Homework Take-Up

6. A subway train travels at an average velocity of 22.3 km/h [W]. How long will it take for the subway train to undergo a displacement of 241 m [W]?

\[ \vec{U}_{av} = 22.3 \frac{\text{km}}{\text{h}} \text{ [W]} \]

\[ = 22.3 \frac{\text{km}}{\text{h}} \left( \frac{1000 \text{m}}{1 \text{km}} \right) \left( \frac{1 \text{h}}{3600 \text{s}} \right) \text{ [W]} \]

\[ = 6.194 \frac{\text{m}}{\text{s}} \text{ [W]} \]

\[ \Delta d = 241 \text{m [W]} \]

\[ \Delta t = ? \]

\[ \vec{v} = \frac{\Delta d}{\Delta t} \]

\[ \Delta t = \frac{\Delta d}{\vec{v}} \]

\[ = \frac{241 \text{m [W]}}{6.194 \frac{\text{m}}{\text{s} [W]}} \]

\[ = 38.9 \text{ s} \]

\[ \therefore \text{It would take about } 38.9 \text{ s}. \]
4. A dog is practicing for her agility competition. She leaves her trainer and runs 80 m due west to pick up a ball. She then carries the ball 27 m due east and drops it in a bucket. The first motion takes 8 s and the second motion takes 4 s.

(a) What is the dog's total distance?
(b) What is the dog's total displacement?
(c) What is the dog's final position with respect to her starting point?
(d) What is the dog's average speed?
(e) What is the dog's average velocity?

\[ \Delta t_1 = 8 \text{ s} \]
\[ \Delta d_1 + \Delta d_2 \]
\[ \Delta t_2 = 4 \text{ s} \]
\[ = 80 \text{ m} + 27 \text{ m} \]
\[ = 107 \text{ m} \]

\[ \Delta x = 80 \text{ m [w] + 27 m [e]} \]
\[ = 80 \text{ m [w] - 27 m [w]} \]
\[ = 53 \text{ m [w]} \]

\[ \text{e) } \vec{v}_{av} = \frac{\Delta d_1 + \Delta d_2}{\Delta t_1 + \Delta t_2} \]
\[ = \frac{80 \text{ m [w] + 27 m [e]}}{8 \text{ s} + 4 \text{ s}} \]
\[ = \frac{53 \text{ m [w]}}{12 \text{ s}} \]
\[ \approx 4 \frac{\text{m}}{\text{s}} \text{ [w]} \]

\[ \text{d) } \vec{v}_{av} = \frac{\Delta d}{\Delta t} \]
\[ = \frac{80 \text{ m} + 27 \text{ m}}{8 \text{ s} + 4 \text{ s}} \]
\[ \approx 9 \frac{\text{m}}{\text{s}} \]
For this lesson you need to know/recall:
- Position, Distance, Displacement
- Speed, Velocity
- Slope of a line formula (Grade 9 math)
- Graphs

Goals for this lesson:
- Be able to determine average speed, instantaneous speed from position time graphs
- Be able to determine average velocity and instantaneous velocity from displacement time graphs
- Introduce acceleration
- Prepare for lab next week
Slope

- You can use position vs. time graphs to quickly compare the speeds of different objects.

A steeper line on a position vs. time graph means a faster speed.
Let's Play ----> http://davidwees.com/graphgame/
Speed is the slope of a distance-time graph and velocity is the slope of a displacement-time graph.

**Rule:** When calculating the slope of a graphed line, never use the actual data points. Most data points have some error. Points taken from the line of best fit usually have less error because the line represents the average of several trials, i.e., the trend of the data.
Uniform Motion Questions:

1. When are you the farthest distance from home? oh, 4.2h, 6.3h
2. When are you at home? 3h
3. Calculate the speed of each of the five parts of the trip.
4. Calculate the average speed of the trip. 
\[ v = \frac{\Delta d}{\Delta t} \]
\[ = \frac{11\text{km}}{7\text{h}} \]
5. 1.6 km/h
6. Determine the average velocity of the trip.
7. Determine the average velocity from 3 h to 7 h. 
\[ \frac{11\text{km} - 1.6\text{km}}{7\text{h} - 3\text{h}} \]
\[ = \frac{9.4\text{km}}{4\text{h}} \]
8. 2.35 km/h

Circle the segments on the graph when you are moving away from home.

9. When are you moving north?
10. When are you stopped?

5. \[ \overrightarrow{\Delta d} = 1.0\text{km} \text{ [N]} \]

6. \[ \overrightarrow{v} = \frac{\overrightarrow{\Delta d}}{\Delta t} \]
\[ = \frac{1.0\text{km} \text{ [N]}}{7.0h} \]
\[ = 0.14 \text{ km/h} \text{ [N]} \]
Non-Uniform Motion

Position (km) [N of home]

1  2  3  4  5  6  7

-4 -3 -2 -1 0 1 2 3 4

time (h)
Non-Uniform Motion Questions:

1. How long do you spend south of home?
2. State your approximate position at the start of the trip.
3. When are you at rest?
4. When is your displacement in the south direction?
5. Determine the average velocity from 2 h to 7 h.
6. Determine the instantaneous velocity at 2 h.
7. Determine the instantaneous velocity at 7 h.
To calculate the speed or velocity from a graph, a **complete** slope formula must be used. The calculation should not appear on your graph.

**Average Speed:**
Determined from **position time graph** using two points on the line of best fit or from a **secant line** for non-uniform motion. Direction is not considered.

**Instantaneous Speed:**
Determined from position time graph using one point and forming a **tangent** line. Direction is not considered.

**Examples**

**Easy - Constant Speed - Uniform Motion**

![Graph showing uniform motion](image1)

**Average Speed:**

**Instantaneous Speed:**

**Harder - Non-Uniform Motion**

![Graph showing non-uniform motion](image2)

**Average Speed:**

**Instantaneous Speed:**
Average Velocity: Determined from displacement time graph using two points on the line of best fit or from a secant line for non-uniform motion. Direction is considered.

Instantaneous Velocity: Determined from displacement time graph using one point and forming a tangent line. Direction is considered.

Example

Displacement vs. time

From the graph, \( t_1 = 5.00 \text{s} \), \( \vec{d}_1 = 27 \text{ m [E]} \), \( t_2 = 20.0 \text{ s} \) and \( \vec{d}_2 = 15 \text{ m [E]} \).