This Week / Next Week

- Warmups #1 and #2a/2b for this week
  - due by 10 AM before Weds. class and Fri. class this week
  - after that, due by 10 AM before Mon. or Weds. class
- Homework #1 opened today
  - it is due on Sunday night (11:59 pm)
  - after that, we move to due dates on Wednesday and Sunday
- Quiz #1
  - our first 20-minute quiz will be NEXT Friday (not this week!)
- Help Sessions
  - first one is with me on Weds. evening (8-10 pm)
  - here is the Zoom link: https://zoom.us/j/2897909637

    (passcode: 10112)

1

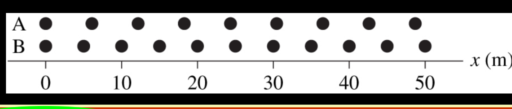
Velocity

PHYS 22: Chap. 26, Pg 2

2

ConcepTest 1 — Motion Diagrams

Two runners jog along a track. The positions are shown at 1 s time intervals. Which runner is moving faster?



1. runner A
2. runner B
3. both the same

$$v = \frac{\Delta x}{\Delta t}$$

Follow-up: What are the speeds of the runners?

0 of 5

PHYS 11: Chap. 1, Pg 3

3

A bird flies a distance of 3 m in only 1/3 second.

1) What does the ratio 3/(1/3) tell you?

2) What does the ratio (1/3)/3 tell you?

3) How far would the bird fly in 1/10 second?

4) How long does it take the bird to fly 4 m?

1.12

PHYS 11: Chap. 1, Pg 4

4

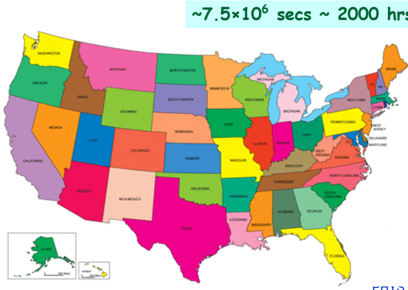
How many paces is it (in a straight line) between Washington and Los Angeles?

~3000 miles

~7.5×10^6 paces

How long would it take you to walk that distance (assuming no stops at all)?

~7.5×10^6 secs ~ 2000 hrs ~ 80 days



Google Maps
2700 miles
860 hrs

PHYS 11: Chap. 1, Pg 5

5

Chapter 2 – Kinematics in One Dimension

- Graphical representations of motion
- Uniform motion
- Instantaneous velocity
- Acceleration
- Motion with constant acceleration
  - solving 1D motion problems
  - free fall
  - motion on an inclined plane

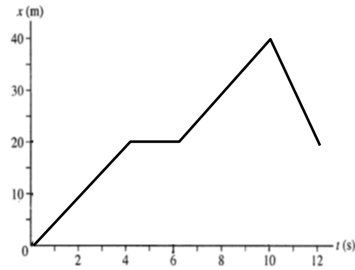
PHYS 22: Chap. 26, Pg 6

6

Graphical Representations

7

This x vs. t graph shows the position of an object moving in a straight line for 12 seconds.



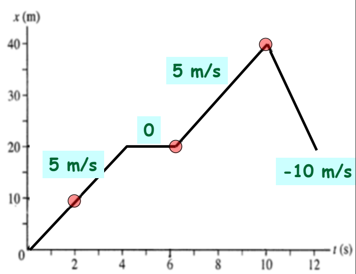
1) Find the position of the object at t = 2, t = 6, t = 10.

2) Find the velocity of the object during each stage.

8

This x vs. t graph shows the position of an object moving in a straight line for 12 seconds.

$$v = \frac{\Delta x}{\Delta t}$$



1) Find the position of the object at t = 2, t = 6, t = 10.

2) Find the velocity of the object during each stage.

