Bag of Cars Lab

Materials:

- one pull-back car
- one hot wheels car
- one battery car

Purpose:

To explore ideas about motion – *how* objects move not *why* they move.

Directions:

4. Observe the motion of each of the cars, and write a description of the motion of each type of car. Describe the <u>motion</u> of the car - not the car or what makes it do what it does.

Pull back car

Hot wheels car

Battery car (the big one)

5. Which type of motion do you think is easiest (or simplest) to study, and why?

6. List a few words that you have used when you described the motion of the cars and that you think are important.

Bubble Lab

Materials:

- Color Bubble Tubes (three tubes per group)
- Metronome
- Metric tape measures
- Dry erase marker
- Masking tape

Purpose:

To investigate how a bubble of air moves in a bubble tube.

Pre-Lab discussion:

1. Hold the tubes vertically and observe the motion of the bubbles in the three tubes individually. After each bubble has reached the top of the tube, hold the three tubes together and turn the tubes over at the same time. make sure the bubbles start from the same height relative to the table. Observe the motion of the bubbles. Make 3-5 observations of how the bubbles move. Compare and contrast their motion.

2. Do all bubbles go the same speed? How do you know?

3. What quantities can you measure or determine for the motion of the bubbles?

4. How would you go about measuring the speed of the bubble?

5. Do you think the bubble's speed is the same in the tube or does it change as the bubble travels up? How could you figure this out?

Directions:

6. Design an experiment to investigate the motion of the bubble as it travels up the tube. The experiment should allow you to obtain a graph of position vs. time for each bubble tube. Time should be the independent variable in this experiment.

Note: Stick a long strip of masking tape on the tube and mark on it. Save the tape (stick it on your table).

a) Experimental question:

b) Independent variable:

c) Dependent variable:

d) Constants:

e) Hypothesis:

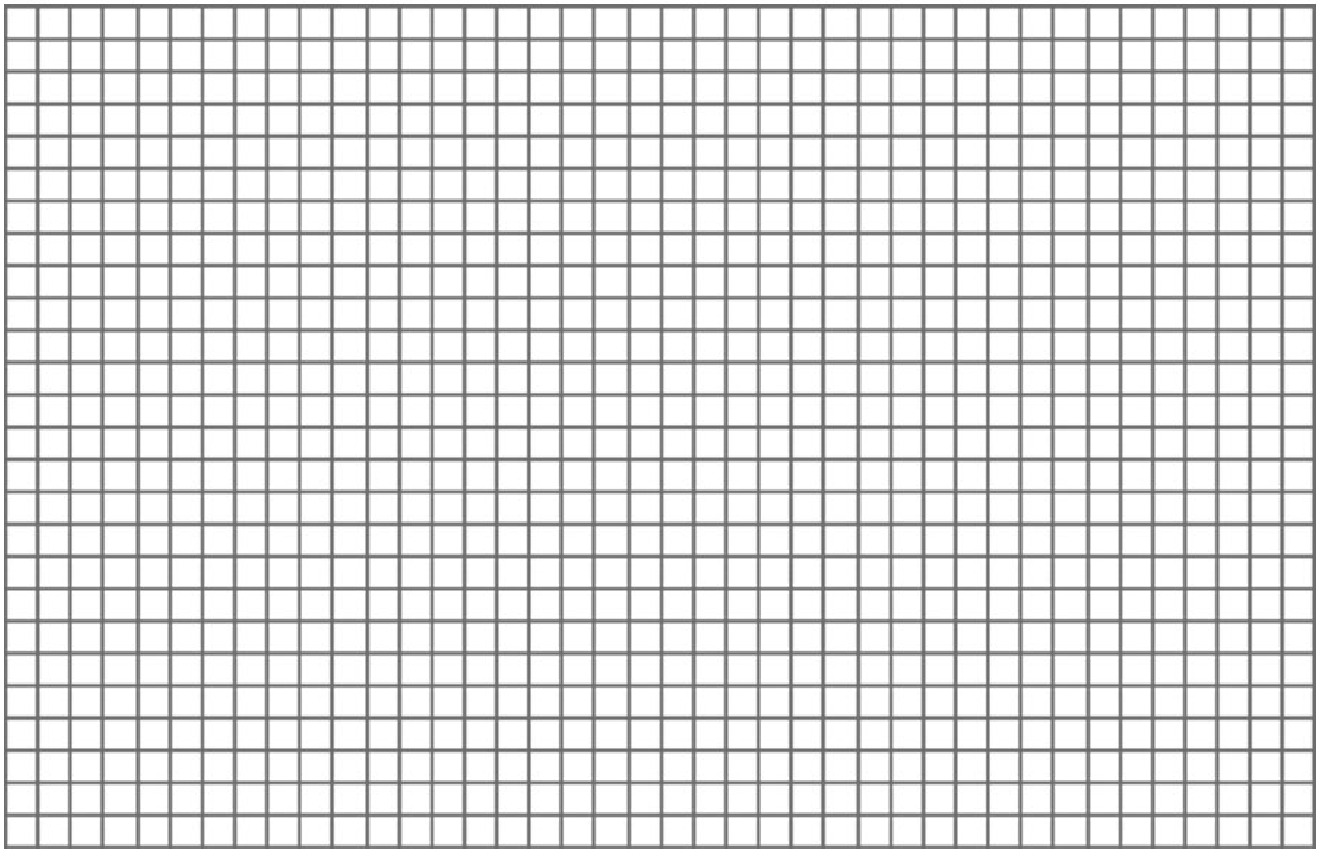
f) Materials List:

