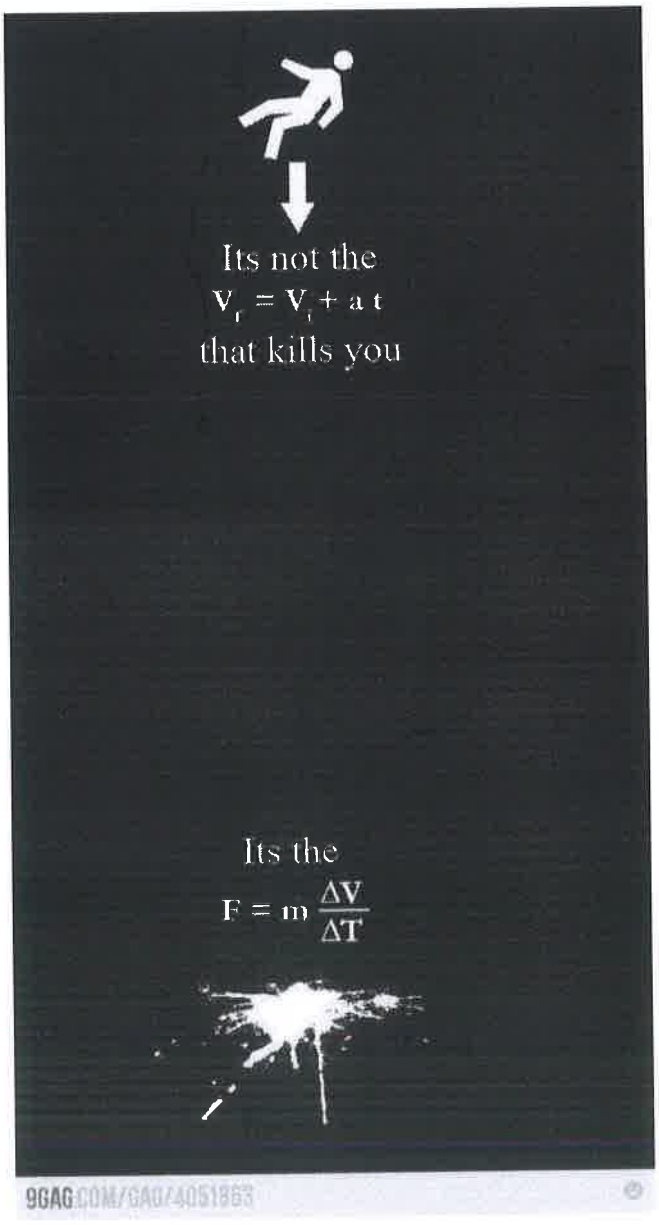
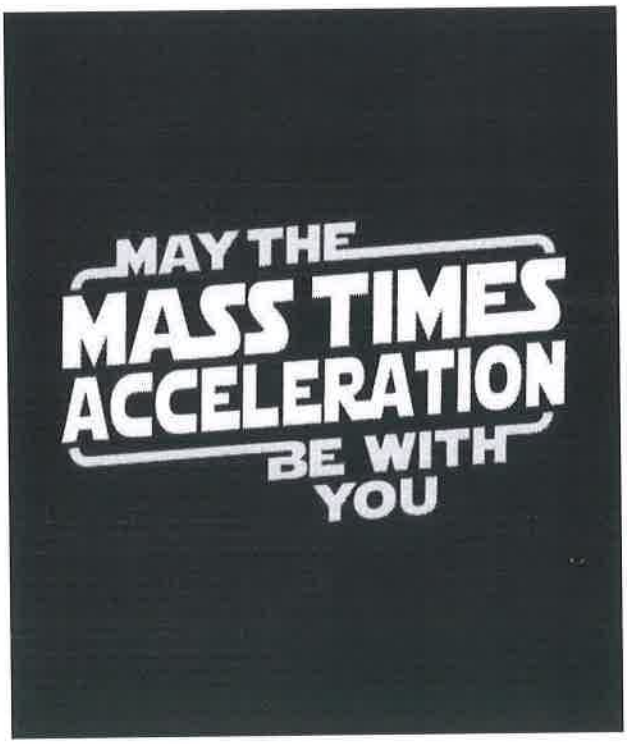
KEY

Unit B:

