Name: ______________________________

Constant Acceleration Model

Physical Quantity	Description	Symbol	Units

CAPM Model Summary

Ramp and Cart Experiment

Sketch and label the experiment setup:

What could we measure? How could we measure it?

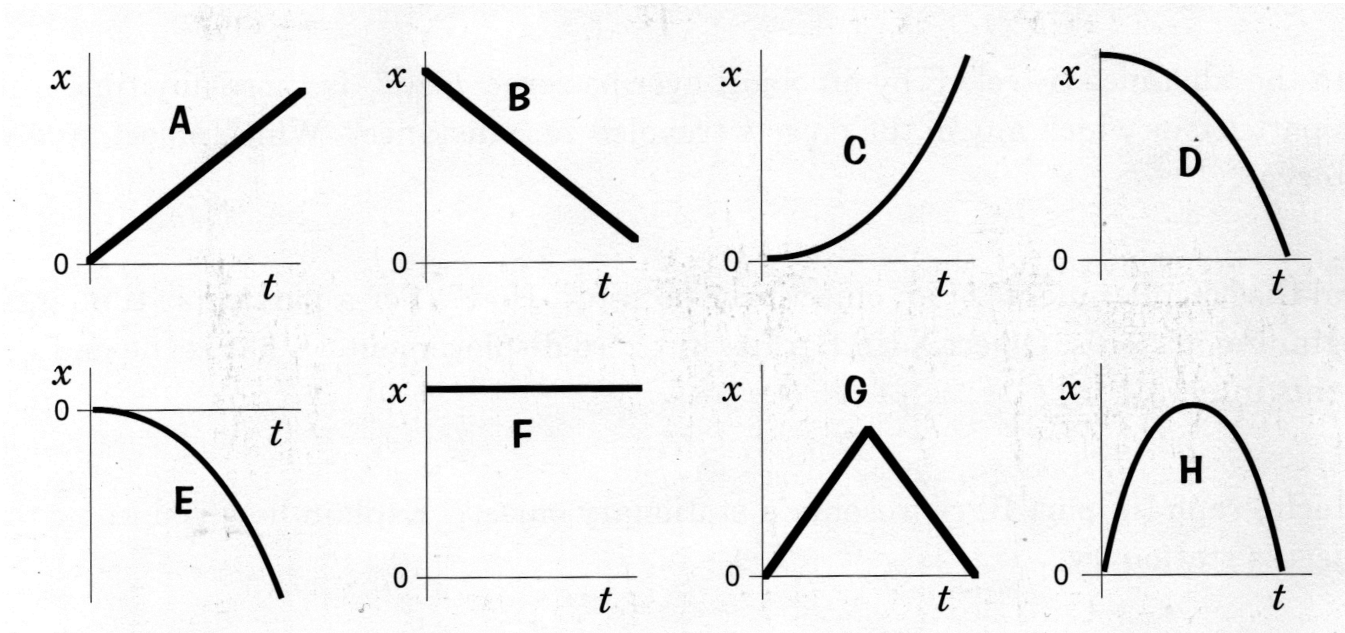
Make sketches of the graphs that the motion sensor and Data Studio make. Do this only **after** your teacher gives you the OK upon checking your computer screen. Remember to do several trials before asking your teacher to check.

Ramp & Cart Experiment (Post-Lab)

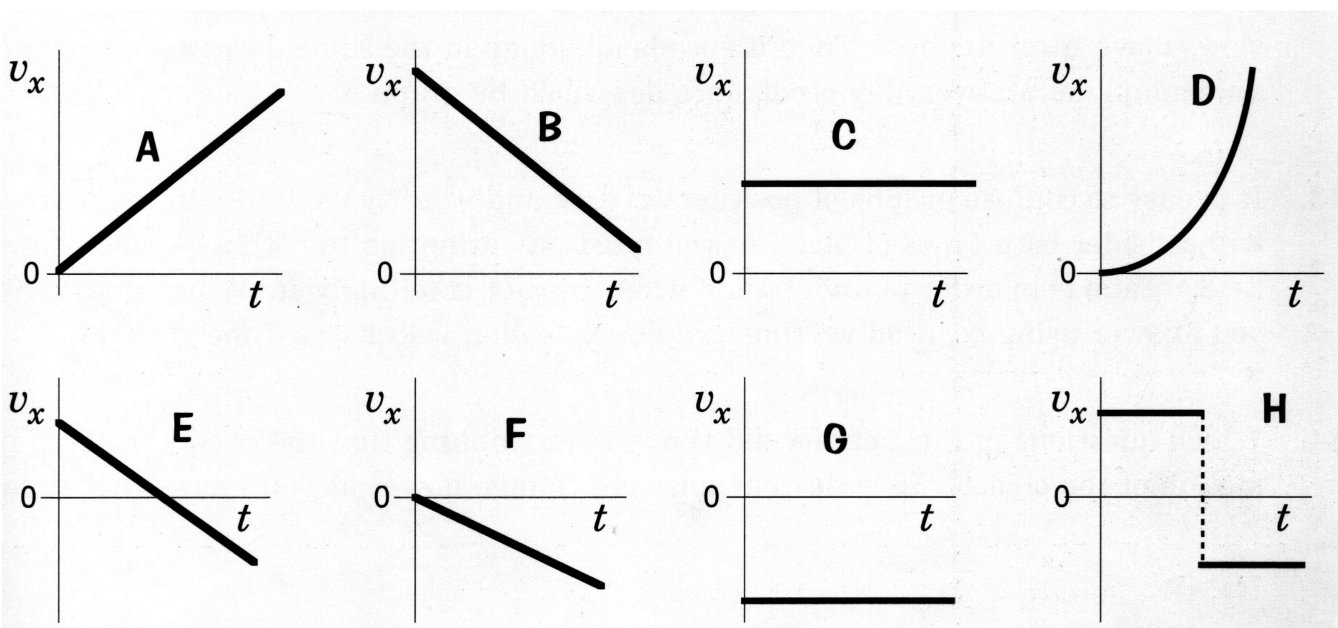
Unit I Constant Velocity Model	Unit III Constant Acceleration Model

