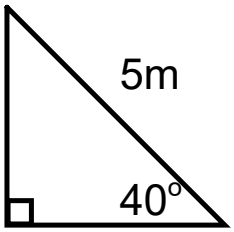
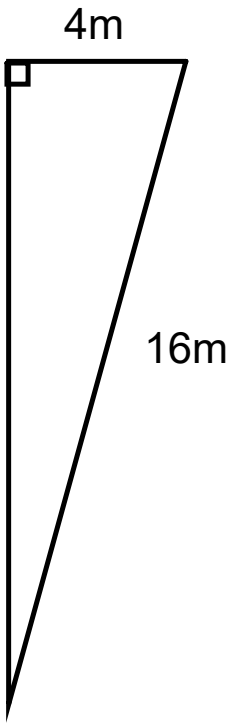
Warm Up

Using primary trig ratios, find the missing sides and angles (Soh Cah Toa).





Unit Conversion

Convert 20 km to m :

Convert 2 hrs to sec :

Convert 40km/hrs to m/sec :

Sep 11-10:56 AM

Unit 1 - Motion

Section 1.1 - Distance, Position and Displacement

Kinematics is the study of MOTION.

Motion is the CHANGE in an object's location as measured by a particular observer.

Why is the OBSERVER important with respect to discussing the MOTION of an object?

Consider the speed at which I am traveling as I sit here on this desk.

How fast am I travelling?

With respect to you, the observers in this room, 0 m/s, with respect to an observer on the SUN, 29,800m/s.

Sep 4-8:59 PM

When discussing the Motion of an object we need to have WORDS that reflect exactly what we are trying to communicate. There are numerous words in the English language that have multiple meanings in our day to day lives. We are going to focus four words in particular for this unit.

Distance vs **Displacement**

and

Speed vs **Velocity**

To distinguish the differences between these sets of words, we need to define what is a SCALAR and a VECTOR quantity.

A **SCALAR** is quantity that only has a magnitude (size);

5m/s or 40km.

A **VECTOR** is a quantity that has BOTH magnitude and direction;

25m/s due North or 60km N30^{o}E

Direction can be described using compass directions, bearings, left/right, up/down, positive/negative, etc.

Sep 4-9:12 PM

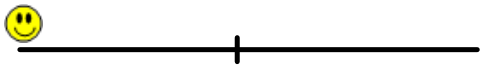
Distance vs Displacement

Distance (d) is the total length of the path traveled by an object in motion. (SCALAR)

Displacement (Δd) is the NET change in position of an object in motion, usually over a specific interval. (VECTOR)

Position is the Displacement from a fixed reference point.

Example: The length of this room is 10m and we will say the center is our zero reference mark.



If I walk from left end to the right end:

Distance = Displacement = Position =

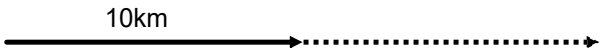
If I walk from right end to the center:

Distance = Displacement = Position =

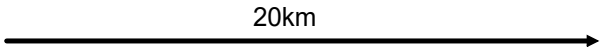
Sep 4-9:25 PM

To visually illustrate a VECTOR concept like DISPLACEMENT we use a "Vector Scale Diagram".

A Vector Scale Diagram is essentially an ARROW with a specific scale; a larger arrow means a larger vector magnitude, the direction of the arrow is the direction of the Vector.



10km due East

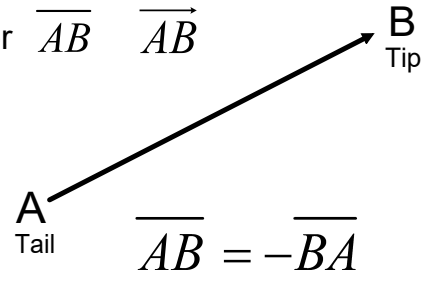


20km due East

The beginning of the Vector is called the TAIL and the end of the Vector is called the TIP; vectors are generally traveled from Tail to Tip.

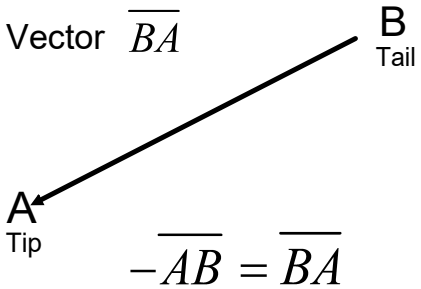
(line or arrow)

Vector $\overline{AB}$ $\overrightarrow{AB}$



$\overline{AB} = -\overline{BA}$

Vector $\overline{BA}$



$-\overline{AB} = \overline{BA}$

Note: a Negative sign implies we are traveling in the opposite given direction.

