Warm Up - Unit Conversion

Convert 20 km to m :

Convert 2 hrs to sec :

Convert 40km/hrs to m/sec :

Sep 11-10:56 AM

Key Concepts
Part 1 - Motion in a Straight Line (One Dimension)

After completing this chapter you will be able to:

- explain how distance, position, and displacement are different
- explain how speed, velocity, and acceleration are different
- explain how vectors and scalars are different
- add and subtract vectors using scale diagrams and algebraic methods
- obtain motion information from position –time, velocity–time, and acceleration–time graphs
- solve uniform velocity and uniform acceleration problems using algebraic methods
- describe how the acceleration due to gravity affects the motion of objects close to the surface of Earth
- assess the impact on society and the environment of a technology that applies concepts related to kinematics

Sep 4-9:02 PM

Part 1 - Motion in a Straight Line

Section 1.2 - Average Speed and Velocity

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

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

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

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

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?

Example:

A sprinter is 8 m from the start line 1.8 seconds into the race. At 8.3 seconds, the sprinter is 72 m from the start line? What is the sprinter's average speed?

How fast would the sprinter run the 100 m dash?

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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.

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

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

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

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

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

Sep 5-12:07 AM

Example:

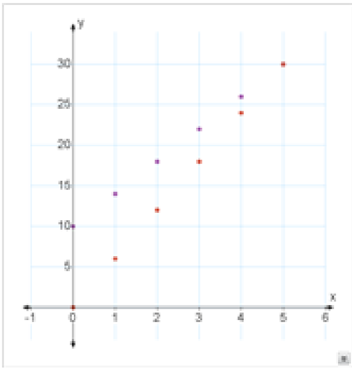
Two Soap Box racing cars (non motorized) are in a race down a hill. Car A has been given a 10m head start from Car B. Determine the average velocity of each car.

Car A

Time (s)	Position (m)
0	10
1	14
2	18
3	22
4	26
5	30

Car B

Time (s)	Position (m)
0	0
1	6
2	12
3	18
4	24
5	30



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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. (no acceleration)

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. (has acceleration)

Sep 5-12:04 AM

Table 1 Examples of Uniform and Non-uniform Velocity

Example	Uniform velocity	Non-uniform velocity	Explanation
A car travels down a straight highway at a steady 100 km/h.	✓		The car is travelling at a constant speed in a straight line.
A passenger on an amusement park ride travels in a circle at a constant speed of 1.2 m/s.		✓	The passenger is travelling at a constant speed but not in a straight line. She is travelling in a circle.
A parachutist jumps out of an aircraft.	✓ (after parachute opens)	✓ (before parachute opens)	Before he opens the parachute, the speed of the parachutist will increase due to gravity. Once the parachute is opened, his speed will become constant due to air resistance. He will then fall at a constant speed in the same direction (downwards).

An elevator rising in a building. Uniform velocity except at the beginning and end (start and stop).

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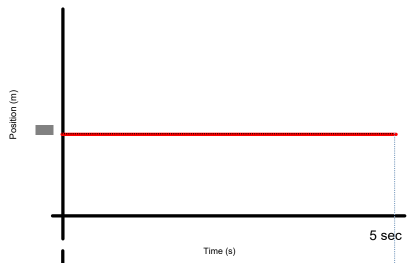
Types of Motion

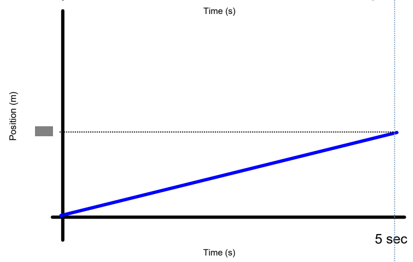
Position - Time Graphs

- 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)



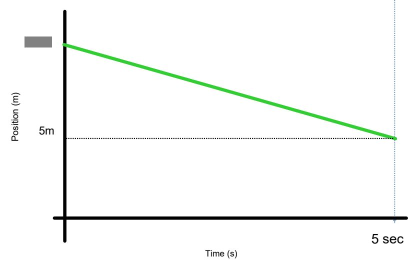
- Object starts 0 m from the reference point;
- position **is** changing over time (increasing - moving AWAY from ref. pt.) in a linear or constant manner, therefore the object is moving at a constraint velocity.

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 constraint velocity.

