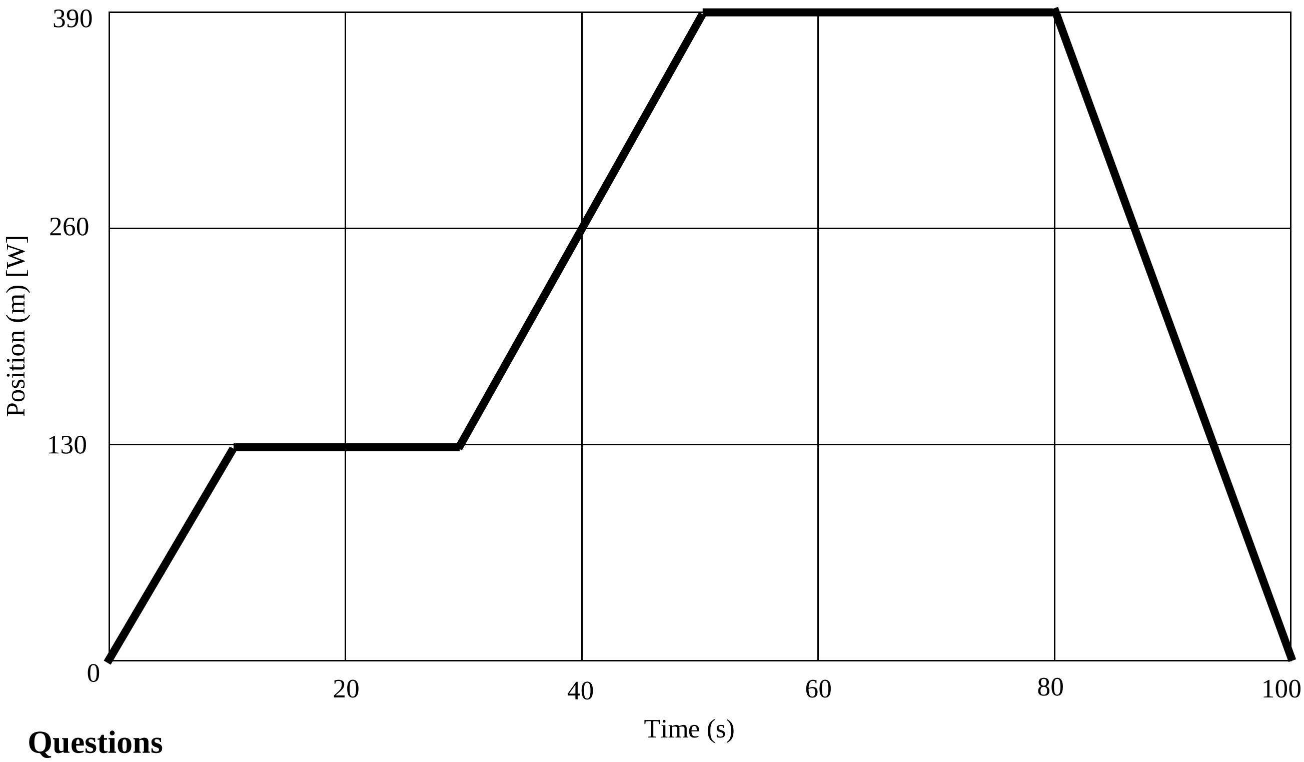
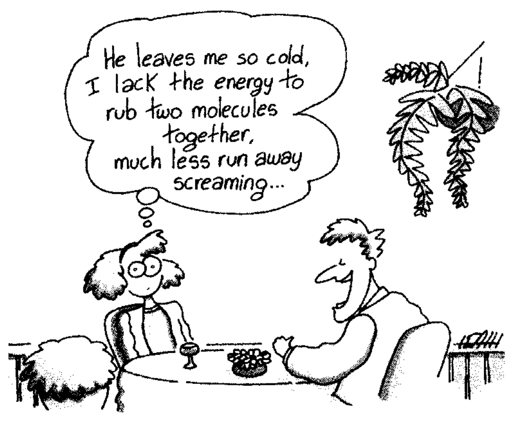
SPH3U: Delivery! Position – Time Graphs

You drive a delivery truck carrying gophers to clients across the city. Below is a **d**-t graph that illustrates one of your delivery runs.



Questions

0. What was your position at: a) 20 s b) 40 s c) 80 s d) 100 s
1. How many stops were made for deliveries?
2. How long was the longest stop?
3. What was the maximum displacement from the store?
4. What was the velocity of the truck in the first 10 seconds?
5. What direction was the truck traveling in at 90 s?
6. What was the maximum speed of the truck at any time?
7. What was the total **distance** driven?
8. What was the total **displacement** driven?
9. What was the average **speed** of the entire trip?
10. What was the average **velocity** of the entire trip?

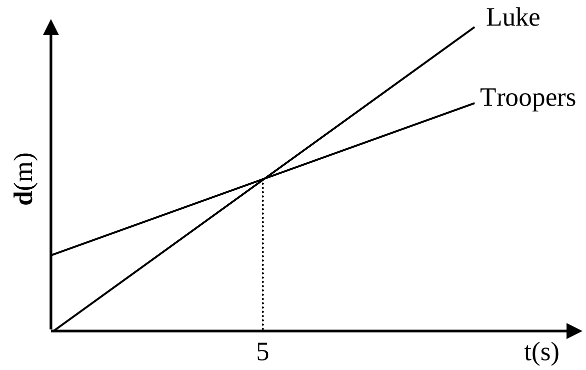


Marge dates an absolute zero.