g) Procedure:

h) Data table:

i) Graph the data (for each tube) on the same graph. Make sure you use as much of the graph paper as possible (make your graph as big as possible). Do not forget to label your axes and include the units for the graphed quantities.

Title of graph:



7. Analyze your graph:

a) How are the graphs for the tubes similar?

b) How are the graphs for the tubes different?

c) Why do you think that some lines are steeper than others?

d) Look at the positions (lines or dots) marked on the tube and look at the graphs. Can you make a connection between the distance between the marks and the steepness of the graphs?

e) What do you think that marks that are more spread out means? If the positions/marks are closer together, what does this mean?

f) The steepness of each line can be described by the slope of the line. Calculate the slope of each line you obtained. Remember that slope is rise/run.

g) What are the units for the calculated slope? (hint: check the units for the rise and run). What do you think that the slope represents?

h) Did the line go through the origin (0,0) of the graph? If not, why not? (Hint: where was the bubble at t=0?)

i) Did your results confirm your hypothesis?

8. Summarize what you have learned from this experiment.

Battery Car Lab

Materials:
- Battery powered vehicle
- A ruler or tape measure with markings in feet
- (Web) metronome or flashing light
- Spark timer (alternate method)
- Clay (make small balls or patties) or washers
- Masking tape

Purpose:

How can we pictorially represent uniform motion?

Pre-lab discussion:

1. Start the vehicle and observe what it does.
   a) Write your observations (in words).

   b) What factors of the car's motion can you measure? How will you measure them? What materials will you need to measure them?

   c) Does the car travel in a straight line? If it does not, run the car along a wall or use the curved path of the car as your position axis (imagine a bent meter stick).

   d) Measure length in terms of floor-tiles or feet, and measure time in "flashes" or "blinks." [Alternate method: use the spark timer, set at 10 Hz. As the car pulls the tape through the spark timer, it makes a spot on the tape every 1/10th of a second.].

   e) What data or information do you need to convert your measurements to meters and sec? Take data to make conversions before you finish the experiment.

Directions:

2. Design an experiment to study the car's motion as a function of time. [Units: you may use "flashes" for time and "floor tiles" or "feet" for position]. Your documentation should contain:

   a) Experimental question:

   b) Independent variable:

   c) Dependent variable:

d) Constants:

e) Hypothesis:

f) Procedure:

g) Data Table:

h) Plot your data in a graph, and draw a smooth line through the data points:

Title of graph:

3. Analysis of data and conclusions

   a) Calculate the slope of the graph (rise/run) from the smooth line you drew through the data points.

   b) What does the slope represent? What units does it have?

   c) Convert the units of the slope to a standard unit (m/sec). How would you make these calculations?

   d) From the graph, figure out a mathematical relationship that connects the speed, change in position and time interval.

4. Producing Motion Diagrams:

   a) Run the car down the floor again, if necessary, and place a washer or clay patty on the floor beside the car every time the clock ticks. [If you are using the spark tape, examine the marks on the tape].

   b) Represent this motion in a diagram. Use the x-axis drawn below. Then indicate the position of the car with a small circle at each clock tick.

   c) What do you notice about the diagram you drew above?

5. Discussion questions:

   a) From your observations and your graph, figure out where the car will be at clock tick 27? Explain your reasoning.

   b) Figure out how much distance the car would travel between clock tick 27 and clock tick 30. Explain your reasoning.

   c) Write one statement about how distance and time are connected to each other when objects move with a steady speed.

6. Summarize what you learned from this activity.

7. Connections: What did you learn in this lab that is similar to the bubble tube lab?

Detecting Motion Lab

Materials:
- Motion Detector
- Masking Tape

Purpose:

To produce motion graphs using the ultrasonic motion detector; to have a kinesthetic experience to relate to a word description, graph and motion diagrams.

