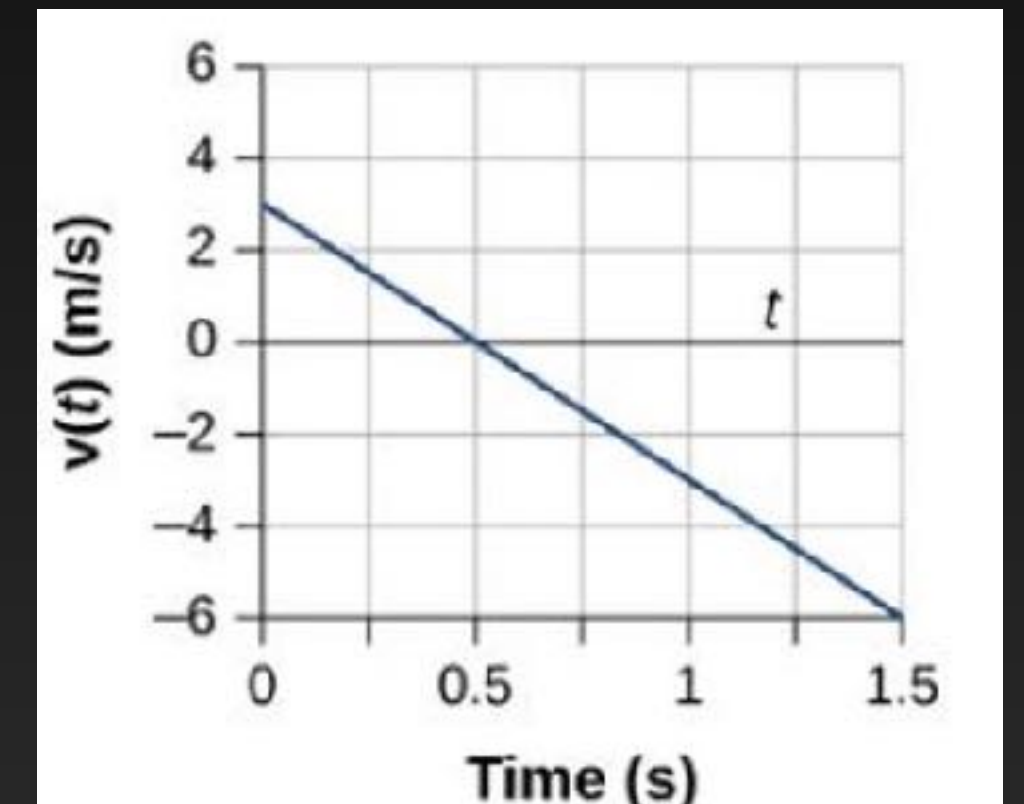
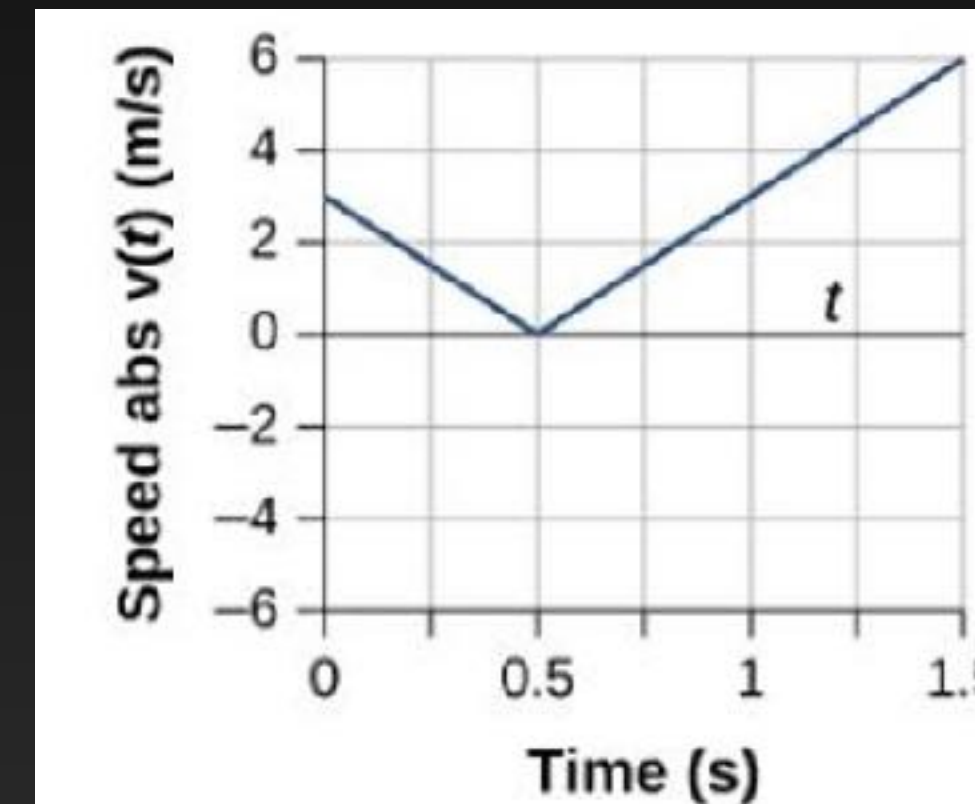
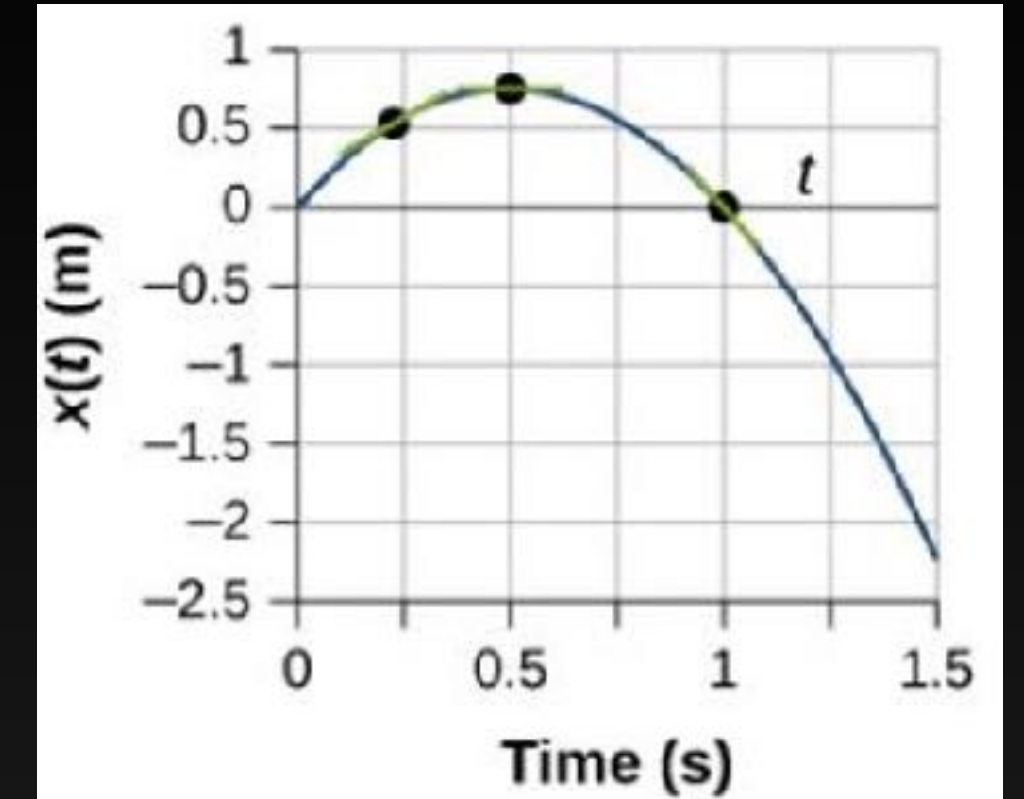
Velocity