Answers: 0) 130 m [W], 260 m [W], 390 m [W], 0 m, 1) 2, 2) 30 s, 3) 390 m [W], 4) 13 m/s [W], 5) East, 6) 20 m/s (going east), 7) 780 m, 8) 0 m, 9) 7.8 m/s, 10) 0 m/s

The Speeder Bike Chase!

Luke is chasing Imperial Troopers on the forest moon of Endor riding on Speeder Bikes, as shown in the **position-time** graph below.



1. Do Luke and the Troopers start at the same point? How do you know? If not, which is ahead?

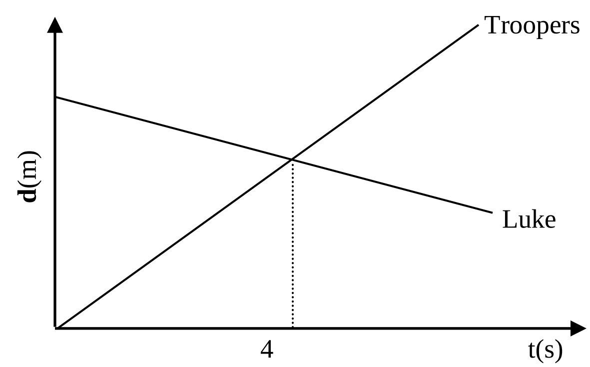
2. At t= 7s, who is ahead? How do you know?

3. Who is travelling faster at 3s? How do you know?

4. Are their velocities equal at any time? How do you know?

5. What is happening at the intersection of the two lines?

In the next dramatic scene, the motion is different:



6. How does Luke's motion in this graph compare to that in the first graph?

7. Who has the greater speed? How do you know?

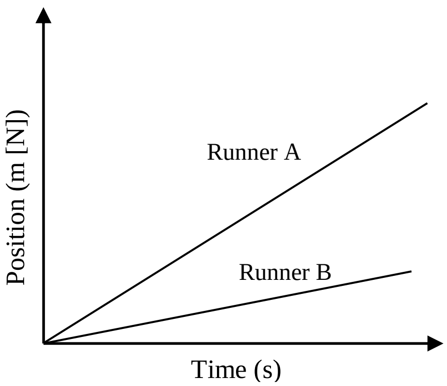
8. Describe what is happening at the intersection of the lines.

9. Who has travelled further during the first 4 seconds? How do you know?

SPH3U: Position-Time Graphs and Velocity

On a **position-time** ($\vec{d} - t$) graph, the slope of the graph represents ___________________.

Graph A

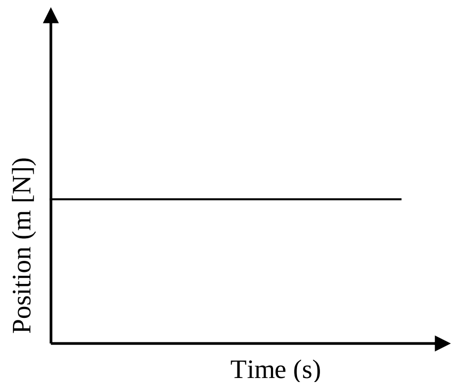


The graphs are **straight:** ______________ velocity.

The **slope** of the graphs are **positive:** objects are traveling in the _______ **direction**.

The **steeper** the slope of the graphs, the _______________ the **velocity**.

Graph B

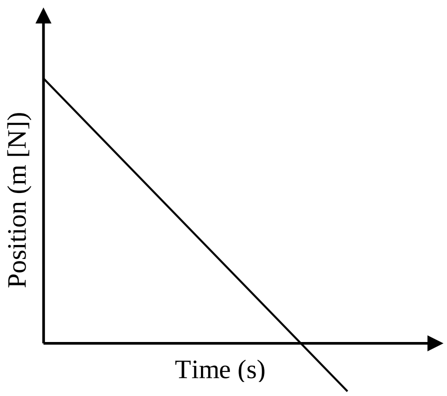


The graph is **straight:** ______________ velocity.

The **slope** of the graph is __________**:** the object is not moving.

The **velocity** of the object is __________.

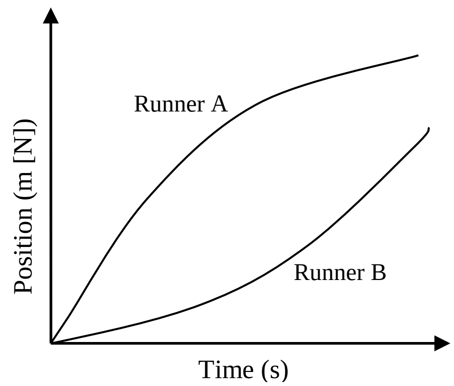
Graph C



The **slope** of the graph is **negative:** object is traveling ____________ the reference point.

The graph is **straight:** ______________ velocity.

Graph D



The **slope** of the graphs are **positive** (objects are traveling in the _______ **direction),** but the graphs are **not straight**: _________________ motion.

