Physics 1010: The Physics of Everyday Life

TODAY

- **Velocity, Acceleration**
- **1D motion under constant acceleration**
- **Newton's Laws**

VOLUNTEERS WANTED!

PHET, The PHysics Educational Technology project, is looking for students to interview about some of their physics applets.

Volunteers will be paid $20/hr.

(There is no extra credit for this; just cash:-)

If interested please contact

Danielle.Harlow@colorado.edu

Help, Office and Tutorial Hours

TUTORIALS

Isidoros: 12:30-2:30 Thursday (same as office hours)

Shaun: 10:00-12:50 Monday

Joseph: ???

HELP

Mark (exams + overall): ???

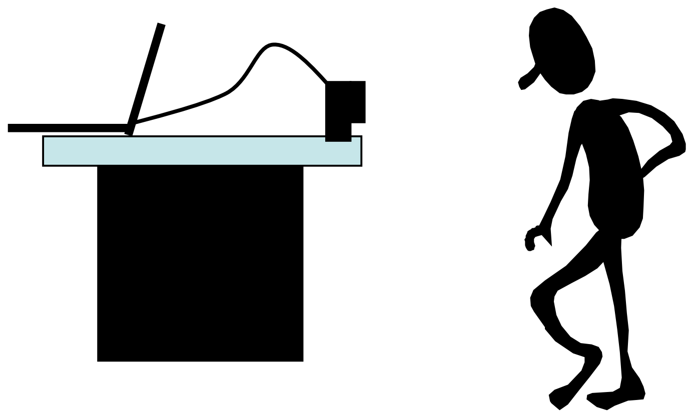
Ye (Clickers): 3:00-5:00 Friday

Yin (Homework): 2:00-3:00 Monday and Friday

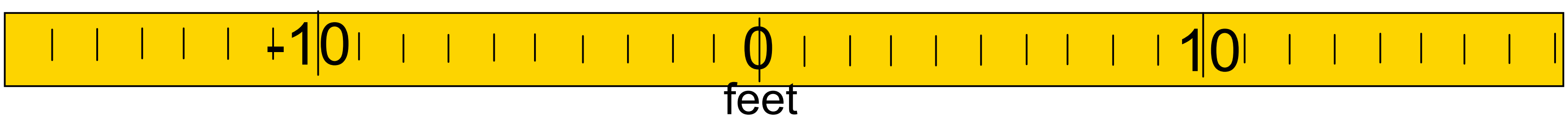
Today

- **Velocity, Acceleration**
- **Motion in one dimension under constant acceleration**
- **Newton's Laws**

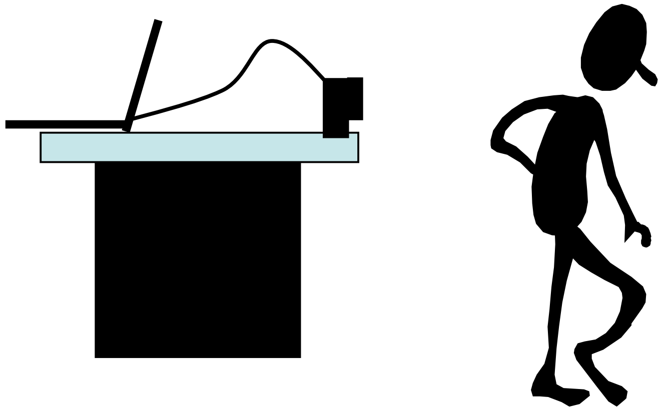
Position is a VECTOR



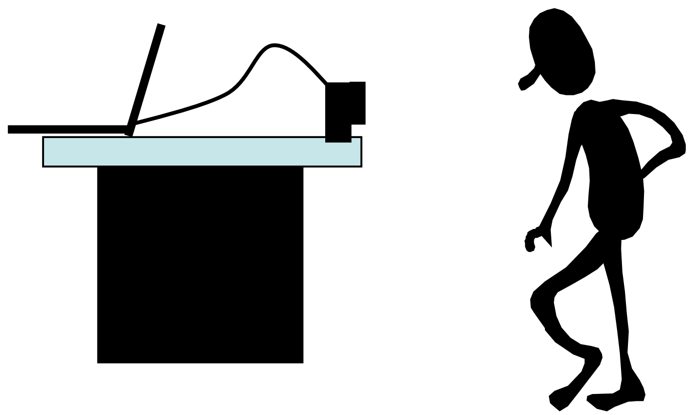
Positive to the right
Negative to the left



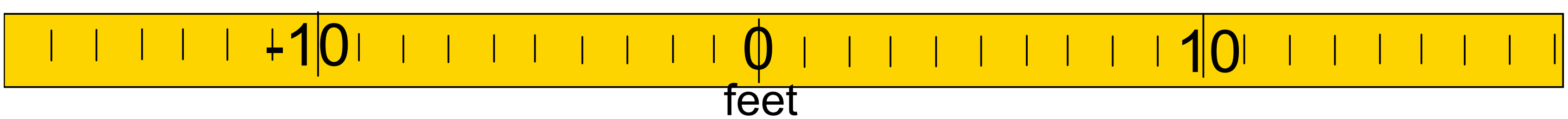
Velocity is a VECTOR



Moving to the right:
(position increases)
positive velocity.



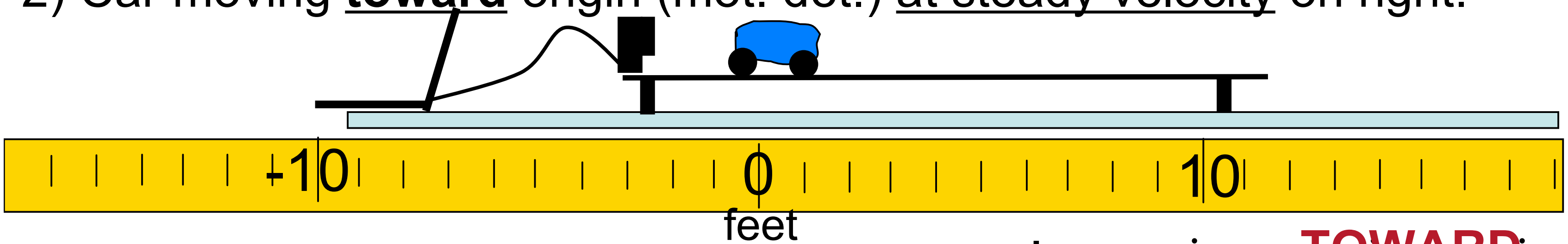
Moving to the left:
(position decreases)
negative velocity.