Walk-A-Graph

From Minds-On Physics



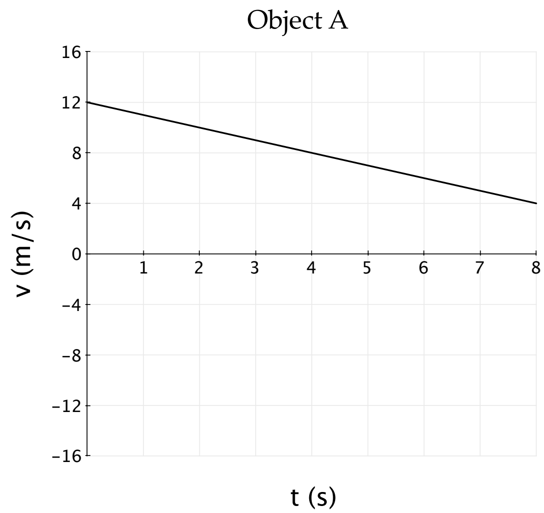
(1) A marble is rolled at constant speed along a horizontal surface toward the origin. The marble is released at a distance of 1 meter away from the origin.
(2) A block sits at rest on a table 1 meter above the floor. Take the origin to be the level of the floor.
(3) A ball is dropped from a height of 2 meters above the floor. Take the origin to be the point from which the ball is released.
(4) A ball is rolled along a horizontal surface. The ball strikes a wall and rebounds toward the origin.
(5) A car is parked on a steep hill.

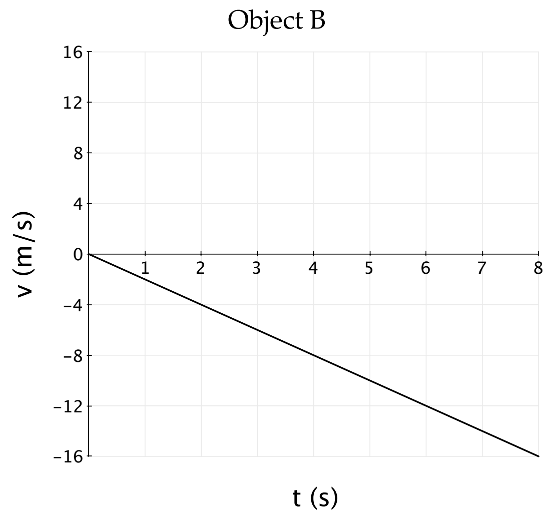


(1) A block is dropped from rest with a height of 1 meter above the floor. Take the origin to be at the level of the floor.
(2) A marble is released from the top of an inclined plane. Assume that positive x is measured down the plane.
(3) A ball is thrown straight up into the air. Take the origin to be at the level of the floor.
(4) A ball rolls along a horizontal surface without changing speed. The ball strikes a wall and rebounds toward the origin at approximately the same speed as before.
(5) A marble rolls on to a piece of felt, eventually stopping.

Worksheet 1: Graphs of Motion with Changing Velocity

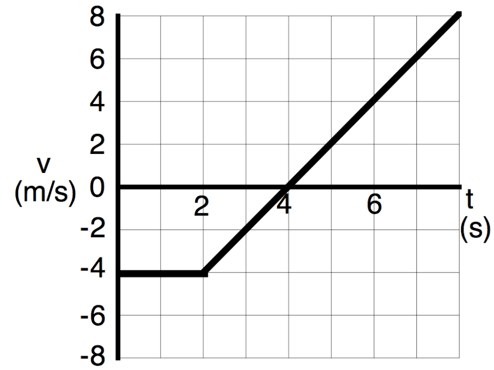
1. Consider the velocity-vs-time graphs and describe the motion of the objects.





Determine the displacement between 4 and 8 seconds. Show work!		
Determine the average acceleration during the first 3 seconds. Show work!		
Describe the motion in words.		
Sketch a motion map. Be sure to include both velocity and acceleration vectors.		

2. Use the velocity-vs-time graph to analyze the motion of the object.



a. Give a written description of the motion.

b. Sketch a motion map. Be sure to include both velocity and acceleration vectors.

c. Determine the displacement of the object from $t = 0$ s to $t = 4$ s.

d. Determine the displacement of the object from $t = 4$ s to $t = 8$ s.