The slope of Runner A is decreasing: runner A is

___________________.

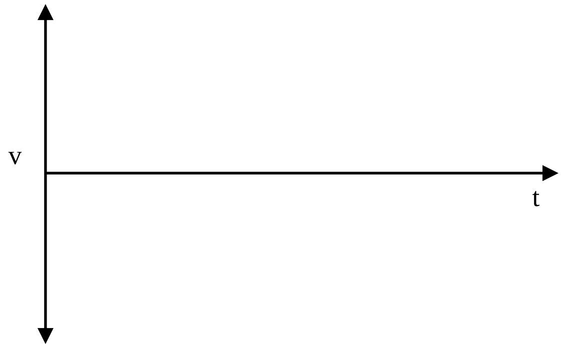
The slope of Runner B is increasing: runner B is

_____________________.

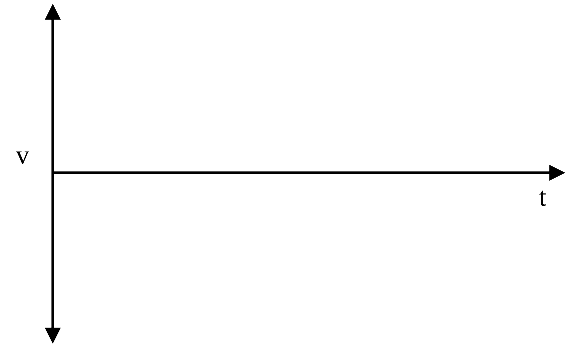
SPH3U: Position and Velocity Graphs Name:

Sketch a motion map and v-t graph corresponding to the following descriptions of the motion of an object.

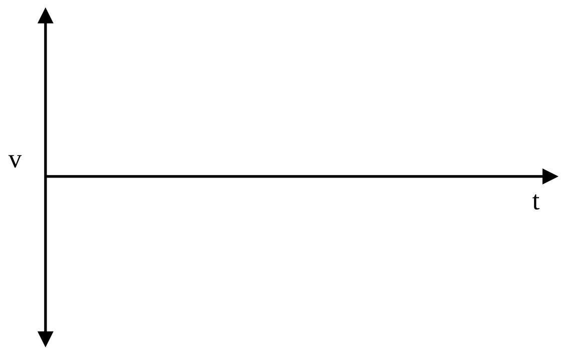
1. The object is moving away from the origin at a constant (steady) speed.



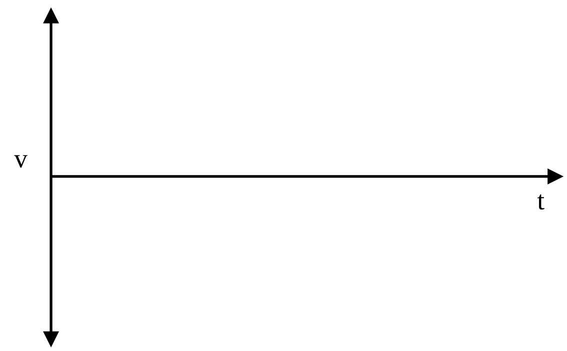
2. The object is standing still



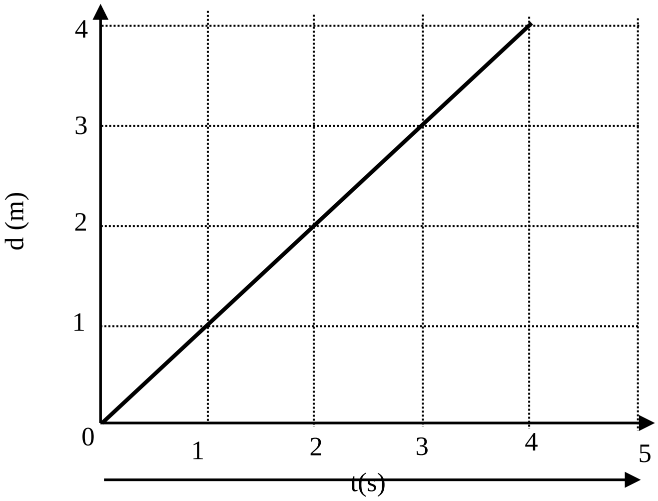
3. The object moves towards the origin at a steady speed for 10 s, then stands still for 10 s.

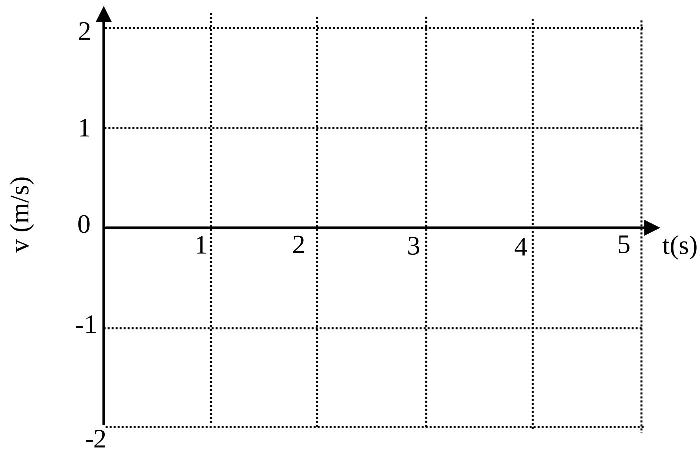


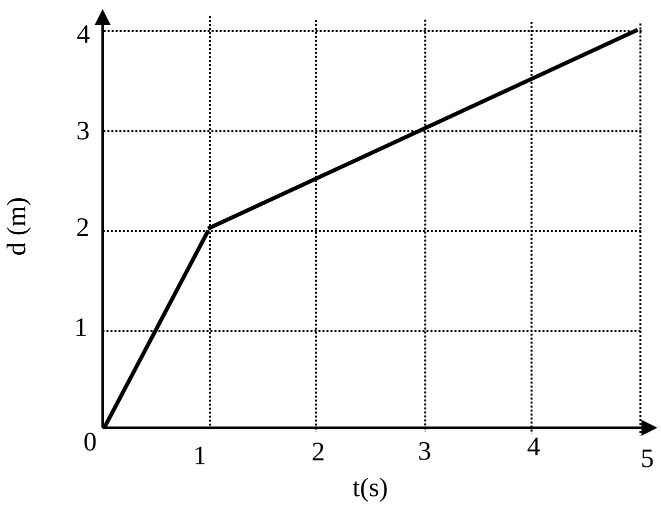
4. The object moves away from the origin at a steady speed for 10 s, then reverses direction and moves back toward the origin at the same speed.