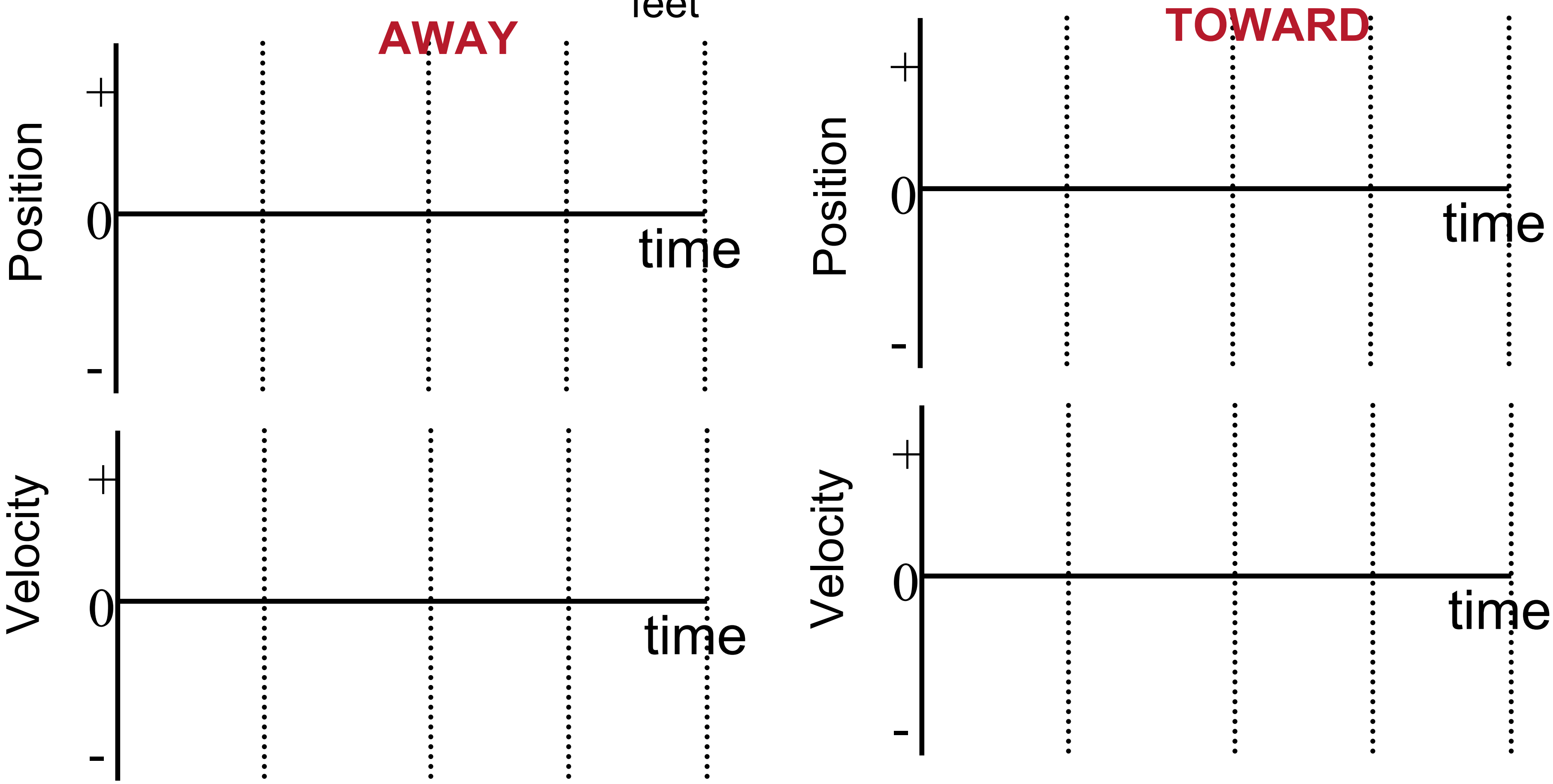


POSITION AND VELOCITY

Sketch **position vs. time** graph and **velocity vs. time** graphs for

1) Car moving **away** from origin (motion detector) at steady velocity on left.
2) Car moving **toward** origin (mot. det.) at steady velocity on right.

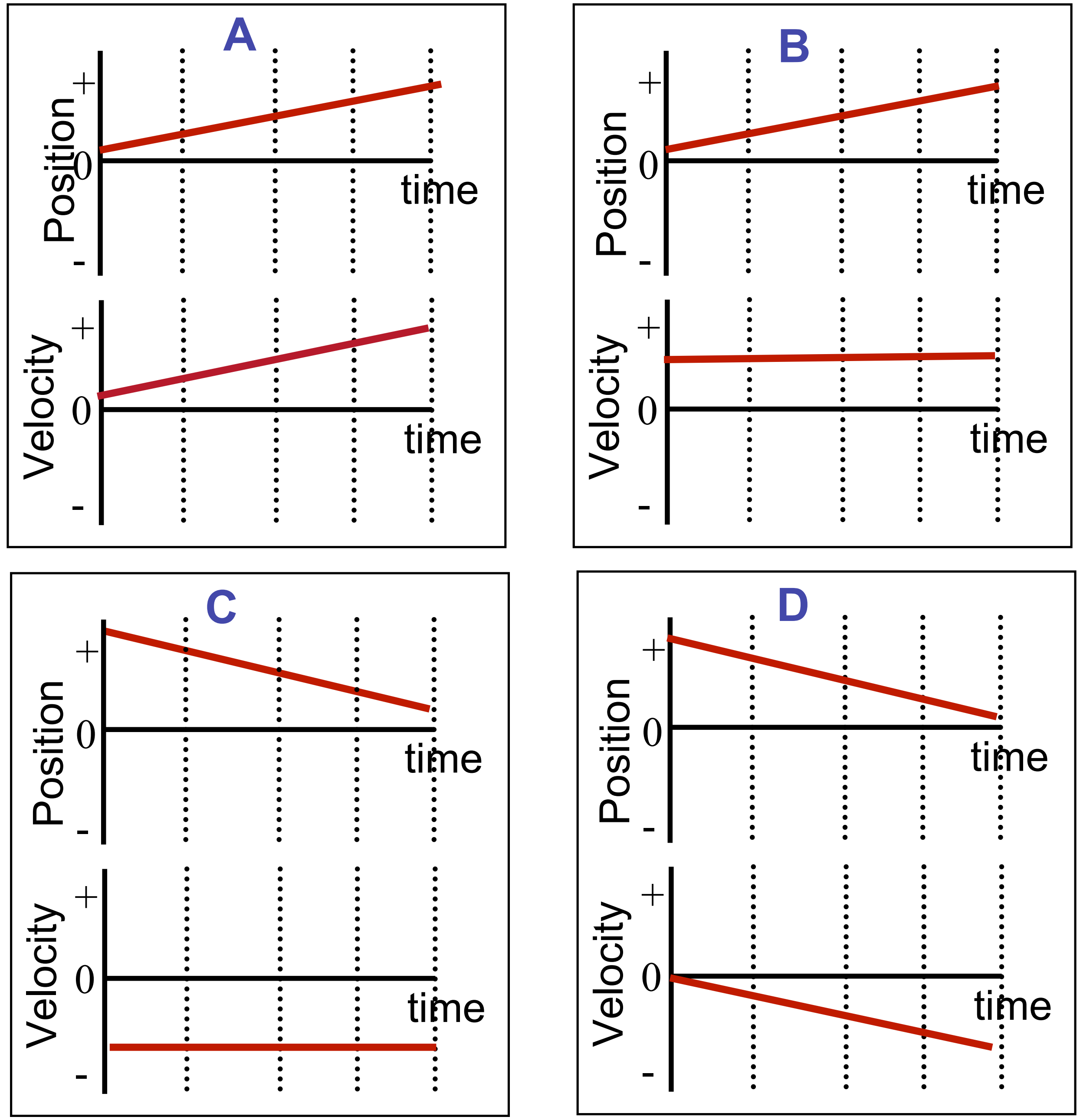




POSITION AND VELOCITY

Sketch **position vs. time** graph and **velocity vs. time** graphs for

1) Car moving **away** from origin (motion detector) at steady velocity.
(Vote on AWAY)

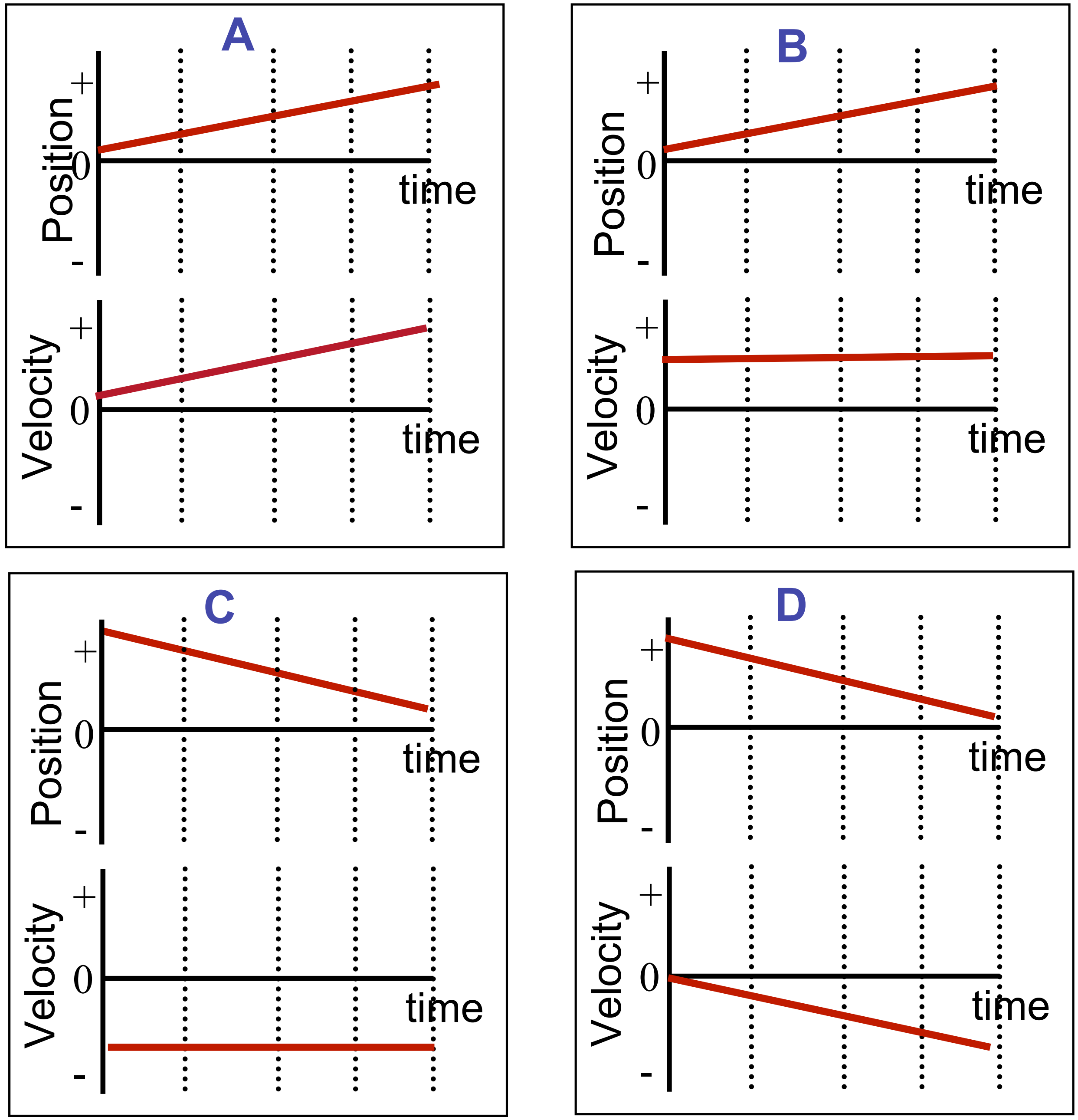


POSITION AND VELOCITY

Sketch **position vs. time** graph and **velocity vs. time** graphs for

1) Car moving <u>**away**</u> from origin (motion detector) <u>at steady velocity</u>.
(Vote on AWAY)