Changes in Motion

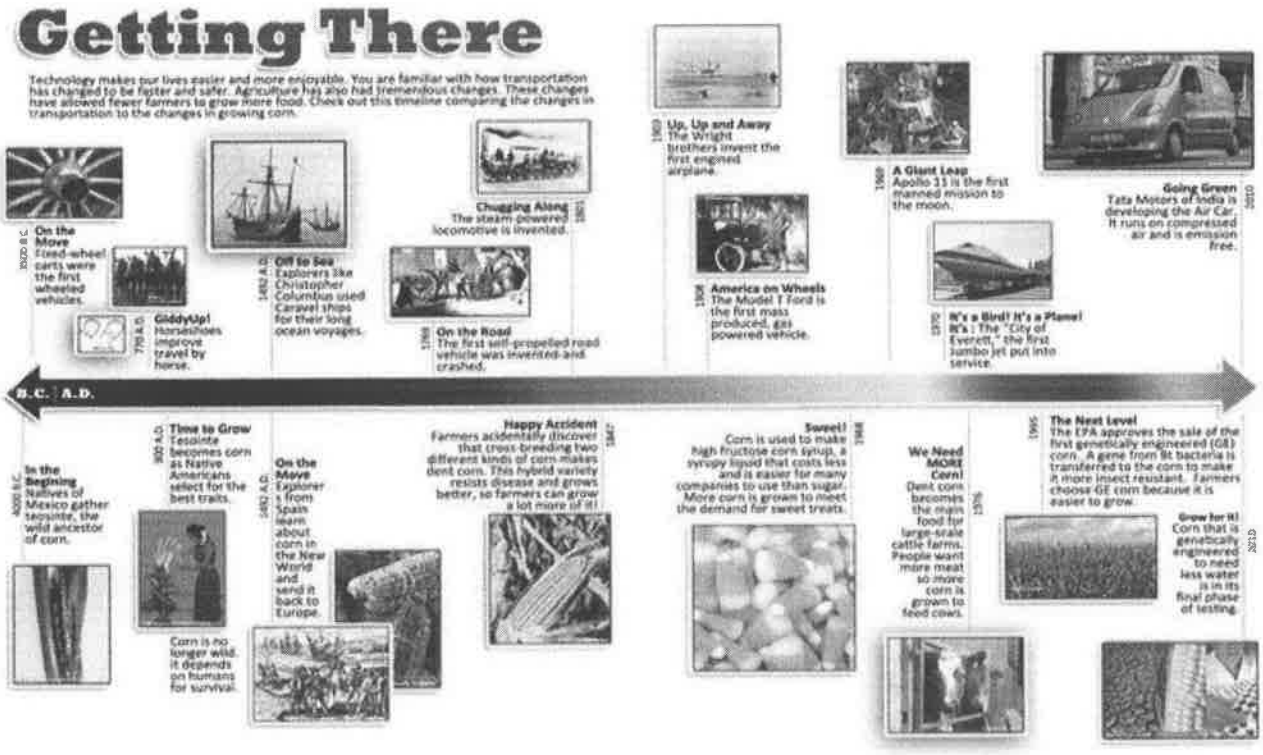




Important Notes

Topic 1: Speed

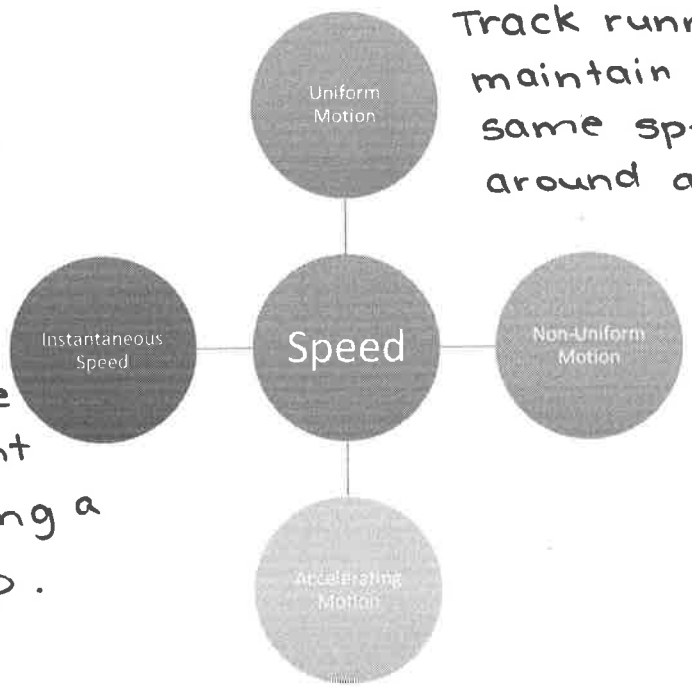
Term	Definition	Example
Uniform Motion		
Non-Uniform Motion		
Average Speed		
Instantaneous Speed		
Scalar Quantity		
Vector Quantity		



Average Speed

$$v = \frac{\Delta d}{\Delta t}$$

- v: speed (m/s)
- Δd: change in distance (m)
- Δt: change in time (s)



Track runners maintain the same speed around a track

A point speed. Police rate instant speed during a speed trap.

On the highway, cars speed up and slow down due to cars, weather, passing...

Dropping an object speeds up due to gravity

Example 1:
Determine the average speed (in km/h) of a motorist who travels 156km in 2hours. Show all your work and include units.

$d = 156\ km$

$t = 2\ h$

$\Delta v = ??$

$$v = \frac{\Delta d}{\Delta t}$$

$$v = \frac{156\ km}{2\ hr}$$

$v =$

Example 2:
Determine the average speed (in km/h) of a cyclist who travels 18.8km in 140mins. Show all your work and include units.

$d = 18.8\ km$

$t = 140\ min$

$v = ???$

$$v = \frac{\Delta d}{\Delta t}$$

$$v = \frac{18.8\ km}{140\ min} \times \frac{60\ min}{1\ hr}$$

$v =$

Example 3:
Determine the average speed (in m/s) of a runner who travels 100m in 9.4seconds. Convert this speed to km/h . Show all your work and include units.

$d = 100\ m$

$t = 9.4\ s$

$v = ???$

$$v = \frac{\Delta d}{\Delta t}$$

$$v = \frac{100\ m}{9.4\ s}$$

$$v = 10.63\ \frac{m}{s} \times \frac{3600\ s}{1\ hr} \times \frac{1\ km}{1000\ m}$$

$$v = 38.3\ \frac{km}{h}$$

Topic 1 Practice Problems

1. Determine whether the following quantities are SCALAR or VECTOR quantities

   a. It is 45km north west to Ms. Mogck's house from Chestermere High Vector

   b. The speed limit on Stony Trail is 100km/h Scalar

   c. The distance to Edmonton is 325km Scalar

   d. The temperature outside is 12C Scalar

2. Use conversion factors to convert each of the following measurements into seconds

   a. $90.0\text{mins} \times \frac{60\text{sec}}{1\text{min}} = 5400\text{ sec}$

   b. $30\text{ days} \times \frac{24\text{ hr}}{\text{day}} \times \frac{3600\text{ sec}}{1\text{hr}} = 2592000\text{ sec}$

   c. $17\text{ years} \times \frac{365\text{ days}}{\text{year}} \times \frac{24\text{ hr}}{\text{day}} \times \frac{3600\text{sec}}{1\text{hr}} = 536112000\text{sec}$