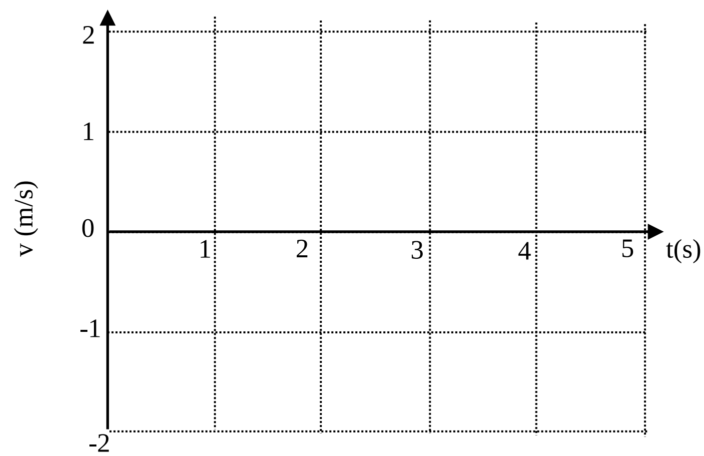


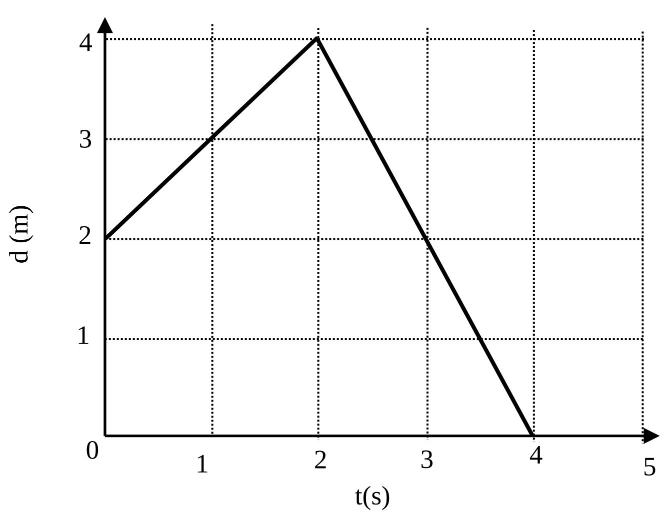
Draw v-t graphs and a motion map for an object whose motion produced the d-t graphs shown below.

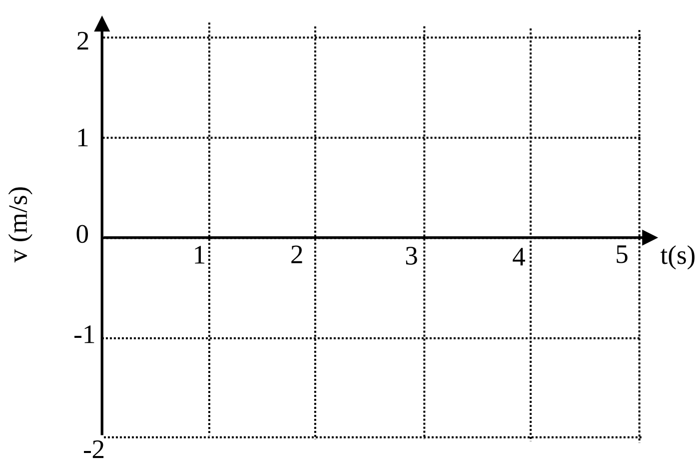




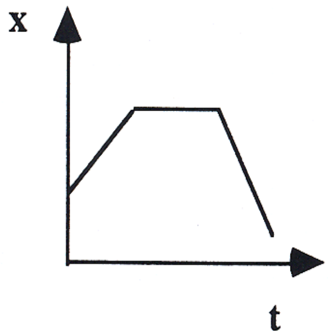
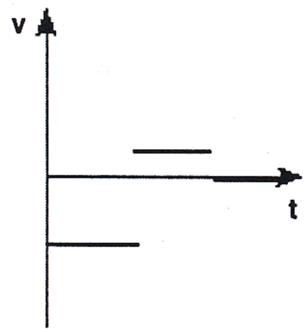
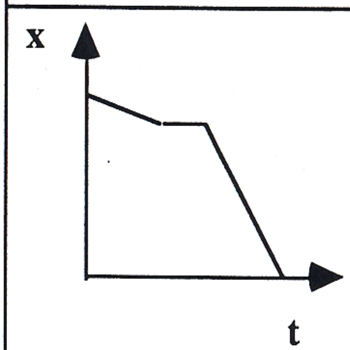
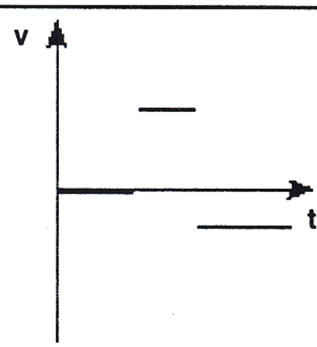


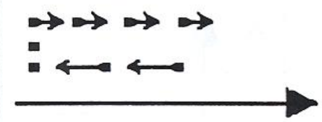






SPH3U: Representations of Motion and Constant Velocity   Name:

x vs. t Graph	v vs. t Graph	Written Description	Motion Map
			
			
			
			

		Object moves with constant positive velocity for 4 seconds. Then, it stops for 2 seconds and returns to the initial position in 2 seconds.	
			