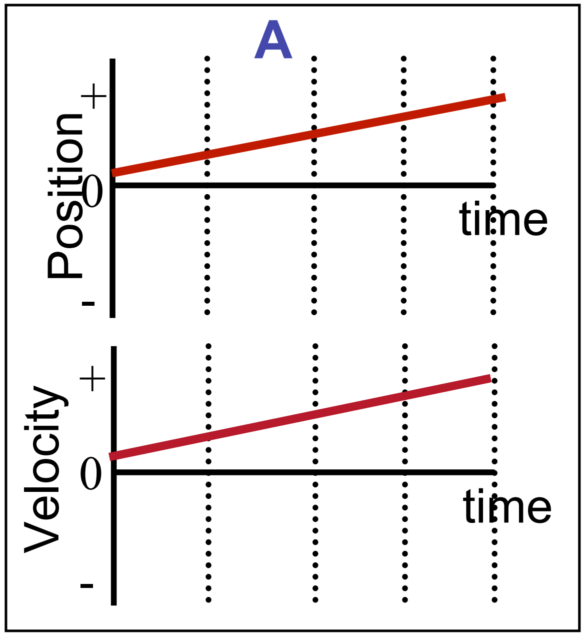
Answer is **B**

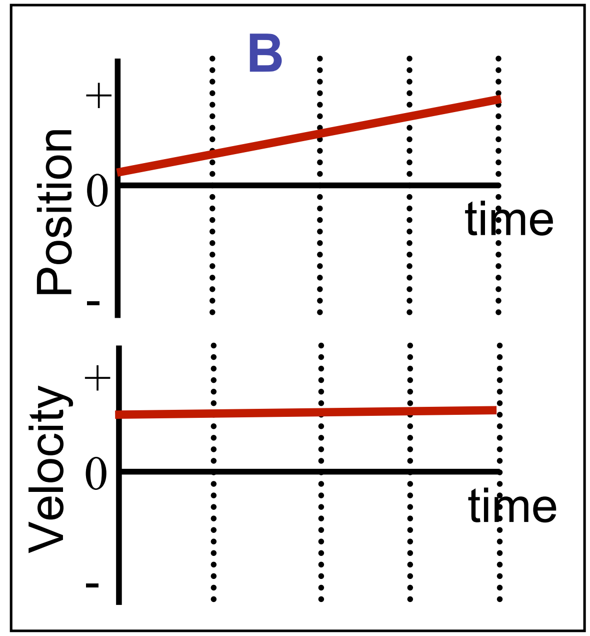


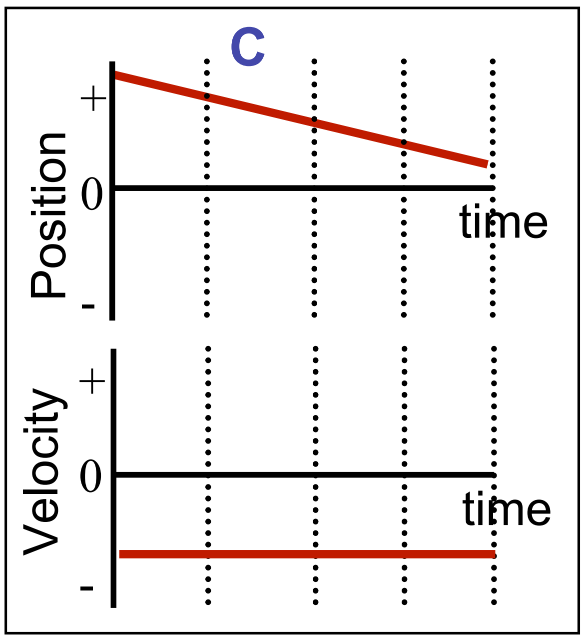
POSITION AND VELOCITY

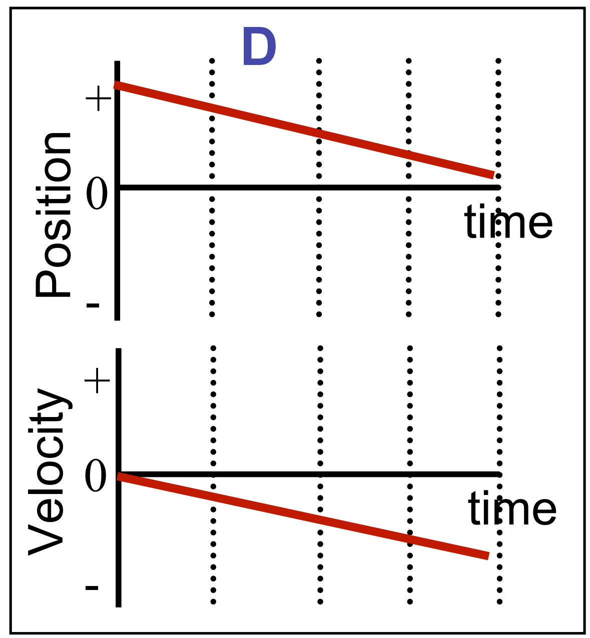
Sketch **position vs. time** graph and **velocity vs. time** graphs for

1) Car moving **toward** from origin (motion detector) at steady velocity.
(Vote on TOWARD)







