POWERFUL OUTCOMES

Math as the Language of Physics

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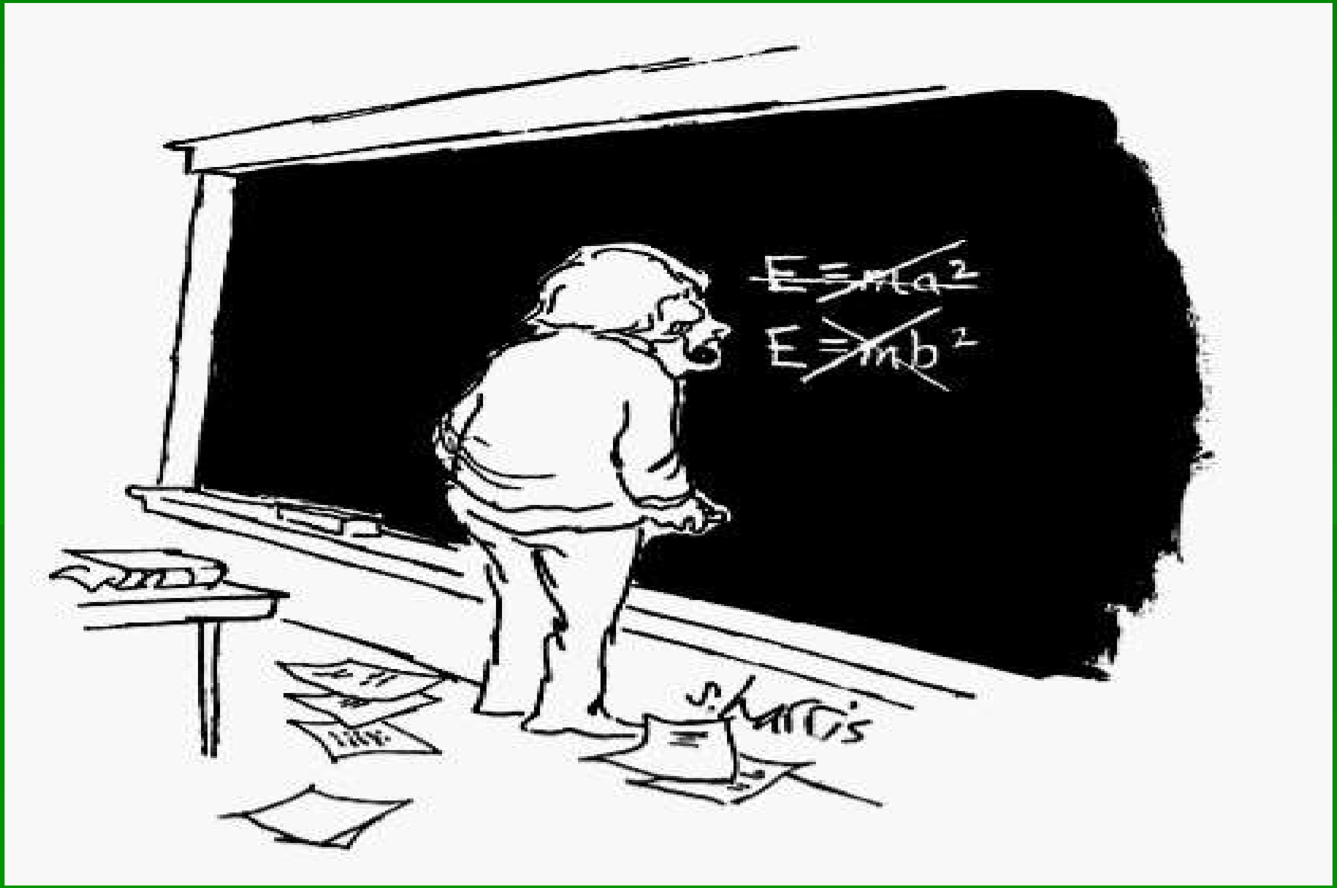
"Philosophy is written in this grand book - I mean the Universe - which stands continually open to our gaze, but it cannot be understood unless one first learns to comprehend the language and interpret the characters in which it is written. It is written in the language of mathematics, and its characters are triangles, circles and other geometrical figures, without which it is humanly impossible to understand a single word of it." -- **Galileo Galilei**