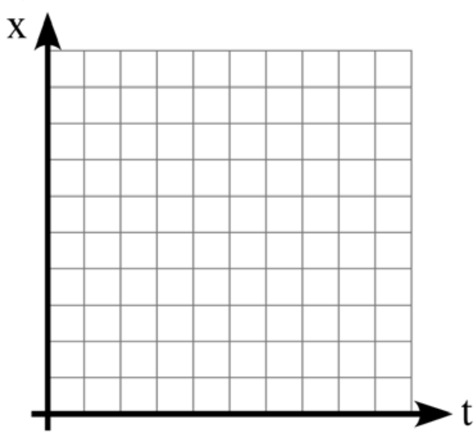
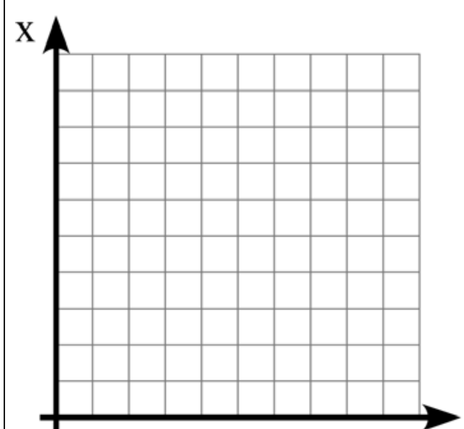
Pre-lab discussion:

1. The equipment: The motion detector (also called a sonic ranger) uses ultrasound to measure distance. The box “shoots” ultrasonic pulses (of pitch beyond the range of human hearing). When the waves hit an object, they are reflected, and then detected by the motion detector. The time it takes for the reflected pulses to return is used to calculate position and velocity. These factors are then plotted on a graph. Sonic rangers work just like the sonar bats use to detect food. Bats have very poor eyesight and rely on their sonar to catch flying insects to eat.

First learn how to “zero” the detector. Hold a whiteboard about 6” from the front of the motion detector, click zero in the software window. This is the position the motion detector will take as x = 0. This needs to be done only once (unless you want to move the zero position). Check out how the software works, and what the graphs of motion look like.

Part I – Directions:

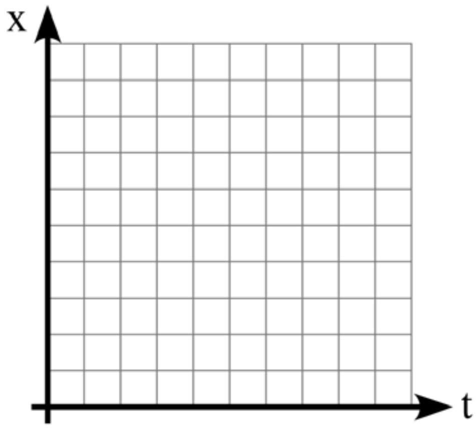
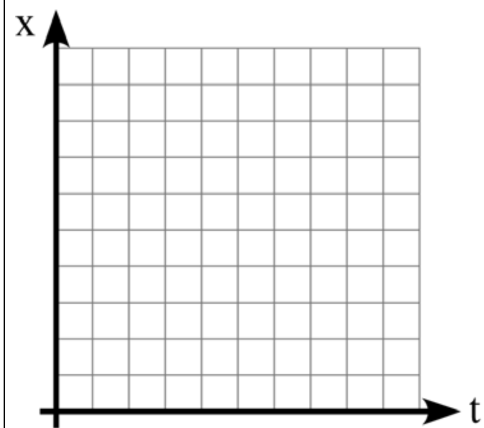
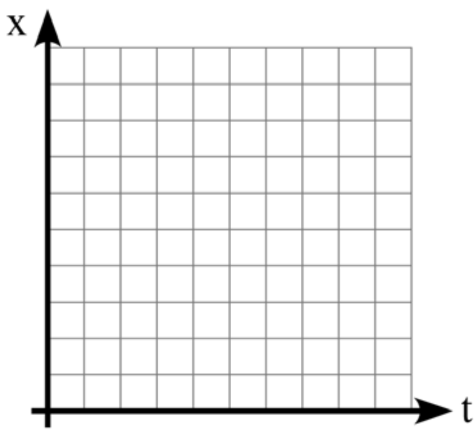
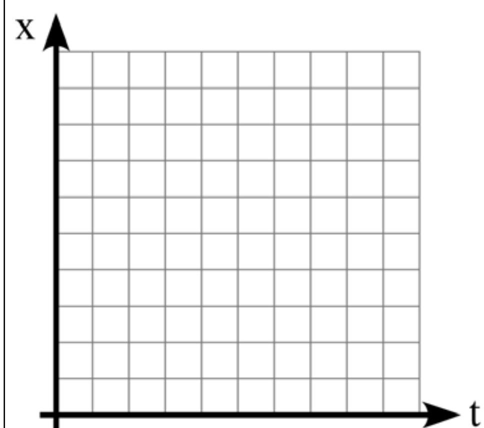
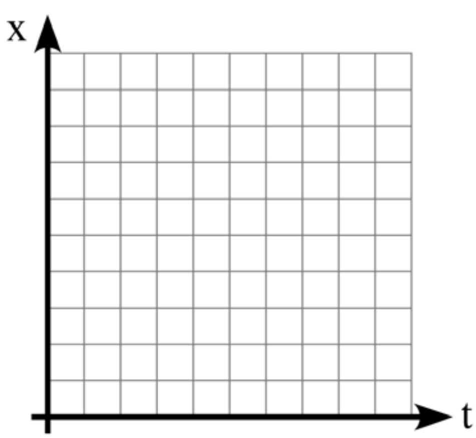
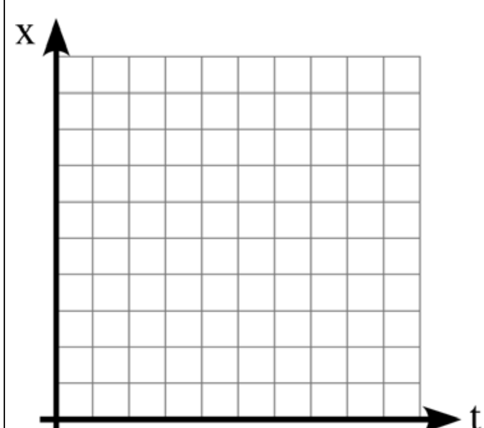
2. Make and test predictions for each of the situations below:

Make Predictions	**Test Predictions**
2A. Predict a graph of a person walking toward the motion detector at a constant speed: 	What you observed: 

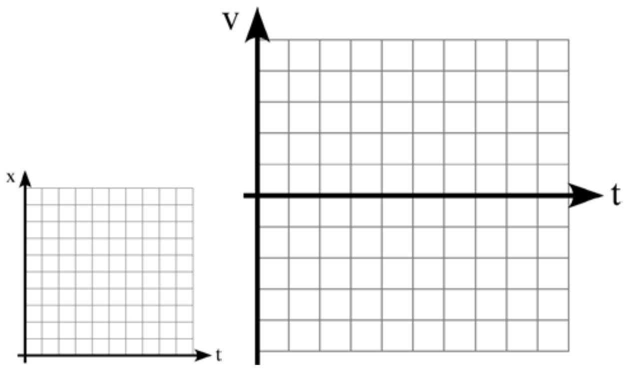
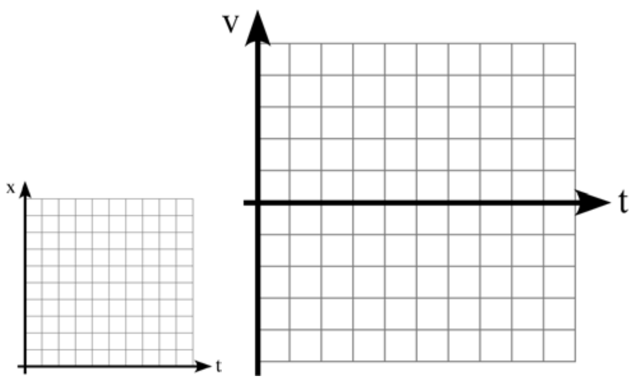
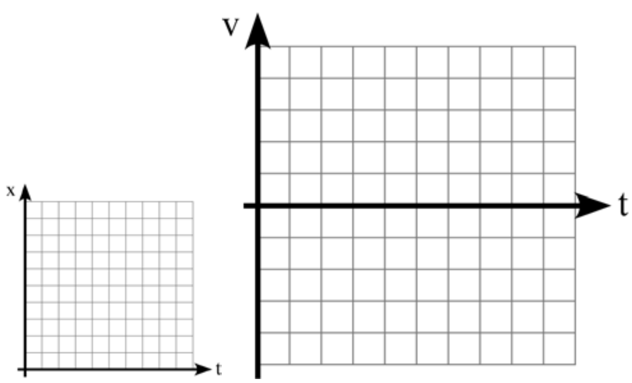
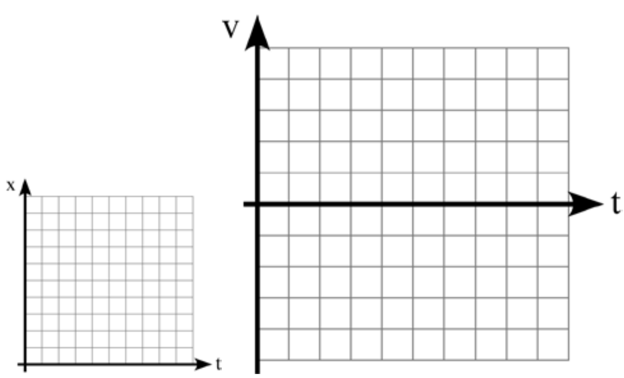
Note:

Speed and *Velocity* have the same amounts or magnitudes. Velocity, however, includes information on direction.