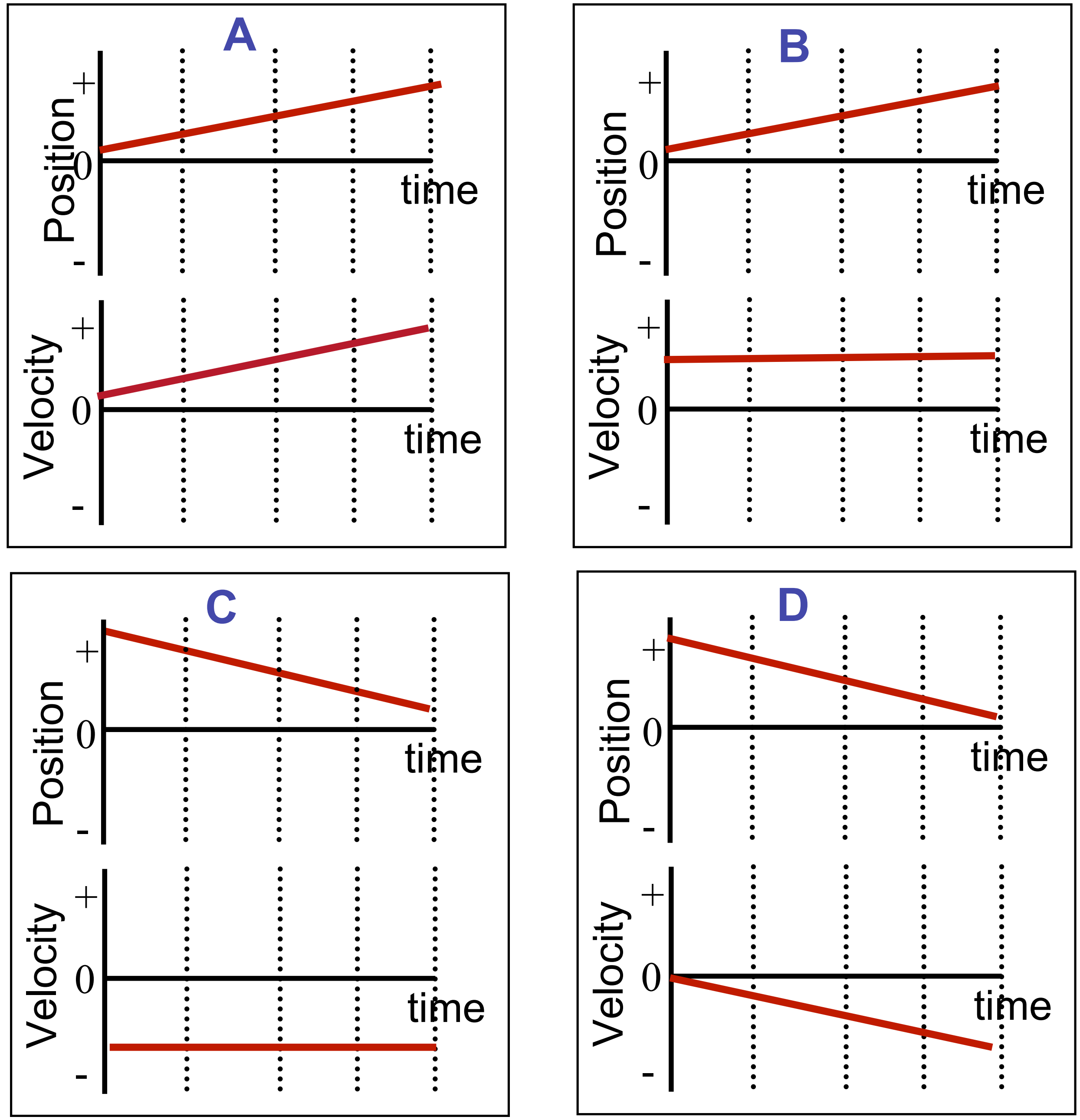


POSITION AND VELOCITY

Sketch **position vs. time** graph and **velocity vs. time** graphs for

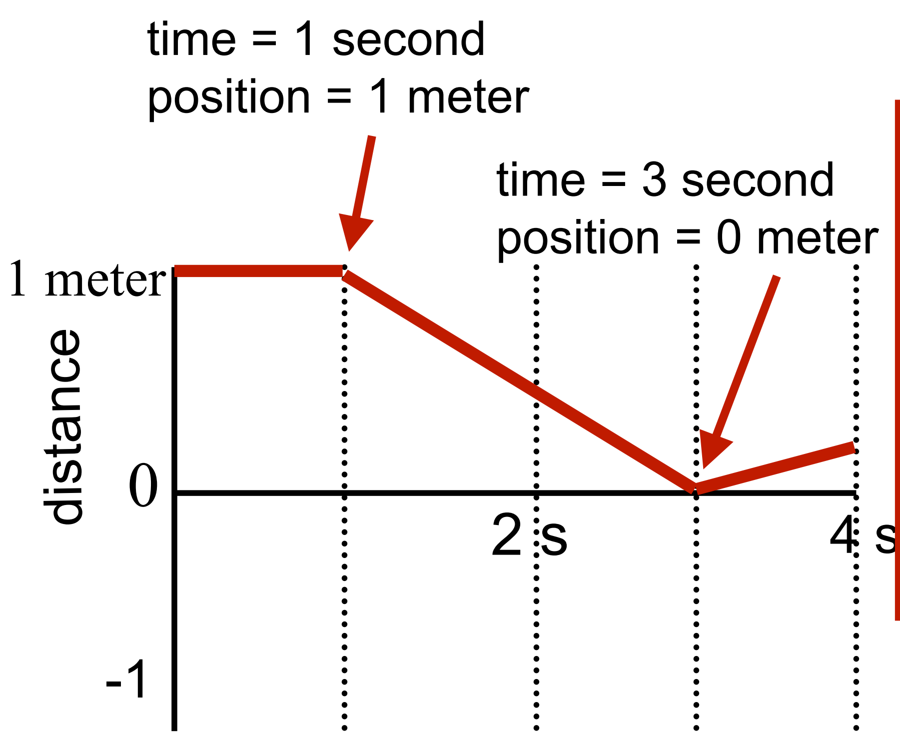
1) Car moving **<u>toward</u>** from origin (motion detector) <u>at steady velocity</u>.
(Vote on TOWARD)

Answer is **C**



Algebraically: Velocity is change in position divided by elapsed time

$$\text{Velocity } (v) = \frac{(\text{final position}) - (\text{initial position})}{(\text{final time}) - (\text{initial time})}$$



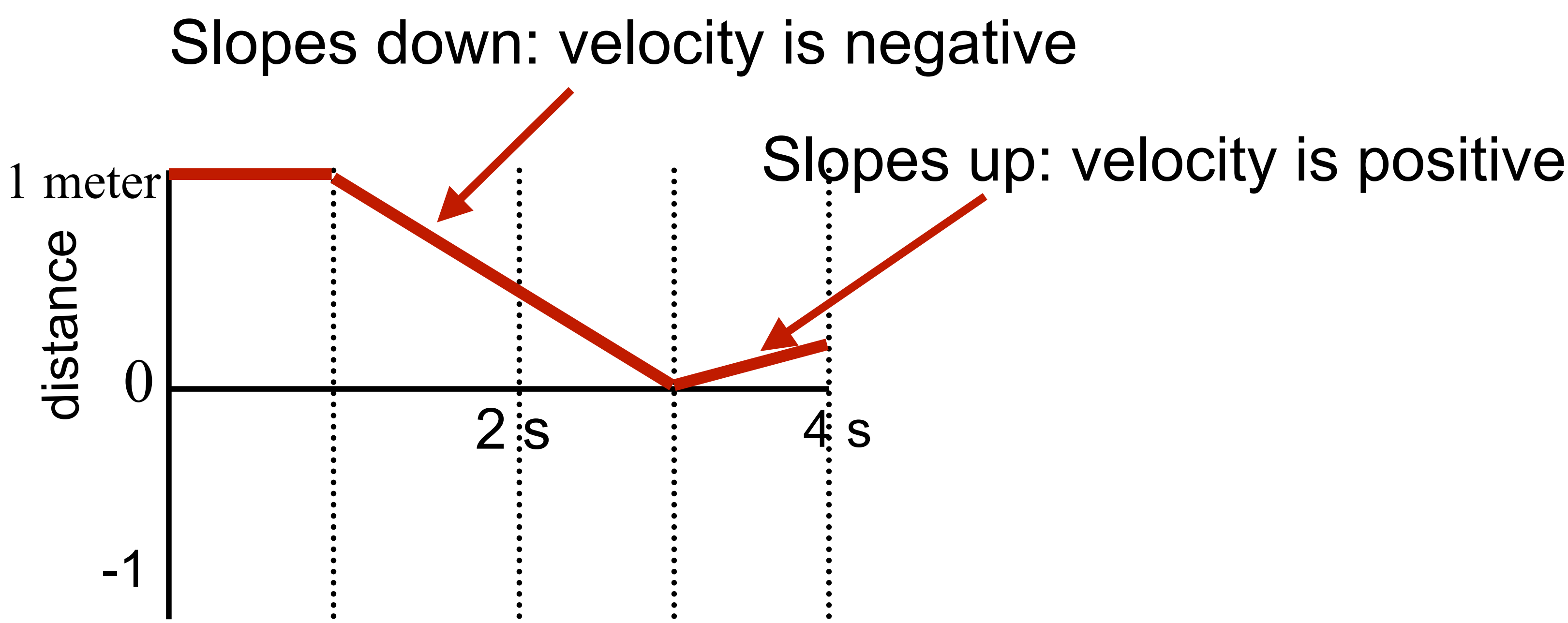
Change in Position = -1 meter

Time elapsed = 2 seconds

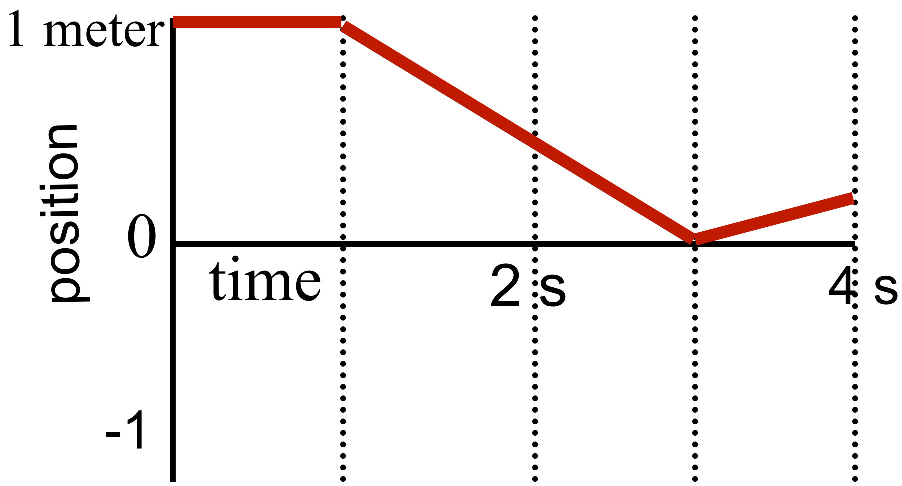
$$\text{Velocity} = \frac{-1 \text{ meter}}{2 \text{ seconds}} = -0.5 \text{ m/s}$$