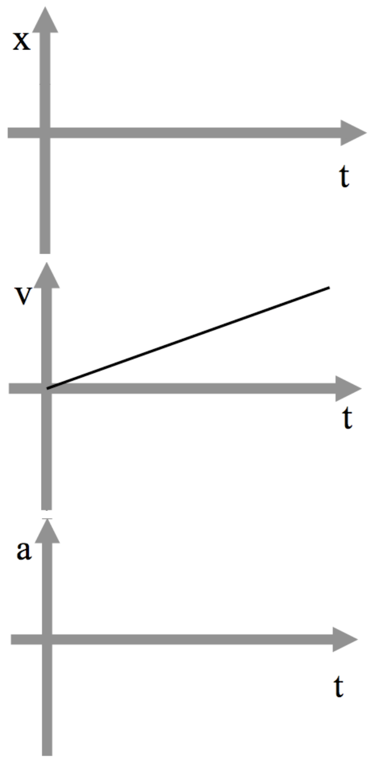
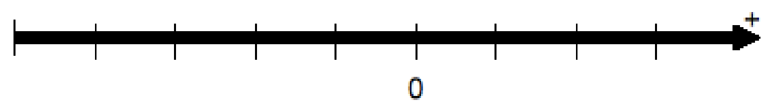
e. Determine the displacement of the object from $t = 2$ s to $t = 6$ s.

f. Determine the object's acceleration at $t = 4$ s.

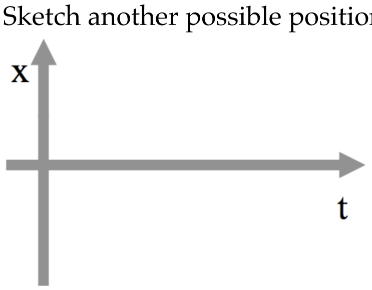
g. Sketch a possible position-vs-time graph for the motion of the object. Explain why your graph is only one of many possible graphs.

Worksheet 2: Multiple Qualitative Representations

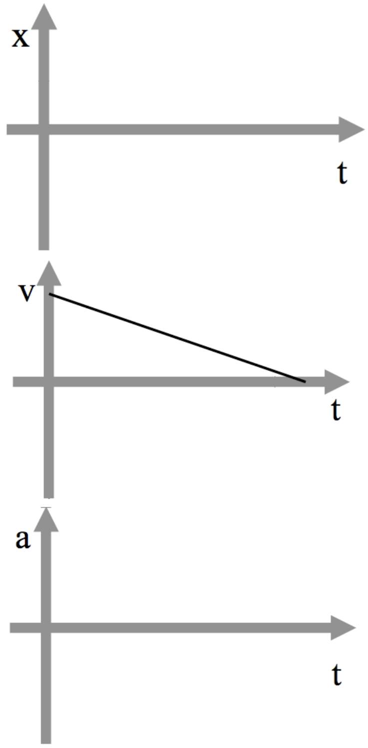
3. In each table below, the motion is described by a velocity-vs-time graph. The other representations have been left blank.
   a. **Complete the missing representations.**
   b. If you have time, try to recreate these graphs (x-t and v-t ONLY) by moving in front of the motion sensor.

	Written Description *In all questions, form your sentences by using (among others) the following types of phrases: speeding up, slowing down, positive direction, negative direction, starting from rest, turning around. Do NOT use the word (or any form of the word) "accelerate" in your description.*
	Motion Map 

Sketch another possible position-vs-time graph for the motion represented above.

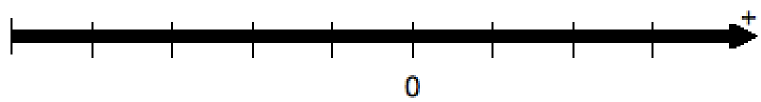


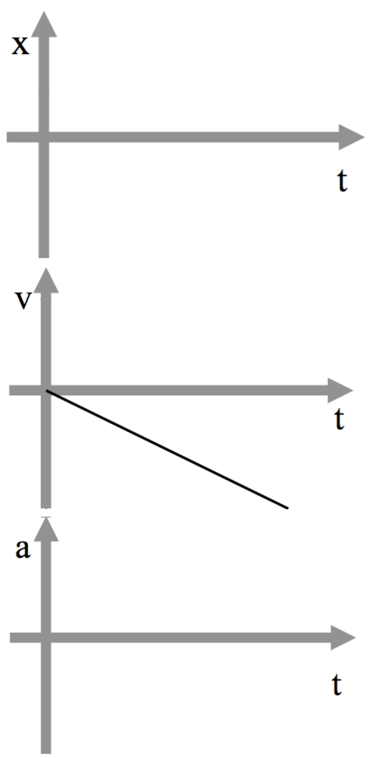
Why are there many possible position-vs-time graphs for this same motion? In fact, how many possible correct position-vs-time graphs are there? How many incorrect?



