"Make It So, Number One"[1]

Spaceship
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Analysis of motion can be difficult enough, but engineers and technicians are often required to do something even more difficult—*to make things move in prescribed ways*. Examples include the motion of trains, elevators, machine tools, conveyor belts, security cameras and more. While a race driver or a movie character may have the single-minded goal of getting to the finish line as quickly as possible, most planned motions involve many other considerations such as the comfort of passengers, the cost of energy, prevention of excess wear and much more.

Task: In this activity you will construct and test sequences of instruction which create specified motions, where the specifications are provided as graphs. The graphs show position as a function of time. Instructions must be given using velocities.

Additional Materials: LACI Smart Cart, track with meterstick, motion detector

Math Machines Program:

LACI Sequence

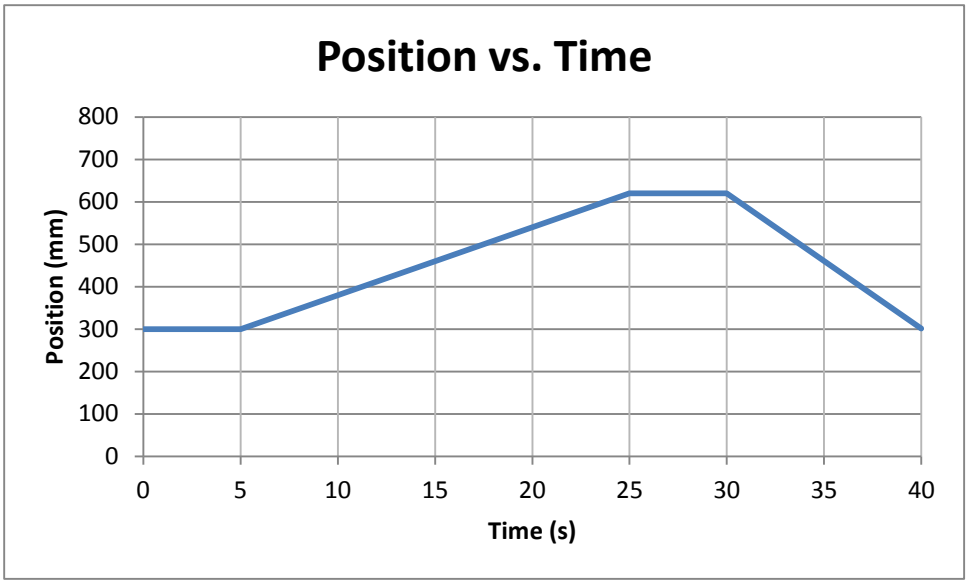
Activity File: none

Constraints: In this mode, LACI can move only at set, constant speeds, each of which can be either forward (positive velocity) or backward (negative velocity). The possible speeds are listed below.

0	mm/s
12.1	mm/s
13.7	mm/s
16.0	mm/s
19.5	mm/s
24.2	mm/s
31.9	mm/s
48.4	mm/s
94.2	Mm/s

[1] Words spoken by Captain Pike to his unnamed and unseen female First Officer in the pilot episode of *Star Trek.* The characters changed as the series developed, but the phrase endured.

1. Determine a sequence of movements to produce the motion shown in Graph 1 below.



a. What is the starting position for this motion? ____

b. How many distinct segments are needed to produce this motion? _____

Note that the control program (like many computer programs) begins counting at zero, not one. The first segment will be "0," the second will be "1," etc.

c. What is the duration (in seconds) for each of the required segments and which of the possible velocities best matches the graph? Enter the values below and in the control program.