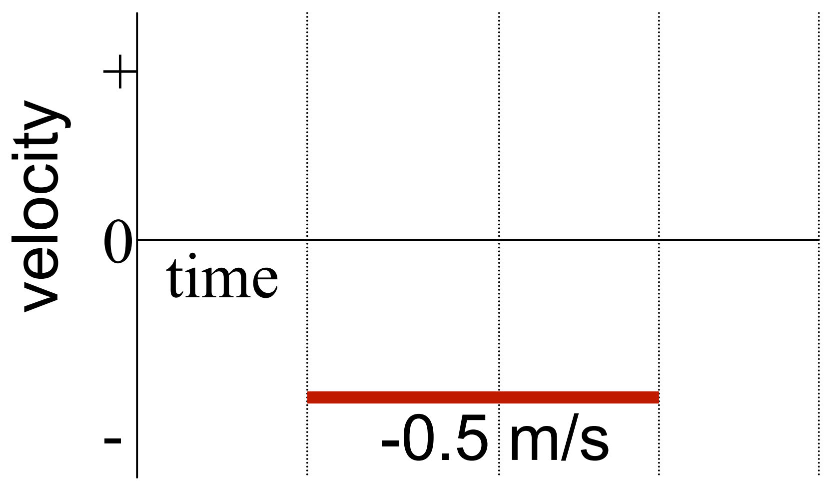
Graphically: Velocity is the slope on the position versus time plot

$$\text{Velocity (v)} = \frac{\text{change in position}}{\text{time elapsed}}$$



We can get velocity graph from position graph





Calculate velocity at t=2s

$$\text{Velocity} = \frac{\text{change in position}}{\text{elapsed time}}$$

<u>Position at 1s is:</u>
a) 1 m
b) -1 m
c) 0.5 m
d) -0.5 m
e) 0 m

<u>Position at 3s is:</u>
a) 1 m
b) -1 m
c) 0.5 m
d) -0.5 m
e) 0 m

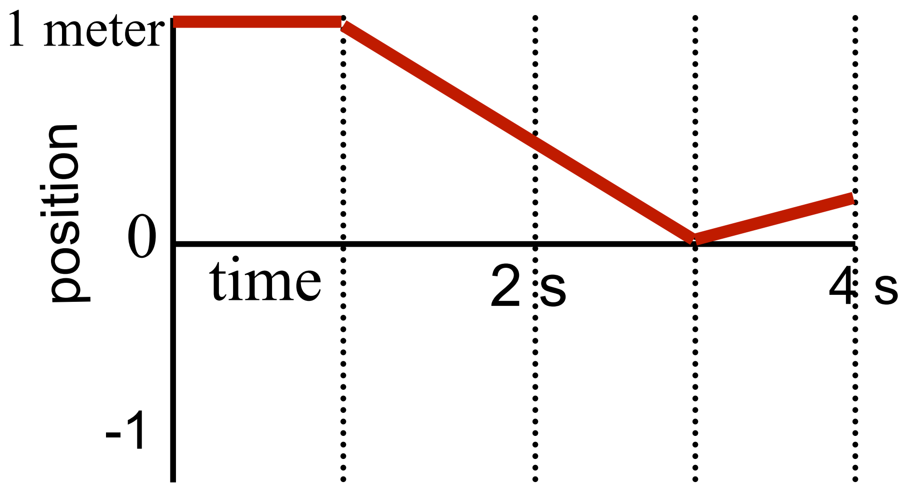
<u>Change in position is:</u>
a) 1 m
b) -1 m
c) 0.5 m
d) -0.5 m
e) 0 m

<u>Elapsed time is:</u>
a) 1 s
b) 2 s
c) -1 s
d) -2 s
e) 0 s

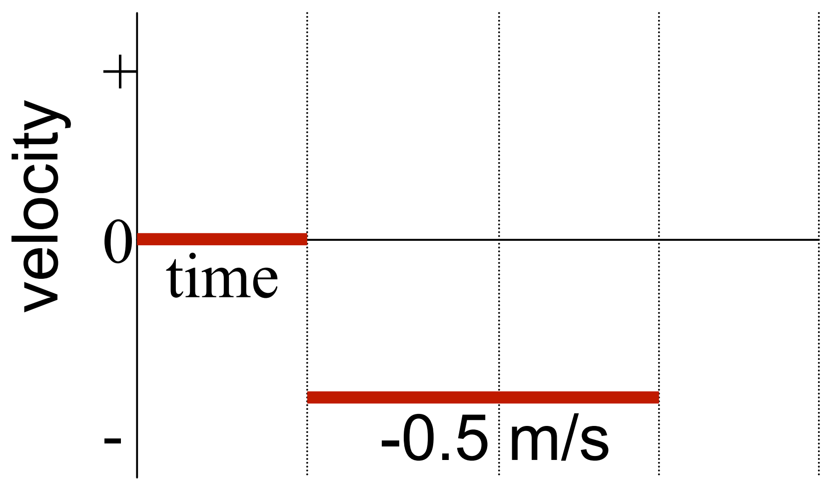
<u>Velocity at 2 s is:</u>
a) 1 m/s
b) -1 m/s
c) 0.5 m/s
d) -0.5 m/s
e) - 1/6 m/s

We can get velocity graph from position graph

velocity at t=0.5s

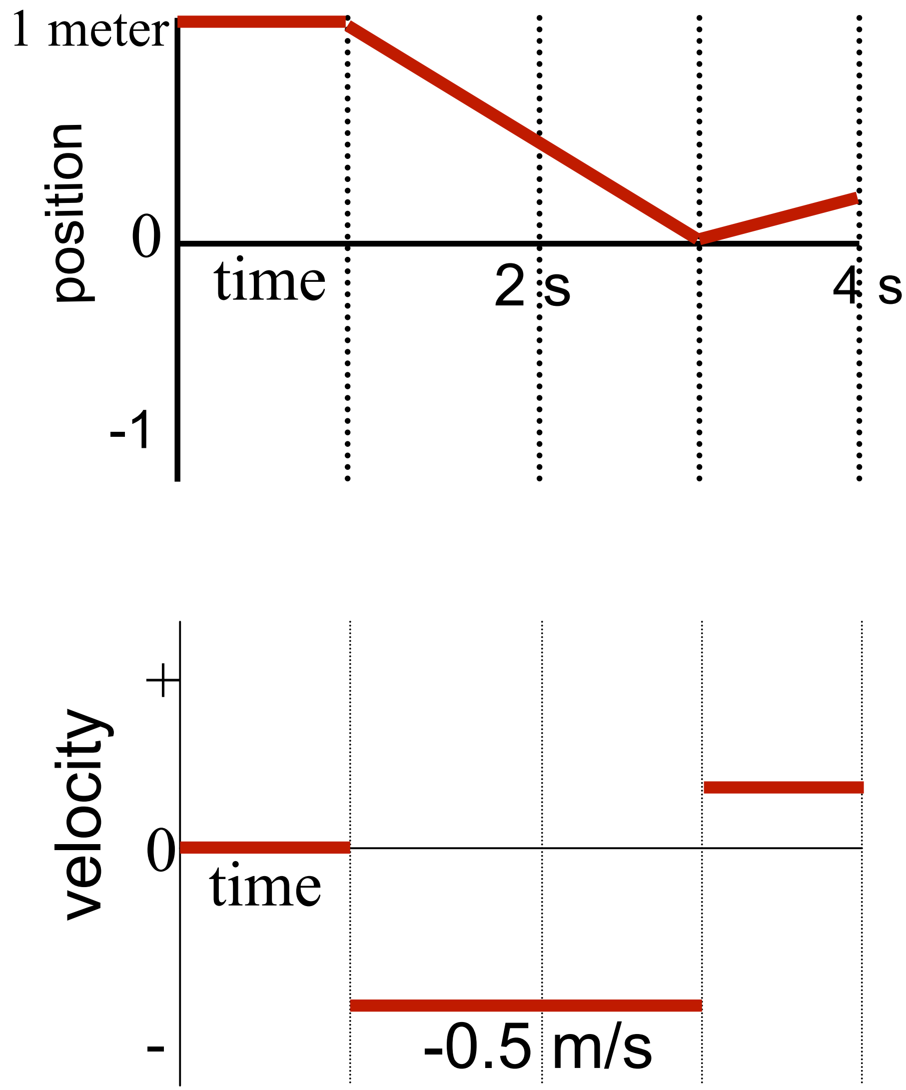


A 0.
B 2.
C -2.
D 0.5



We can get velocity graph from position graph

velocity at t=3.5s



A
B
C
D

Given velocity, we can mathematically predict position

$$\text{Velocity} = \frac{\text{change in position}}{\text{elapsed time}}$$

change in position = velocity x elapsed time

Position = Starting position + change in position
Position = Starting position + velocity x time

$x = x_{initial} + vt$
FOR CONSTANT VELOCITY

To succeed in this course, the above algebra should be easy

What is the x

$X(t) = x_{initial} + vt$

- A final position
- B change in position
- C current position
- D none of the above

VELOCITY RECAP

- Velocity is a VECTOR: it has both magnitude (length) and direction
- Velocity is the slope of the position graph
- Motion can be described both algebraically (formula) and geometrically (graph)
- The two descriptions are equivalent, and we can use one to produce the other

WHAT IS THE DIFFERENCE BETWEEN SPEED AND VELOCITY

a) Velocity is just to make you sound smarter
b) Velocity is the acceleration
c) Speed does not have direction
d) Velocity can be negative
e) C and d

What is the difference between “speed” and “velocity”?

1. You are driving 60 miles per hour north.
2. You are driving 60 miles per hour.

a. both give your speed, can’t tell your velocity.
b. 2. gives speed, 1. gives velocity.
c. both are giving your velocity.
d. 2 gives velocity, 1. gives your speed.

What is the difference between "speed" and "velocity"?