Written Description

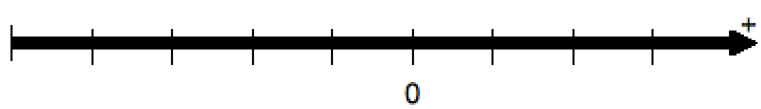
Motion Map

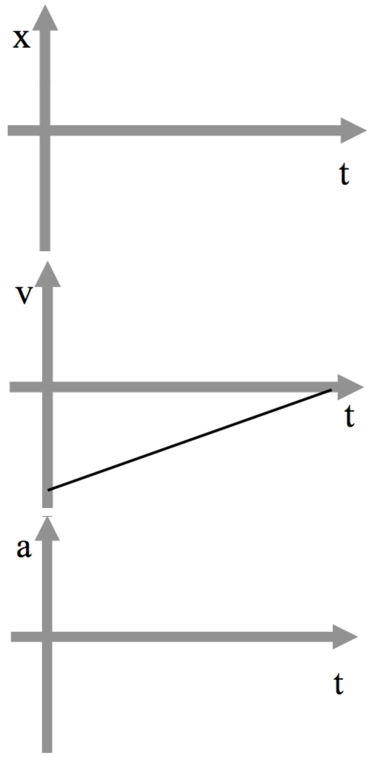




Written Description

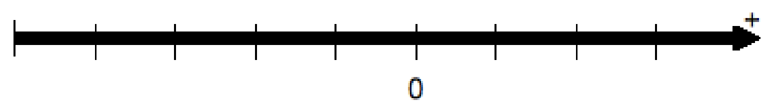
Motion Map

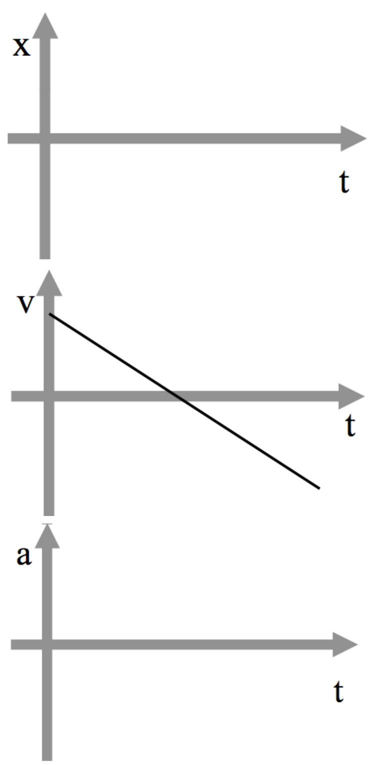




Written Description

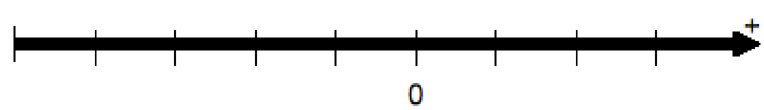
Motion Map





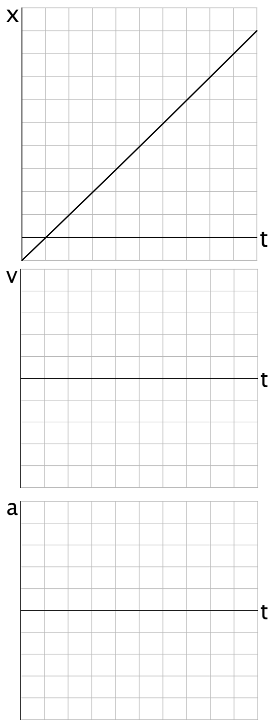
Written Description

Motion Map

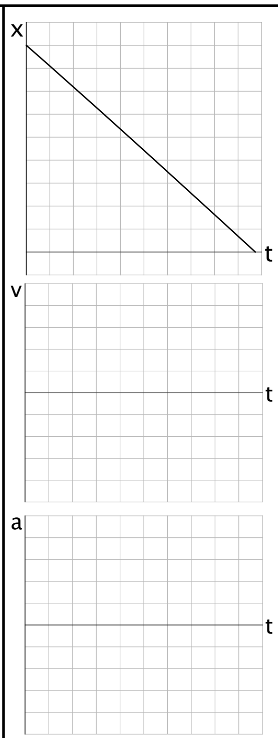


Stacks of Kinematics Curves

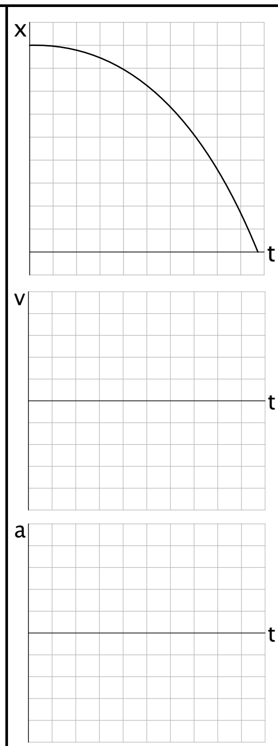
Given the following position vs time graphs, sketch the corresponding velocity vs time and acceleration vs time graphs. For each problem (or part of problem), tell whether the forces on the object must be balanced or unbalanced. If they are unbalanced, say whether they are unbalanced in the positive or negative direction.



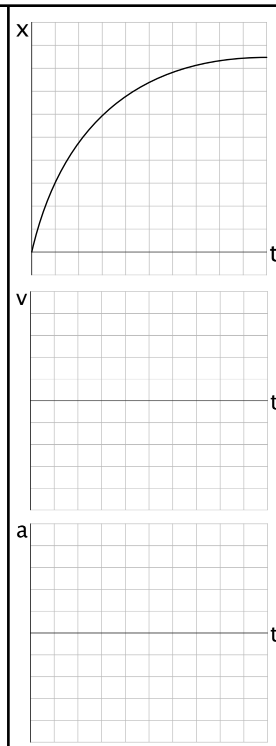
Balanced or Unbalanced? (+ / –)



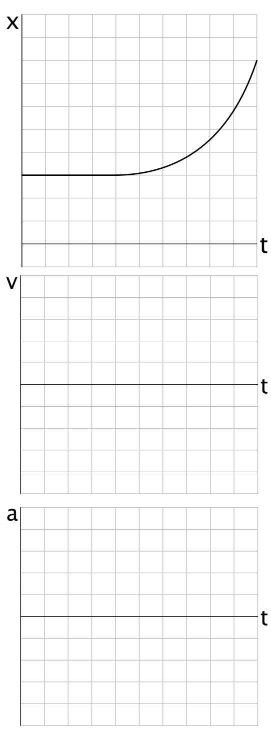
Balanced or Unbalanced? (+ / –)