9

TACTICS BOX 2.1 Interpreting position-versus-time graphs

Information about motion can be obtained from position-versus-time graphs as follows:

1. Determine an object's *position* at time *t* by reading the graph at that instant of time.
2. Determine the object's *velocity* at time *t* by finding the slope of the position graph at that point. Steeper slopes correspond to faster speeds.
3. Determine the *direction of motion* by noting the sign of the slope. Positive slopes correspond to positive velocities and, hence, to motion to the right (or up). Negative slopes correspond to negative velocities and, hence, to motion to the left (or down).

Exercises 2,3

10

Let's check...

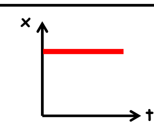
1) Draw x vs. t and v vs. t graphs for an object at rest at x = 5 m.

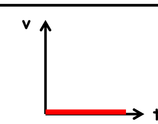
2) Draw x vs. t and v vs. t graphs for an object moving at a constant velocity of +3 m/s.

3) Draw #2 again, but for a velocity of -10 m/s.

11

1) Draw x vs. t and v vs. t graphs for an object at rest at x = 5 m.





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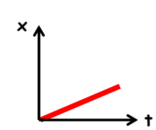
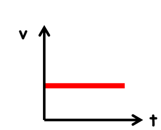
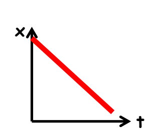
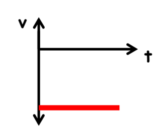




3) Draw #2 again, but for a velocity of -10 m/s.





12

Sketch x vs. t graphs for the following motions.
Include numerical scales on the axes with units that are reasonable for this motion.

1) A student walks to the bus stop, waits for the bus, then rides to campus. Assume the motion is along a straight street.

2) A student walks slowly to the bus stop, realizes that he forgot his homework, and quickly walks back home to retrieve it.

3) A quarterback drops back 10 yards from the line of scrimmage, then throws a 20 yard pass to the tight end, who catches it and sprints 20 yards to the goal line.
Draw the graph for the football.

1.32 PHYS 21: Chap. 2, Pg 13

13

Sketch x vs. t graphs for the following motions.
Include numerical scales with reasonable units.
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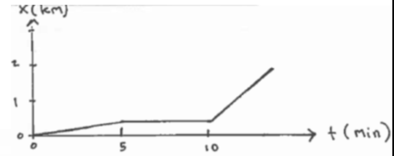
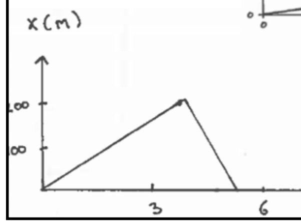


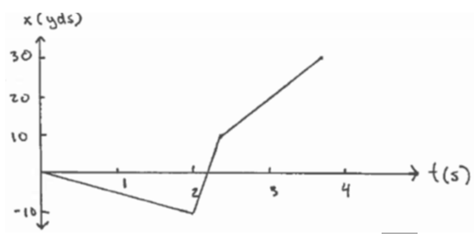


2) A student walks slowly to the bus stop, realizes that he forgot his homework, and quickly walks back home to retrieve it.

PHYS 11: Chap. 2, Pg 14

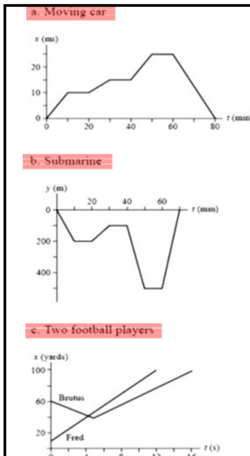
14

Sketch x vs. t graphs for the following motions.
Include numerical scales on the axes with units that are reasonable for this motion.
3) A quarterback drops back 10 yards from the line of scrimmage, then throws a 20 yard pass to the tight end, who catches it and sprints 20 yards to the goal line.
Draw the graph for the football.



1.32 PHYS 11: Chap. 2, Pg 15

15



Write a short story about what is happening in the x vs. t graphs shown.

Be creative, with real characters and situations.

Note the distances moved and the times elapsed, including velocities, etc.