1. You are driving 60 miles per hour north.

2. You are driving 60 miles per hour.

a. both give your speed, can't tell your velocity.
b. 2. gives speed, 1. gives velocity.
c. both are giving your velocity.
d. 2 gives velocity, 1. gives your speed.

Answer is b. 1. Gives both magnitude and direction. 2. Gives only magnitude

IF SPEED IS CONSTANT 60mi/hr CAN VELOCITY BE CHANGING?

YES

a) Direction can change but speed stay same

b) Going around a track

NO

c)

d)

IF SPEED IS CONSTANT 60mi/hr CAN VELOCITY BE CHANGING?

YES

Velocity has both magnitude (60mi/hr) AND direction (north). If either magnitude OR direction changes, velocity is changing.

A change in velocity implies ACCELERATION

HOW IS ACCELERATION SIMILAR TO VELOCITY?

a) they're both vectors
b) Acceleration is the change in velocity
c) They both measure a change
d) thy're both speed
e) They can both be calculated

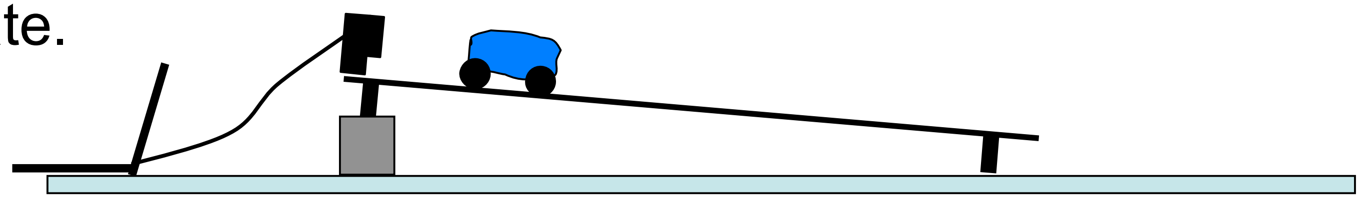
Acceleration is to velocity like velocity is to position

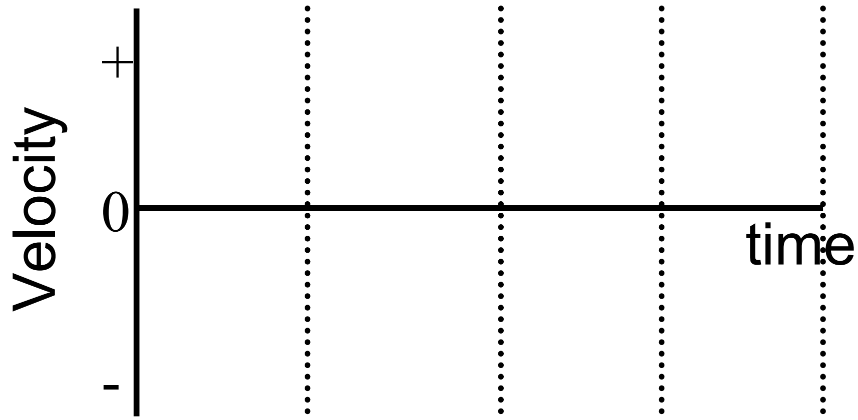
- Velocity = Change in position divided by elapsed time
- Velocity = slope on position graph
- Position = Initial position + velocity x time
- Must select which direction is positive

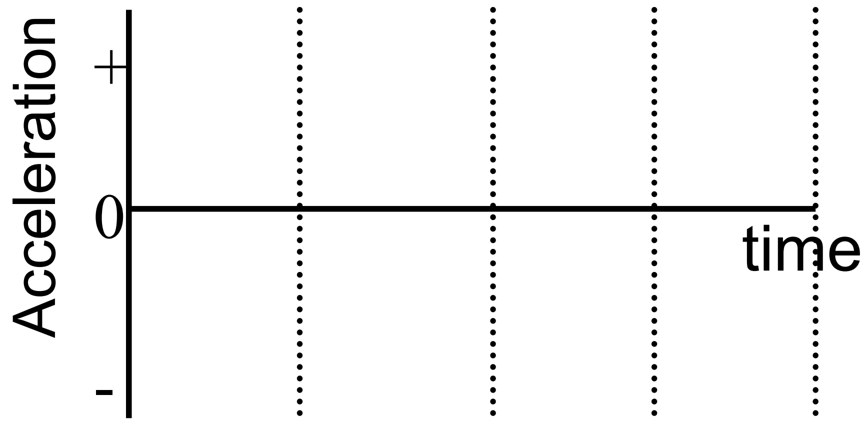
- Acceleration = Change in velocity divided by elapsed time
- Acceleration = slope on velocity graph
- Velocity = Initial velocity + acceleration x time
- Must select which direction is positive <u>consistently</u>

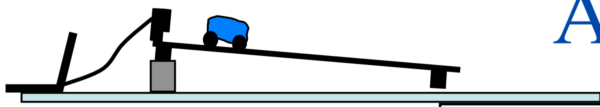
ACCELERATION

Sketch **Velocity vs. time** graph and **Acceleration vs. time** graphs for the car **moving away** from the motion detector and **speeding up** at a steady rate.