$$a(t) = \frac{v_f - v_1}{t_1 - t_0}$$

Acceleration

Calculus

Graphical



Clicker Questions

CQ.3.1

Billy drops a ball from a height of 1 m. The ball bounces and reaches a height of 0.8 m, after the first bounce, 0.5 m after the second bounce, and lastly 0.2 m after the third bounce. The ball is caught at that final height. Up is the positive direction. What are the total displacement of the ball and the total distance traveled by the ball?

- a) The displacement is equal to -4 m and the distance is equal to 4 m.
- b) The displacement is equal to -1 m and the distance is equal to 1 m.
- c) The displacement is equal to 4 m and the distance is equal to 1 m.
- d) The displacement is equal to -1 m and the distance is equal to 4 m.

A

B

C

D

E

CQ.3.2

Alan starts from his home and walks 1.3 km east to the library. He walks an additional 0.68 km east to a music store. From there, he walks 1.1 km north to a friend's house and an additional 0.42 km north to a grocery store before he finally returns home along the same path. What is his final displacement and total distance traveled?

- a) Displacement is 0 km and distance is 7 km.
- b) Displacement is 0 km and distance is 3.5 km.
- c) Displacement is 7 km towards west and distance is 7 km.
- d) Displacement is 3.5 km towards east and distance is 3.5 km.

A

B

C

D

E

CQ.3.3

Daniel set a timer before he started on a walk. He walked 1.2 km north and then turned and walked 1.6 km east. He then turned and walked straight back to his starting point. The timer showed that the trip took him 56.5 minutes. What was his average speed (in km/h) for the entire trip?

- a) 5.1 km/hr
- b) -5.1 km/hr
- c) 0 km/hr
- d) 3.0 km/hr

A

B

C

D

E

CQ.3.4

A car is moving on a straight road at a constant speed in a single direction. Which of the following statements is true?

- a) Average velocity is zero.
- b) The magnitude of average velocity is equal to the average speed.
- c) The magnitude of average velocity is greater than the average speed.
- d) The magnitude of average velocity is less than the average speed.

A

B

C

D

E

Displacement $x(t)$	Velocity $v(t)$	Acceleration $a(t)$
$x(t) = 4t^2 + 3t + 2$	$v(t) = 8t + 3$	$a(t) = 8$
$x(t) = 2t^2 + 8$		
$x(t) = 8t^3 + 3t$	$v(t) = 24t^2 + 3$	
$x(t) = -t^3 + 5t^2 + 3t$		

See you next class!

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