1.33 PHYS 21: Chap. 2, Pg 16

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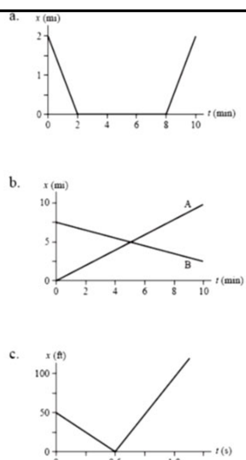


Tell a short story about what is happening in the x vs. t graphs shown.

You should specifically refer to the speeds of the objects in your story.

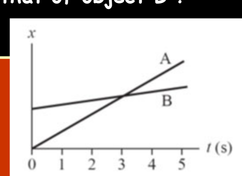
2.3 PHYS 21: Chap. 2, Pg 17

17

ConcepTest 3 Speed and Position

At time t = 1 s, how does the speed of object A compare to that of object B ?

1. $v_A > v_B$
2. $v_A = v_B$
3. $v_A < v_B$

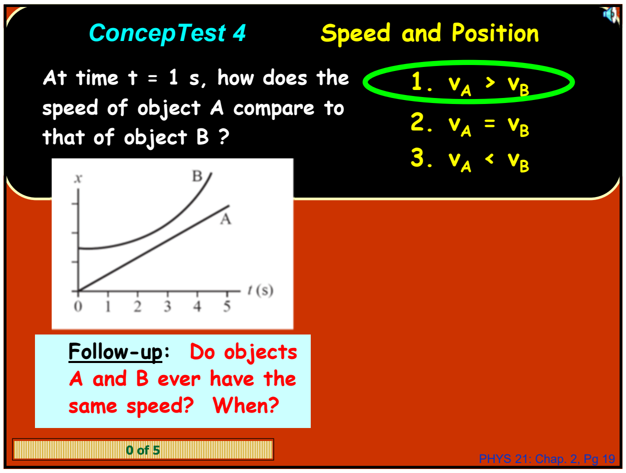


Follow-up: Do objects A and B ever have the same speed? When?

0 of 5

PHYS 21: Chap. 2, Pg 18

18



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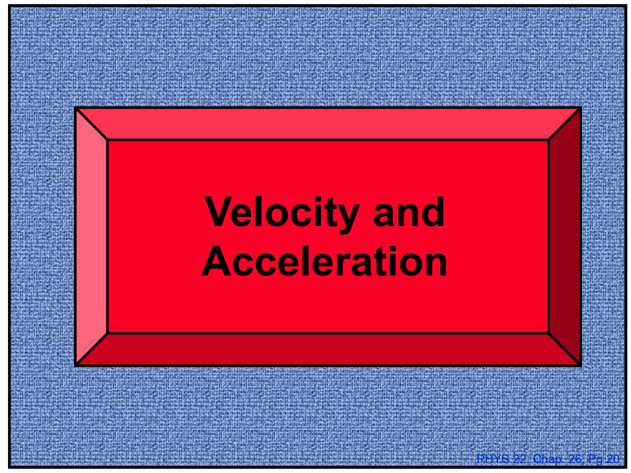

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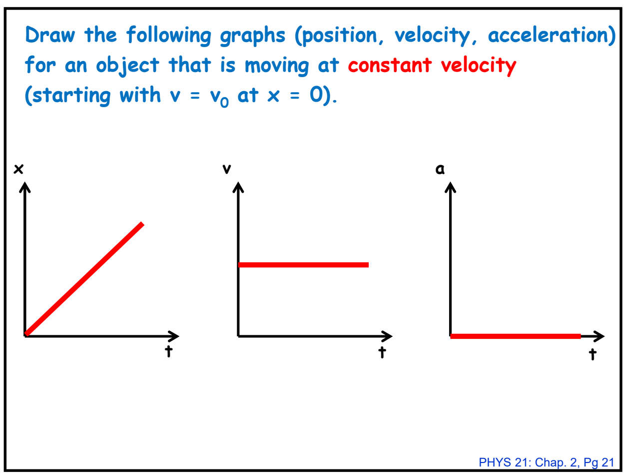

