

# More Chapter 2

## 1 – D Motion

Review from last class:

Scalars: distance, speed (only had magnitude)

Vectors: displacement, velocity, acceleration  
(magnitude and direction)

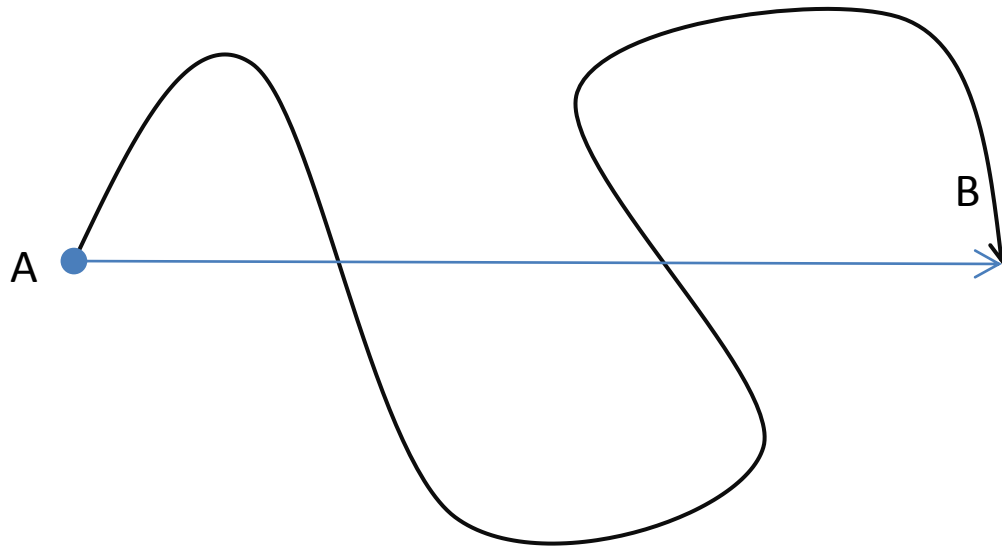
Average Velocity depends on the displacement, so we only have to consider the initial and final position.

$$\mathbf{V}_{\text{ave}} = (\mathbf{x}_f - \mathbf{x}_i) / (t_f - t_i)$$

For motion involving constant velocity this can be rewritten as:  $\mathbf{x} = \mathbf{x}_0 + \mathbf{v} * t$

The position,  $x$ , is described by a function of time.

If two objects leave point A at the same time and arrive at point B simultaneously, following different paths, they will have the same average velocity but different average speeds.



# Equations for 1-d motion with constant acceleration

$$\mathbf{v} = \mathbf{v}_0 + \mathbf{a} t$$

$$\Delta \mathbf{x} = \mathbf{x}_0 + \mathbf{v}_0 t + \frac{1}{2} \mathbf{a} t^2$$

Special case when  $\mathbf{a} = 0$

$$\mathbf{x} = \mathbf{x}_0 + \mathbf{v} t$$

$$\mathbf{v}^2 = \mathbf{v}_0^2 + 2 \mathbf{a} \Delta \mathbf{x}$$

# Problems

Two cars are stopped at a light. When the light goes green, Car A begins traveling with constant velocity 10 m/s East. Car B moves East with a velocity of 5 m/s but accelerates at a rate of 5 m/s<sup>2</sup>. After what time interval will the two cars be side-by-side? How far did they travel?

- Car A  $v = 10 \text{ m/s}$
- Car B  $v_0 = 5 \text{ m/s}, \quad a = 5 \text{ m/s}^2$

When the cars are side-by-side they will have equal displacements.

Car A  $x_a = x_0 + v_a t$

Car B  $x_b = x_0 + v_{0b} t + \frac{1}{2} a_b t^2$

Set these two equations equal to each other and solve.

$$(10 \text{ m/s}) t = (5 \text{ m/s}) t + \frac{1}{2} (5 \text{ m/s}) t^2$$

This is a quadratic equation.

$$\text{Rewrite as } ax^2 + bx + c = 0$$

$$\Rightarrow 2.5t^2 - 5t = 0$$

Can solve by using  $t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Gives two answers. One of them is zero. So the second solution is the answer that we want.

$$t = 2 \text{ seconds}$$

How far did the cars travel?