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



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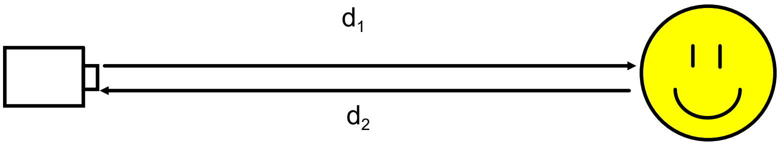
Motion Using a CBR - Demonstration

The CBR measures the distance between an object and itself by sending out a signal at a known velocity and measuring the time required for that signal to leave, reflect and return to the sensor.



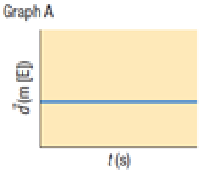
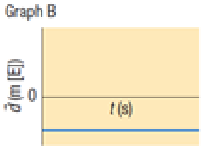
distance = speed x time

- if the speed of the signal is a constant value, and time is measured from the time it was generated till the time it is received, the calculator can determine the distance to the object by dividing the result by two

I will need a few volunteers please to move in front of the CBR.

Sep 11-10:46 AM

Table 2 Interpreting Position–Time Graphs

Position–time graph	Type of motion	Example
Graph A 	• graph is a horizontal straight line • the slope of a horizontal straight line is zero • the object has a velocity of zero • the object is ***at rest*** • the object is at a constant positive position relative to the reference position • the object is stationary at a location to the east of the reference position	
Graph B 	• graph is a horizontal straight line • the slope of a horizontal straight line is zero • the object has a velocity of zero • the object is ***at rest*** • the object is at a constant negative position relative to the reference position • the object is stationary at a location to the west of the reference position	

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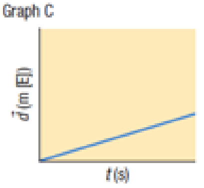
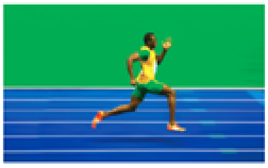
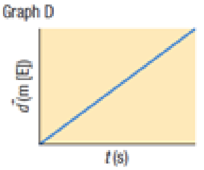
Graph C



- graph is a straight line with positive slope
- straight lines with non-zero slopes always represent ***constant*** **(non-zero)** ***velocity***
- from the *y*-axis, we know the object is moving eastward
- the object's velocity can be determined from the slope of the graph (rise divided by run)

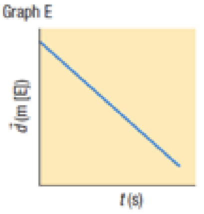


Graph D

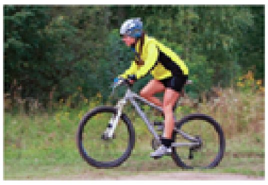


- graph is a straight line with positive slope, which represents ***constant*** **(positive)** ***velocity***
- from the *y*-axis, we know the object is moving eastward
- the object's velocity can be determined from the slope of the graph
- since graph D has the steeper slope, we can conclude that this object has a greater velocity than the object described by graph C

Graph E



- graph is a straight line, which represents ***constant velocity***
- the slope of the graph is negative
- the object's velocity can be determined from the slope of the graph
- note that the direction for position on the *y*-axis is given by a vector with direction [E]
- the negative slope indicates that the object is moving westward



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1.2 Questions

1. When you are solving a problem, how do you know if you are given a speed value or a velocity value? K/U
2. Define motion with uniform velocity in your own words. K/U C
3. Give two real-life examples each of motion with uniform velocity and motion with non-uniform velocity. A
4. Determine the velocity for the motion described by the graph in **Figure 4**. T/I

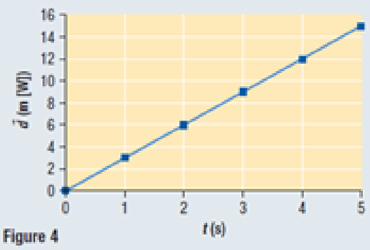

Figure 4

5. Copy and complete **Table 3** in your notebook. T/I

Table 3

$\vec{v}_{av}$	$\Delta\vec{d}$	Δt
	12.6 m [S]	16.3 s
2.0×10^3 m/s [E]	25 m [E]	
40 m/s [N]		0.25 s

6. What is the displacement of a horse that runs at a velocity of 3.2 m/s [S] for 12 s? T/I
7. How many seconds would it take a car travelling at 100.0 km/h to travel a distance of 16 m? T/I
8. What is the velocity (in metres per second) of a Canadian Forces CF-18 fighter jet that travels 8.864 km [S] in 0.297 min? T/I

Sep 4-10:39 PM