"Do not worry about your difficulties in Mathematics. I can assure you mine are still greater." **Albert Einstein**



Existing Courses

- College Physics I
  - Algebra-based mechanics class focusing on motion, force, and energy
  - 4 credits
  - Meets 3 hrs per week with 3-hr lab
  - Pre-Reg: Algebra II and English Comp I
- Technical Mathematics I
  - College algebra with trig
  - 4 credits
  - Meets 4 hrs per week
  - Pre-Req: Algebra II

Learning Community

POWERFUL OUTCOMES is the Learning Community in which these courses are combined

Why a Learning Community?

- To enhance the experience for those technology, pre-engineering, and engineering students taking both Technical Mathematics I and College Physics I as either program requirements or pre-requisites for upper level math and physics courses
  - Math concepts will be illustrated and reinforced with physics applications
  - Physics will be better explained and understood with improved math skills and understanding
  - Problem-solving skills will be improved and connections between math and physics will be made

Course Organization

- 8 credits
- Double block of class time 3 days per week
- Co-taught – both faculty in classroom
- Separate grades
- Separate exams including finals
- Integrated homework
- Integrated labs
- Two books

Integrating the Two Disciplines

- Lab analysis will require both physics and math approaches
- Lab grade will count in both courses
- Homework will consist of pure math problems and physics problems which require the application of the math concepts
- Lectures and group work will be geared to both disciplines

Example of Course Mapping

Physics	Math
Motion in One Dimension	Linear Functions Slope Graphing
Motion in Two Dimensions	Triangles & Angle Measurement Trig Functions Vectors Quadratic Functions