3. Use conversion factors to convert each of the following measurements into meters

   a. $628\mu\text{m} = 628 \times 10^{-6}\text{ m} = 6.28 \times 10^{-4}\text{ m}$

   b. $85.5\text{cm} = 85.5 \times 10^{-2}\text{ m} = 0.855\text{ m}$

   c. $285\text{km} = 285 \times 10^{3}\text{ m} = 285000\text{ m}$

4. If a car travels 400 meters in 20 seconds, how fast was it going?

   $d = 400\text{m}$

   $t = 20\text{ s}$

   $v = ??$

   $$v = \frac{\Delta d}{\Delta t}$$

   $$v = \frac{400\text{m}}{20\text{ s}}$$

   $$\boxed{v = 20.0\text{ m/s}}$$

5. If a person jogs 50 meters in 10 seconds, what is your speed?

$d = 50\,m$

$t = 10\,s$

$v = ??$

$v = \frac{\Delta d}{\Delta t}$

$v = \frac{50\,m}{10\,s} = \boxed{5\,m/s}$

6. You arrive to my class 45 seconds after leaving math, which is 90 meters away. How fast did you travel?

$d = 90\,m$

$t = 45\,s$

$v = ??$

$v = \frac{\Delta d}{\Delta t}$

$v = \frac{90\,m}{45\,s} = \boxed{2.0\,m/s}$

7. A plane travels 3.95×10^5 m in 9.0×10^3 seconds. What was its speed?

$d = 3.95 \times 10^5\,m$

$t = 9.0 \times 10^3\,s$

$v = ??$

$v = \frac{\Delta d}{\Delta t}$

$v = \frac{3.95 \times 10^5\,m}{9.0 \times 10^3\,s} = \boxed{43.89\,m/s}$

8. It takes Charlie 0.25 hours to drive to school. His route is 15 km long. What is Charlie's average speed on his drive to school (in km/h)?

$d = 15\,km$

$t = 0.25\,h$

$v = ??$

$v = \frac{\Delta d}{\Delta t}$

$v = \frac{15\,km}{0.25\,h} = \boxed{60\,km/h}$

9. How long will it take for a bug to travel 5 meters across the floor it is travelling at 1 m/s?

$d = 5\,m$

$v = 1\,m/s$

$t = ??$

$\Delta t = \frac{\Delta d}{v}$

$\Delta t = \frac{5\,m}{1\,m/s} = \boxed{5\,s}$

10. You need to get to class, 200 meters away, and you can only walk in the hallways at about 1.5 m/s (if you run any faster, you'll be caught for running.) How long will it take to get to your class?

$d = 200\,m$

$v = 1.5\,m/s$

$t = ??$

$\Delta t = \frac{\Delta d}{v}$

$\Delta t = \frac{200\,m}{1.5\,m/s} = \boxed{133.33\,s}$

11. In a competition, an athlete threw a flying disk 139 meters through the air. While in flight, the disk travelled at an average speed of 13.0 m/s. How long did the disk remain in the air?

$d = 139\ m$

$v = 13.0\ m/s$

$\Delta t = ??$

$\Delta t = \frac{d}{v}$

$\Delta t = \frac{139\ m}{13\ m/s} = \boxed{10.69\ s}$

12. How far can you get away from your littler brother with a squirt gun filled with paint if you can travel 3.0 m/s and you have 15 s before he sees you?

$v = 3.0\ m/s$

$t = 15\ s$

$d = ??$

$\Delta d = v\,\Delta t$

$\Delta d = (3.0\ m/s)(15\ s)$

$\boxed{\Delta d = 45\ m}$

13. How far can you little brother get if he can travel at 2.5 m/s, and in 5.0 seconds you will discover that his squirt gun has run out of paint?

$v = 2.5\ m/s$

$t = 5\ s$

$d = ??$

$\Delta d = v\,\Delta t$

$\Delta d = (2.5\ m/s)(5\ s)$

$\boxed{\Delta d = 12.5\ m}$

14. If you shout into the Grand Canyon, your voice travels at the speed of sound (340 m/s) to the bottom of the canyon and back, and you hear an echo. How deep is the Grand Canyon at a spot where you can hear your echo 5.2 seconds after you shout?

$v = 340\ m/s$

$t = 5.2\ s$

$d = ??$

$\Delta d = v\,\Delta t$

$\Delta d = (340\ m/s)(5.2\ s)$

$\Delta d = 1768\ m \div 2$ (there and back)

$\boxed{= 884\ m \text{ deep}}$

Challenge Problem

Bill and Amy want to ride their bikes form their neighbourbood to school, which is 14.4 km away. It takes Amy 40 minutes to arrive at school. Bill arrives 20 minutes after Amy. How much faster (**in meters/second**) is Amy's average speed for the entire trip?

$d = 14.4\ km$

$t = 40\ min$ Amy

$t = 60\ min$ Bill

Amy

$v = \frac{\Delta d}{\Delta t}$

$v = \frac{14.4\ km}{40\ min} \times \frac{60\ min}{1\ hr} = \frac{21.6\ km}{hr}$

$v = \frac{21.6\ km}{1\ h} \times \frac{1\ h}{3600\ s} \times \frac{1000\ m}{1\ km} = \boxed{6\ \frac{m}{s}}$