T0 = _____ s V0 = _____ mm/s

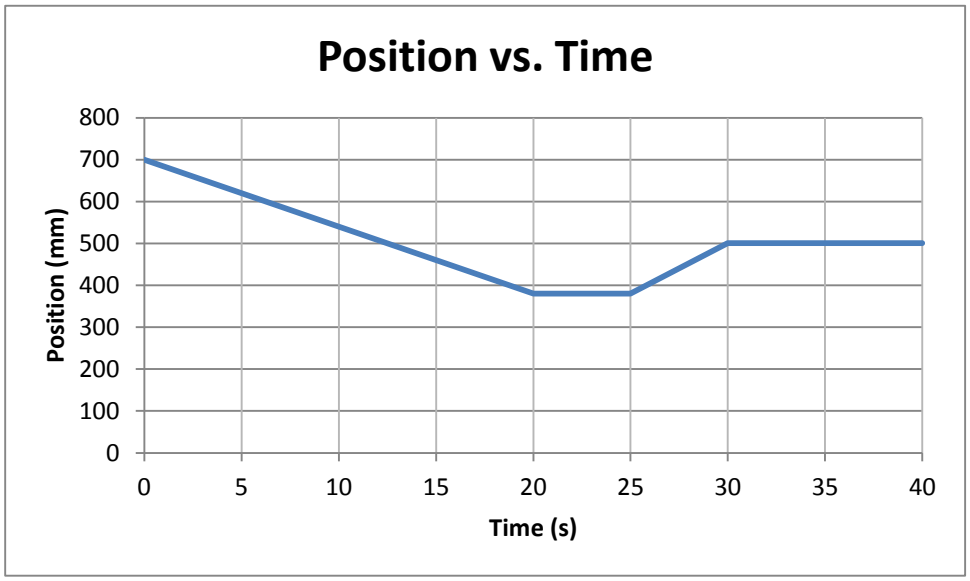
T1 = _____ s V1 = _____ mm/s

T2 = _____ s V2 = _____ mm/s

T3 = _____ s V3 = _____ mm/s

d. Test your answer by graphing LACI's motion with a motion detector. How well does the actual graph match the original instruction? Carefully explain any differences.

2. Determine a sequence of movements to produce the motion shown in Graph 2 below.



a. What is the starting position for this motion? ____

b. How many distinct segments are needed to produce this motion? _____

c. What is the duration (in seconds) for each of the required segments and which of the possible velocities best matches the graph? Enter the values below and in the control program.

T0 = _____ s V0 = _____ mm/s

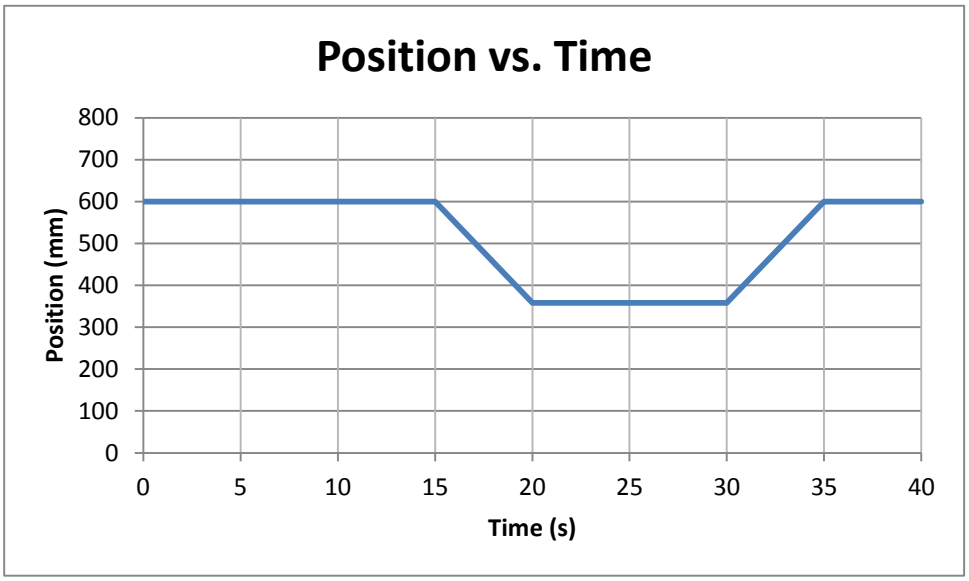
T1 = _____ s V1 = _____ mm/s

T2 = _____ s V2 = _____ mm/s

T3 = _____ s V3 = _____ mm/s

d. Test your answer by graphing LACI's motion with a motion detector. How well does the actual graph match the original instruction? Carefully explain any differences.

3. Determine a sequence of movements to produce the motion shown in Graph 3 below.



a. What is the starting position for this motion? ____

b. How many distinct segments are needed to produce this motion? _____

Note that the control program (like many computer programs) begins counting at zero, not one. The first segment will be "0," the second will be "1," etc.

c. What is the duration (in seconds) for each of the required segments and which of the possible velocities best matches the graph? Enter the values below and in the control program.

T0 = _____ s V0 = _____ mm/s

T1 = _____ s V1 = _____ mm/s

T2 = _____ s V2 = _____ mm/s

T3 = _____ s V3 = _____ mm/s

T4 = _____ s V4 = _____ mm/s

d. Test your answer by graphing LACI's motion with a motion detector. How well does the actual graph match the original instruction? Carefully explain any differences below.