- A positive slope on an x-t graph indicates a velocity in the positive direction
- A negative slope on an x-t graph indicates a velocity in the negative direction.

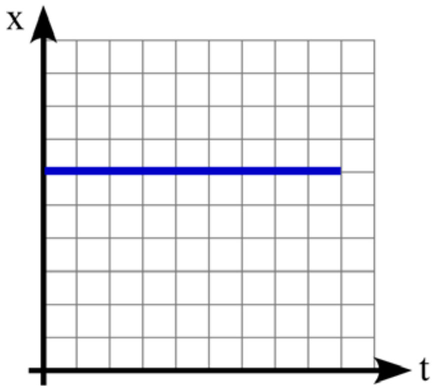
Make Predictions	Test Predictions
2B. Predict a graph of a person walking away from the motion detector at constant speed. 	What you observed: 
2C. Predict a graph of a person walking toward the motion detector at a slow speed then away at a slow speed. 	What you observed: 
2D. Predict a graph of a person walking toward the motion detector at a fast speed then away at a fast speed. 	What you observed: 

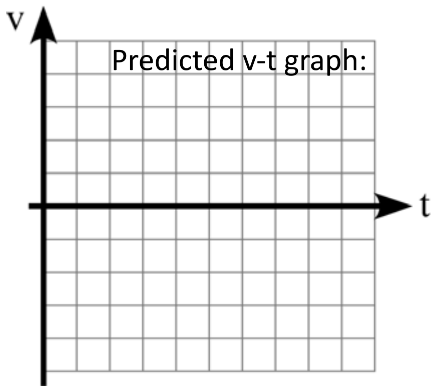
3. Copy the x-t graphs from the step 2 into the small graphs below. Then draw the v-t graph you expect for A, B, C and D, and explain your reasoning

3A. 	Because
B. 	Because
3C. 	Because
3D. 	Because

Part II – Directions:

4. Examine the position vs. time graphs provided below. Predict the v-t graph and then try it. Include the following in your description: starting position, direction of motion, type of motion.

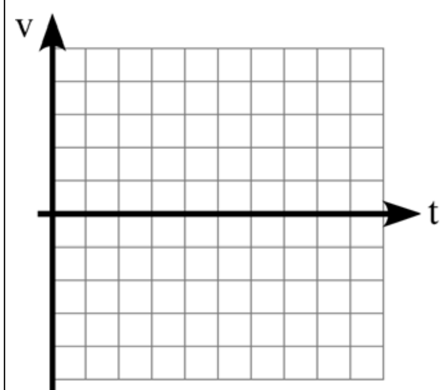


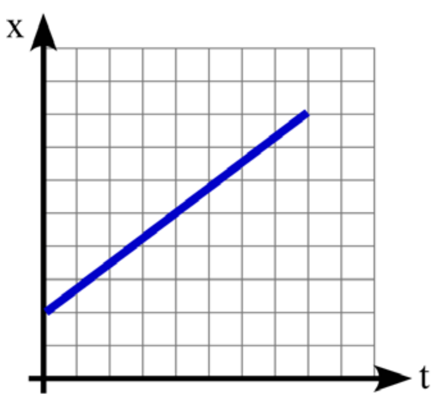


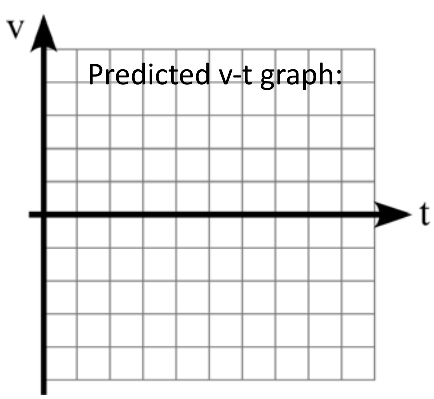
4A. Predict what you need to do to obtain the x-t graph shown. Include starting position, direction of motion and type of motion.

Now try it. What did you do?