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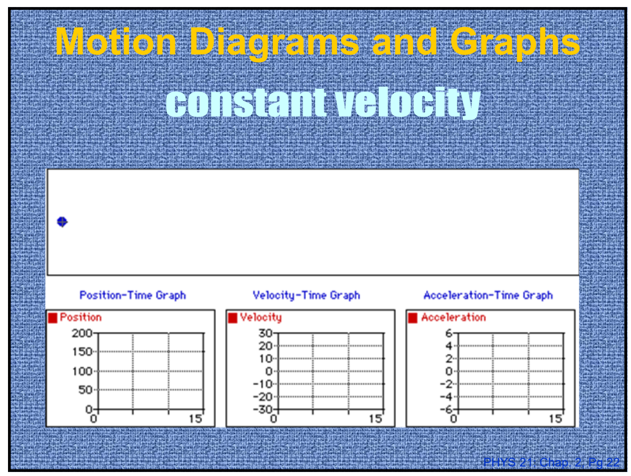

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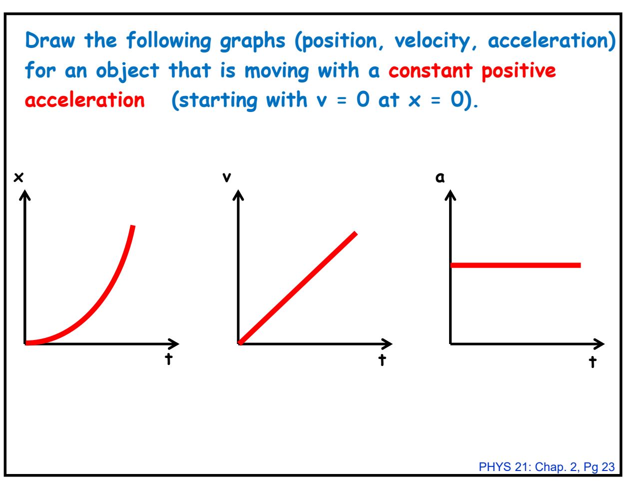

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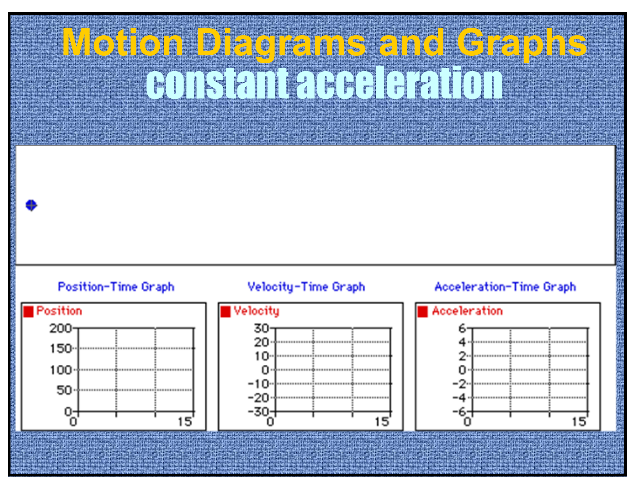

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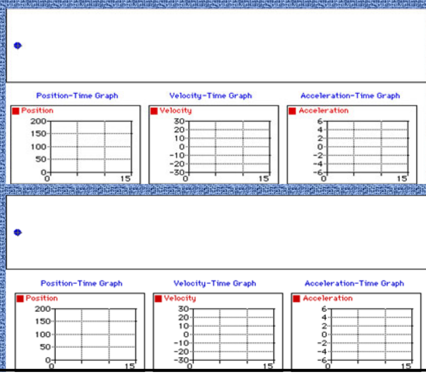
Motion Diagrams and Graphs
constant acceleration



Chap. 2, Pg 25

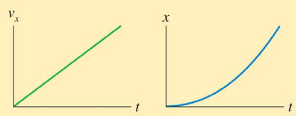
25

1D Kinematics
(including free fall)

26

Motion with constant acceleration

An object with constant acceleration has a constantly changing velocity. Its velocity graph is linear; its position graph is a parabola.



