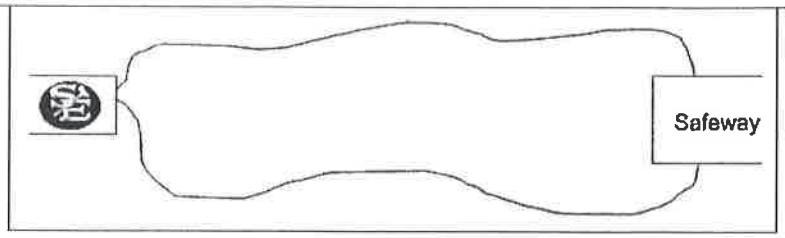
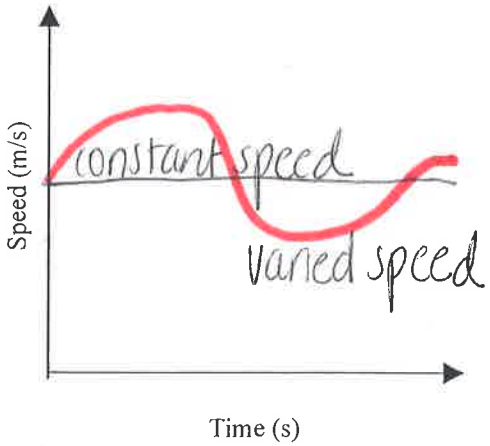
Average vs. Instantaneous



Calculate your speed for a trip to Safeway.

$v = \frac{d}{t}$ distance = speed $\frac{0.5 \text{ miles}}{10 \text{ minutes}}$

Sketch a graph of your speed for your trip.



1. Average speed (or velocity): Total distance / total time
   average distance / unit time
2. Instantaneous speed (or velocity): how fast the object is at any given instant
3. Describe a trip in which a car's average speed equals its instantaneous speed for the entire time.
   constant speed entire trip

Problem Solving –Smooth Form

1) state known variables 3) show all work w/units
2) show equation used in manipulated 4) box answer w/units

4. An airplane flies at a constant speed of 300. m/s. How long will it take the plane to fly a distance of 1.2 km?

$t = ?$ $v = 300. \frac{m}{s}$ $d = 1.2 \text{ km}$ $v = \frac{d}{t}$ $t = \frac{d}{v}$

$t = \frac{1.2 \text{ km}}{300. \frac{\text{m}}{s}} = \boxed{4.0 \times 10^{-3} \text{ s}}$

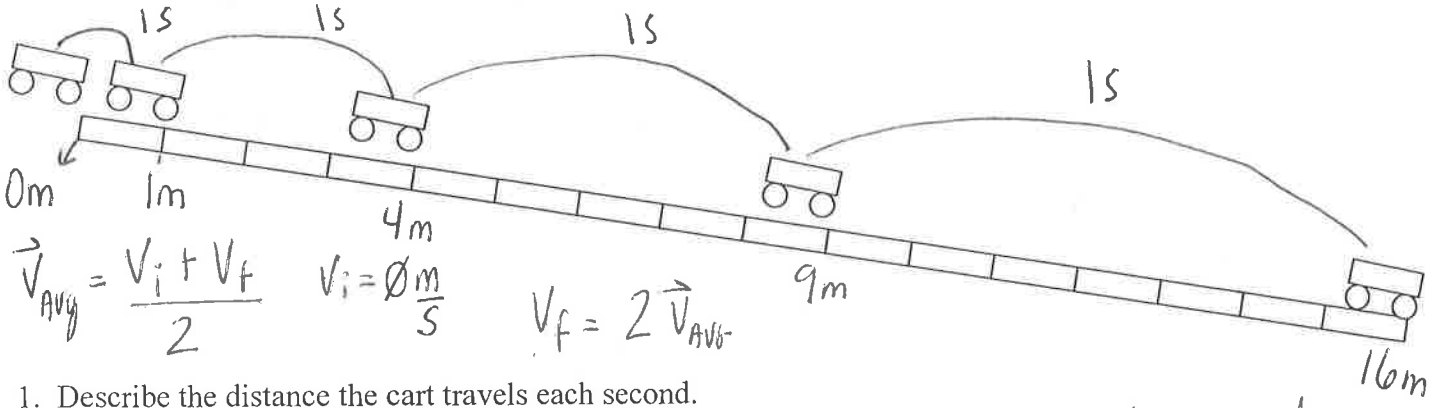
5. A car travels at an average speed of 30. m/s. How far will the car go in 3.0 hours?