Sketch the v-t graph you obtained



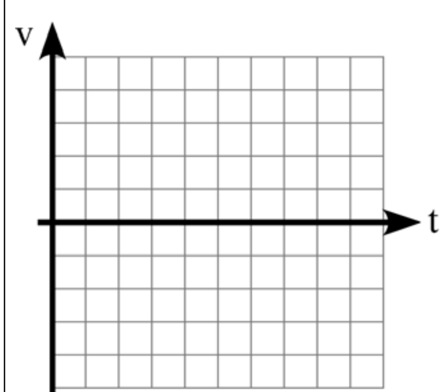


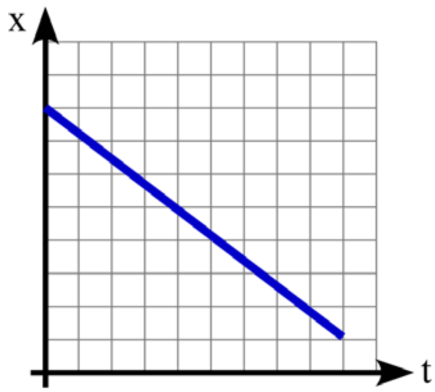


4B. Predict what you need to do to obtain the x-t graph shown: Include starting position, direction of motion and type of motion.

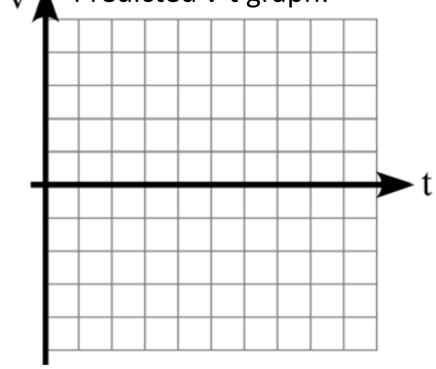
Now try it. What did you do?

Sketch the v-t graph you obtained





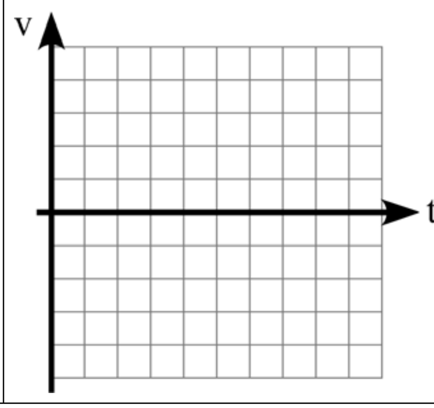
Predicted v-t graph:

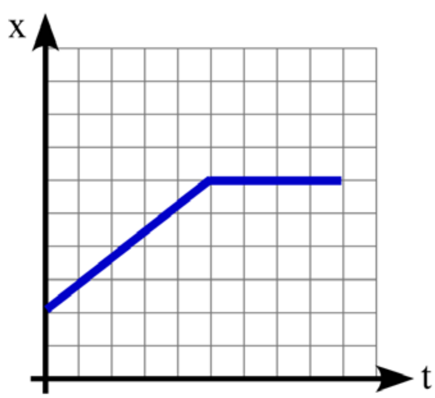


4C. Predict what you need to do to obtain the x-t graph shown: Include starting position, direction of motion and type of motion.

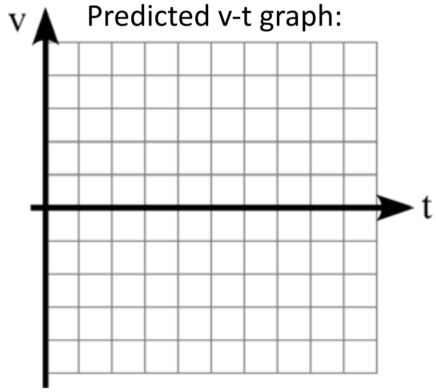
Now try it. What did you do?

Sketch the v-t graph you obtained





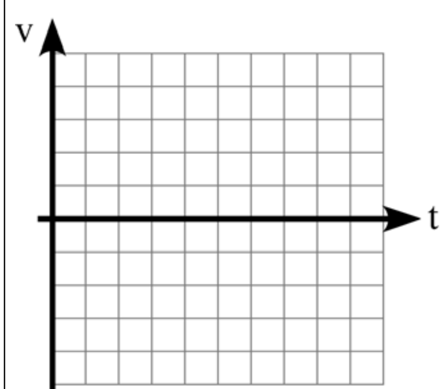
Predicted v-t graph:

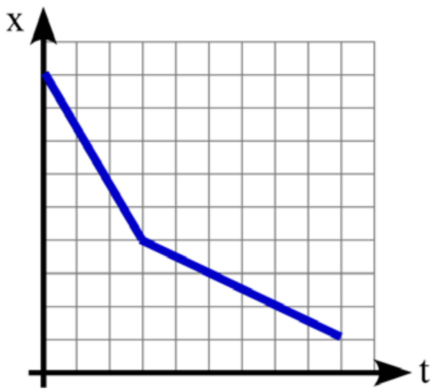


4D. Predict what you need to do to obtain the x-t graph shown. Include starting position, direction of motion and type of motion.