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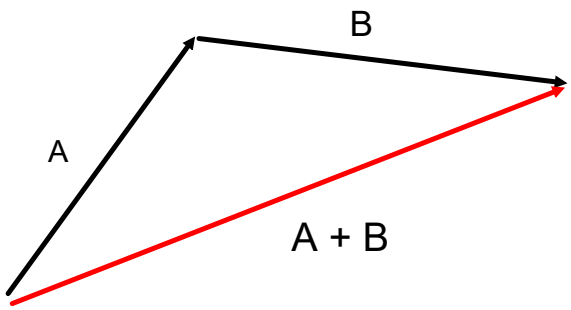
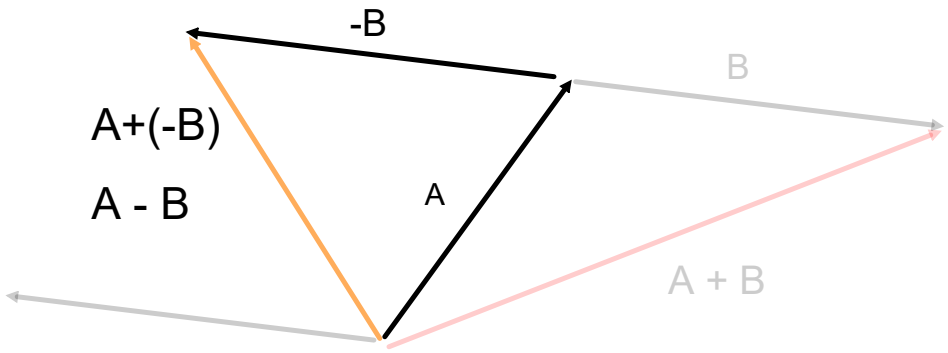
Vector Addition (tip to tail)



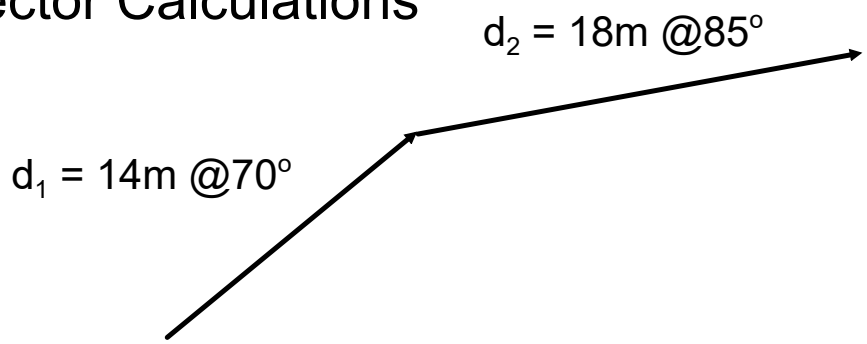
Vector Subtraction

(Difference between two vectors)



Feb 2-11:29 AM

Vector Calculations



Component Method

Cosine Law Method

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Average Speed and Velocity

Average Speed (v_{av}) is the **total distance travelled** divided by the total time taken to travel that distance.

$$v_{ave} = \frac{\Delta d}{\Delta t}$$

$$v_{ave} = \frac{d_2 - d_1}{t_2 - t_1}$$

Δd is the change in distance, Δt is the change in time

Note: scalar quantity (speed) since there are no arrows above the terms

Example:

A dog travels 54m in 9 seconds. What is the dogs average speed?

Average Velocity $(\vec{v}_{ave})$ is the total **displacement, or change in position**, divided by the total time for that ***displacement.***

$$\vec{v}_{ave} = \frac{\Delta \vec{d}}{\Delta \vec{t}}$$

$$\vec{v}_{ave} = \frac{\vec{d}_2 - \vec{d}_1}{\vec{t}_2 - \vec{t}_1}$$

$\Delta \vec{d}$ is the change in distance, $\Delta \vec{t}$ is the change in time

Note: vector quantity (velocity) since there are arrows above the terms

A **position–time graph** is a graph describing the motion of an object, with position on the vertical axis and time on the horizontal axis.

Rates of Change (Slope)

Average speed and average velocity are examples of rates of change— an important concept in science that describes how quickly a quantity is changing.

Velocity is the rate of change of position, which means that the more rapidly an object's position is changing, the greater is the magnitude of its velocity.

Motion with Uniform and Non-uniform Velocity

Motion with **uniform or constant velocity** is motion at a constant speed in a straight line. It is the simplest type of motion that an object can undergo, except for being at rest. Note that both requirements (constant speed and straight line) must be met for an object's velocity to be uniform.

In contrast, motion with **non-uniform velocity** is motion that is not at a constant speed or ***not in a straight line***. Motion with non-uniform velocity may also be called accelerated motion.

Note: We will have (i) no acceleration, (ii) constant (average) acceleration, or (iii) different accelerations during clearly defined stages of a problem; we will NOT have accelerations that change during the motion (higher level mathematics required).

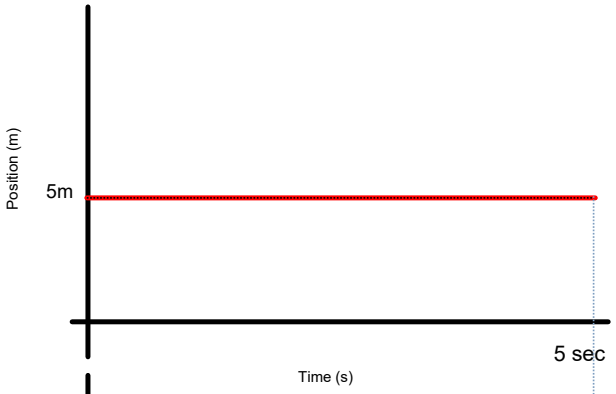
Sep 5-12:07 AM

Types of Motion

Position - Time Graphs

- Object starts 5 m from the reference point;

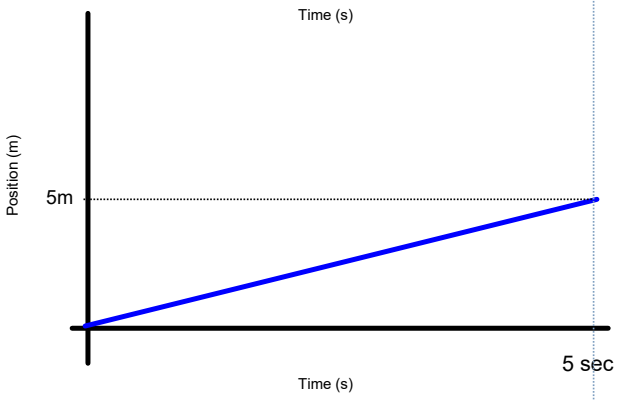
- position does not change over time, therefore object is NOT moving (rate of change of 0 m/s, the line has a slope of Zero)



- Object starts 0 m from the reference point;

- position **is** changing over time (increasing - moving AWAY from ref. pt.) in a linear or constant manner, therefore the object is moving at a constant velocity.

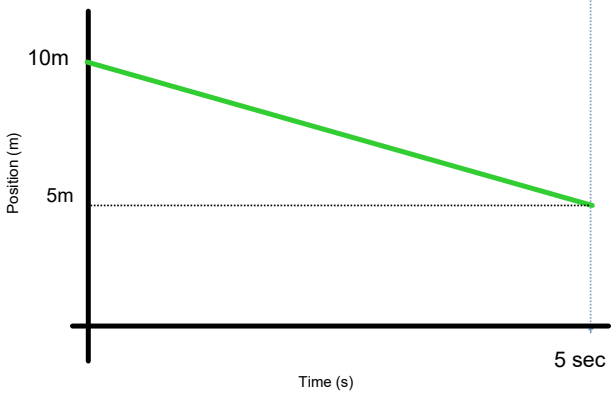
Vel = 5m / 5sec
Vel = 1m/s



- Object starts 10 m from the reference point;

- position **is** changing over time (decreasing - moving TOWARDS the ref. pt) in a linear or constant manner, therefore the object is moving at a constant velocity.