$v = 30. \frac{m}{s}$ $t = 3.0 \text{ hours}$ $\frac{3600 \text{ s}}{\text{hr}}$

$d = vt$ $30. \frac{m}{s}(3.0 \text{ hrs})\left(\frac{3600 \text{ s}}{\text{hr}}\right) = \boxed{3.2 \times 10^5 \text{ m} = d}$

Acceleration

A cart is allowed to roll freely down a ramp, as shown below. The position of the cart is marked after each second.



$\vec{V}_{Avg} = \frac{V_i + V_f}{2}$ $V_i = \emptyset \frac{m}{s}$ $V_f = 2\vec{V}_{AVG}$

1. Describe the distance the cart travels each second.

The distance is increasing at an increasing rate each second. Velocity is not constant. = quadratic graph

2. Describe any changes in the speed and velocity of the cart as it rolls downhill.

Both increasing at a constant rate = linear graph

Time (s)	Position (m)	Average Velocity (m/s) ~~Total d / Total t~~ $\vec{V} = d/t$	Instantaneous Velocity (m/s) Final (V_f) $V_f = 2\vec{V}_{AVG}$	Acceleration
0	0m	$\emptyset \frac{m}{s}$	$\emptyset$ m/s	$\emptyset \frac{m}{s^2}$
1	1m	$\frac{1m}{1s} = 1\frac{m}{s}$	$1m/s \times 2 = 2\frac{m}{s}$	$\frac{2m/s - 0m/s}{1s} = 2\frac{m}{s^2}$
2	4m	$\frac{4m}{2s} = 2\frac{m}{s}$	$2\frac{m}{s} \times 2 = 4\frac{m}{s}$	$\frac{4m/s - 0\frac{m}{s}}{2s} = 2\frac{m}{s^2}$
3	9m	$\frac{9m}{3s} = 3\frac{m}{s}$	$3\frac{m}{s} \times 2 = 6\frac{m}{s}$	$\frac{6\frac{m}{s} - 0\frac{m}{s}}{3s} = 2\frac{m}{s^2}$
4	16m	$\frac{16m}{4s} = 4\frac{m}{s}$	$4\frac{m}{s} \times 2 = 8\frac{m}{s}$	$\frac{8\frac{m}{s} - 0\frac{m}{s}}{4s} = 2\frac{m}{s^2}$

Instantaneous initial velocity = V_i

Instantaneous final velocity = V_f

Average velocity =

$\vec{V}_{AVG} = \frac{V_i + V_f}{2}$

only if acceleration is constant!

Acceleration: Rate of change in velocity

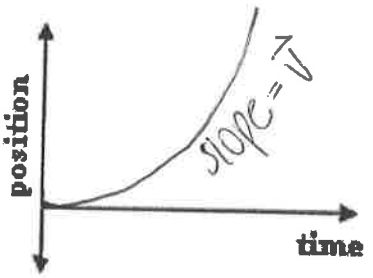
Formula: $\vec{a} = \frac{\Delta\vec{V}}{\Delta t}$

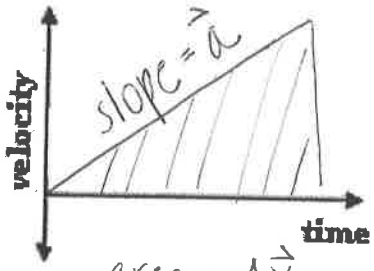
$\vec{a} = \frac{\vec{V}_f - \vec{V}_i}{t_f - t_i}$

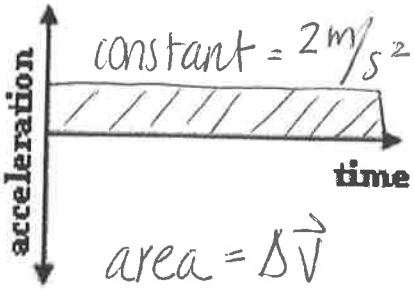
Units: $\frac{m}{s^2}$

Type: vector

3. Use the chart you just filled in to sketch the following graphs of motion for the cart.







4. What is the relationship between position and time? quadratic

5. What is the relationship between velocity and time? linear, direct

6. What is the relationship between acceleration and time? constant or ∅ slope

Uniform acceleration: = constant acceleration or acceleration remains constant

* not the same thing as constantly accelerating

7. What is the meaning of the slope of the velocity-time graph?

$\vec{a}$

8. What is the meaning of the area under the velocity-time graph?

$\vec{d}$ or $\Delta\vec{x}$ displacement

9. What is the meaning of the slope of the position-time graph? $\vec{v}$

instantaneous velocity is the tangent of the slope