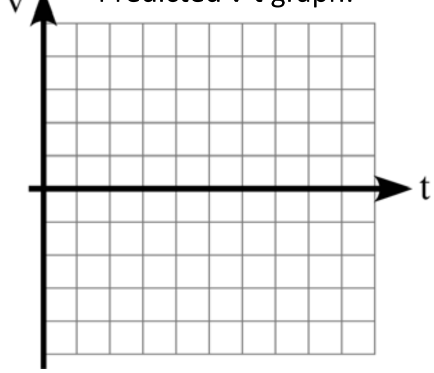
Now try it. What did you do?

Sketch the v-t graph you obtained





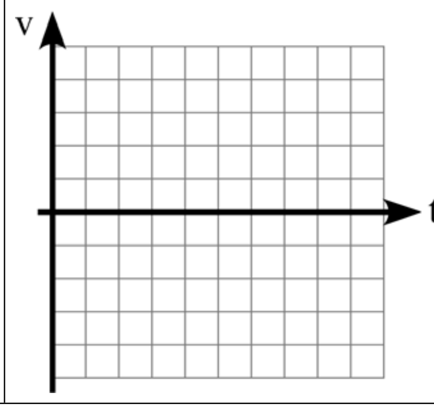
Predicted v-t graph:

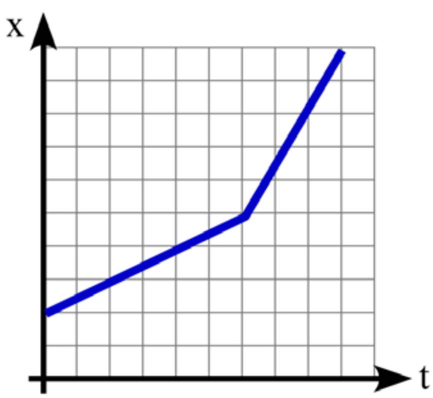


4E. Predict what you need to do to obtain the x-t graph shown. Include starting position, direction of motion and type of motion.

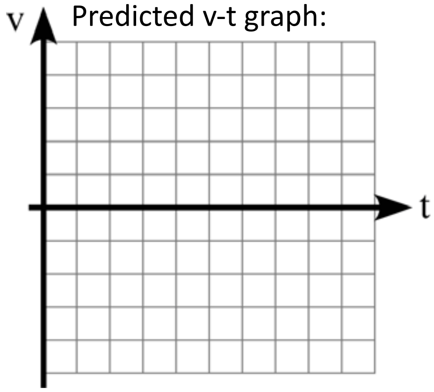
Now try it. What did you do?

Sketch the v-t graph you obtained





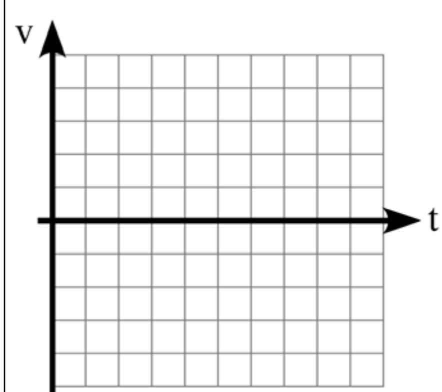
Predicted v-t graph:



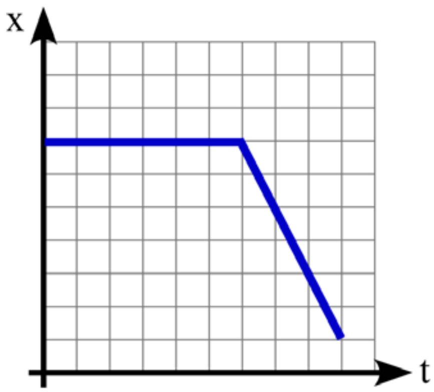
4F. Predict what you need to do to obtain the x-t graph shown. Include starting position, direction of motion and type of motion.

Now try it. What did you do?

Sketch the v-t graph you obtained

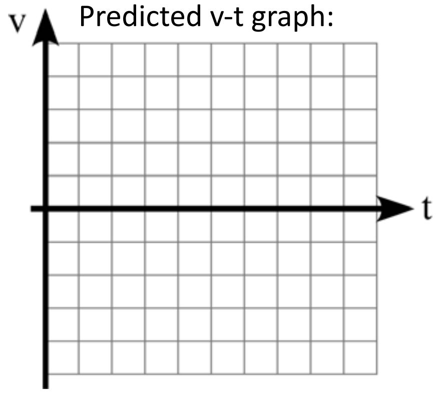


4G. Predict what you need to do to obtain the x-t graph shown. Include starting position, direction of motion and type of motion.