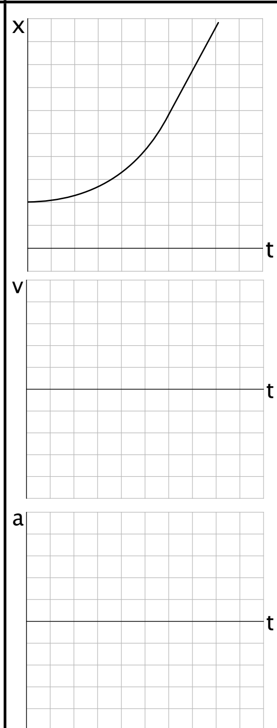
Balanced or Unbalanced? (+ / –)



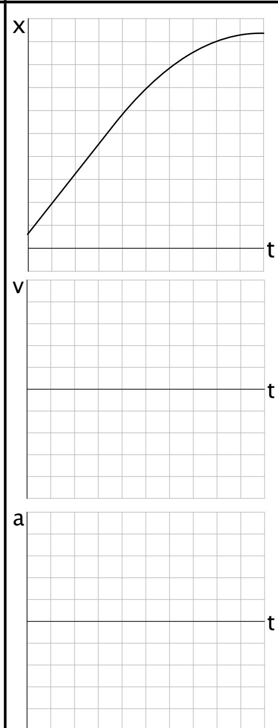
Balanced or Unbalanced? (+ / –)



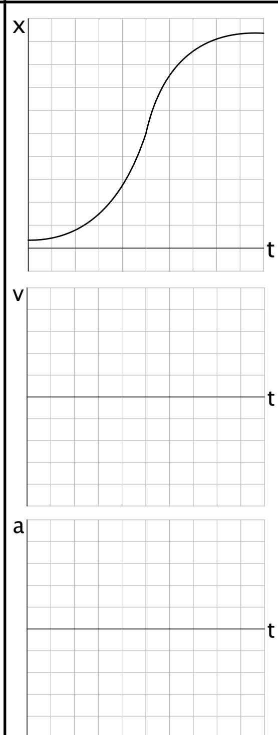
Balanced or Unbalanced? (+ / –)



Balanced or Unbalanced? (+ / –)

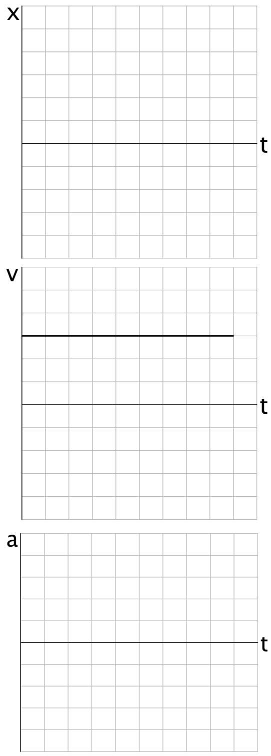


Balanced or Unbalanced? (+ / –)

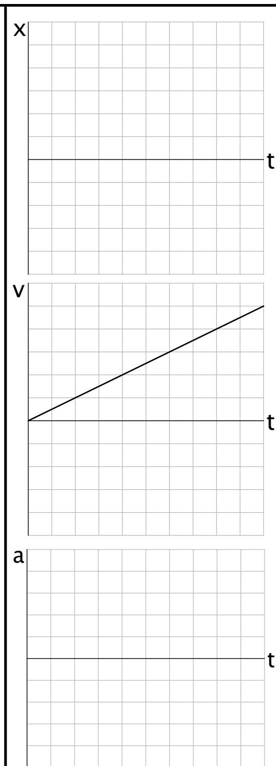


Balanced or Unbalanced? (+ / –)

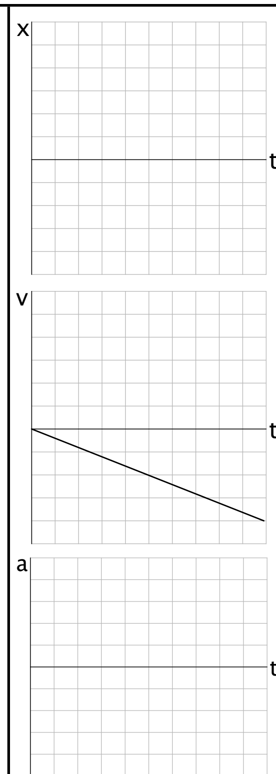
For the following velocity vs time graphs, draw the corresponding position vs time and acceleration vs time graphs. For each problem (or part of problem), tell whether the forces on the object must be balanced or unbalanced. If they are unbalanced, say whether they are unbalanced in the positive or negative direction.