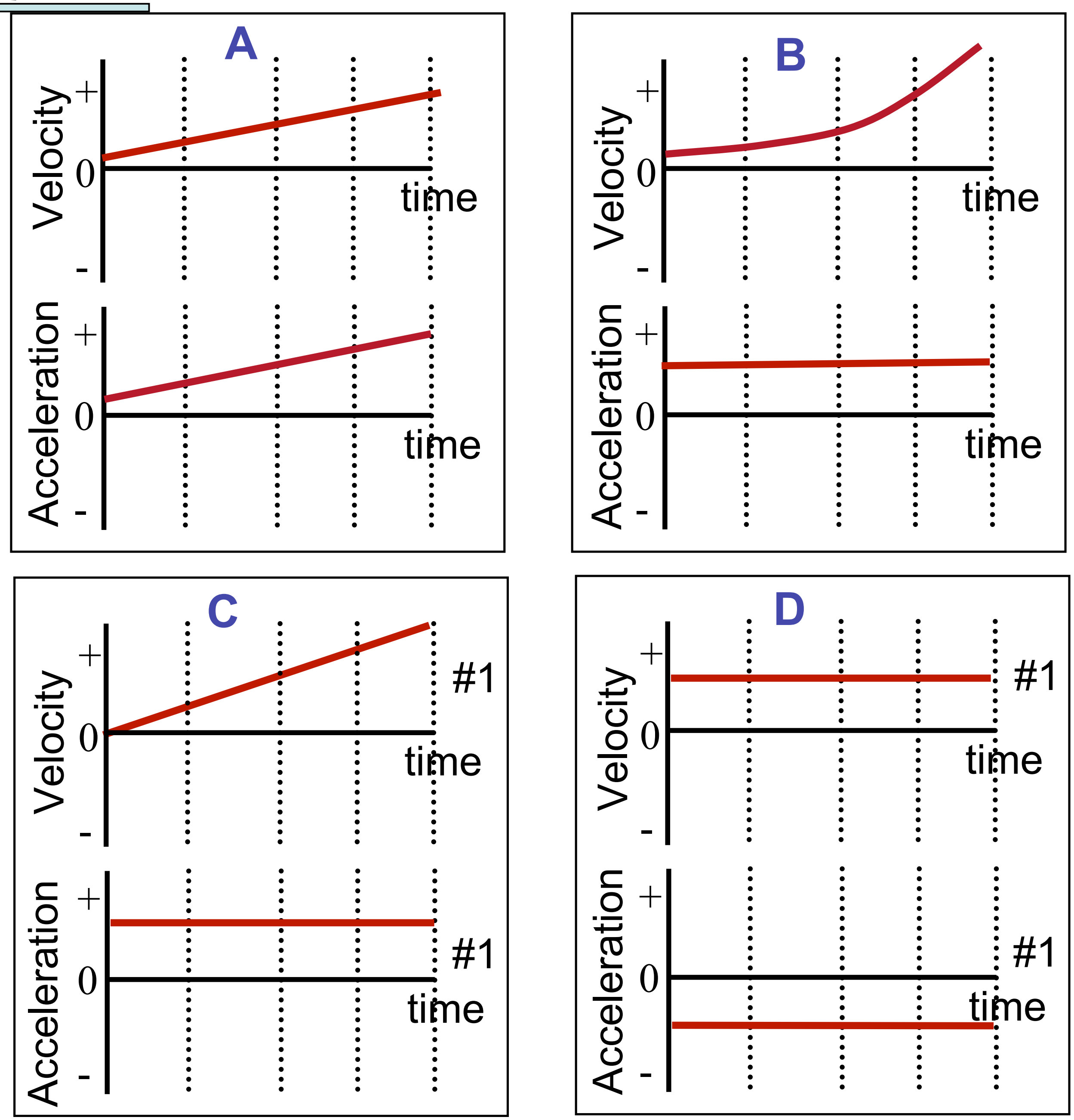






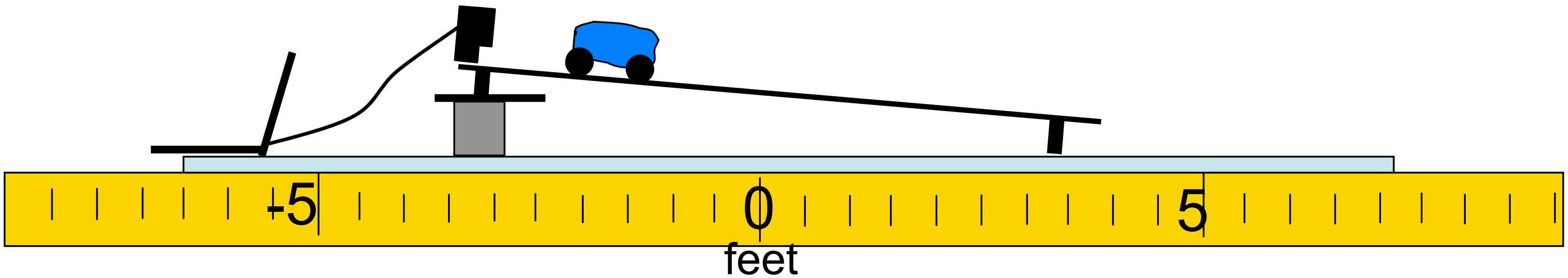
ACCELERATION

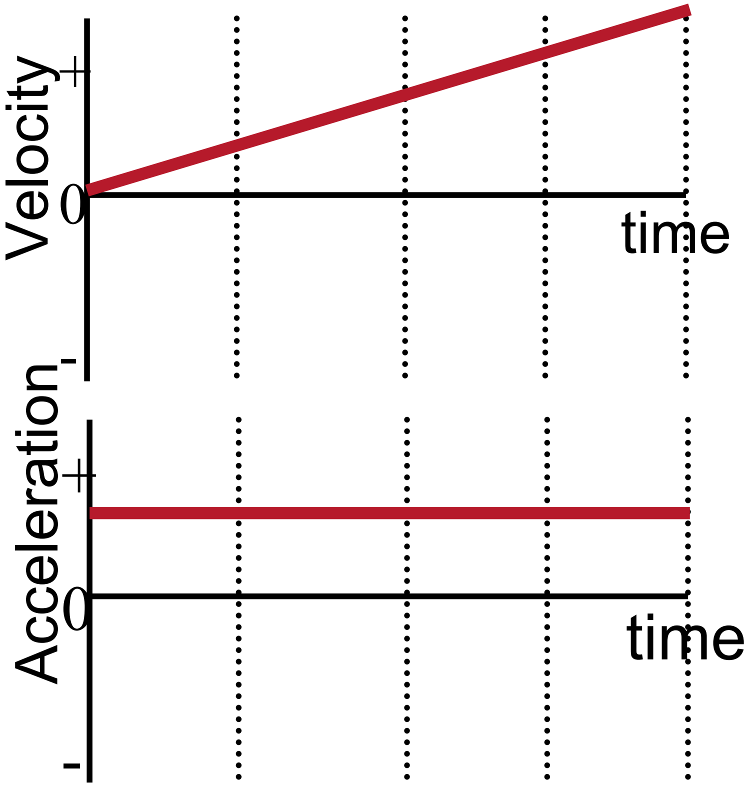
Sketch
Velocity vs. time graph
and **Acceleration vs. time** graphs
for the car **moving away** from the motion detector
and **speeding up** at a steady rate.



ACCELERATION

Sketch **Velocity vs. time** graph and **Acceleration vs. time** graphs for the car **moving away** from the motion detector and **speeding up** at a steady rate.



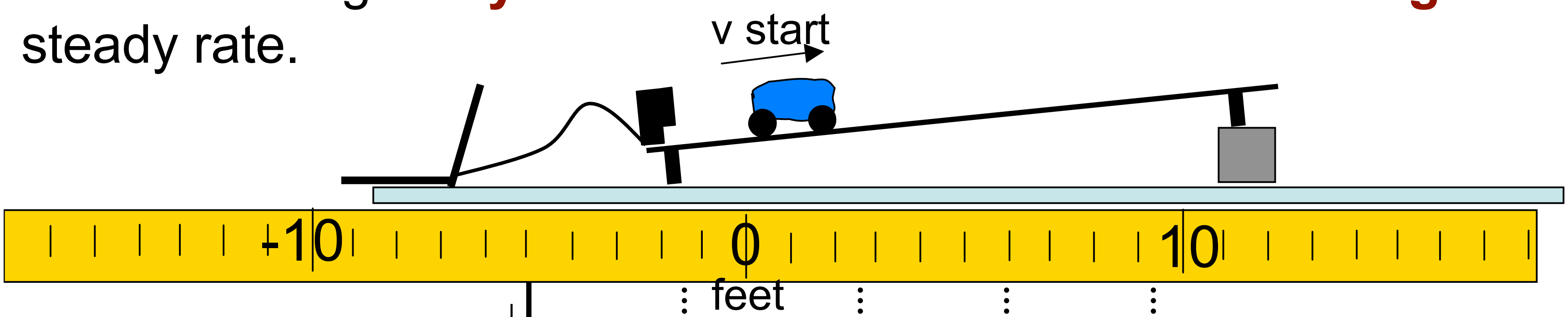


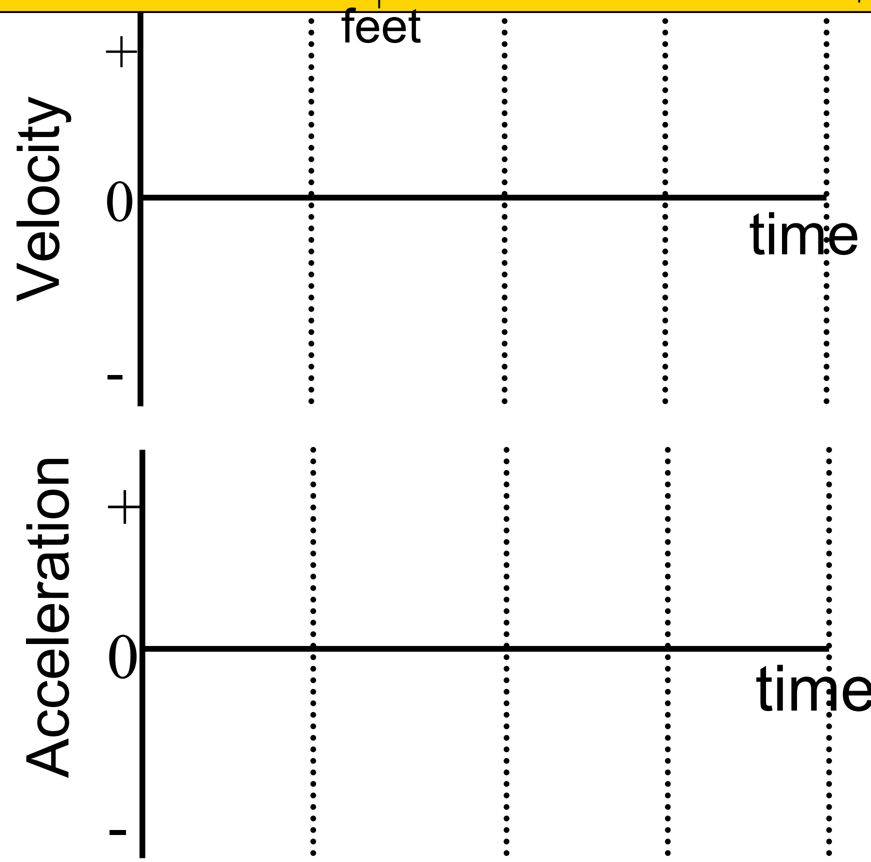
ANSWER IS C

$$\text{Acceleration} = \frac{\text{change in velocity}}{\text{time elapsed}}$$

ACCELERATION

Sketch **Velocity vs. time** graph and **Acceleration vs. time** graphs for the car moving **away from** the motion detector and **slowing down** at a steady rate.