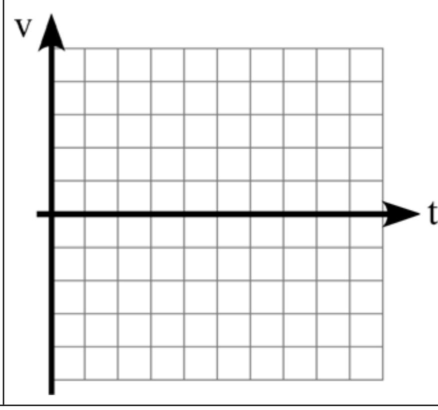


Now try it. What did you do?

Predicted v-t graph:

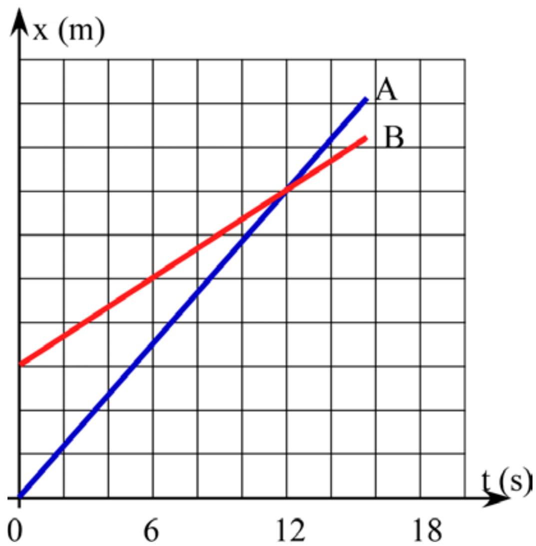


Sketch the v-t graph you obtained



Motion of Two Bikers – Theoretical Lab

1. The motion of two cyclists is shown by the x-t graph below.

Graphical representation of A and B	Draw a motion diagram for A and for B:
	

2. Examine the position vs. time for cyclists A and B again.
   a) Do the cyclists start at the same point? How do you know? If not, which is ahead?

   b) At t= 14 s, which cyclist is ahead? How do you know?

   c) Are their speeds equal at any time? How do you know?

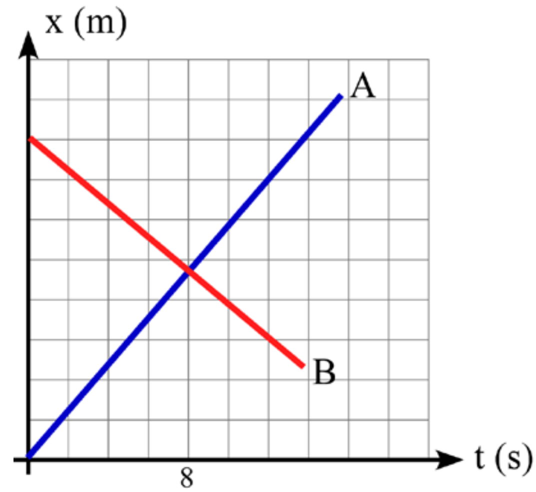
   d) Which cyclist is traveling faster at t = 8 s? How do you know?

   e) What is happening at the intersection of lines A and B?

3. Examine the position vs. time graph below for cyclists A and B.

a) How does the motion of the cyclist A in this graph compare to that of A in the previous graph?

Graphical representation:



b) How does the motion of cyclist B in this graph compare to that of B in the previous graph?

c) Which cyclist has the greater speed? How do you know?

d) Describe what is happening at the intersection of lines A and B.

e) Which cyclist traveled a greater distance during the first 5 seconds? How do you know?

f) Draw a motion diagram for both cyclists.

Toy Car Application Lab

Purpose: How can we predict where the paths of two cars intersect?

Materials:
- Fast toy car
- Slow toy car
- stopwatches
- approx. 20 ft. of floor tiles or other non-standard scale set up on floor

Pre-lab discussion

1. You have two cars - one of which moves slower than the other. The cars will be moving toward each other at two different constant velocities from a known distance apart. You will have to determine all quantities necessary. You will then have to calculate where on the floor the cars will pass each other, and place a marker at that point on the floor.

2. Class groups will work together. Use the materials given. The purpose is to determine where they will hit (or at least pass each other) by placing a marker on the floor. You will be allowed to work with one car at a time. Once data has been gathered from one car and you begin working with the second car, you cannot work with the first car.

Your lab notes: