

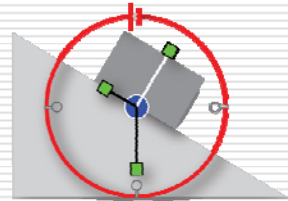
Uniform and Accelerated Motion

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www.physicsfirstmo.org



A TIME for PHYSICS FIRST



A TIME for PHYSICS FIRST

What is A TIME for Physics First?

- Physics First is a national movement to teach a year-long Physics course in 9th grade
- The National Science Foundation has funded a new grant for teacher intellectual leadership and professional development, 2009-2014
- 80 Missouri 9th grade teachers recruited in Fall 2009, 40 of whom will start the summer academy series in 2010, 40 in 2011: see www.physicsfirstmo.org
- This grant follows a MO-DESE funded partnership led by Columbia Public Schools and Univ. of Missouri-Columbia to develop curriculum and conduct PD, 2005-08

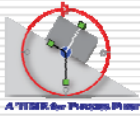




Curriculum (2010-14)

- Year 1: Electricity, Uniform and Accelerated Motion, Forces and Newton's Laws
- Year 2: Application of Newton's Laws, Energy, Planetary Motion, Heat, Waves
- Year 3: Flexible topics
- Pedagogy - based on Modeling, Inquiry & 5E

- Today - parts of Unit 2: Uniform and Accelerated Motion



Structure of a unit

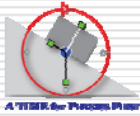
- Big ideas
- Students' misconceptions
- Unit objectives
- Sequence of concepts (5E)
- Framing questions
- Activities and experimental design labs
- Reading pages
- Practice problems





Big Ideas

- Position, distance and displacement have different meanings.
- Uniform motion means that an object travels equal distance in equal time intervals.
- Uniform accelerated motion means that velocity changes by equal amounts in equal time intervals
- An object that accelerates is speeding up, slowing down, or turning.
- Motion can be described in different ways: with words, graphs, motion diagrams and mathematical models.



Students' Misconceptions

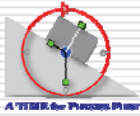
- Same position means same speed
- Position and velocity graphs show the path of the particle
- Difficulty relating real world motion to a graph
- Leading particle moves at a faster speed
- Velocity must always be positive
- The meaning of the phrase "graph a-versus-b".
- Identify quantity in a graph that will answer the question (coordinate, slope, area)
- Same velocity means same acceleration for two objects
- Zero velocity means zero acceleration





Objectives for the "Constant Speed Car Lab"

- Design experiment, collect data, draw x vs. t graph
- Interpret slope, units of slope, and intercept of straight line graph
- Calculate speed from data table, relate to slope
- Unit conversion
- Distinguish between position and distance
- Distinguish between time and time intervals
- Mathematical expression for speed
- Relate different slopes of the x - t graphs to different speeds
- Create motion diagrams



Activity: Constant Speed Car Lab





Uniform Motion: x vs t graph from experiment



- position changes linearly with time
- the rate of change of position with time = velocity
- slope of graph = velocity
- slope is constant => velocity is constant
- build a v vs t graph



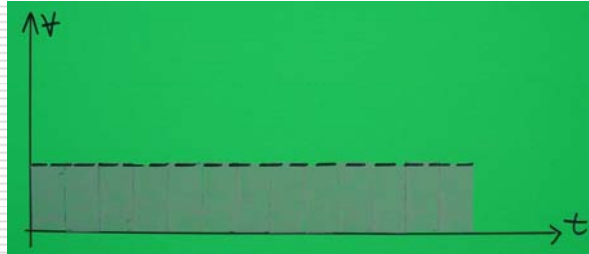
Big Understandings and Skills

- Given an x vs. t graph, you should be able to:
 - describe the motion of the object (starting position, direction of motion, velocity)
 - draw the corresponding v vs. t graph
 - draw a motion diagram for the object.
 - determine the average velocity of the object (slope).
 - write a mathematical expression that describes the motion.





Uniform Motion: v vs t graph from experiment



- velocity is constant
- slope of velocity graph represents the rate at which velocity changes = no slope, no change
- calculate the distance traveled as the area under the v vs t graph



Big Understandings and Skills

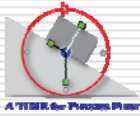
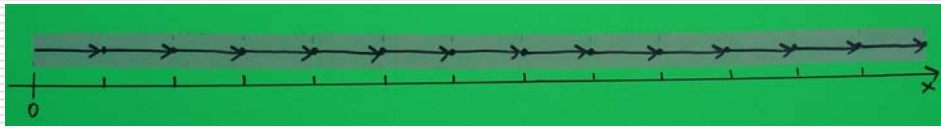
- Given a v vs. t graph, you should be able to:
 - describe the motion of the object (direction of motion, how fast)
 - draw the corresponding x vs. t graph
 - determine the change in position of the object (area under curve).
 - draw a motion diagram for the object.
 - write a mathematical expression to describe the motion.