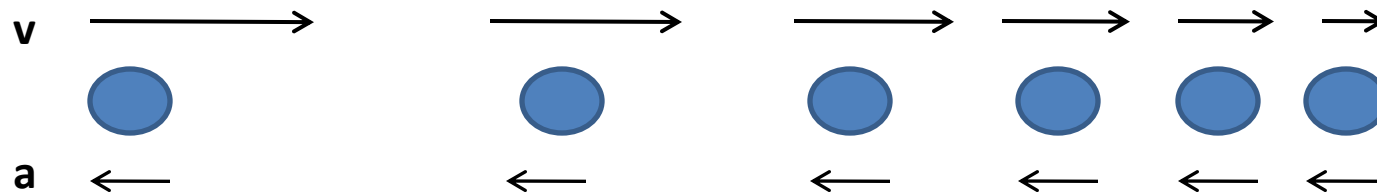
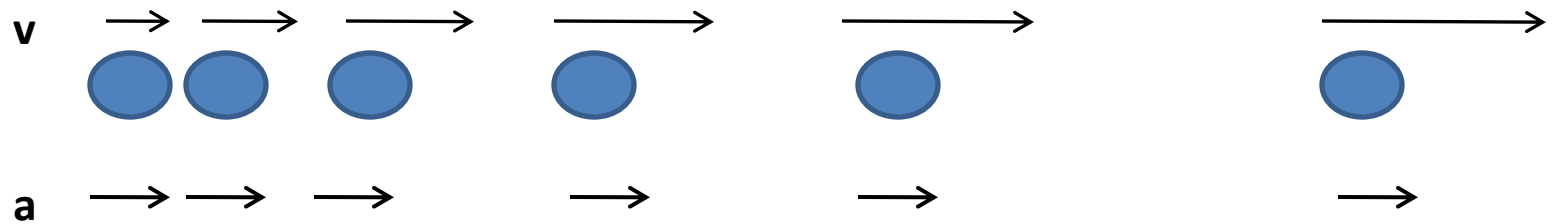
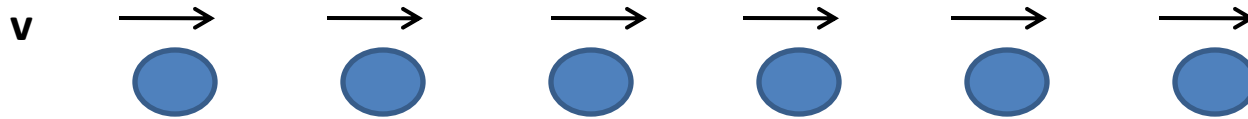
Plug in 2 seconds for the displacement equation for either car.

$$\text{A: } x_a = v_0 t + \frac{1}{2} a t^2 = (10 \text{ m/s})(2 \text{ s}) = 20 \text{ m}$$

$$\text{B: } x_b = v_0 t + \frac{1}{2} a t^2 = (5 \text{ m/s})(2 \text{ s}) + \frac{1}{2} (5 \text{ m/s})(2 \text{ s})^2 = 20 \text{ m}$$

# Motion diagram

(similar to that on page 34)



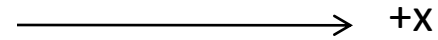
Do quick quizzes on 2.4 and 2.5

# Conceptual Question 9

Consider the following combinations of signs and values for the velocity and acceleration of a particle with respect to a 1-D x-axis.

	<u>Velocity</u>	<u>Acceleration</u>
a	+	+
b	+	-
c	+	0
d	-	+
e	-	-
f	-	0
g	0	+
h	0	-

Choosing motion to the right to be positive:



	<b>v</b>	<b>a</b>	<b>motion</b>
a	+	+	moving to right, speeding up
b	+	-	moving right, slowing down
c	+	0	moving right, constant velocity
d	-	+	moving to left, slowing down
e	-	-	moving left, speeding up
f	-	0	moving left, constant velocity
g	0	+	turning around to the right
h	0	-	turning around to the left

## P. 25

Steam catapult launches jet, giving it a speed of 175 mi/hr in 2.5 seconds. a) Find the average acceleration of the jet. b) Assuming that the acceleration is constant, find the distance the plane moves.

a) convert 175 mi/hr to m/s

then use  $v = v_0 + a t$

to solve for the acceleration

b) use  $\Delta x = v_0 t + \frac{1}{2} a t^2$

## P. 37

Train traveling down a straight track at 20 m/s when the brakes are hit, resulting in an acceleration of  $-1.0 \text{ m/s}^2$  as long as the train is moving. How far does the train move during a 40 s time interval starting at the instant the brakes are applied?

## P. 37

Don't use 40 seconds and  $\Delta x = v_0 t + \frac{1}{2} a t^2$   
 $\Delta x = (20 \text{ m/s})(40 \text{ s}) + \frac{1}{2} (-1 \text{ m/s}^2)(40 \text{ s})^2 = 0 \text{ m}$

Find out how long the train needs to stop.

$$t = \Delta v/a = \frac{0 \text{ m/s} - 20 \text{ m/s}}{-1.0 \text{ m/s}^2} = 20 \text{ seconds.}$$

Only needs 20 seconds.

Now do  $\Delta x = v_0 t + \frac{1}{2} a t^2$

$$\Delta x = (20 \text{ m/s})(20 \text{ s}) + \frac{1}{2} (-1 \text{ m/s}^2)(20 \text{ s})^2 = 200 \text{ m}$$