Bill

$v = \frac{\Delta d}{\Delta t}$

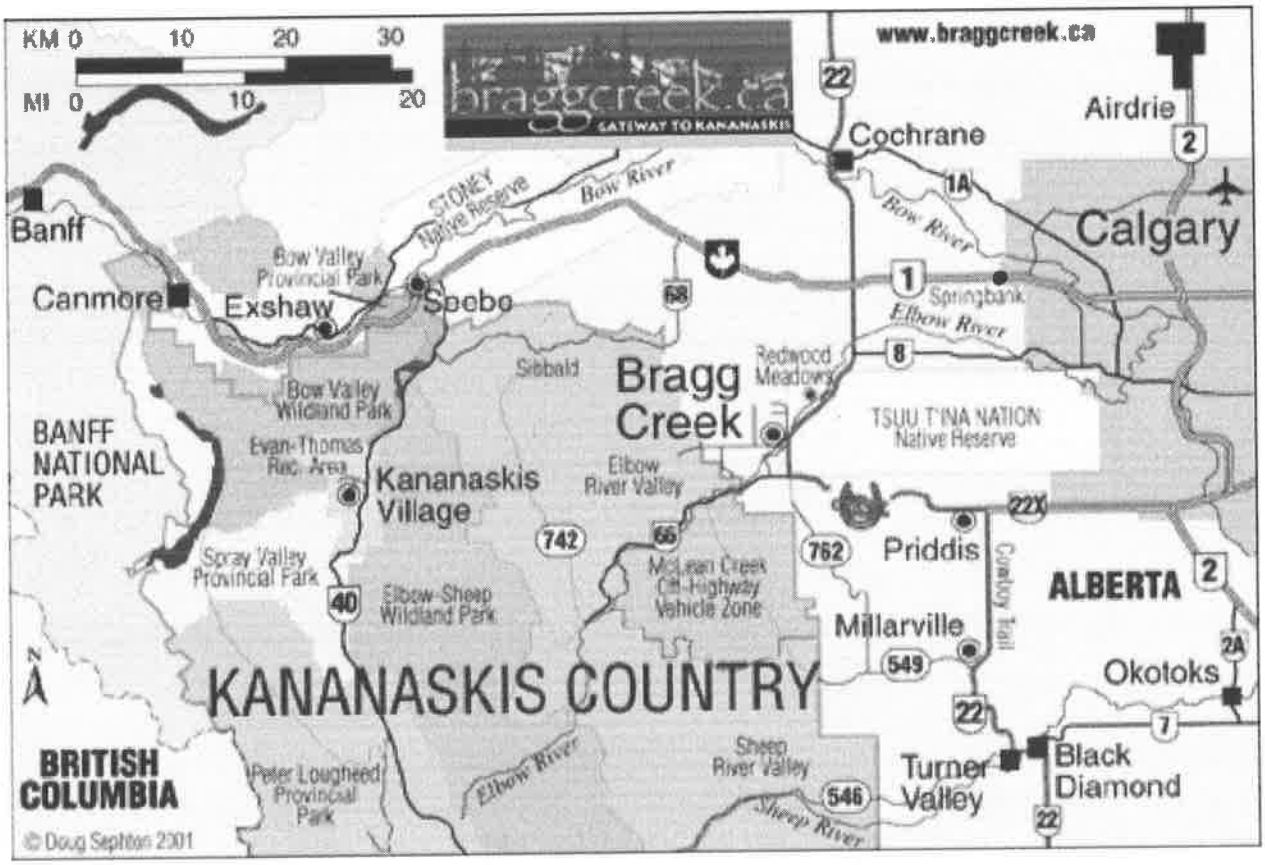
$v = \frac{14.4\ km}{1\ hr} \times \frac{1000\ m}{1\ km} \times \frac{1\ hr}{3600\ s}$

$\boxed{v = 4.0\ m/s}$

$\boxed{\text{Amy walks } 2\ m/s \text{ faster than Bill.}}$

Topic 2: Average Velocity

Term	Definition	Example
Position		
Vector Quantity		
Displacement		
Average Velocity		



Use the map on the previous page to complete the following examples:

1. Melissa leaves Priddis and travels along at 2.50m/s [N] for 1.25h.
   a. Calculate Melissa's displacement from Priddis

$\vec{v} = \frac{\Delta \vec{d}}{\Delta t}$ $\quad \vec{d} = (2.5\ m/s)(1.25\ h \times \frac{3600s}{1h})$

$\Delta \vec{d} = \vec{v}\,\Delta t$ $\quad \vec{d} = 11.25\ km\ N$

   b. Use the map and a ruler to determine where Melissa likely stopped.

Tsuu T'ina First Nation

2. Suppose Usha and Melissa start a day-long trip along the Bow River travelling from Exshaw towards Cochrane. This leg of the trip takes 5.25hours. They stay at Cochrane for 1.75hours before deciding to head towards Spring Bank. The entire journey takes 9hours. Determine Usha and Melissa's average velocity for the entire trip.

$9\ cm = 64\ km$ $\quad \vec{v} = \frac{\Delta \vec{d}}{\Delta t}$

$\Delta t = 9\ hr.$

$\vec{v} = \frac{64\ km}{9\ hr} = 7.11\ km/h\ E$

3. Because the fish weren't biting ac Bragg Creek, Raj and Harvey travelled north for 2.5hours to try their luck at Bow Valley Provincial Park. This trip took 45 minutes.
   a. Determine the displacement from Bragg Creek to Bow Valley Provincial Park using the head to tail method. (Show your work).

   b. Calculate the speed for the journey.

$\Delta d = 9\ cm = 64.28\ km$ $\quad \Delta v = \frac{64.28\ km}{2.5\ h} = 25.71\ \frac{km}{h}$

$\Delta t = 2.5\ h$

   c. Calculate the velocity for the journey.

$\vec{\Delta} d = 5.8 = 41.4\ km$ $\quad \vec{\Delta v} = \frac{41.43\ km}{2.5\ h} = 16.57\ \frac{km}{h}\ NW$

$\Delta t = 2.5\ h$

Topic 2 Practice Problems

1. Sam is driving along the highway towards Saint John. He travels 150km in 3.00hrs. What is his average speed for his trip?

$$v = \frac{d}{t}$$

$$v = \frac{150\,km}{3\,h} = \boxed{50\ km/h}$$

2. A vehicle travels 2345 m [W] in 315 s toward the evening sun. What is its average velocity?

$$\vec{v} = \frac{d}{t}$$

$$v = \frac{2345\ m}{315\ s} = \boxed{7.44\ m/s\ W}$$

3. What distance will a car, traveling 65 km/hr, cover in 3.0 hrs?

$$d = \vec{v}\,\Delta t$$

$$d = \frac{65\ km}{h} \times 3\ h = \boxed{195\ km}$$

4. How long will it take to go 150 km [E] traveling at 50 km/hr [E]?

$$t = \frac{d}{v}$$

$$t = \frac{150\ km}{50\ km/h} = \boxed{3\ hr}$$

5. What is the displacement of the Earth after one orbit about the Sun? What is the average velocity of the Earth after one orbit in m/s?

$d = \emptyset$ b/c the start and stop is the same.