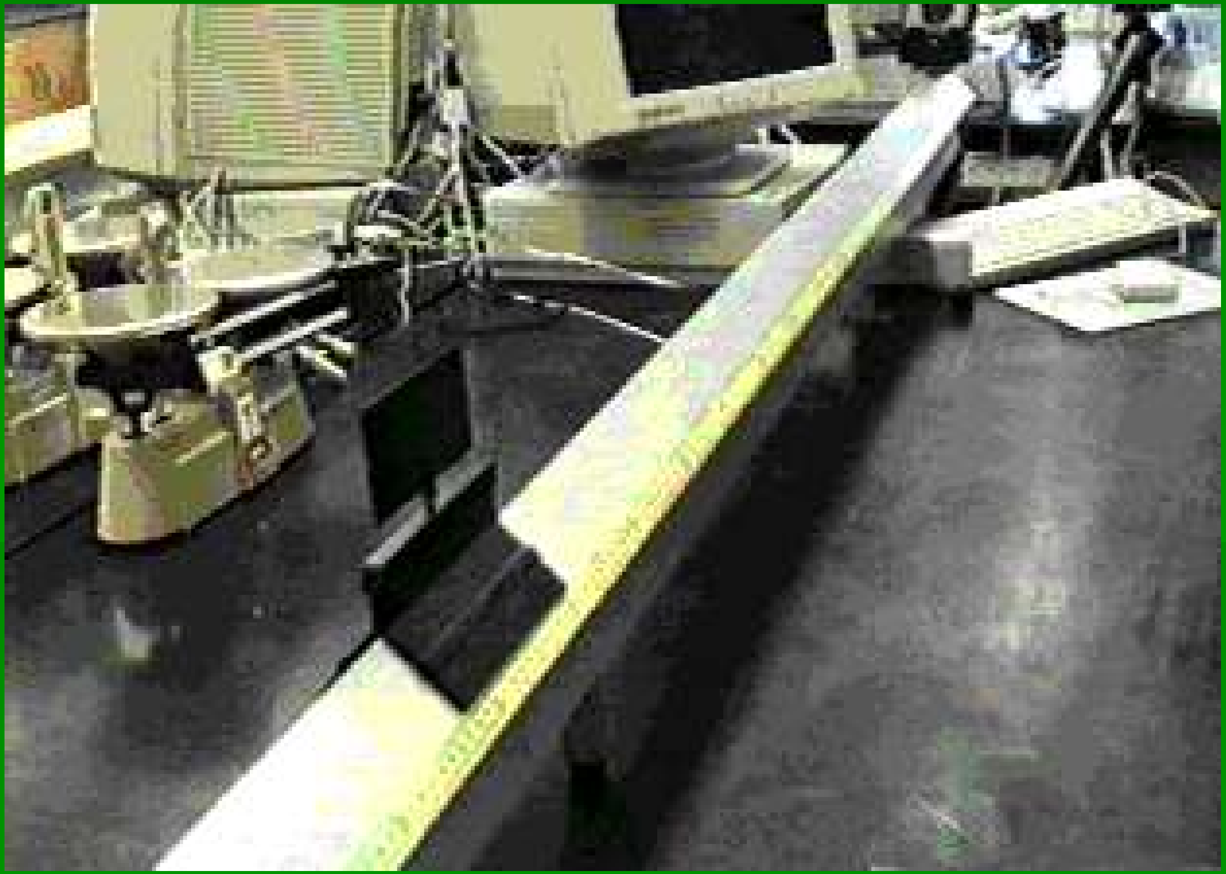
Lab 1 – Constant Velocity Overview

- Stationary glider accelerated on frictionless air track
- Using recorded position and time data, students calculate displacement and velocity by hand and using Excel formulas
- Students generate two graphs using Excel: position vs. time and velocity vs. time
- Students will analyze the graphs and answer questions in both disciplines as part of an overall written summary of results and conclusions

Students Will ….

- Physics
  - Identify regions of constant and non-constant velocity on both graphs
  - Find max velocity
  - Determine if graphs indicate frictionless environment
  - Understand slope as rate of change for each graph
- Math
  - Graph data
  - Determine domain and range
  - Find slope of p vs. t graph
  - Compare value to v vs. t graph
  - Find linear function
  - Extrapolate positions