Kinematic equations for motion with constant acceleration:

$a = \frac{\Delta v}{\Delta t}$

$v = \frac{\Delta x}{\Delta t}$

$(v_x)_f = (v_x)_i + a_x \Delta t$ — $v(t)$

$x_f = x_i + (v_x)_i \Delta t + \frac{1}{2} a_x (\Delta t)^2$ — $x(t)$

$(v_x)_f^2 = (v_x)_i^2 + 2 a_x \Delta x$ — $v(x)$

YS 11: Chap. 2, Pg 27

27

SYNTHESIS 2.1 Describing motion in one dimension

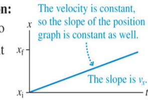
We describe motion in terms of position, velocity, and acceleration.

For **all motion:**

Velocity is the rate of change of position, in m/s. $v_x = \frac{\Delta x}{\Delta t}$

Acceleration is the rate of change of velocity, in m/s². $a_x = \frac{\Delta v_x}{\Delta t}$

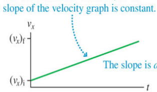
For **uniform motion:**
- acceleration is zero
- velocity is constant
- position changes steadily



$x_f = x_i + v_x \Delta t$ (2.4)

Final and initial position (m); Velocity (m/s); Time interval (s)

For **motion with constant acceleration:**
- acceleration is steady; it does not change

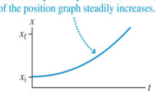


- velocity changes steadily

$(v_x)_f = (v_x)_i + a_x \Delta t$ (2.11)

Final and initial velocity (m/s); Acceleration (m/s²); Time interval (s)

- the position changes as the square of the time interval



$x_f = x_i + (v_x)_i \Delta t + \frac{1}{2} a_x (\Delta t)^2$ (2.12)

Final and initial position (m); Time interval (s); Initial velocity (m/s); Acceleration (m/s²)

- we can also express the change in velocity in terms of **displacement, not time**

This gives us a third equation, which is useful for many kinematics problems.

$(v_x)_f^2 = (v_x)_i^2 + 2 a_x \Delta x$ (2.13)

Final and initial velocity (m/s); Acceleration (m/s²); Change in position (m)

28

ConcepTest 2 **Kinematics**

If the velocity of an object is non-zero ($v \neq 0$), can the acceleration of the object be zero?

1. yes
2. no
3. depends on the velocity

Follow-up: How about the other way around? Can an object have a non-zero acceleration, but zero velocity?

0 of 5

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ConcepTest 4 **Kinematics**

If the velocity of an object is zero ($v = 0$), can the acceleration of the object be non-zero ($a \neq 0$)?

1. yes
2. no
3. depends on the velocity

0 of 5

PHYS 11: Chap. 1, Pg 30

30

Give a specific example for each of the following situations:

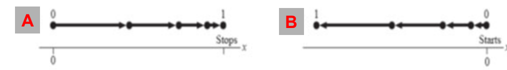
1) a = 0 but v ≠ 0

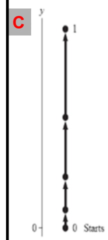
2) v = 0 but a ≠ 0

3) v < 0 and a > 0

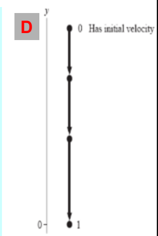
31

Indicate whether the quantities in the table are positive (+), negative (-) or zero (0).



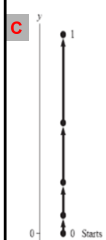


	A	B	C	D
initial position				
final position				
initial velocity				
final velocity				
accel.				

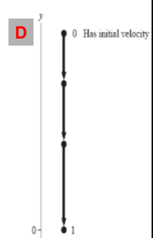


32

Indicate whether the quantities in the table are positive (+), negative (-) or zero (0).