		Object A starts 10m to the right of the origin and moves to the left at 2 m/s. Object B starts at the origin and moves to the right at 3m/s.	
			

SPH3U: Velocity-Time Graphs and Displacement

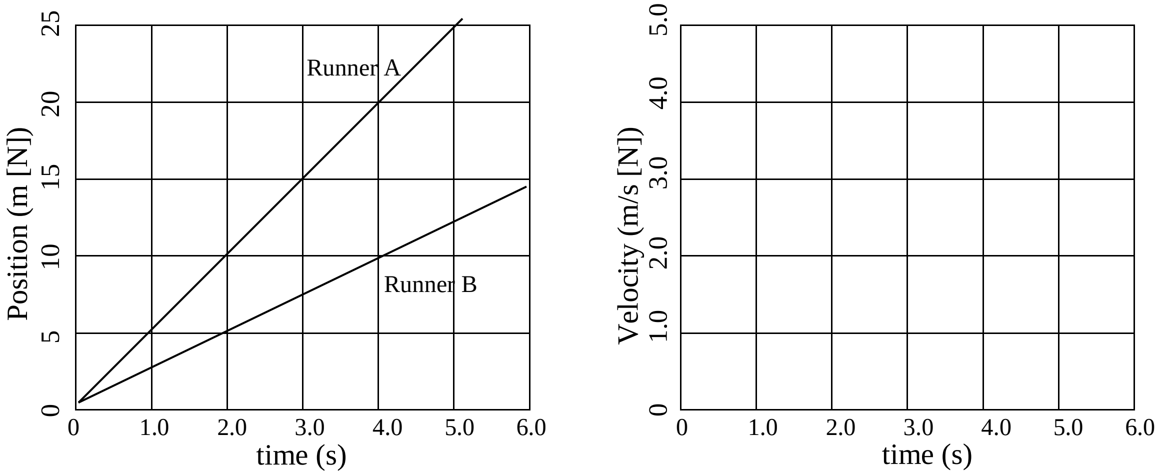
On a **position-time** ($\vec{d} - t$) graph,

1. the **slope** of the graph represents ________________________.

On a **velocity-time** ($\vec{v} - t$) graph,

2. the **slope** of the graph represents ________________________.
3. the **area under** the graph represents _____________________.

Position-Time Graphs and Velocity-Time Graphs



1. What is the **slope** of the **position-time** graph for Runner A?

2. What is the **slope** of the **position-time** graph for Runner B?

3. What is the **displacement** (change in position) of Runner A after 4 s?

4. What is the **displacement** of Runner B after 6 s?

5. What is the **area** under the **velocity-time** curve for Runner A from 0 to 4 s?

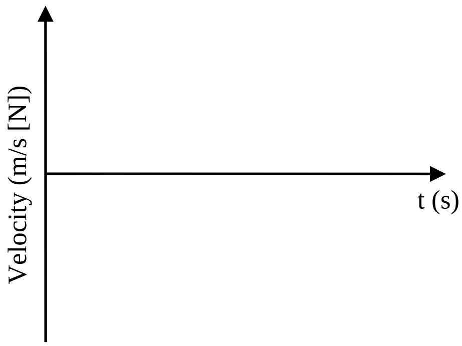
6. What is the **area** under the **velocity-time** curve for Runner B from 0 to 6 s?

7. What is the **slope** of the velocity-time curve for Runner A?

8. What is the **slope** of the velocity-time curve for Runner B?

Sketching Velocity-Time Graphs:

Graph A



Runner A runs at a constant velocity of 2 m/s [N], while Runner B runs at a constant velocity of 2 m/s [S] for 4 s?

What is Runner A’s displacement after 4 s?

Graph B

A runner runs at a constant velocity of 2 m/s [N] for 2 s, and then instantaneously changes direction and runs 2 m/s [S] for another 2 s.

What is the runner’s displacement after 4 s?

Graph C

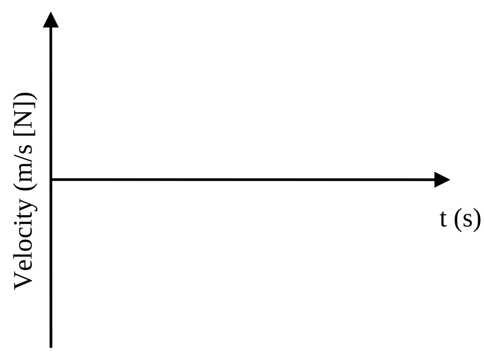
Starting from rest, Bicycle A accelerates smoothly to 5 m/s [N] in 10 s. Starting from rest, Bicycle B accelerates smoothly to 5 m/s [N] in 5 s, and then continues for another 5 s at constant velocity.

What is Bicycle A’s displacement?

What is Bicycle B’s displacement?

If they both have the same starting position, who is ahead after 10 s?