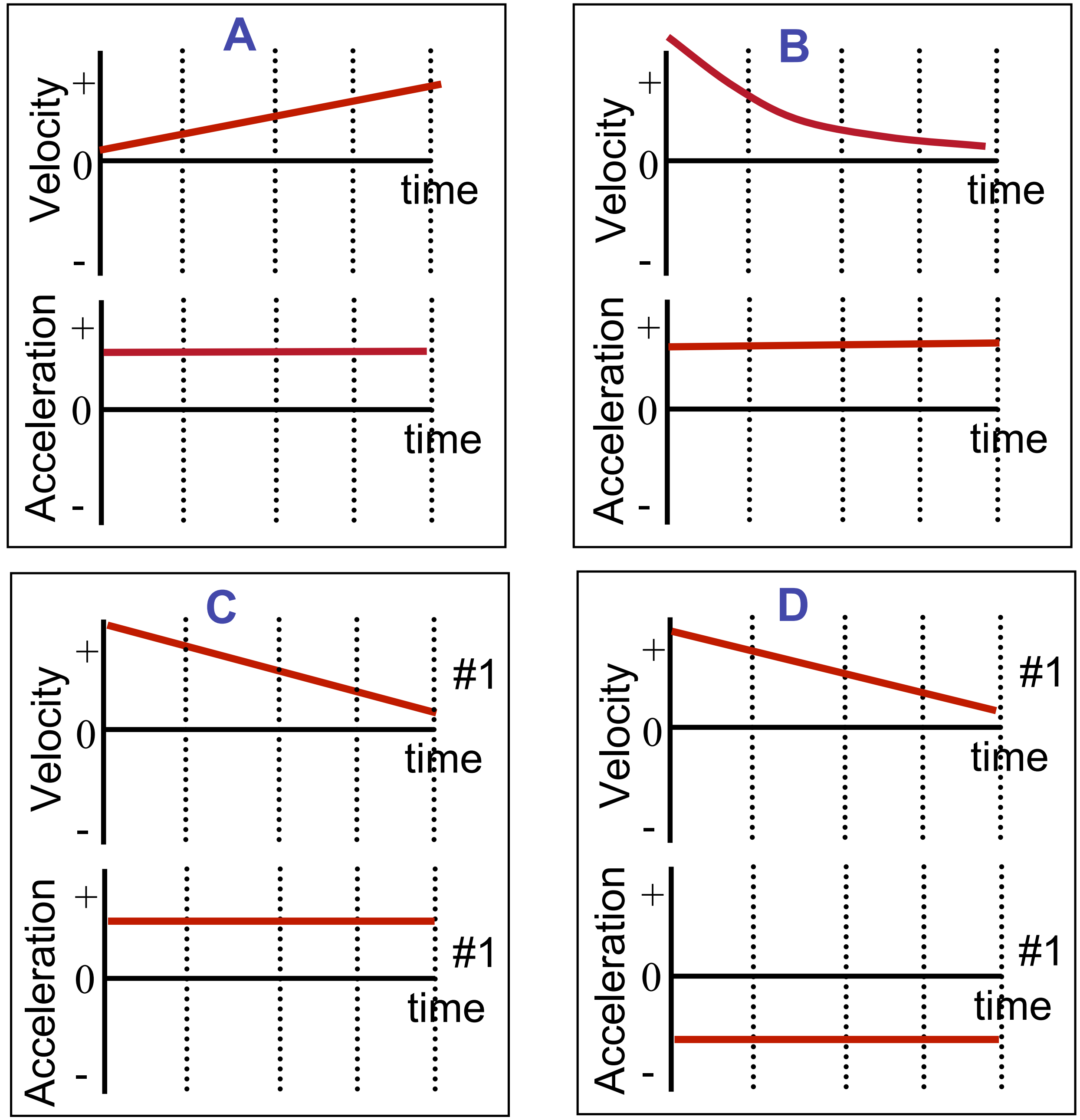




ACCELERATION

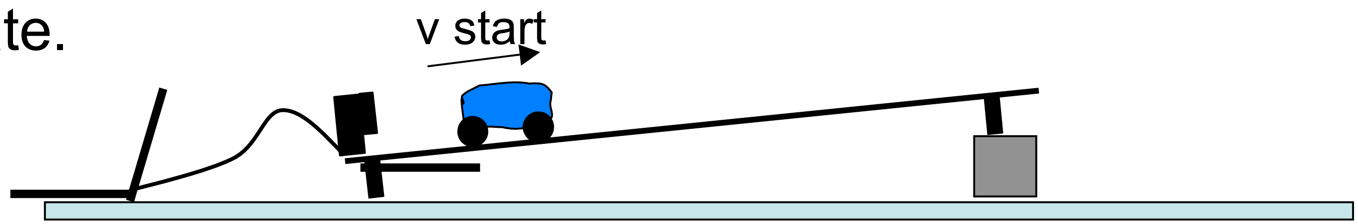
Sketch
Velocity vs. time graph
and **Acceleration vs. time** graphs
for the car **moving away** from the motion detector and **slowing down** at a steady rate.

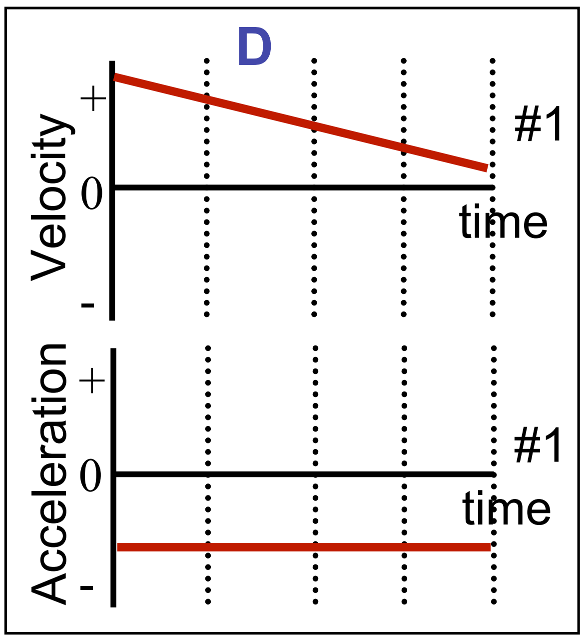
E: none of the above



ACCELERATION

Sketch **Velocity vs. time** graph and **Acceleration vs. time** graphs for the car moving **away from** the motion detector and **slowing down** at a steady rate.



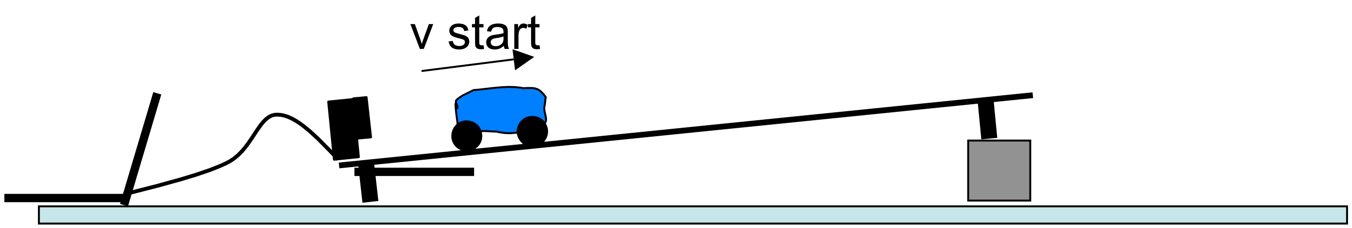


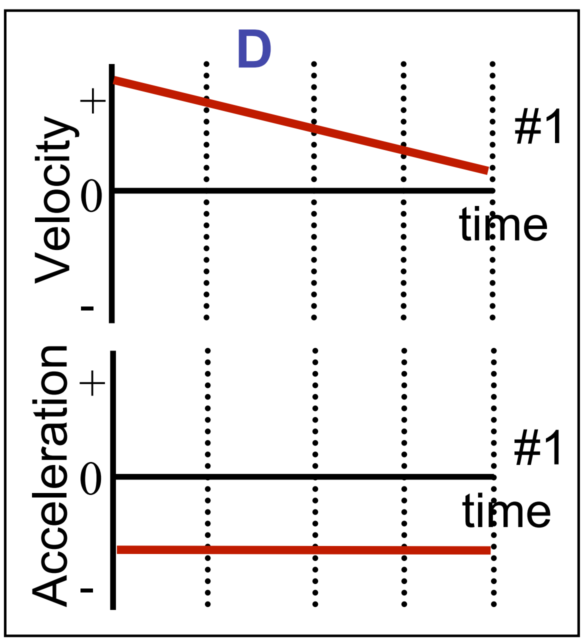
ANSWER IS D

$$\text{Acceleration} = \frac{\text{change in velocity}}{\text{time elapsed}}$$

ACCELERATION

Which way is the cart's weight pushing the cart?





a) Left
b) Right
c) Out of the screen

Newtons second law:
Force = mass x acceleration

- Car accelerates downhill because there is a (gravitational) force pulling it downhill (despite the fact that it's moving uphill).
- Acceleration and force are in the same direction (velocity and force do not have to be in the same direction)
- The mass tells us the ratio

Answer is A, Left (same as acceleration)

From acceleration and velocity we can find the position

Acceleration (a) = $\frac{\text{change in velocity}}{\text{time elapsed}}$

Velocity = Starting velocity + change in velocity

Velocity = Starting velocity + acceleration x time

$v_{final} = v_{initial} + at$

Position = initial position + (average velocity) x time

$v_{average} = (v_{initial} + v_{final})/2 = (v_{initial} + v_{initial} + at)/2 = v_{initial} + (1/2)\,at$

$x = x_{initial} + v_{average}\,t = x_{initial} + (v_{initial} + (1/2)\,at)\,t$

$x = x_{initial} + v_{initial}\,t + (1/2)\,at^2$

To succeed in this course you have to be able to do this algebra.

Summary

- Acceleration is
  - Change in velocity divided by elapsed time
  - Slope on velocity versus time graph
- Position is related to acceleration
- Acceleration given by force (F = ma)

- Position, Velocity, Acceleration are all VECTORS

(beware of the signs!)