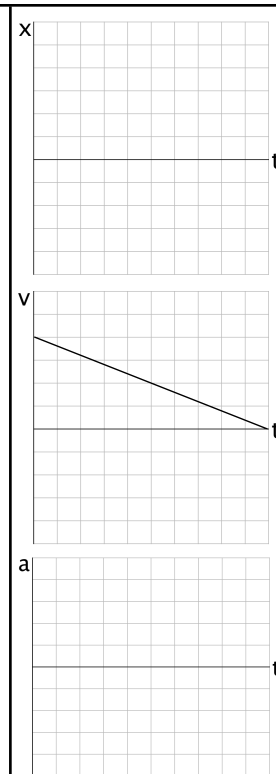
Balanced or
Unbalanced? (+ / –)



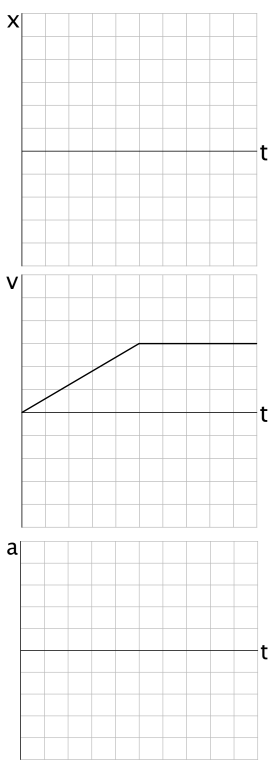
Balanced or
Unbalanced? (+ / –)



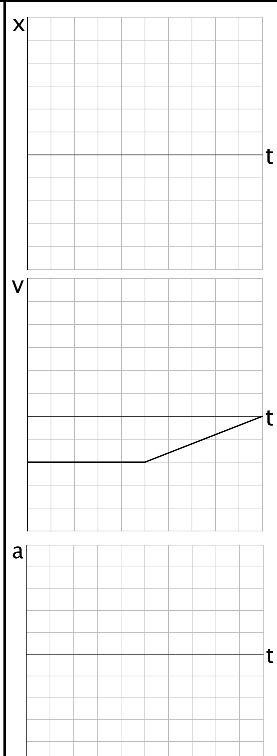
Balanced or
Unbalanced? (+ / –)



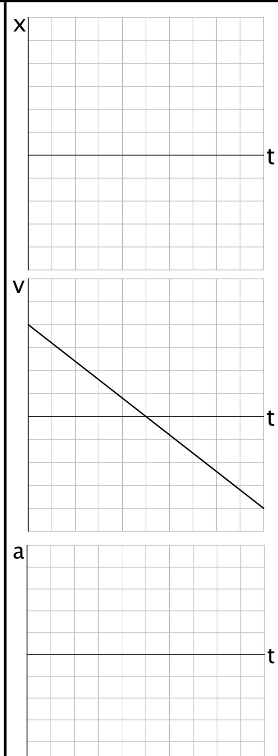
Balanced or
Unbalanced? (+ / –)



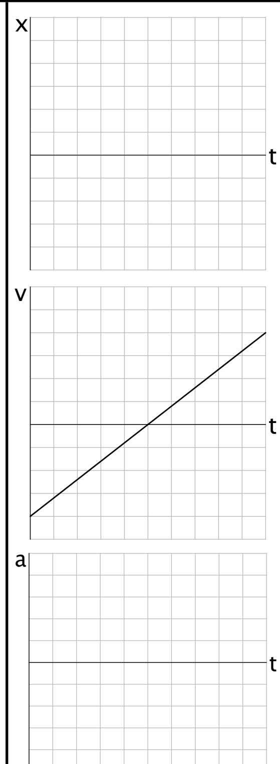
Balanced or
Unbalanced? (+ / –)



Balanced or
Unbalanced? (+ / –)



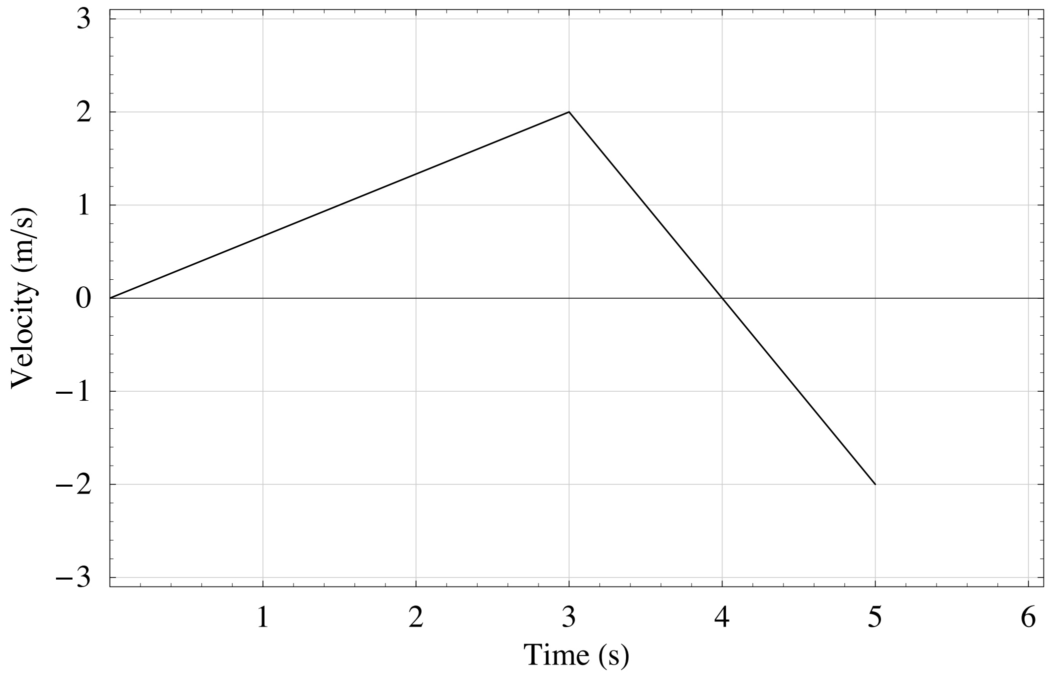
Balanced or
Unbalanced? (+ / –)



Balanced or
Unbalanced? (+ / –)

Worksheet 3: More Analyzing Velocity Graphs

4. An object moves with the velocity shown on the graph below.



a. What is the displacement of the object between time $t = 0$ and $t = 3.0$ s?

b. What is the displacement of the object between time $t = 3.0$ s and $t = 4.0$ s?