$v = \emptyset$ b/c $\Delta\vec{d}$ is $\emptyset$

6. What is the average velocity of the Earth the instant it has traveled half of its circular orbit about the Sun in m/s?

$$v = \frac{d}{t}$$

$$v = \frac{74.8 \times 10^6\ km}{4380\ hr}$$

$$v = 17077.63\ km/h$$

$$\frac{m}{s} = 17077.63\ \frac{km}{h} \times \frac{1000\,m}{1\,km} \times \frac{1\,hr}{3600\,s}$$

$$\boxed{\frac{m}{s} = 4743.78\ m/s}$$

7. Calculate the average speed of the Earth about the Sun in m/s.

$$v = \frac{d}{t}$$

$$v = \frac{149.6 \times 10^6 \text{ km}}{8760 \text{ hr}} = 17077.63 \frac{\text{km}}{\text{h}} = \boxed{4743.78 \frac{\text{m}}{\text{s}}}$$

8. How long will it take to travel 200 000 m [N] traveling 10 m/s [N]?

$$t = \frac{d}{v}$$

$$t = \frac{2000000 \text{ m}}{10 \text{ m/s}} = 20\,000 \text{ s} = \boxed{5.55 \text{ hrs.}}$$

9. A car drives 12 m/s [S] for 5.0 seconds, then 18 m/s [N] for 9.0 seconds, and finally 15 m/s [S] for 11 seconds. Calculate the average speed and average velocity.

Avg speed

$$= \frac{12 \text{ m}}{\text{s}} + \frac{18 \text{ m}}{\text{s}} + \frac{15 \text{ m}}{\text{s}} \div 3$$

$$= 15 \text{ m/s}$$

Avg Velocity

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

$$v = \frac{60 \text{ m S} - 162 \text{ m N} + 165 \text{ m S}}{5 \text{ s} + 9 \text{ s} + 11 \text{ s}}$$

$$v = 2.5 \text{ m/s S}$$

10. A soccer ball is kicked 25 m [E], then 15 m [E], 8 m [W], and finally 12 m [E]. All this takes place in 45 seconds. Calculate the average speed and velocity of the ball.

Speed

$$v = \frac{d_{tot}}{t_{tot}}$$

$$v = \frac{25 \text{ m} + 15 \text{ m} + 8 \text{ m}}{45 \text{ s}}$$

$$v = 1.066 \frac{\text{m}}{\text{s}}$$

velocity

$$\vec{v} = \frac{d_{tot}}{t_{tot}}$$

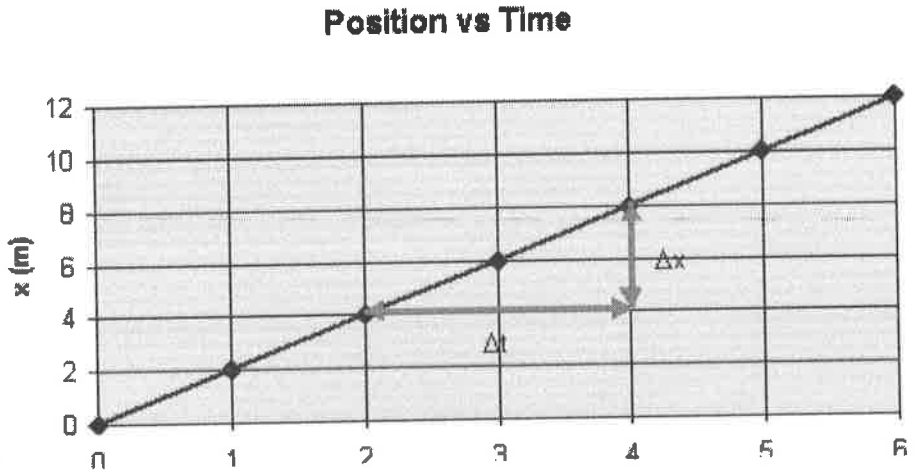
$$\vec{v} = \frac{25 \text{ m E} + 15 \text{ m E} - 8 \text{ m W}}{45 \text{ s}}$$

$$\vec{v} = 0.7111 \text{ m/s E}$$

Topic 3: Graphing Uniform Motion

You can use a distance versus time graph to determine the average velocity by taking the slope of the line of best fit.

ex)



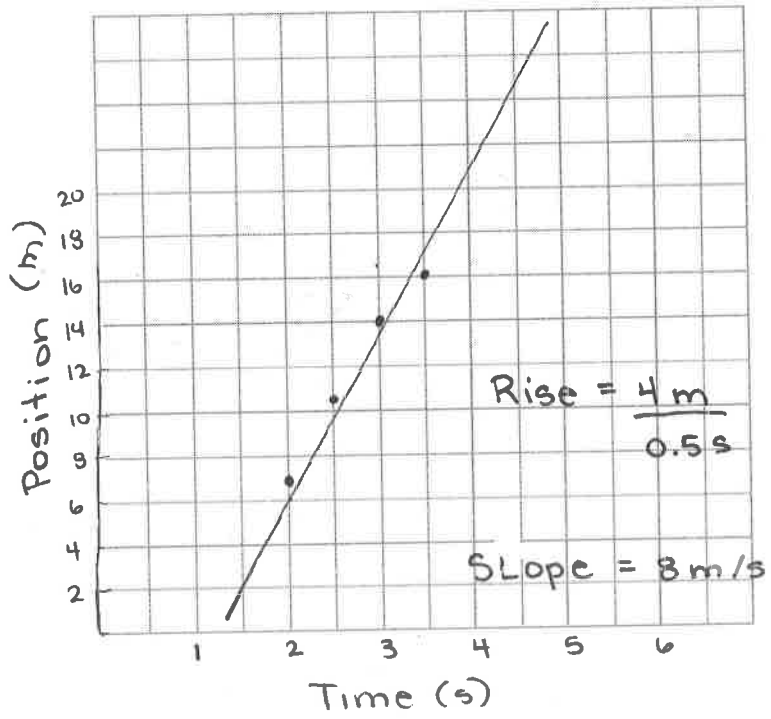
$$v = slope = \frac{rise}{run} = \frac{y_2 - y_1}{x_2 - x_1}$$