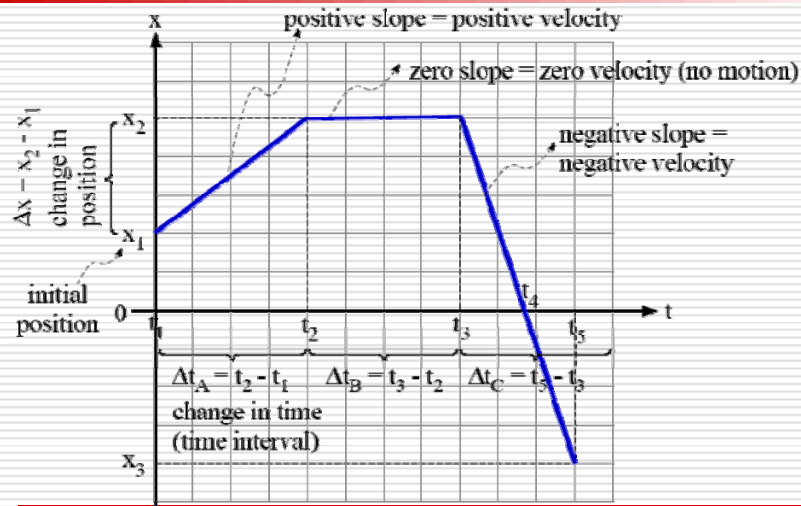


Uniform Motion: Motion Diagram

- Build a motion diagram and relate it to the v vs t graph
- Length of each arrow represents distance traveled per unit time = velocity → same length, velocity is constant
- Velocity arrows indicate the direction of motion

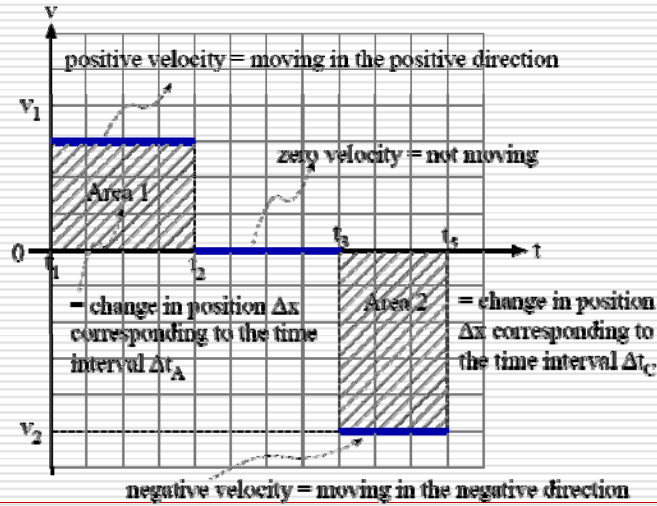


Uniform Motion: Position vs time graph





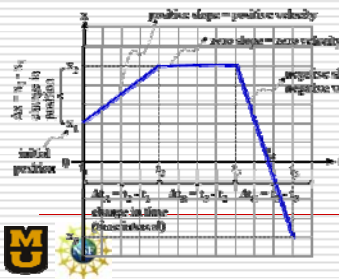
Uniform Motion: Velocity vs time graph



Uniform Motion: Verbal Description of Motion

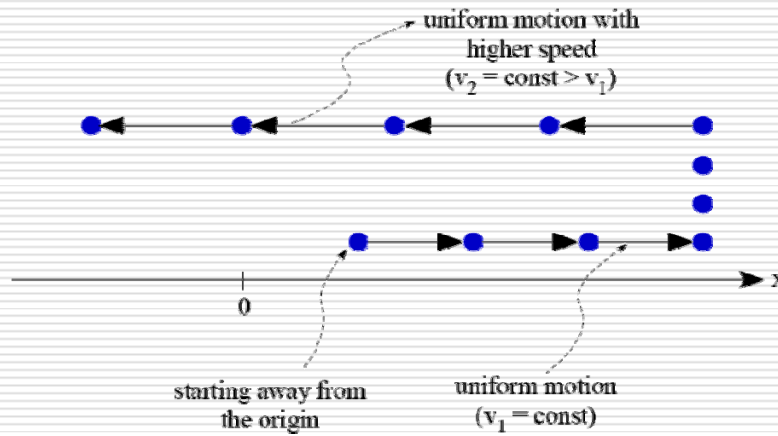
An object starts moving in the positive direction from position x_1 to position x_2 , with a constant speed, for a time interval $\Delta t_A = t_2 - t_1$, where $t_1 = 0$ seconds. During the time interval $\Delta t_B = t_3 - t_2$ the object does not move, its position is not changing and its velocity is therefore zero. During the time interval $\Delta t_C = t_5 - t_3$ the object moves faster than during the time interval Δt_A (it moves with a higher speed)

but it moves in the negative direction. At time t_4 the object passes through the origin of the coordinate axis.