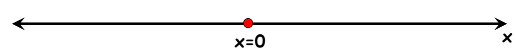
	A	B	C	D
initial position	0	0	0	+
final position	+	-	+	0
initial velocity	+	0	0	-
final velocity	0	-	+	-
accel.	-	-	+	-



33

The kinematic variables for position, velocity and acceleration have 8 possible combinations of signs, such as (x,v,a) = (+,-,+) for example.

List all 8 combinations. Draw a motion diagram for each case and draw the corresponding velocity and acceleration vectors.



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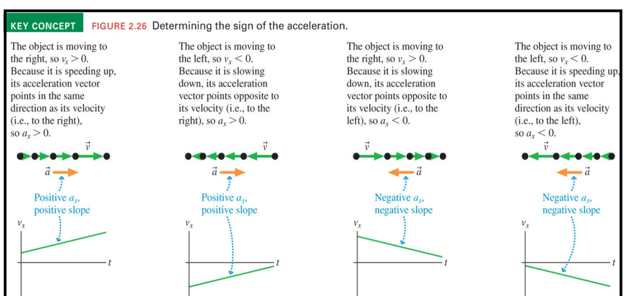
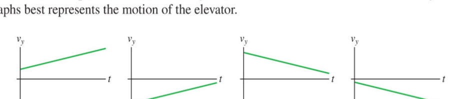


STOP TO THINK 2.5 An elevator is moving downward. It is slowing down as it approaches the ground floor. Adapt the information in Figure 2.26 to determine which of the following velocity graphs best represents the motion of the elevator.



35

A truck driver has a shipment of apples to deliver to a store 500 miles away. The trip usually takes him 8 hours. Today he is daydreaming and realizes 150 miles into his trip that he is running a half hour later than his usual pace at this point.

How fast must he drive for the remainder of the trip in order to complete the trip in the usual amount of time?

v = 68.6 mph

36

A truck driver has a shipment of apples to deliver to a store 500 miles away. The trip usually takes him 8 hours. Today he is daydreaming and realizes 150 miles into his trip that he is running a half hour later than his usual pace at this point.

How fast must he drive for the remainder of the trip in order to complete the trip in the usual amount of time?

$v_{avg} = \frac{500\ miles}{8\ hrs} = 62.5\ \frac{miles}{hr}$

v = 68.6 mph

SOLUTION

Normally: $t_1 = \frac{150\ miles}{62.5\ mph} = 2.4$ hrs $\quad t_2 = \frac{350\ miles}{62.5\ mph} = 5.6$ hrs

But today: $t_1 = 2.9$ hrs $\quad t_2 = 5.1$ hrs

So to make up lost time: $v_{fast} = \frac{350\ miles}{5.1\ hrs} = 68.6\ \frac{miles}{hr}$

PHYS 21: Chap. 2, Pg 37

37

A truck driver has a shipment of apples to deliver to a store 500 miles away. The trip usually takes him 8 hours. Today he is daydreaming and realizes halfway into his trip (at the 250 mile mark) that he is running a half hour later than his usual pace at this point.

How fast must he drive for the remainder of the trip in order to complete the trip in the usual amount of time?

v = 71.4 mph

3+2.5

2.57

PHYS 21: Chap. 2, Pg 38

38

A truck driver has a shipment of apples to deliver to a store 500 miles away. The trip usually takes him 8 hours. Today he is daydreaming and realizes halfway into his trip (at the 250 mile mark) that he is running a half hour later than his usual pace at this point.

How fast must he drive for the remainder of the trip in order to complete the trip in the usual amount of time?

