Representations of Motion

Introduction

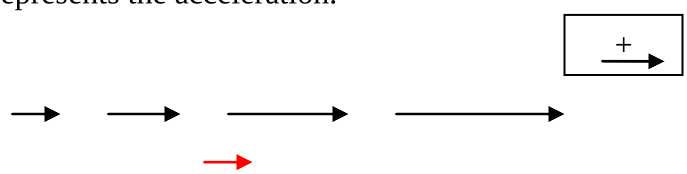
The motion of an object can be represented in various ways. These representations include:

- Verbal Description
  Example: The ball is moving in the positive direction (to the right) and it is speeding up.

- Equations
  Example: $x=3(m/s^2)t^2+2(m/s)t+5(m)$ *This is the equation of motion for an object starting at x=5m with an initial velocity of 2m/s and speeding up at a rate of 6m/s every second.*

- Motion diagram – A motion diagram consists of three parts.
  - An arrow with a (+) on top inside a rectangle to show the positive direction.
  - A series of arrows representing the relative magnitude and direction of velocity of the object as time progresses.
  - Another arrow represents the acceleration.

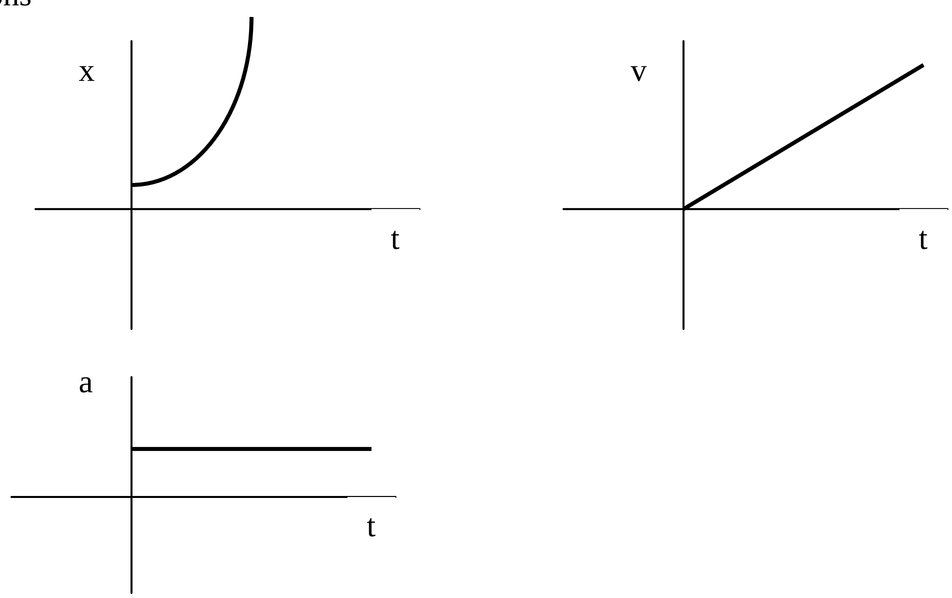
  Example:



a

Object moving in the positive direction (to the right) and speeding up.

- Graphs



The graphs above represent an object moving in the positive direction and speeding up with constant acceleration.

In this lab you will represent the motion of a cart on a frictionless track under various conditions with verbal descriptions, with graphs, and with motion diagrams.

Apparatus

PASCO track and cart
Motion Detector

Procedure

In each of the following situations, a motion is described in terms of position, velocity, or acceleration. In each case you must

- Translate the description of the motion into simpler words that describe how the cart would have to move to produce this motion. If it is not possible to reproduce this motion, explain why not.
- Predict the graphs of position vs time, velocity vs time, and acceleration vs time.
- Predict the set up of the track and motion detector that would produce the desired graphs.
- Set up the track as predicted and record the graphs of position, velocity, and acceleration vs time with the motion detector.
- If necessary make adjustments in the set up of the track and cart to get the desired results.
- Using your data, determine the functions that describe position as a function of time, and velocity as a function of time.
- Draw a motion diagram for the cart.

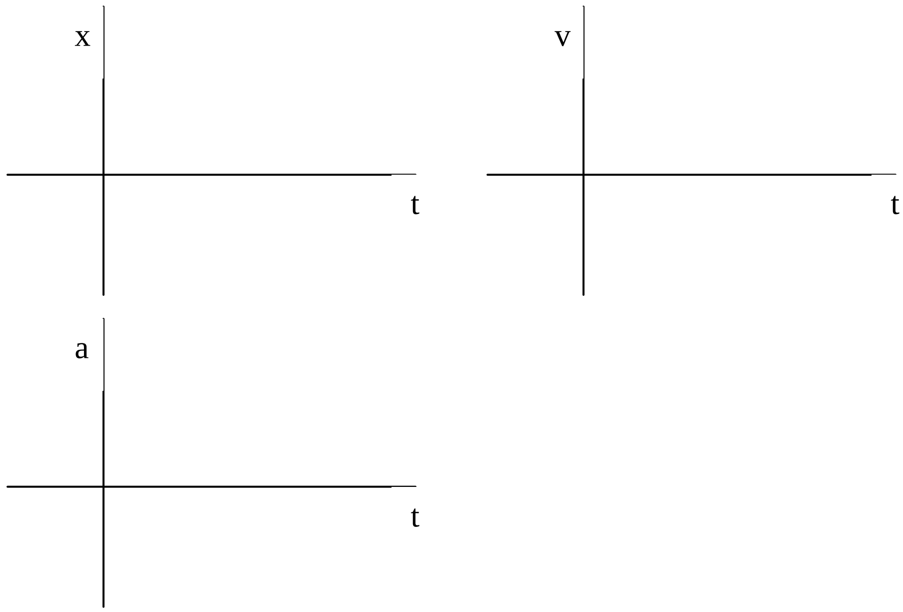
These are the situations you will consider in this experiment:

1. Constant Positive Velocity
2. Constant negative velocity
3. Constant positive acceleration (two different situations)
4. Constant zero acceleration (two different situations)
5. Constant negative acceleration (two different situations)

The next page is a guideline for how to organize your report for each situation.

1. **Constant Positive Velocity**

Description of Motion
Is the cart at rest or moving? If moving, is it moving toward the motion detector or away from it? Is the cart moving with constant speed, or is it speeding up or slowing down?
Predict graphs



Predict the set up of the track and motion detector
Should the track be horizontal or tilted?
Where should you place the motion detector?
Should the cart be moving toward the motion detector or away from it?
Draw a diagram to show all this.

Describe the actual set up of the track, motion detector and cart that produced the desired results. Draw a sketch of the set up.

Examine the graphs generated by the motion detector.
Adjust the scales on the vertical axes on the graphs to magnify the section of interest. **DO NOT CHANGE THE TIME SCALE. All graphs must show the full 5.0(s)**. Print the graphs. Highlight the sections of interest on all three graphs. On each graph indicate the shape of the curve. Use terms such as “straight line with positive/negative/zero slope”, and “parabola opening up/down”.

Use the printed graphs to determine the equations of motion, X(t) and V(t).
Determine the constants with the precision you can obtain from your printed graphs. Remember that in these equations, the instant the motion starts is when t=0. Keep that in mind when you are trying to figure out the initial position and the initial velocity.

Draw a motion diagram for the cart.