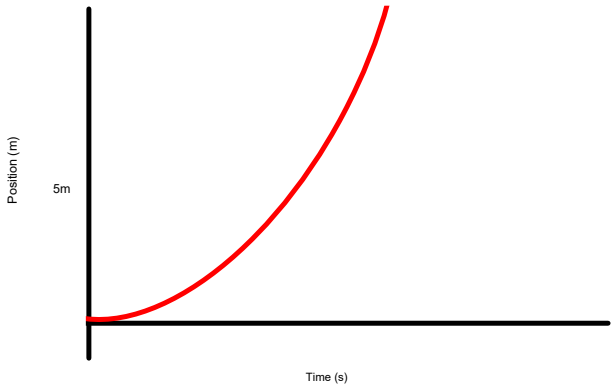
Vel = -5m / 5sec
Vel = -1 m/s



Sep 5-12:13 AM

Type of Motion - Non Uniform

- Object starts 0 m from the reference point;
- position is changing over time, therefore object is moving AWAY from the ref. pt
- graph is NOT linear, therefore the rate of change is NOT constant
- therefore NON uniform velocity,which means the object is accelerating

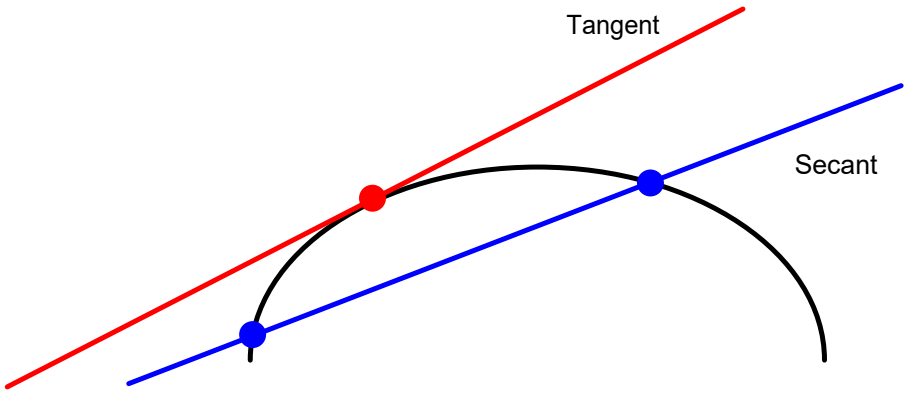


Accelerated Motion

Sep 11-11:01 AM

A SECANT line is a line that contacts a curve at TWO different points.

A TANGENT line is a line that contacts a curve at ONE point only.



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Average Velocity vs Instantaneous Velocity

Average Velocity is the change in position over a given period of time. As we will see, the larger the period of time used, the more varied our solutions will be. The average velocity is represented by a SECANT line.

$$v_{ave} = \frac{s_f - s_i}{\Delta t}$$ slope / gradient equation from grade 9

Instantaneous (v_{inst}) velocity is the change in position at a specific INSTANCE in time (as if the problem was suddenly frozen). The instantaneous velocity is represented by a TANGENT line.

The value of either the ARC (secant) or IRC (tangent) is determined by finding the Slope or gradient of the line.

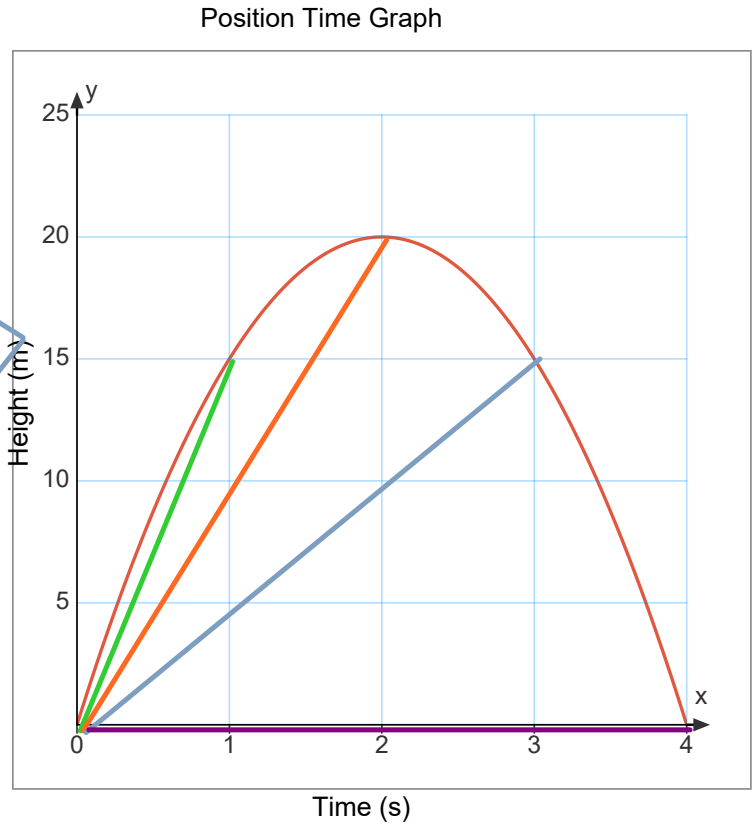
The instantaneous velocity will eventually utilize Calculus techniques, but we can always use the time tested tradition of DRAWING a tangent line on a graph and calculating the slope/gradient of the tangent line from the graph.

