Review

- Length, mass, time – fundamental quantities
- Meter, kilogram and second – SI units
- Dimensional analysis – can be used to obtain dimensions of constants
- Significant figures – how reliable a result is based upon the measured data

Position

The position of a particle (or an object that moves like a particle) is its point on an axis relative to some origin,

This ball starts at x=1 m
The ball moves to x=-2 m
The ball stops at x=3 m

Displacement and total distance traveled

**Displacement of a particle**: Its change in position:

\[ \Delta x = x_f - x_i \]

- \( x_f \): final position
- \( x_i \): initial position

**Displacement** is a **vector**: It has both magnitude and direction.

Total distance traveled is a **scalar**: It has just a magnitude

A baseball player hits a home run, and travels around the bases 360 ft. What is the baseball player’s net displacement?

- A) 360 ft
- B) -360 ft
- C) 0 ft
- D) 90 ft
Velocity and Speed

**Average Velocity of a particle:**

\[ v = \frac{\Delta x}{\Delta t} \]

- \( \Delta x \): displacement of particle
- \( \Delta t \): total time during which displacement occurred.

**Average speed of a particle:**

Average speed = \( \frac{\text{total distance}}{\text{total time}} \)

**Velocity** is a vector: It has both magnitude and direction.

**Speed** is a scalar: It has just a magnitude.

The position of a car is measured every 10 seconds.

- Point 1: 30m (t=0)
- Point 2: 52m (t=10s)
- Point 3: 38m (t=20s)
- Point 4: 0m (t=30s)
- Point 5: -37m (t=40s)
- Point 6: -53m (t=50s)

What is the displacement between Point 1 and Point 6?

A) -53m
B) 105m
C) -83m
D) 127m

What is the average velocity between Point 1 and Point 6?

A) -0.9m/s
B) 1.06 m/s
C) 1.66 m/s
D) -1.66m/s

Instantaneous velocity and speed

\[ v = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt} \]

- Instantaneous velocity is the derivative of x with respect to t, \( \frac{dx}{dt} \).
- Instantaneous velocity is the slope of a position-time graph.

The instantaneous speed (scalar) is defined as the magnitude of its velocity (vector).
A particle moves along the x-axis according to the expression: \( x = -4t + 2t^2 \). What is the instantaneous velocity of the particle at \( t=2.5\text{s} \)?

A) 2.5 m/s  
B) 1 m/s  
C) 6 m/s  
D) 14 m/s

Dimensional Analysis: revisited

Dimensional Analysis can also be used to determine forms of equations.

Suppose we know that energy has units of mass times \((\text{length})^2/\text{(time)}^2\). Suppose we want to know the form of the energy which results from motion. How can we express energy in terms of velocity and mass?

A) \( E \propto v^2/m \)  
B) \( E \propto m/v^2 \)  
C) \( E \propto m\nu \)  
D) \( E \propto mv^2 \)

You cannot obtain the constant in front from dimensional analysis!

Practice Problem

How far does the runner below travel in 10 seconds?
Practice Problem: Solution

How far does the runner below travel in 10 seconds?

Practice Problem II

Suppose a particle’s position is given by: 
\[ x = 3t - 4t^2 + 60\sin(4t \pi/180) \]. What is its position and velocity, at \( t = 0, 1, 2, \) and 30 secs? (to 4 sig figs and assume radians)

Solution