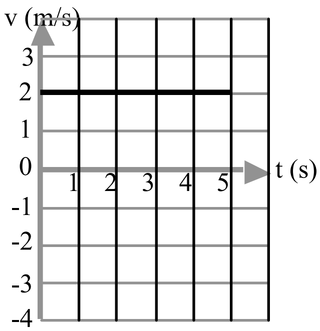
c. What is the displacement of the object between time $t = 4.0$ s and $t = 5.0$ s?

d. What is the displacement of the object during the entire first five seconds?

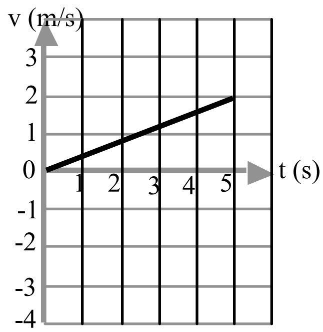
e. If the object's starting position at $t = 0$ is $x = –3.0$ m, then what is its position at $t = 5.0$ s?

f. Describe the motion of the object in words.

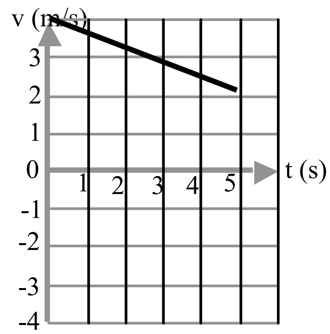
Worksheet 4: CAPM Ranking Tasks



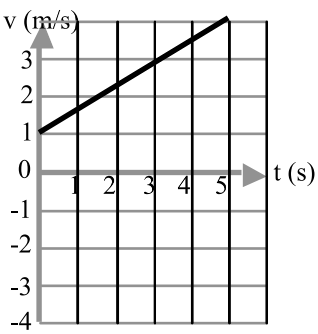
(a)



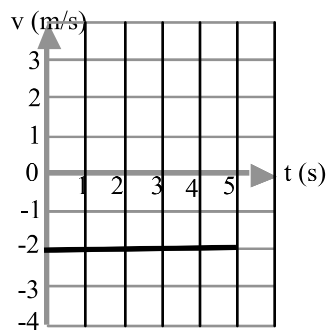
(b)



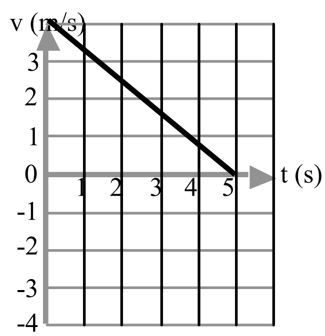
(c)



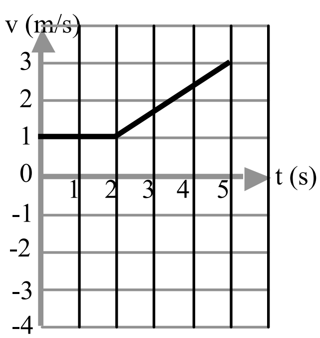
(d)



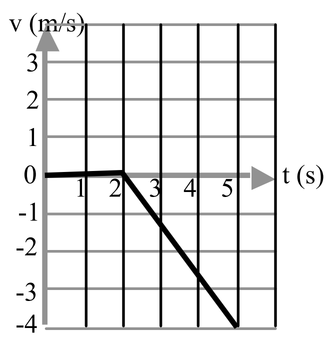
(e)



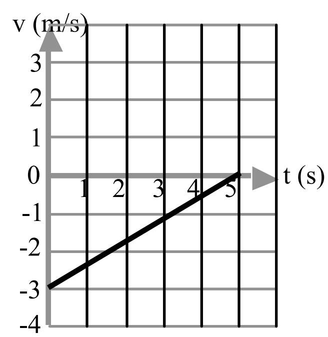
(f)



(g)



(h)



(i)