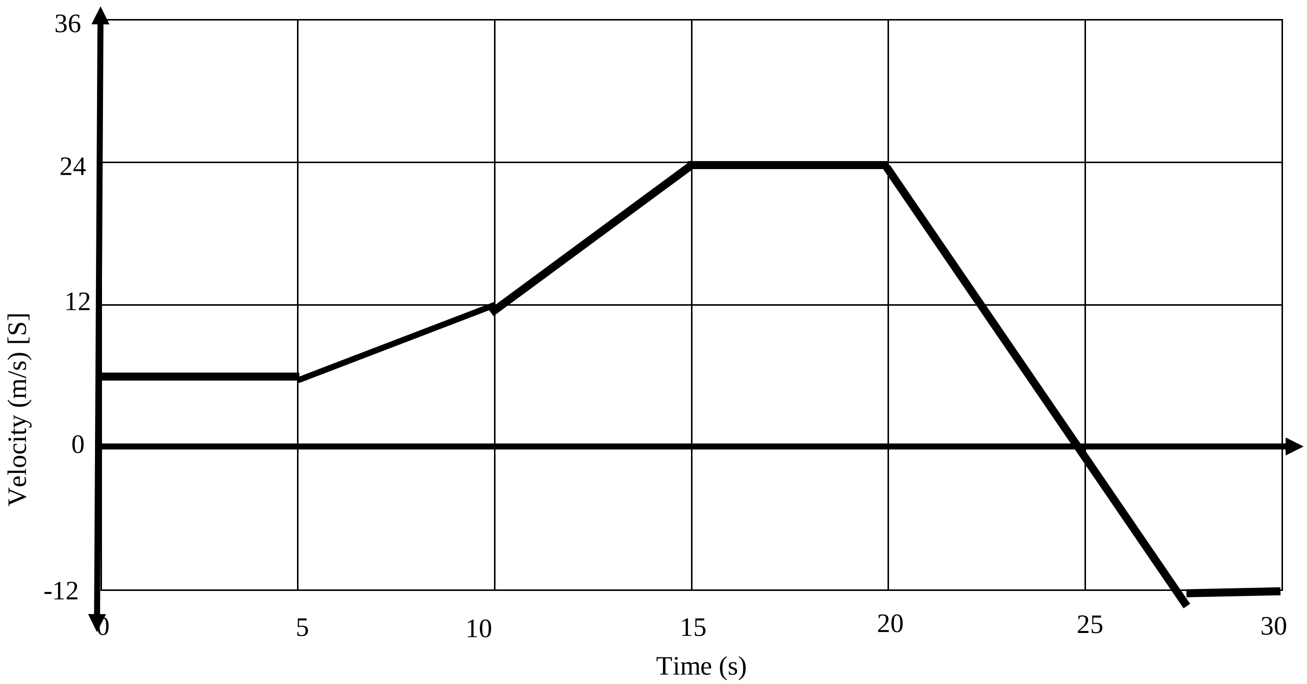
Graph D



A lab cart is pushed so that it coasts up an inclined plane, starting at 5 m/s [N], and then it rolls back down the plane.

What can you say about the area between the graph and the time axis when the lab cart rolls back down to its original position?

SPH3U: Velocity Time Graphs



Questions

0. What was the truck's velocity at 5 s, 15 s, 25 s, 30 s?

1. What was the displacement of the truck in the interval 0 to 5 s?

2. What was the displacement of the truck in the interval 10 to 20 s?

3. What was the displacement of the truck in the interval 25 to 30 s?

4. What was the distance of the entire trip?

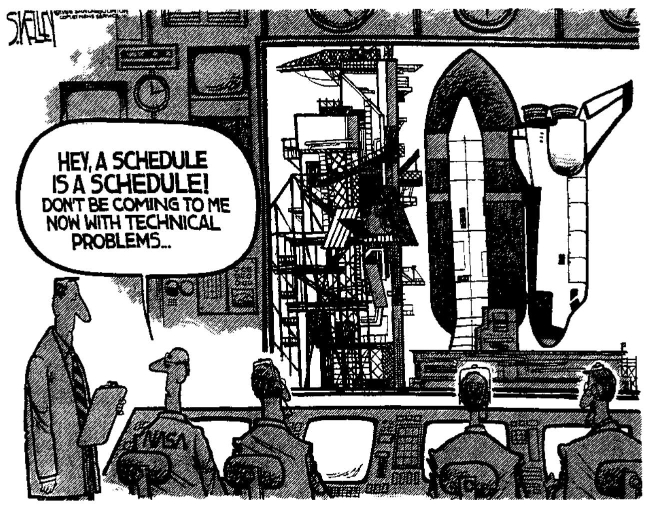
5. What was the average **speed** for the whole trip?