$$= \frac{8-4}{4-2} = \frac{4}{2} = 2 \text{ m/s}$$

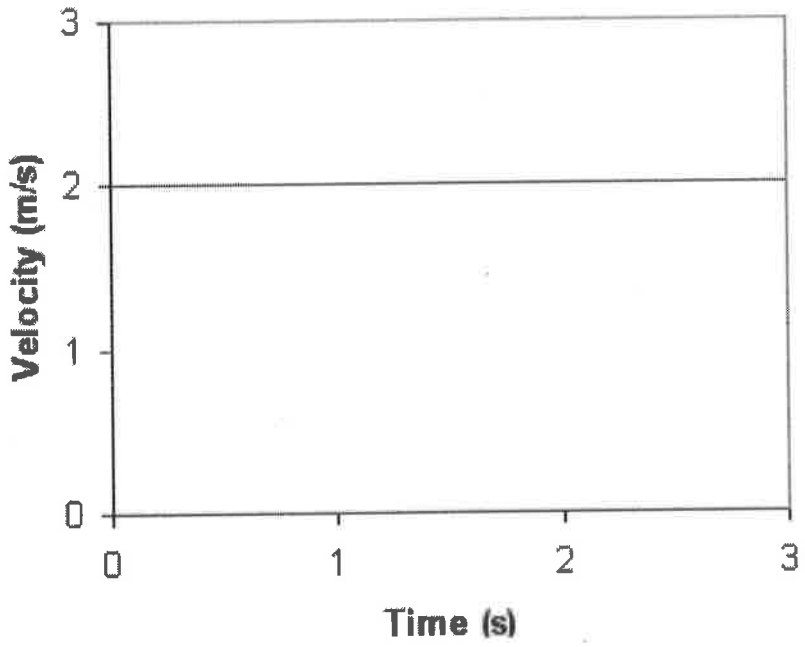
Example 1

Find the velocity for the following data. You will need to graph it and find a line of best fit.

Time (s)	Position (m)
2	9
2.5	10.5
3	14
3.5	16



You can determine the displacement of an object by graphing a velocity versus time graph and finding the area of the resulting rectangle formed.

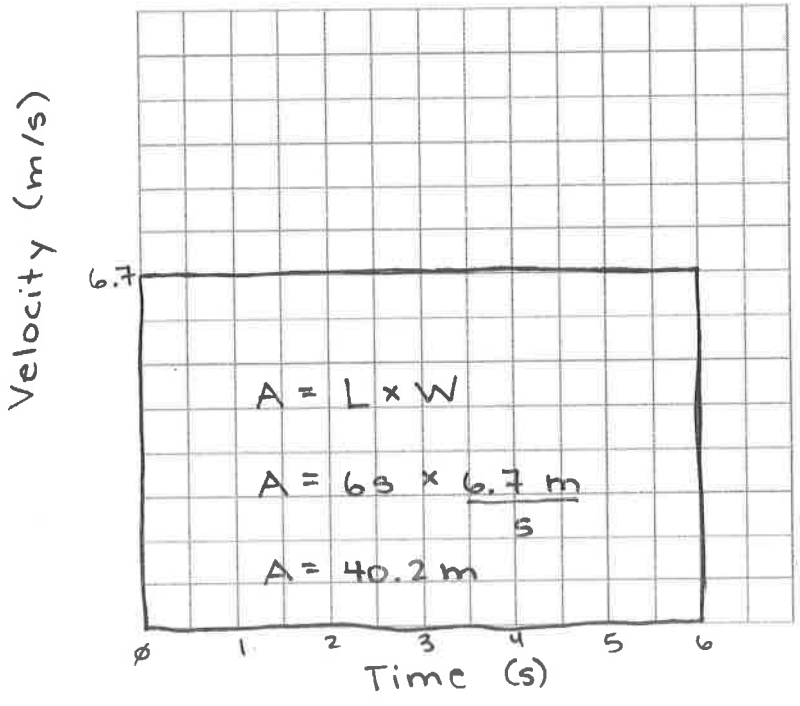


d = area of rectangle $= l \times w$
$= (3)(2) = 6$ m

Example 2

Find the displacement for the following data. Graph the data first.

Times (s)	Velocity (m/s)
1	6.7
2	6.7
3	6.7
4	6.7
5	6.7
6	6.7



Topic 3 Gedanken Lab

The *Never-Go* toy company has a problem. Customers are complaining that the *Roaring Roadster®* radio controlled toy car that *Never-Go* makes is not able to move fast enough when the speed is set at maximum. The packaging claims that it can move at over 35km/h. The company wants you to figure out what the speed of the car is when it is set at maximum.

Gedanken Lab?

The idea of a "Gedanken" is most associated with Einstein, but physicists have been doing it for centuries. Simply put, it is an experiment you run in your mind to simulate physics principles or theories. This is sometimes necessary, since it may not be possible or convenient to actually perform the experiment!

You take one of the cars and set the speed to maximum. You then measure how far it is able to travel (displacement) during several different time intervals. The data that you collect follows.

Trial	Time (s)	Displacement (m)
1	5.00	49.5
2	10.0	101
3	15.0	147
4	20.0	199
5	25.0	245

Based on this information. you need to write up a full lab report to determine if the car actually does run at the speed guaranteed on the package. You must keep the following in mind while writing up your lab report.

Procedure:

- Complete a proper Procedure to test this lab. Your "Procedure" must describe how you ***would have*** conducted your experiment with the car to get the data above.

Analysis:

- Create a graph based on the data. Think carefully about how to correctly place the variables on the x and y axis.

- Use ***your graph*** to get the average velocity of the car.

Error Analysis:

- compare your experimental value to the company's accepted value for the speed of the car. Use the formula for percent error.

$$\frac{\text{Experimental value} - \text{Theoretical value}}{\text{Theoretical value}} \times 100$$

Topic 4: Acceleration

Acceleration is the rate of change in the speed of an object. To determine the rate of acceleration, you use the formula below. The units for acceleration are meters per second per second or m/s².

$$\text{Acceleration} = \frac{\text{Final speed} - \text{Beginning speed}}{\text{Time}}$$

$$a = \frac{v_2 - v_1}{t}$$

A positive value for acceleration shows speeding up, and negative value for acceleration shows slowing down. Slowing down is also called *deceleration*.