$v_{avg} = \frac{500\ miles}{8\ hrs} = 62.5\ \frac{miles}{hr}$

v = 71.4 mph

SOLUTION

Normally each half of the trip requires: $t_1 = t_2 = \frac{250\ miles}{62.5\ mph} = 4$ hrs

But today: $t_1 = 4.5$ hrs $\quad t_2 = 3.5$ hrs

So to make up lost time: $v_{fast} = \frac{250\ miles}{3.5\ hrs} = 71.4\ \frac{miles}{hr}$

PHYS 21: Chap. 2, Pg 39

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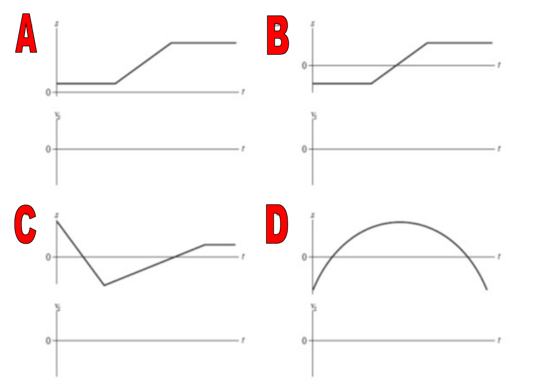
For the x vs. t graphs, draw corresponding v vs. t graphs.



2.7

PHYS 21: Chap. 2, Pg 40

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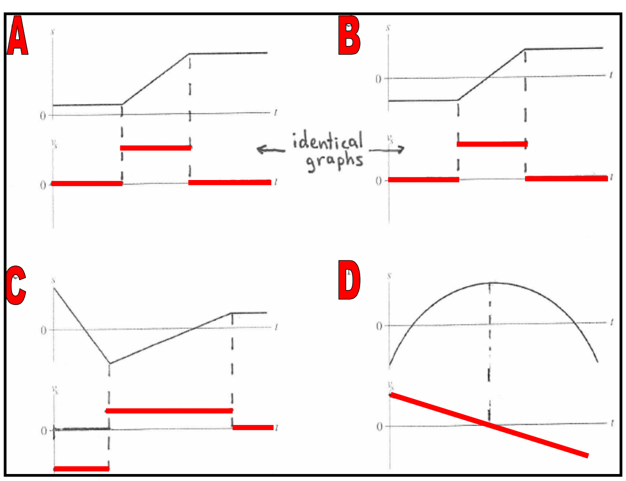

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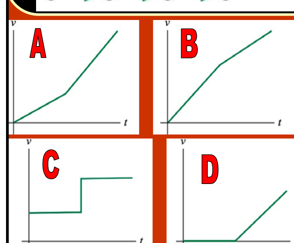
ConcepTest 3 Speed and Position

Which of the following v vs. t graphs matches the motion diagram?

1. A
2. B
3. C
4. D



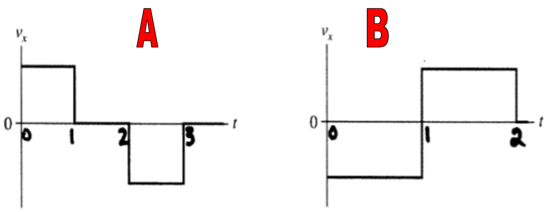
Follow-up: Which of these figures could be the x vs. t graph?

0 of 5

PHYS 11: Chap. 2, Pg 42

42

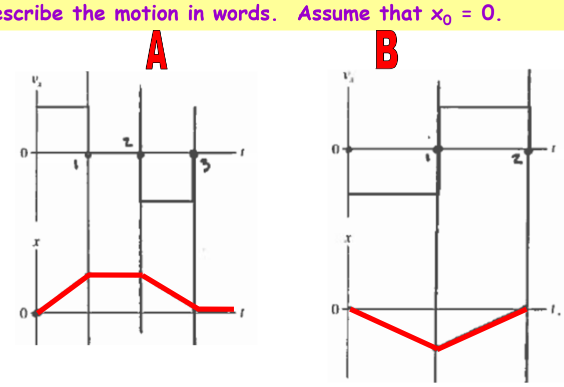
For the v vs. t graphs, draw corresponding x vs. t graphs. Describe the motion in words. Assume that $x_0 = 0$.



2.8

43

For the v vs. t graphs, draw corresponding x vs. t graphs. Describe the motion in words. Assume that $x_0 = 0$.



2.8

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