6. What was the **displacement** for the whole trip?

7. What was the average **velocity** for the whole trip?

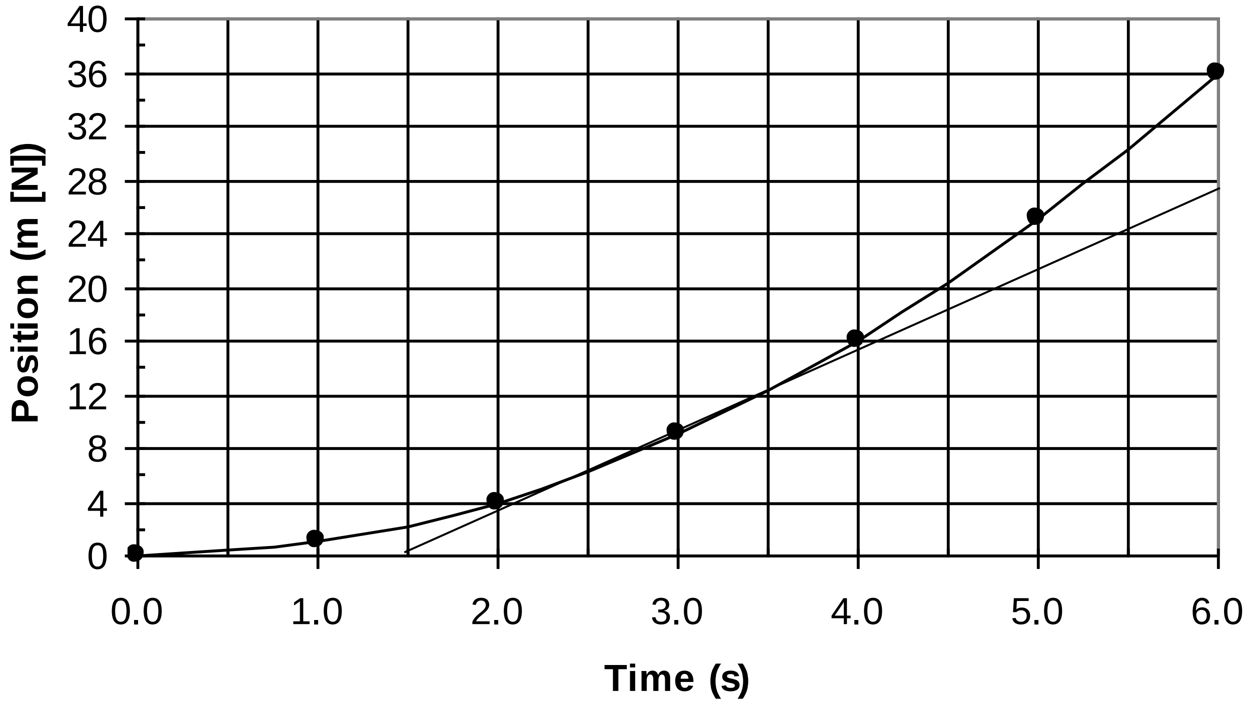
8. In which interval was the acceleration the greatest?

9. During which time intervals is the truck
   a) speeding up?
   b) slowing down?
   c) traveling South
   d) traveling North



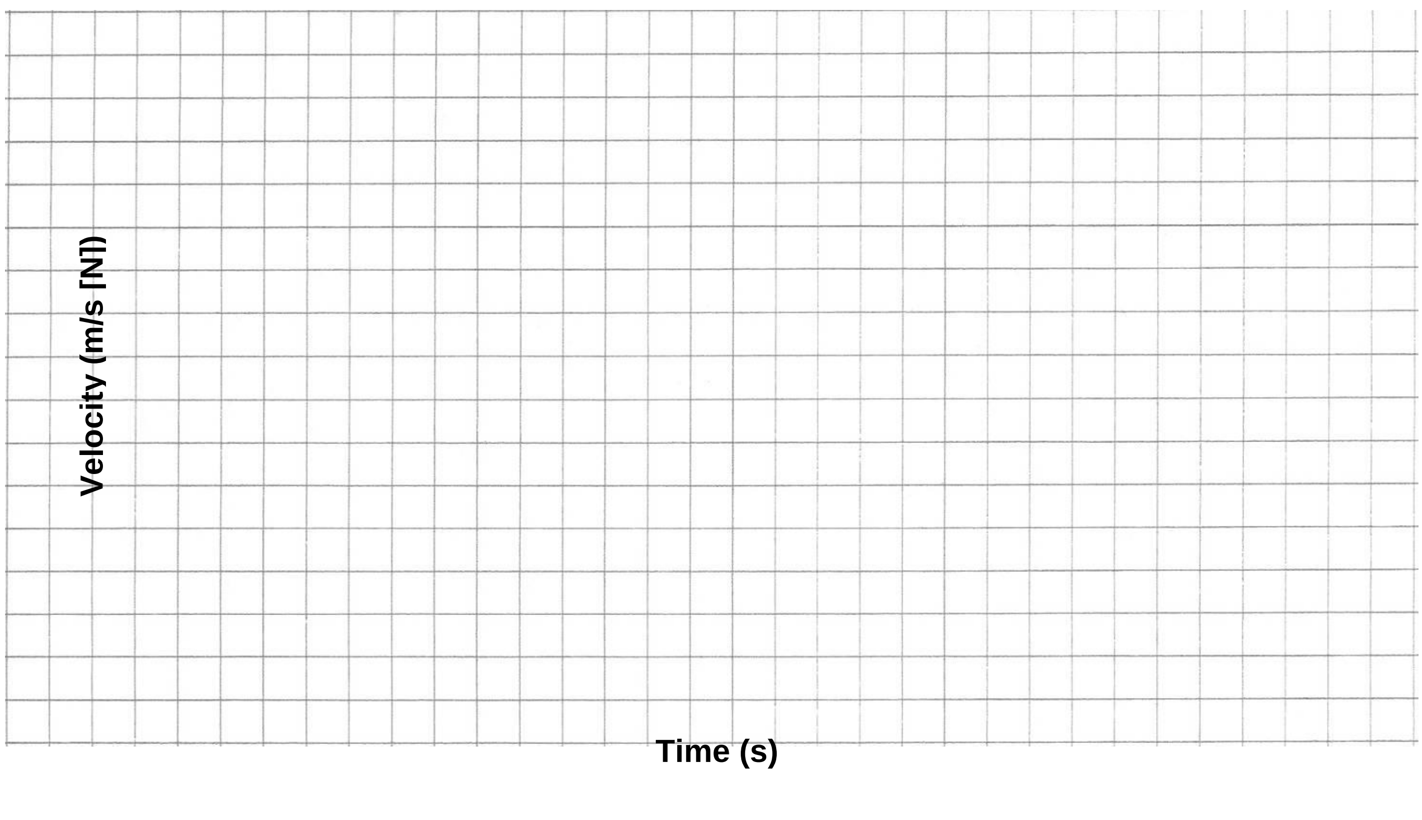
Answers: (0) 6 m/s [S], 24 m/s [S], 0, 12 m/s [N], (1) 30 m[S], (2) 210 m[S], 3. 45 m [N], 4. 390 m, 5. 13 m/s, 6. 300 m [S], 10.0 m/s[S], 8. 20 – 27.5 s, 9. a) 5 - 10s, 10 - 15s, 25 – 27.5s , b) 20 - 25s , c) 0 – 25 s , d) 25 - 30 s