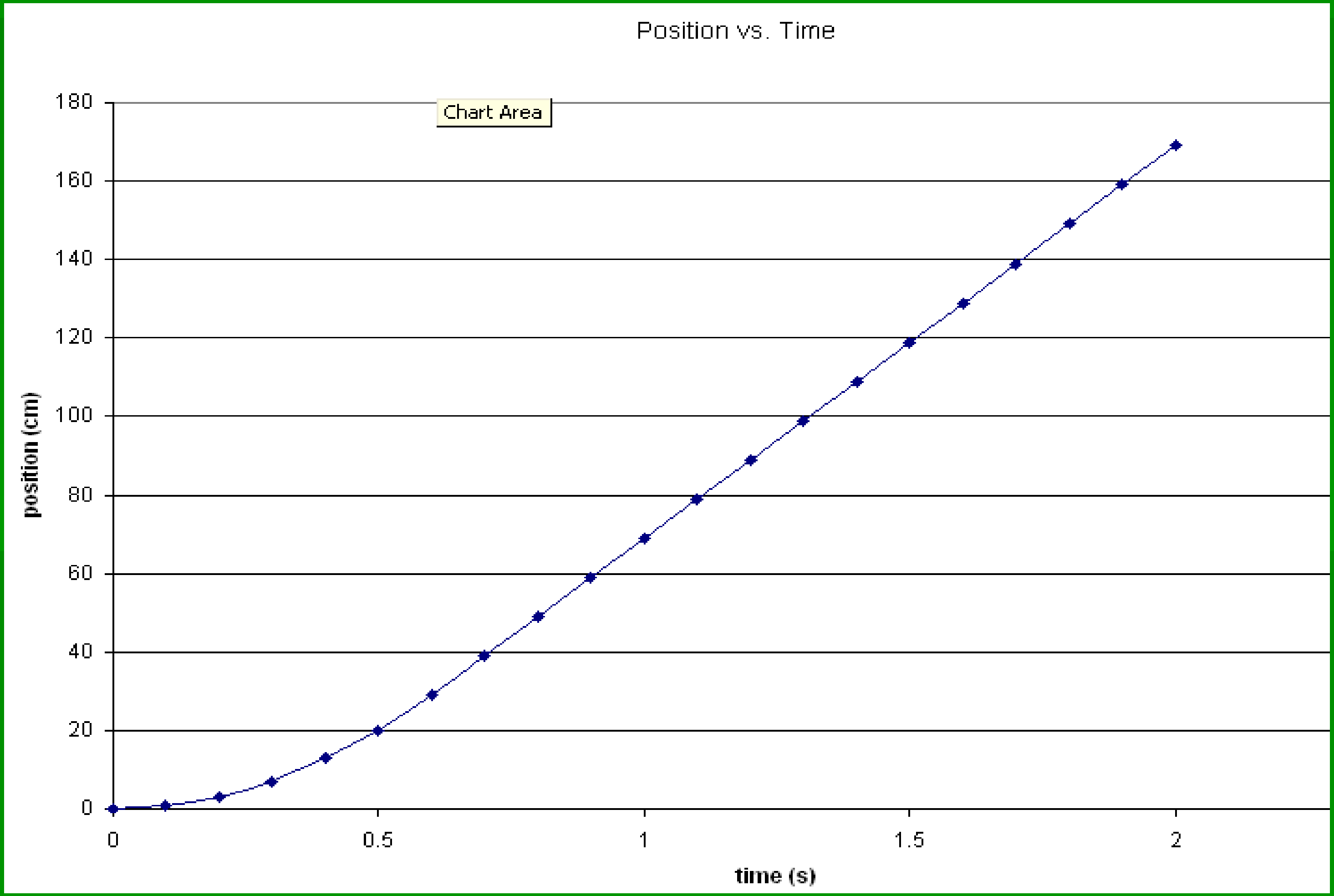
Glider on Frictionless Air Track Demonstrates Newton's First Law (Law of Inertia)