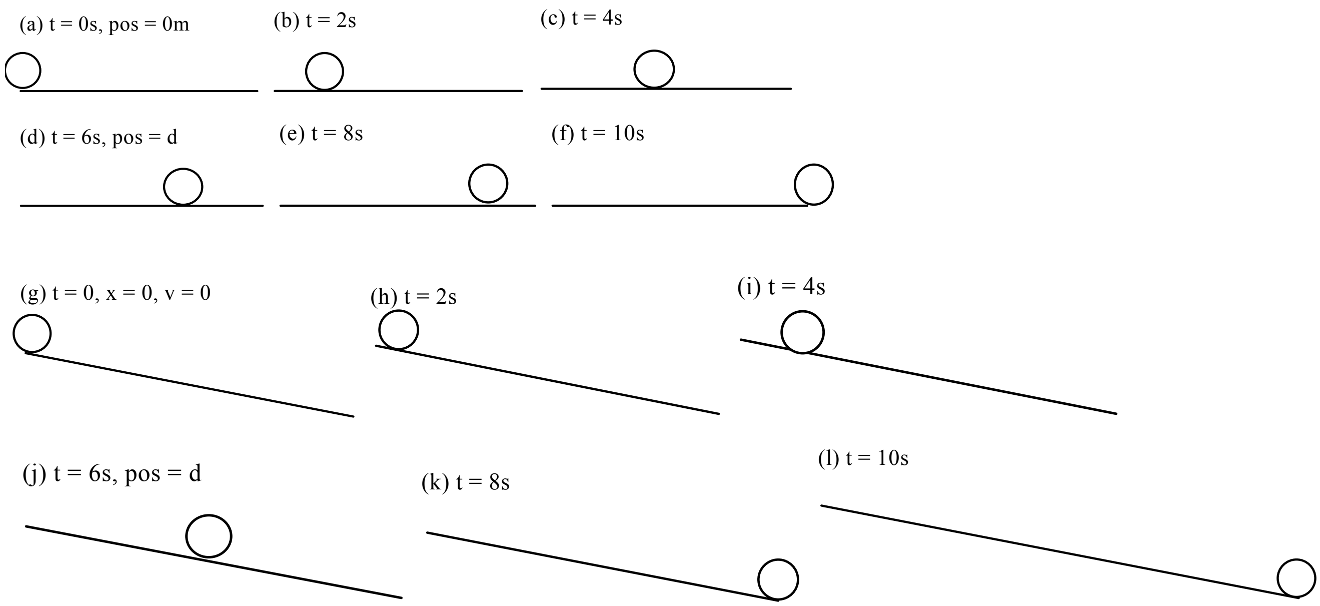
5. Rank the situations (a through i) based on the *total distance traveled* for the object during the time shown on the graph. Write your answers on a single line using the > and = signs to show the relationships.

   Explain the reason for your ranking. Try to make a single, clear statement that applies to every case rather than enumerating the work for each case.

6. Rank the situations based on the *maximum absolute value of acceleration* during the time shown on the graph.

   Explain the reason for your ranking. Try to make a single, clear statement that applies to every case rather than enumerating the work for each case.

The following situations illustrate the position of two different balls at different times. The first ball (a through f) rolls with constant velocity across a horizontal surface, while the second ball (g through l) rolls with constant acceleration down an inclined ramp. Both objects are at position zero at time = 0, and both are at position = d at time = 6 s.



7. Rank each situation (a through l… yes, all 12 together, not two separate lists) according to the *position* along the surface of the ball at the indicated time. Write your answer on a single line, using the > and = signs to show the relationships. NOTE: The pictures are not drawn to scale, so **you <u>cannot</u> rely on them to show** which ball is ahead.

   Explain the reason for your ranking. Try to make a single, clear statement that applies to every case rather than enumerating the work for each case.

   Rank each situation (a through l) according to the *instantaneous velocity* of the ball at the indicated time. Write your answer on a single line, using the > and = signs to show the relationships. NOTE: The pictures are still not necessarily drawn to scale.

   Explain the reason for your ranking. Try to make a single, clear statement that applies to every case rather than enumerating the work for each case.

Worksheet 5: Apply the Model

8. Read the following three problems and consider if the Constant Velocity Particle Model (CVPM) applies.
   I. A Mac Truck starts from rest and reaches a speed of 8.5 m/s in 20 seconds.
   II. A dune buggy travels for 20 seconds at a speed of 8.5 m/s.
   III. A driver sees a deer in the road ahead and applies the brakes. The car slows to a stop from 8.5 m/s in 20 seconds.

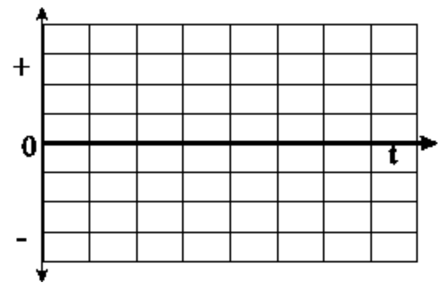
   a. For each of the three above problems, say whether CVPM applies, whether BFPM applies, whether CAPM applies, or whether none of those models apply, and explain your reasoning.

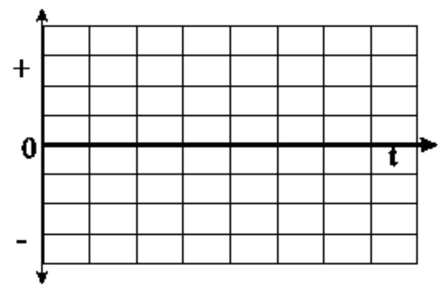
   b. For each problem where CAPM applies, draw *at least three* diagrams and/or graphs to illustrate the situation. Choose the diagrams and graphs that you find most useful.

   c. Using the constant acceleration particle model, solve for any unknown quantities. Show your work and use units.

For the following problems, a complete solution will consist of
(a) at least three diagrams and/or graphs to represent the situation. (Use the ones you find most useful.)
(b) a determination of the quantities for which it is possible to solve.
(c) a clear presentation of the procedure used to produce a numerical answer for each unknown quantity, with units.

9. A car whose initial speed is 30 m/s slows uniformly to 10 m/s in 5 seconds.





10. A bear spies some honey 10 m away and takes off from rest, accelerating at a rate of 2.0 m/s^2.