Summer 2019

Lecture 3

KINEMATICS

17 June 2019

Chapter 2 homework

- Problems & Exercises
- **Homework**:.
- *Due: 6-24-19*

Chapter 2: outline

Chapter Outline

•2.1 Displacement

Define position, displacement, distance, and distance traveled.

•2.2 Vectors, Scalars, and Coordinate Systems

Define and distinguish between scalar and.

•2.3 Time, Velocity, and Speed

Explain the relationships between instantaneous velocity,

•2.4 Acceleration

Define and distinguish between instantaneous acceleration, average

•2.5 Motion Equations for Constant Acceleration in One Dimension

Calculate displacement.

•2.6 Problem-Solving Basics for One-Dimensional Kinematics

Apply problem-solving steps

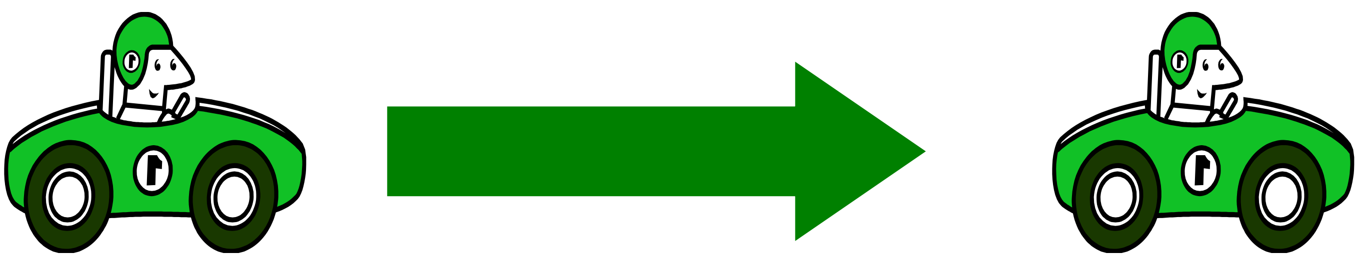
•2.8 Graphical Analysis of One-Dimensional Motion

Describe a straight-line graph in terms of its slope and y-intercept.

Distance

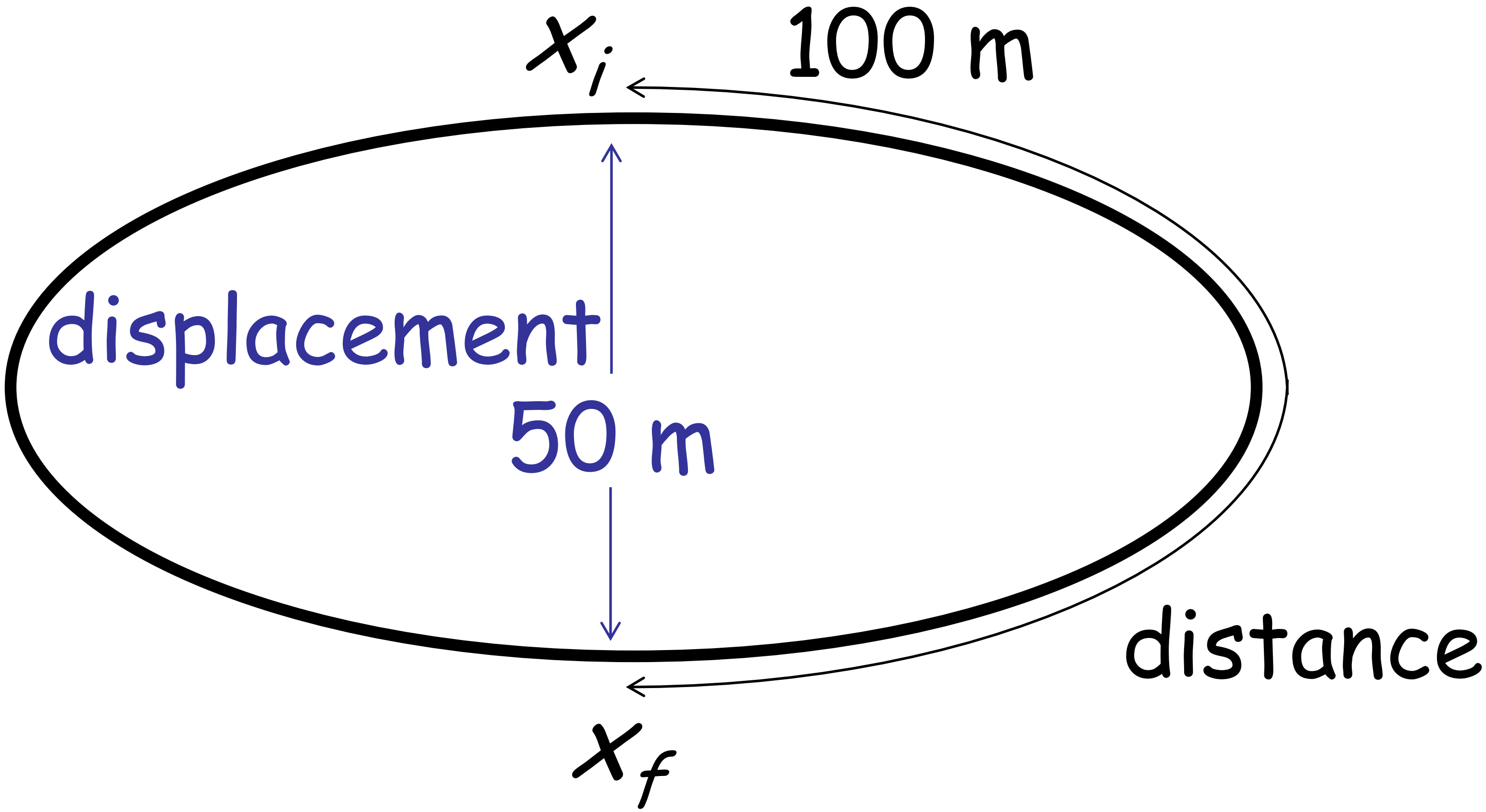
When an object moves, it goes from point A to point B – that is the DISTANCE it traveled. (SI unit is the meter)

Distance is how much ground an object has covered during its motion.



A B

Distance vs Displacement

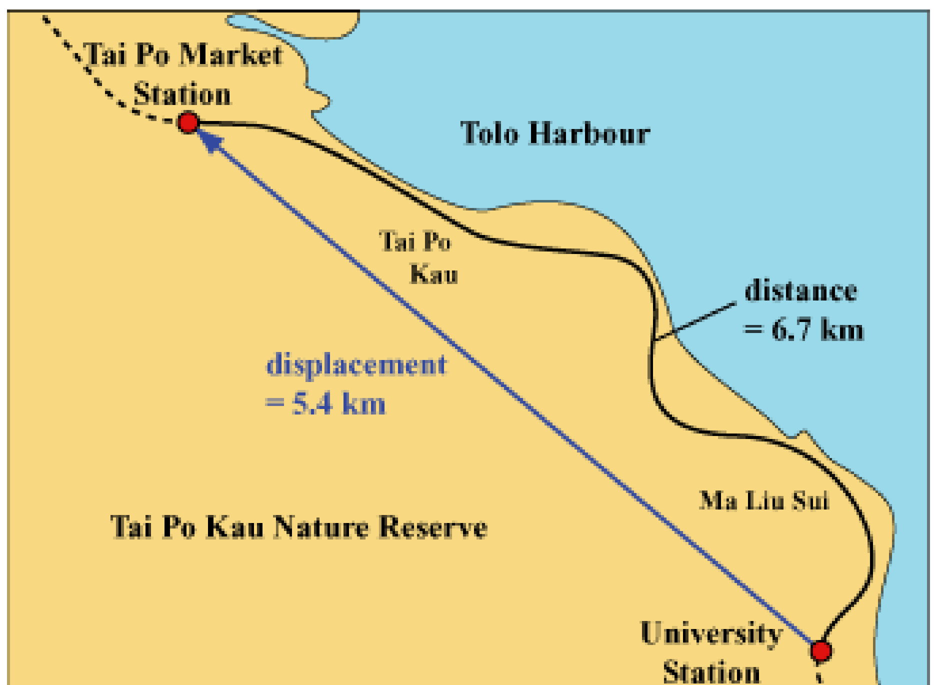


Displacement is the *change in position* of an object:

$\Delta x = x_f - x_i$, where *Δx is displacement, X_f is the final position and the x_i is the initial position*

Displacement vs. Distance

- Distance is the length of the path that an object travels
- Displacement is the change in position of an object (shortest distance)



Describing Motion

- What we want to know?
  - How fast is moving ? speeding up? slowing down? turning? direction?

- Speed: How fast and object is moving

Quantitative descriptions involve numbers, and numbers require units. This speedometer gives speed in mph and km/h.

Ex: 22 mph

Speedometer

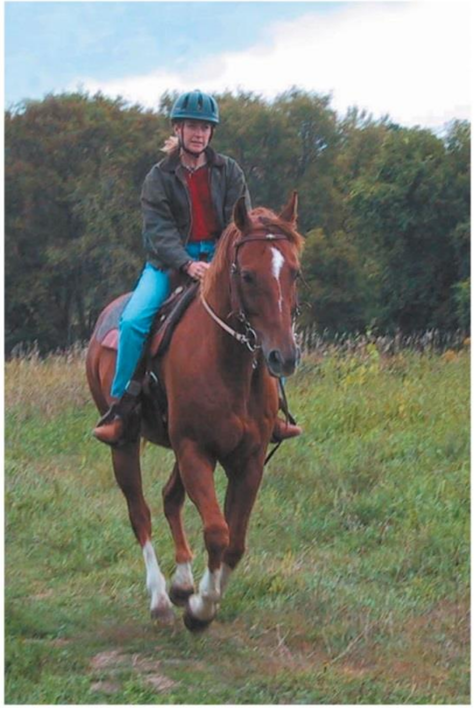
Speed and Velocity

- **Speed** is described as the distance covered per amount of travel time.

$$\text{Speed} = \frac{\text{distance covered}}{\text{travel time}}$$

Units are : **m/s**

$$S = \frac{d}{t}$$



Speed

Calculating Speed: If you know the <u>**distance**</u> an object travels in a certain amount of time, you can calculate the <u>**speed**</u> of the object.

What is instantaneous speed?

<u>**Instantaneous speed**</u> is the speed of an object at a certain time.

Speed = Distance/time

Average speed = Total distance/Total time

Velocity

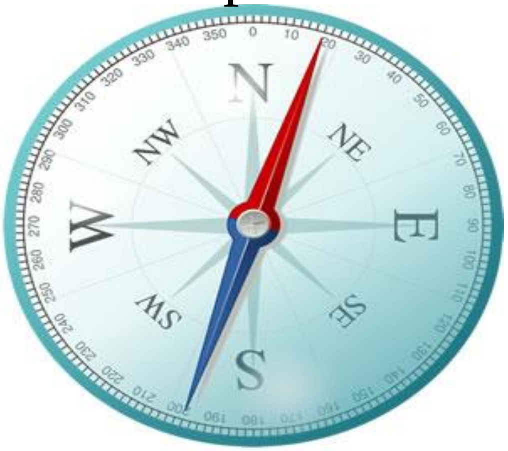
Velocity: How fast it is moving and direction of motion

$$V = \frac{d}{t}$$ **Velocity**

Ex: 30 mph, east

Speedometer

Compass



Speed v. Velocity

1. How are speed and velocity similar?

They both measure how **fast** something is moving

2. How are speed and velocity different?

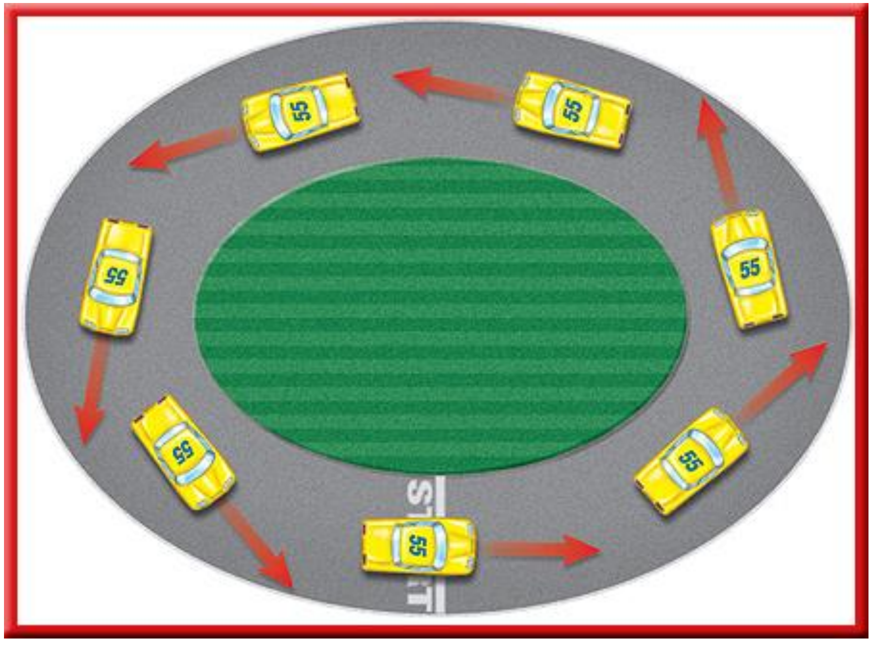
Velocity includes the **direction** of motion and speed does not (the car is moving 5mph East)

2.1

Velocity

Because velocity depends on **direction** as well as **speed**, the velocity of an object can change even if the speed of the object remains constant.

The speed of this car might be constant, but its velocity is not constant because the direction of motion is always changing.



Speed and Velocity
CHECK YOUR NEIGHBOR

The average speed in driving 30 km in 1 hour is the same average speed as driving

A. 30 km in one-half hour.
B. 30 km in two hours.
C. 60 km in one-half hour.
D. 60 km in two hours.

Acceleration

Acceleration is the rate at which velocity changes with time. The change in velocity may be in magnitude, in direction, or both.

Equation for acceleration:

$$\text{Acceleration} = \frac{\text{change of velocity}}{\text{time interval}}$$

Calculating Acceleration

Acceleration = $\dfrac{\text{Change in velocity}}{\text{Total time}}$

So…Acceleration = $\dfrac{\text{(Final velocity – Initial velocity)}}{\text{Time}}$

$$a = \frac{v_f - v_i}{t}$$

acceleration

v_f: final velocity

v_i: initial velocity

t: time

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

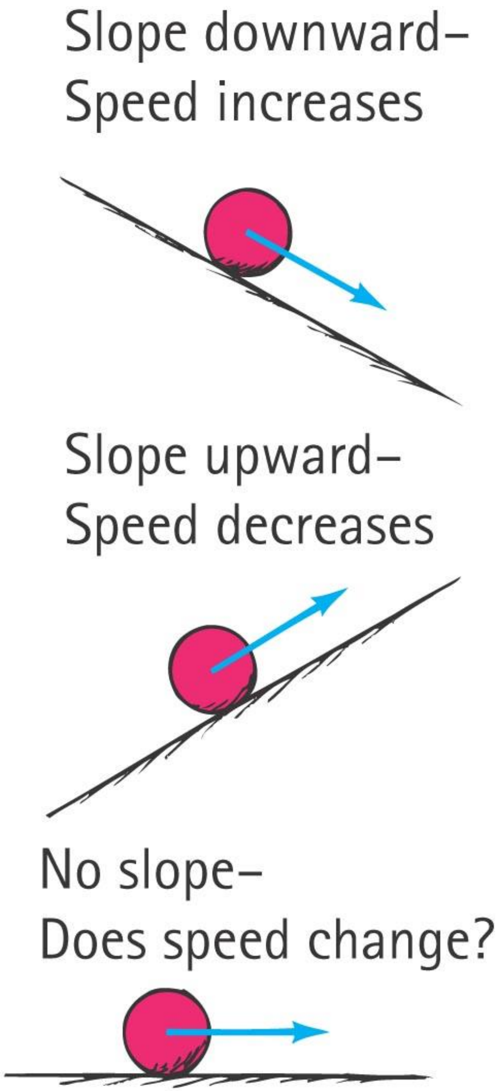
Units of Acceleration

$$\text{Acceleration} = \frac{\text{change of velocity}}{\text{time interval}}$$

The SI unit for acceleration is m/s^2.

Acceleration

Galileo first formulated the concept of acceleration in his experiments with inclined planes.



Acceleration

- Acceleration: A change in velocity. Or acceleration measures how fast velocity changes

- How an object accelerates?

-Speeding up

-Slowing down

-Changing direction

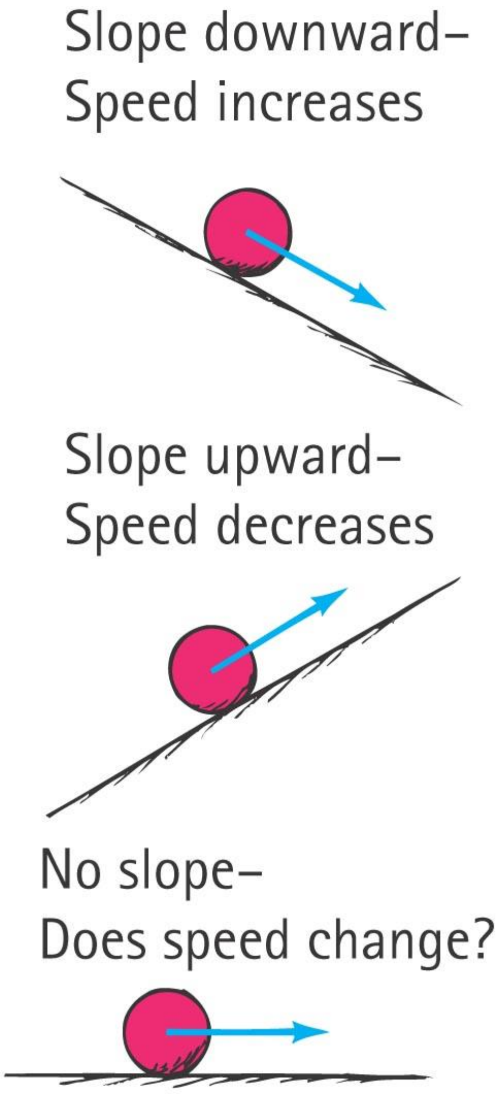
Calculations

- A roller coaster starts down a hill at 10 m/s. Three seconds later, its speed is 32 m/s. What is the roller coaster's acceleration?

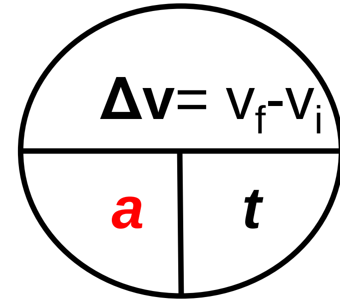
GIVEN:	WORK:
v_i = 10 m/s t = 3 s v_f = 32 m/s a = ? $a = \frac{\Delta v}{t}$	

Acceleration

Galileo first formulated the concept of acceleration in his experiments with inclined planes.



Calculating Acceleration



Acceleration = $\dfrac{\text{Change in velocity}}{\text{Total time}}$

So…Acceleration = $\dfrac{\text{(Final speed – Initial speed)}}{\text{Time}}$

$$a = \frac{v_f - v_i}{t}$$

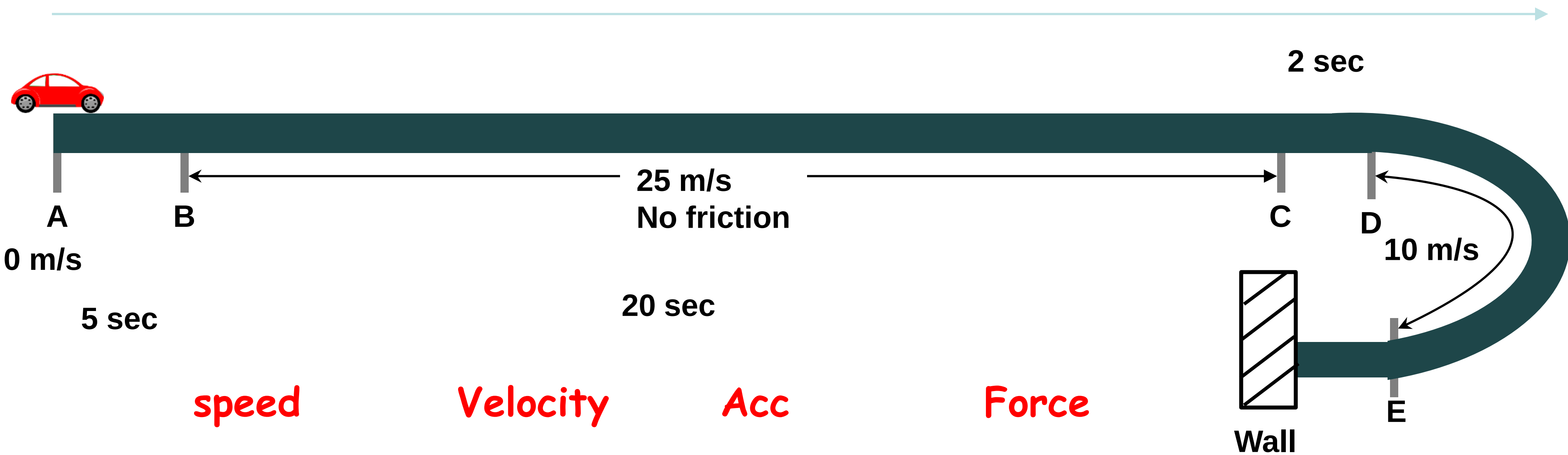
acceleration

v_f: final velocity

v_i: initial velocity

t: time

Motion



	speed	Velocity	Acc	Force
At A				
A→ B				
B→ C				
C→ D				
D→ E				

$F_{car\ on\ wall} =$

Practice Problems

A bicycle takes 8.0 seconds to accelerate at a constant rate from rest to a velocity of 4.0 m/s.

What is the acceleration? What is the velocity after 4 sec?

a=change in velocity/ time

$a=(v_f-v_i)/t$

$= (4.0\ m/s - 0.0 m/s) / 8.0\ s$

$= 0.50\ m/s^2$

At t= 4 sec

v = a x (time)

$= (0.50\ m/s^2) \times 4.0\ s$

$= 2.0\ m/s$

Describing Motion

If there is:

NO speeding, NO slowing, and no turning

Constant speed

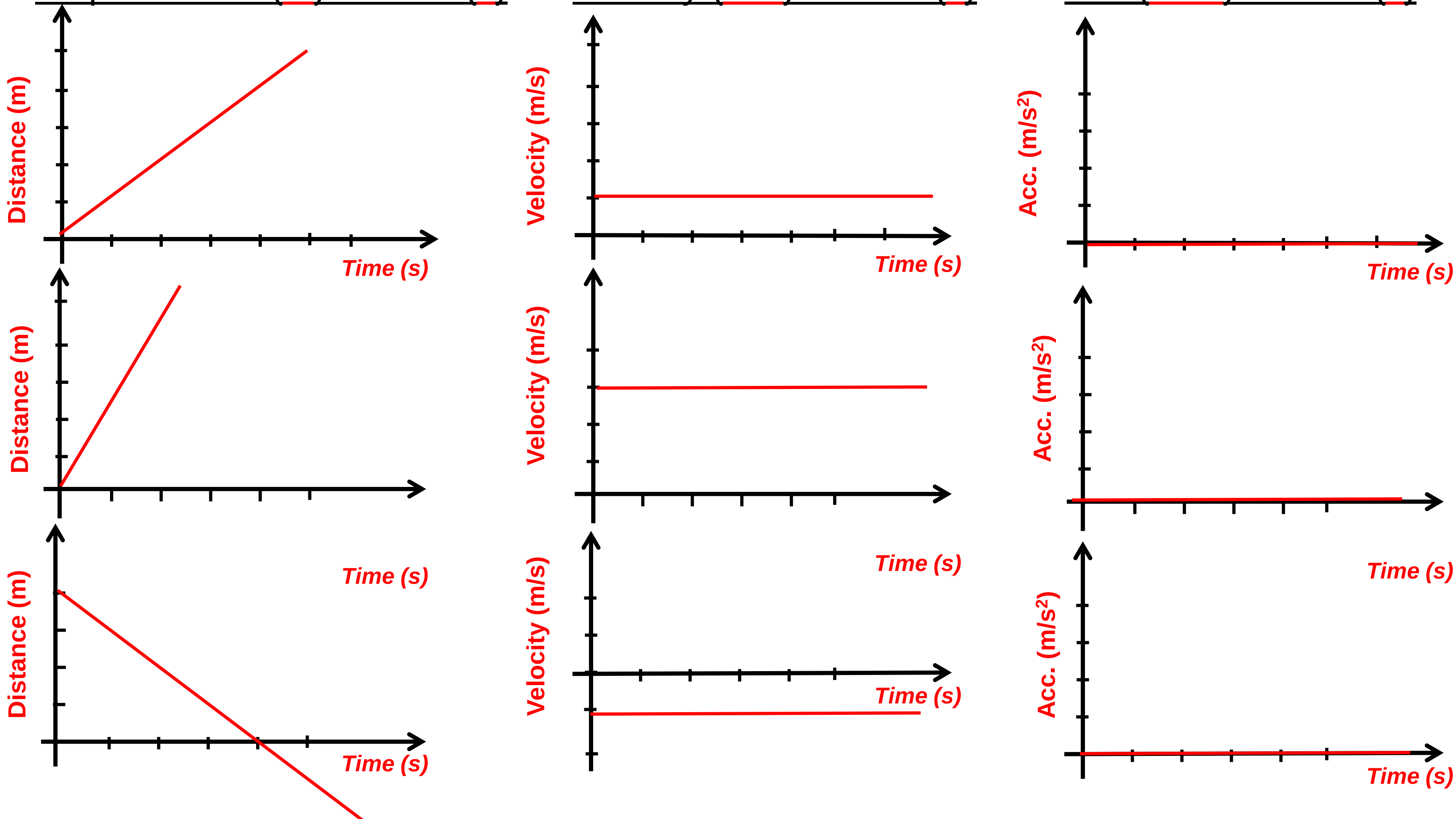
Constant direction

Constant velocity

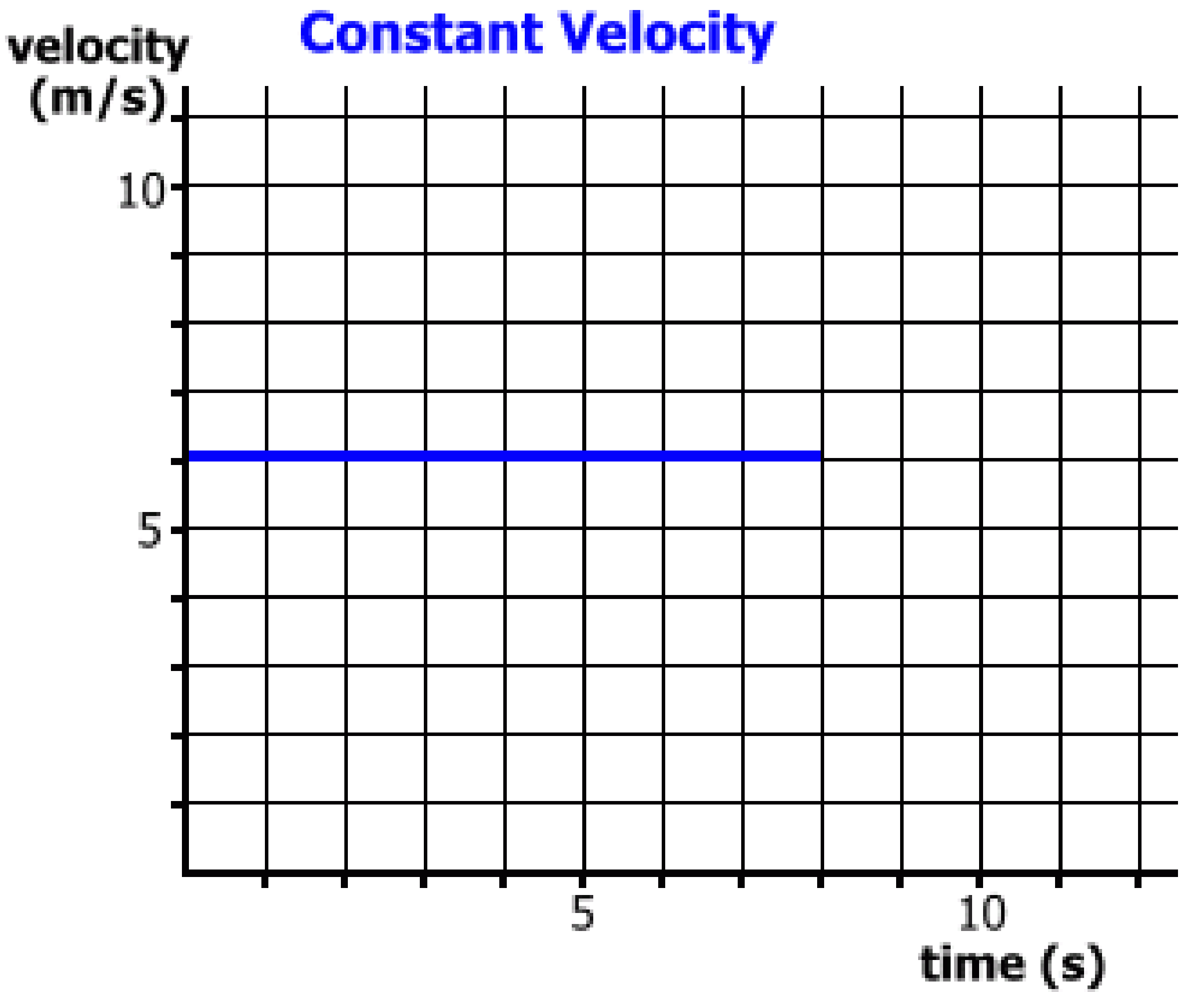
Inertia wants constant velocity (*no interference*)

Describing Motion— Displacement & Velocity

Displacement (m) *vs* time (s) | Velocity (m/s) *vs* time (s) | Acc (m/s^2) *vs* time (s)

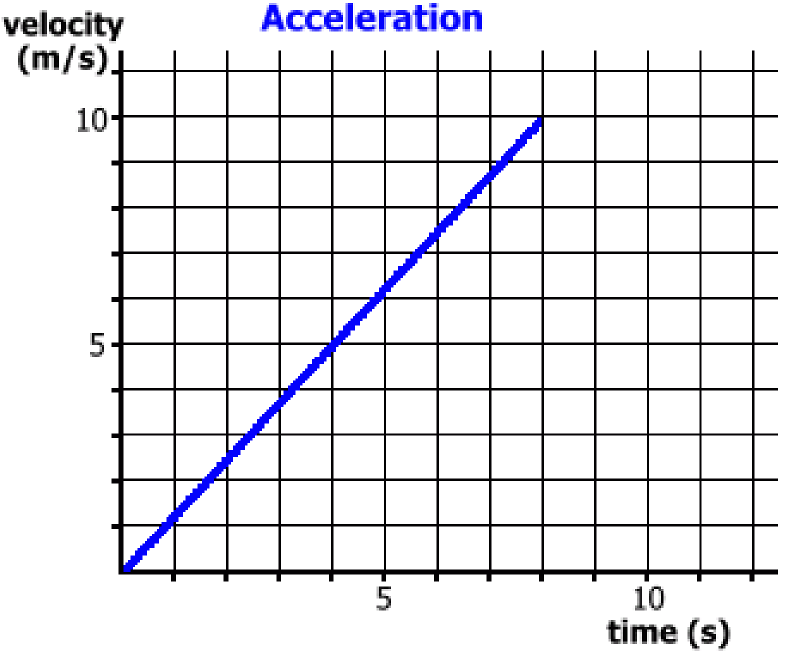


To begin, let's look at constant velocity. In the first graph below you can see the result of an object moving at a constant velocity of 6 m/s for a time interval of 8 seconds.

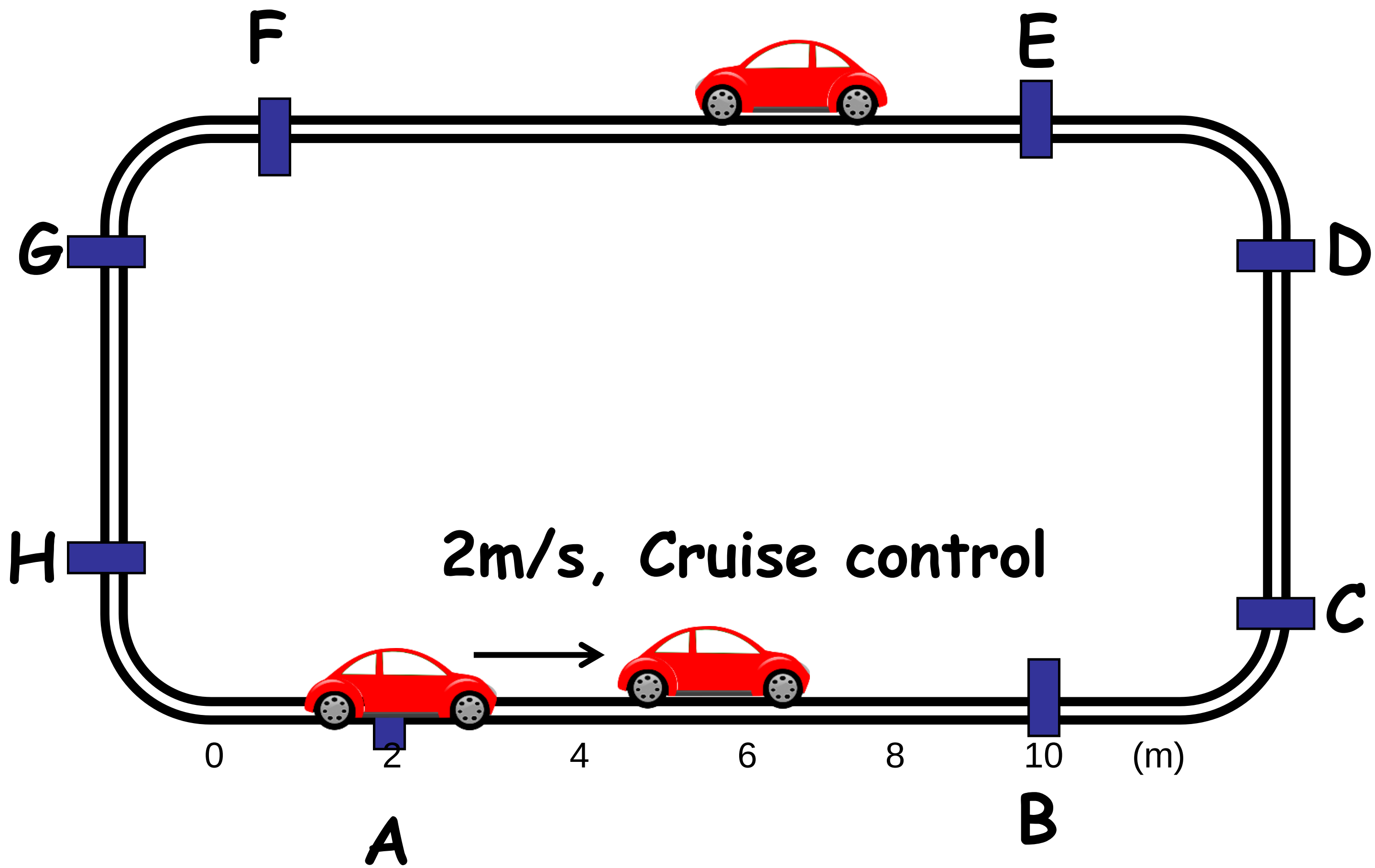


Changing Velocity

- Now let's look at an example where there *is* acceleration. We'll begin with the case where an object starts from rest.



Motion



at A

A->B

E->F