The acceleration formula can be rearranged to solve for other variables such as final speed (v_2) and time (t).

$$v_2 = v_1 + (a \times t)$$

$$t = \frac{v_2 - v_1}{a}$$

Example 1

A skater increases her velocity from 2.0 m/s to 10.0 m/s in 3.0 seconds. What is the skater's acceleration?

$v_i = 2.0\ m/s$

$v_f = 10.0\ m/s$

$t = 3s$

$a = ???$

$$a = \frac{v_f - v_i}{t}$$

$$\vec{a} = \frac{(10\ m/s) - (2.0\ m/s)}{3s}$$

$$\boxed{\vec{a} = 2.67\ m/s^2}$$

Example 2

A car accelerates at a rate of 3.0 m/s². If its original speed is 8.0 m/s, how many seconds will it take the car to reach a final speed of 25.0 m/s?

$a = 3.0\ m/s^2$

$v_i = 8.0\ m/s$

$v_f = 25\ m/s$

$\Delta t = ??$

$$t = \frac{v_f - v_i}{a}$$

$$t = \frac{(25\ m/s) - (8\ m/s)}{3.0\ m/s^2}$$

$$\boxed{\Delta t = 5.67\ s}$$

Topic 4 Practice Problems

1. While traveling along a highway a driver slows from 24 m/s to 15 m/s in 12 seconds. What is the automobile's acceleration? (Remember that a negative value indicates a slowing down or deceleration.)

$v_f = 24\ m/s$
$v_i = 15\ m/s$
$t = 12\ s$
$a = ??$

$a = \frac{v_f - v_i}{t}$

$a = \frac{15\ m/s - 24\ m/s}{12\ s} = \boxed{-0.75\ m/s^2}$

2. A parachute on a racing dragster opens and changes the speed of the car from 85 m/s to 45 m/s in a period of 4.5 seconds. What is the acceleration of the dragster?

$v_i = 85\ m/s$
$v_f = 45\ m/s$
$t = 4.5\ s$

$a = \frac{v_f - v_i}{t}$

$a = \frac{45\ m/s - 85\ m/s}{4.5\ s} = \boxed{-8.89\ m/s^2}$

3. A car traveling at a speed of 30.0 m/s encounters an emergency and comes to a complete stop. How much time will it take for the car to stop if it decelerates at -4.0 m/s²?

$v_i = 30\ m/s$
$v_f = \emptyset$
$a = -4\ m/s$
$t = ??$

$t = \frac{v_f - v_i}{a}$

$t = \frac{-30\ m/s}{-4\ m/s^2} = \boxed{7.5\ s}$

4. If a car can go from 0 to 60 km/hr in 8.0 seconds, what would be its final speed after 5.0 seconds if its starting speed were 50 km/hr?

$v_i = \emptyset$
$v_f = 60\ km/h\ (16.67\ m/s)$
$a = ??$
$t = 8.0\ s$

$a = \frac{v_f - v_i}{\Delta t}$

$a = \frac{16.67\ m/s}{8.0\ s}$

$a = 2.083\ m/s^2$

$v_i = 50\ km/h\ (13.89\ m/s)$
$v_f = ??$
$a = 2.083\ m/s^2$
$t = 5.0\ s$

$v_f = ta + v_i$

$v_f = (5s)(2.083) + 13.89$

$\boxed{v_f = 24.305\ m/s = 87.5\ km/h.}$

5. A cart rolling down an incline for 5.0 seconds has an acceleration of 4.0 m/s². If the cart has a beginning speed of 2.0 m/s, what is its final speed?

$t = 5\ s$
$a = 4\ m/s^2$
$v_i = 2.0\ m/s$
$v_f = ??$

$v_f = at + v_i$

$v_f = (4\ m/s^2)(5\ s) + 2.0\ m/s$

$\boxed{v_f = 22.0\ m/s}$

6. A helicopter's speed increases from 25 m/s to 60 m/s in 5 seconds. What is the acceleration of this helicopter?

$v_i = 25\ m/s$

$v_f = 60\ m/s$

$t = 5\ s$

$a =$

$$a = \frac{v_f - v_i}{t}$$

$$a = \frac{60\ m/s - 25\ m/s}{5\ s} = \boxed{7.0\ m/s^2}$$

7. As she climbs a hill, a cyclist slows down from 25 km/hr to 6 km/hr in 10 seconds. What is her deceleration?

$v_i = 25\ km/h$

$v_f = 6\ km/h$

$t = 10\ s = 0.00278\ h$

$a = ??$

$$a = \frac{v_f - v_i}{t}$$

$$a = \frac{6\ km/h - 25\ km/h}{0.00278\ h} = \boxed{-6839.99\ km/h^2}$$

$$= -0.52777\ m/s^2$$

8. A motorcycle traveling at 25 m/s accelerates at a rate of 7.0 m/s² for 6.0 seconds. What is the final speed of the motorcycle?

$v_i = 25\ m/s$

$a = 7.0\ m/s^2$

$t = 6.0\ s$

$v_f = ??$

$$v_f = at + v_i$$

$$v_f = (7\ m/s^2)(6s) + 25\ m/s$$

$$\boxed{v_f = 67\ m/s}$$

9. A car starting from rest accelerates at a rate of 8.0 m/s/s. What is its final speed at the end of 4.0 seconds?

$v_i = \emptyset$

$v_f = ??$

$a = 8\ m/s^2$

$t = 4.0\ s$

$$v_f = at + v_i$$

$$v_f = (8\ m/s^2)(4s) + 0$$

$$\boxed{v_f = 32\ m/s}$$

10. A cyclist accelerates at a rate of 7.0 m/s². How long will it take the cyclist to reach a speed of 18 m/s?

$a = 7.0\ m/s^2$

$t = ??$

$v_f = 18\ m/s$

$v_i = \emptyset$

$$t = \frac{v_f - v_i}{a}$$

$$t = \frac{18\ m/s}{7.0\ m/s^2}$$

$$\boxed{t = 2.57\ s}$$

Topic 5: Graphing Acceleration

Procedure:

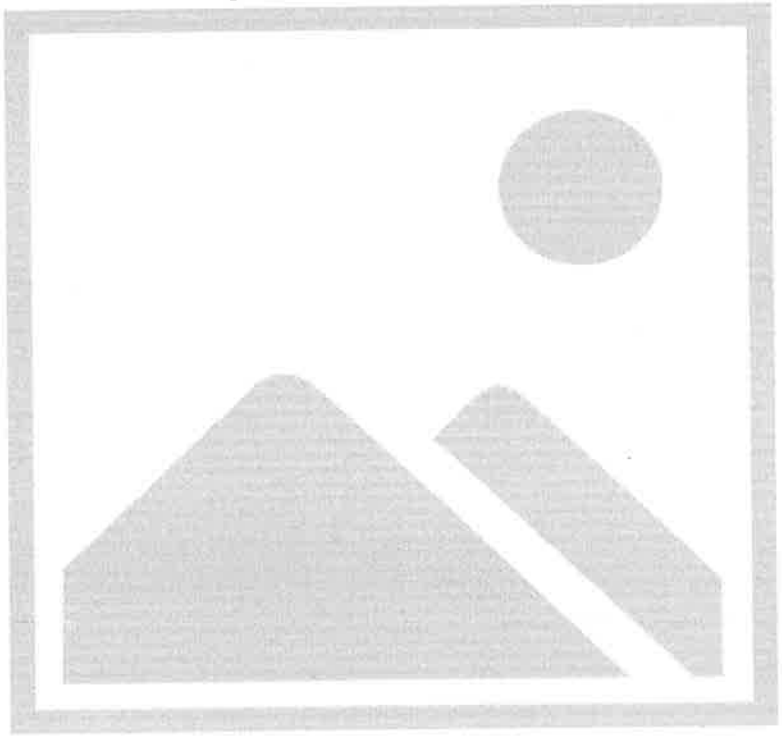
1. Measure a height of 2.5 m and mark it on the wall using tape
2. Drop a marble from that height and measure the time it takes to hit the ground
3. Repeat 4 more times using heights of 2.0m, 1.5m, 1.0m and 0.5m

Observations:

Distance (m) Y	Time (s) X
2.5m	
2.0m	
1.5m	
1.0m	
0.5m	

Analysis:

1. Draw a distance vs. time graph.



2. What does the shape of the line indicate?

3. Using your kinematics formula, determine the velocity of the marble for each height. Show your work.

Distance (m)	Time (s) X	Velocity (m/s) Y
2.5m		
2.0m		
1.5m		
1.0m		
0.5m		

4. Draw a velocity vs. time graph.

5. Find the acceleration of the marble for each of your 5 trials. Use a kinematics equation and show work below.

Time (s)	Velocity (m/s)	Acceleration

6. Average your acceleration.

7. Calculate your percentage error using this equation:

$$\frac{\text{Experimental value} - \text{Theoretical value}}{\text{Theoretical value}} \times 100$$

Topic 6: Calculating Displacement

Quick Question: Is it possible to have negative acceleration? Explain.

Yes! Slowing down!!

Problems involving objects that move through the air near the Earth's surface frequently involve displacement, velocity and acceleration vectors that do not all point in the same direction.

Using the displacement equation, you don't have to start with a velocity-time graph!

$$\Delta\vec{d} = \left(\frac{\vec{v}_i + \vec{v}_f}{2}\right)\Delta t$$

Example 1
A baseball leaves a bat and travels straight up into the air, reaching its highest point 15.9m above the bat in just 1.8s. Determine the initial velocity of the ball using the displacement formula

$\Delta t = 1.8s$

$v_i = ??$

$v_f = \emptyset$

$d = 15.9\ m$

$$v_i = \frac{\Delta d}{\Delta t} \times 2$$

$$v_i = \frac{15.9\ m}{1.8\ s} \times 2$$

$$\boxed{v_i = 17.67\ m/s}$$

Example 2
A car travelling 90km/h accelerates at 0.50m/s² while passing another vehicle. If it takes 5.0s to pass the vehicle, determine the distance travelled by the vehicle during this time.

$t = 5.0s$

$v_i = 90\ \frac{km}{h} = \frac{25m}{s}$

$a = 0.5\ m/s^2$

$d = ???$

$$\vec{d} = \frac{(v_i + v_f)}{2}\Delta t$$

* not enough info!

$$\Delta d = v_i \Delta t + \frac{1}{2} a (\Delta t)^2$$

$$\Delta d = \frac{25\ m}{s} \times 5s + \frac{1}{2}\left(0.5\ \frac{m}{s^2}\right)(5s)^2$$

$$\boxed{\Delta d = 131.25\ m}$$

Another Displacement Equation

By rearranging the acceleration equation, it is possible to determine the distance using the following formula:

$$\Delta\vec{d} = \vec{v}_i\Delta t + \frac{1}{2}\vec{a}(\Delta t)^2$$

Example 3
Ella leaves the surface of a trampoline with an initial velocity of 11.8m/s, directed straight up. Determine the displacement of the gymnast after 8.0s

$v_i = 11.8\ m/s$

$a = -9.81\ m/s^2$

$t = 8.0\ s$

$d = ??$

$\Delta d = v_i \Delta t + \frac{1}{2}\vec{a}(\Delta t)^2$

$\Delta d = \left(11.8\ \frac{m}{s}\right)(8s) + \frac{1}{2}\left(-9.81\ \frac{m}{s^2}\right)(8s)^2$

$\Delta d =$

Example 4
A diver steps off the edge of a platform and enters the water 5.0m below. If the initial velocity of the diver was zero, determine the time it took for the diver to reach the water.

$v_i = \emptyset$

$d = 5.0m$

$t = ???$

$a = 9.81\ m/s^2$

$$\Delta t = \sqrt{\frac{\Delta d \times 2}{a}}$$

$$\Delta t = \sqrt{\frac{5.0m \times 2}{9.81\ m/s^2}}$$

$$\boxed{\Delta t = 1.0096\ s}$$