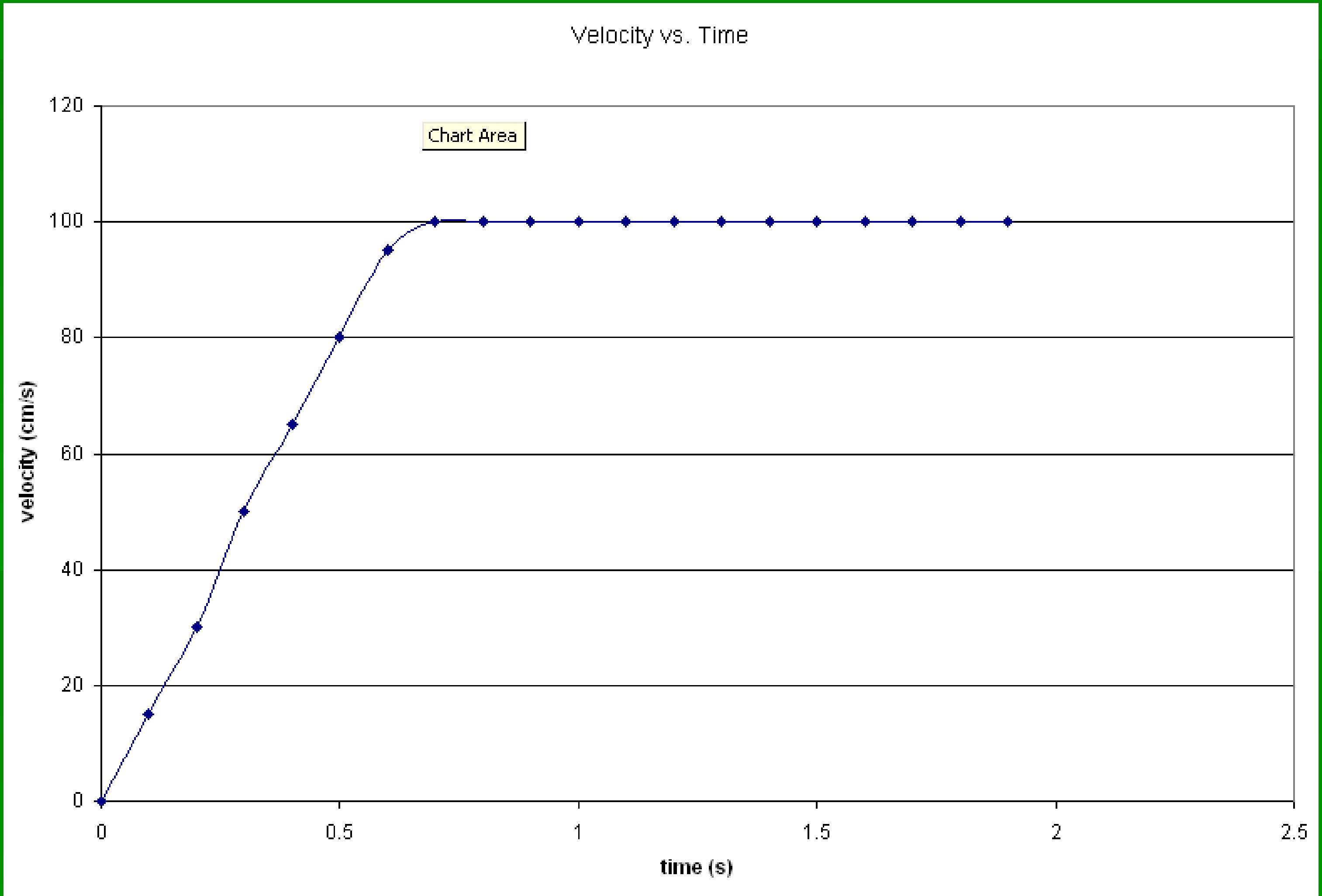
Data Chart

Data Point (Spark #)	Time, t (s)	Position, x (cm)	Δx (cm)	Velocity, v (cm/s)
0	0	0	0	**0**
1	0.1	2	$\Delta x_1 = x_2 - x_0 = 5$	$\Delta x_1 / 0.2\ s = 25$
2	0.2	5	$\Delta x_2 = x_3 - x_1 = 8$	$\Delta x_2 / 0.2\ s = 40$
3	0.3	10	$\Delta x_3 = x_4 - x_2 = 12$	$\Delta x_3 / 0.2\ s = 60$
4	0.4	17	…	…

Position vs. Time Graph



Velocity vs. Time Graph



“Physics” Analysis

- Indicate on both graphs where the glider was pushed.
- Did the glider move with a constant velocity when it was not being pushed? Indicate constant velocity on both graphs.
- When did the glider have maximum velocity?   Indicate maximum velocity on the *velocity vs. time* graph. What was the maximum velocity?
- Should maximum velocity have been maintained in a frictionless environment? Did the air track eliminate all or most of the friction in this experiment? Does either graph indicate friction in any way?
- Find the slope of the *position vs. time* graph in the constant velocity region. According to the graph, what is the magnitude of the slope? Does this magnitude agree with the magnitude of constant velocity on the *velocity vs. time* graph? Indicate on the graphs.

“Math” Analysis

- Identify where the slope formula was used.
- What is the relationship between the slope and constant velocity?
- Identify the domain and range.
- Where does the graph become linear?
- Given the constant velocity, create a linear position function and find the position of the object at various times

Student Assessment

- Graded lab will include
  - Cover page
  - Formal written Introduction
  - Data Section
  - Lab notes
  - Graphs
  - Sample Calculations
  - Formal Written Conclusion
- Students will receive a grading rubric in lab

Springfield Technical Community College

An Education with **Powerful Outcomes**