Sep 11-12:59 PM

Example: A water powered rocket is fired straight up and its height is given by, $s = -5t^2 + 20t$ where (s) is in metres and (t) is in seconds.

$$s = -5t^2 + 20t$$

t (s)	s (m)
0	0
1	15
2	20
3	15
4	0



What is the average velocity from 0 to 1 second? 15m/s

What is the average velocity from 0 to 2 seconds? 10m/s

What is the average velocity from 0 to 3 seconds? 5m/s

What is the average velocity from 0 to 4 seconds? 0m/s

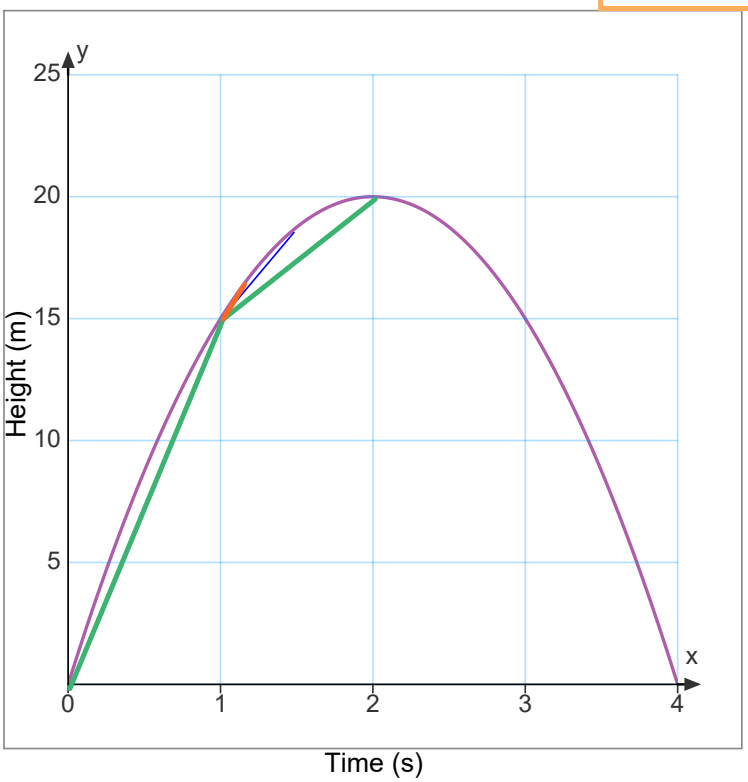
What factors should be considered when calculating the average velocity?

Sep 4-11:08 PM

Example: A water powered rocket is fired straight up and its height is given by, $s = -5t^2 + 20t$ where (s) is in metres and (t) is in seconds.

$$s = -5t^2 + 20t$$

t (s)	s (m)
0	0
1	15
1.01	15.0995
1.1	15.95
1.5	18.75
2	20



What is the average velocity from 0 sec to 1 second? 15m/s

What is the average velocity from 1 sec to 2 seconds? 5m/s

What is the average velocity from 1 sec to 1.5 seconds? 7.5m/s

What is the average velocity from 1 sec to 1.1 seconds? 9.5m/s

What is the average velocity from 1 sec to 1.01 seconds? 10m/s

Draw a tangent line. 10m/s

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Homework

Read Sec. 1.1

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Feb 2-11:06 AM