Uniform Motion: Motion Diagrams



Uniform Motion: Mathematical Description

Change in position: $\Delta x = x_f - x_i$

Change in time: $\Delta t = t_f - t_i$

Speed and slope:

$$\text{slope} = \frac{\text{rise}}{\text{run}} \Rightarrow \text{slope} = \frac{\Delta x}{\Delta t} \Rightarrow \text{slope} = \text{speed} = v = \frac{\Delta x}{\Delta t}$$

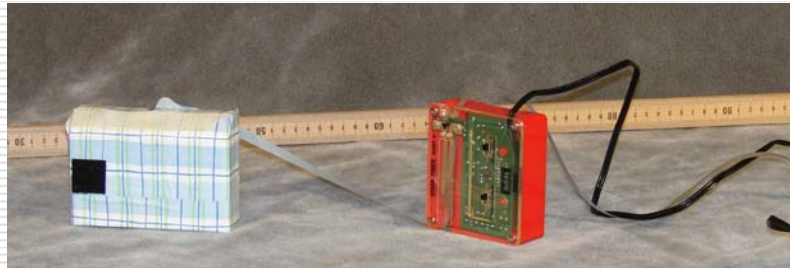
Units for slope: m/s



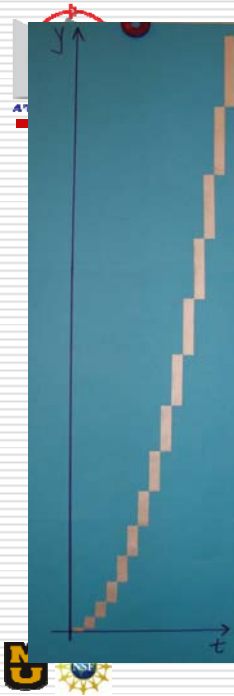


Accelerated Motion

- How is the v vs t different for the accelerated motion?
- How does the motion diagram look like?
- Demo: the spark timer



Accelerated Motion: x vs t graph from experiment

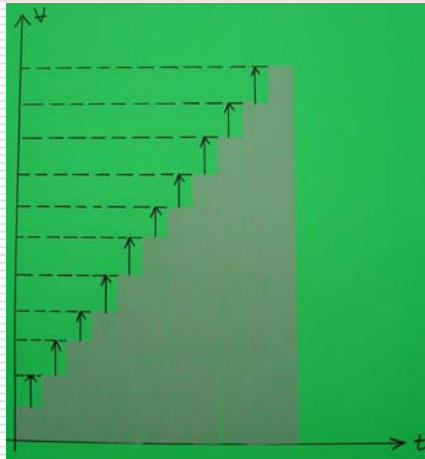


- graph is not linear \Rightarrow velocity is not constant
- slope is not constant \Rightarrow can only calculate slope at a point = instantaneous velocity
- build a v vs t graph





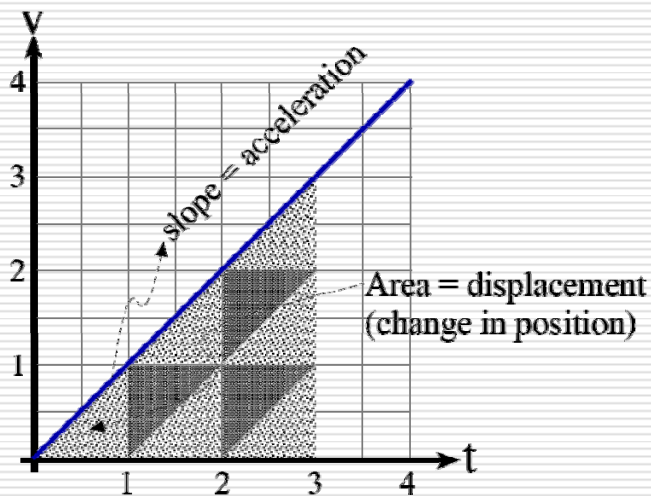
Accelerated Motion: v vs t graph from experiment



- velocity is not constant, changes linearly with time
- slope of velocity graph represents the rate at which velocity changes = acceleration
- calculate accelerations as the slope of the v vs t graph.
- Calculate the distance traveled as the area under the v vs t graph



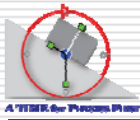
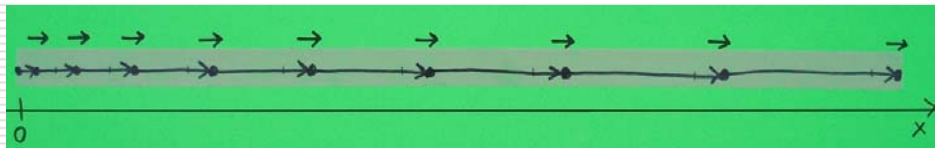
Accelerated Motion: v vs t graph





Accelerated Motion: Motion Diagram

- Build a motion diagram and relate it to the v vs t graph
- Length of each arrow represents distance traveled per unit time = velocity \rightarrow it changes
- Difference between length of arrows (velocities) is the same = acceleration \rightarrow it is constant
- Velocity arrows indicate the direction of motion
- Acceleration arrows show if velocity increases or decreases



Accelerated Motion Motion Diagram