SPH3U: Position-Time Graphs, Instantaneous Velocity, and Acceleration



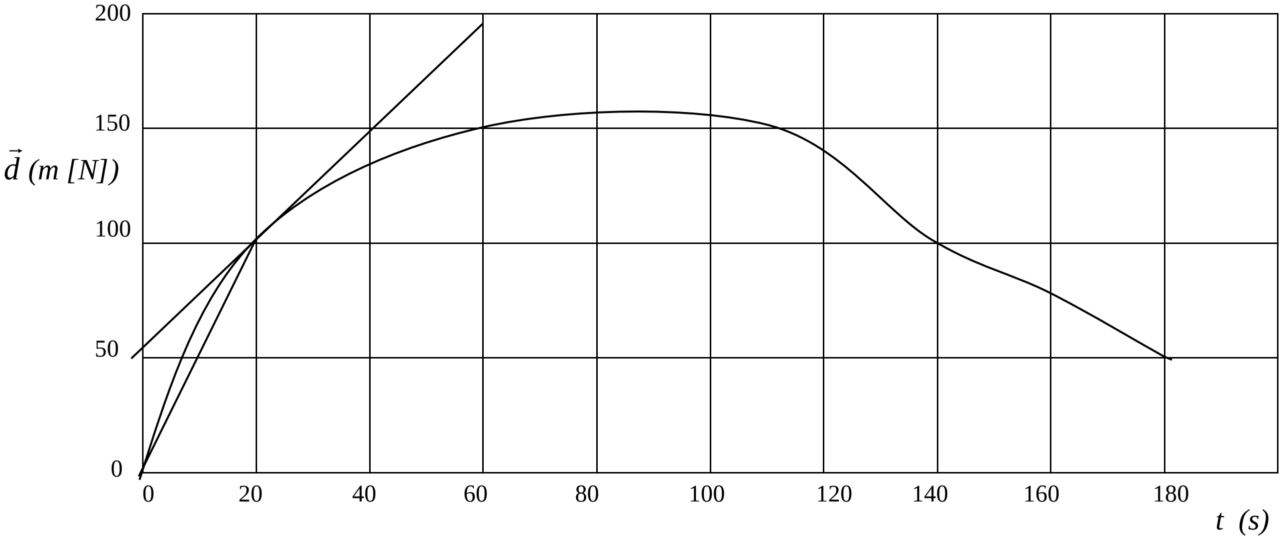
Draw tangents on the position-time graph for at least 4 time points, calculate the slopes of these tangents to find the instantaneous velocities, plot them on a velocity-time graph, and draw a best-fit straight line.

What is the **slope** of your velocity-time graph? What is the **area** under your velocity-time graph from 0 to 6 s? What is the acceleration? What do you notice about the displacement from 0 to 6 s?



Finding Instantaneous and Average Velocity from Position-Time Graphs

Consider the following position-time graph for a scooter:



Over the course of the **entire trip**, the scooter's motion is **non-uniform** (not constant in velocity – the speed and/or direction change) because the graph is not straight.

Instantaneous Velocity: the velocity at a **specific point** in time, calculated by finding the **slope of a <u>tangent line</u> to the curve (graph) at that point.**
A **tangent line** is a straight line which "touches" the curve only at the point of interest, and does not intersect it.

Average Velocity: displacement divided by the time required to complete that displacement; **ignores the actual path** travelled; calculated by finding **the slope of a <u>secant line</u> connecting the starting position and the end position**.
A **secant line** is a straight line which intersects two points on a curve.

$\vec{v}_{ave} = \frac{\Delta \vec{d}}{\Delta t} = \frac{\vec{d}_2 - \vec{d}_1}{t_2 - t_1}$, where Δd is the displacement (change in position), and Δt is the change in time

Worked Examples from the Graph:
A tangent line and secant line for t = 20 s have been drawn for you, and sample calculations for instantaneous and average velocity are shown. Find the instantaneous and average velocities for t = 80 s and t = 180s by drawing tangent and secant lines.

Timepoint (s)	Instantaneous Velocity	Average Velocity (from t = 0 s)
t = 20 s	$\vec{v}_{inst} = \frac{195-50}{60-0} = 2.4$ m/s [N]	$\vec{v}_{ave} = \frac{100-0}{20-0} = 5$ m/s [N]
t = 80 s		
t = 180 s		