

Two-Stage Rocket Lab

Teacher's Guide

Topic:

One Dimensional Kinematics

The following information is provided to the student:

Question:

How do you describe the motion of a two-stage rocket?

Purpose:

To conduct a complete conceptual and mathematical analysis of the motion of two-stage rocket including slope and area calculations for the various stages and the no-fuel stage.

A complete lab write-up includes a Title, a Purpose, a Data section, and a Conclusion/Discussion. The Data section should include a velocity-time graph; strategic coordinates (at the end/beginning of stages, the peak of the trajectory and at the instant it explodes) should be listed on the graph. Coordinate values are used to calculate the slope and areas; work is shown and organized; units are listed. Results of calculations are summarized in the provided table. The Conclusion/Discussion should include a summary of your analysis and a response to the provided post-lab questions.

Materials Required:

A page from The Shockwave Physics Studios:

<http://www.physicsclassroom.com/shwave/twostage.html>

Description of Procedure:

Students log on to the above page and first acquire the coordinates of strategic locations during the rocket's trajectory. Then students conduct slope and area calculations in an effort to make the connection between slope and acceleration and area and displacement for a velocity-time graph. The information in the auxiliary materials section (below) should be sufficient to guide students through the activity.

Alternative Materials and Procedure:

A more thorough approach to this lab is provided at The Shockwave Physics Studios:

<http://www.physicsclassroom.com/shwave/twostagedirns.html>

The alternative exercise is a guided exercise with an extensive procedure.

Safety Concern:

There is always a higher than usual level of risk associated with working in a science lab. Teachers should be aware of this and take the necessary precautions to insure that working environment is as safe as possible. Student *horseplay* and off-task behaviors should not be tolerated.

Suggestions, Precautions, Notes:

The Laboratory

1. There are six possible sets of accelerations and time periods for the two stage rocket. Students receive one of the six sets of data. Not all students will have the same data.

Auxiliary Materials:

The following page is provided to the student for completion and inclusion in the Data section of their lab notebook.

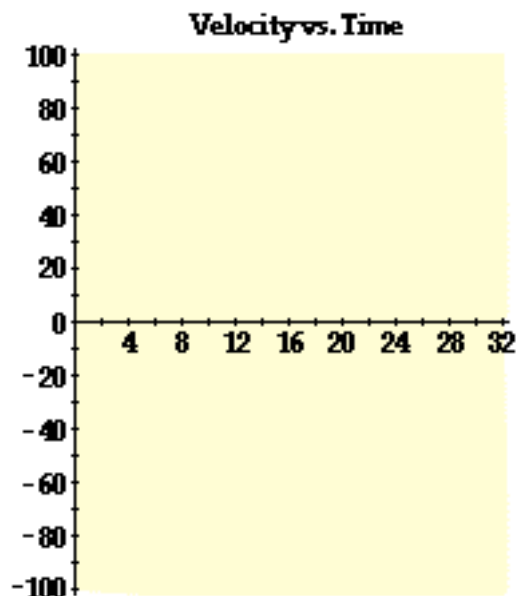
Sketch the graph for your rocket's motion (as displayed on the screen). Be accurate and show strategic coordinates - for example, at the end of stage 1 and stage 2 and at the rocket's peak position. These coordinates can be read off the screen by moving your mouse over the graphical display.

End of stage 1: $(t, v) =$ _____

End of stage 2: $(t, v) =$ _____

When crossing axis: $(t, v) =$ _____

At explosion time: $(t, v) =$ _____



	Slopes of v-t Graph	Area of v-t Graph
End of Stage 1		
End of Stage 2		
At the peak of motion		
At the time of explosion		

Post-Lab Questions:

1. Compare the rocket's motion during the first stage to its motion during the second stage. When is it moving faster? What is it accelerating at a greater rate?
2. Is the rocket ever moving in one direction (up or down) and accelerating in the opposite direction (down or up)? If so, when does this occur (list some times)? And what does it mean to be accelerating in the opposite direction of the motion?
3. What is the line on the graph doing as the rocket reaches the peak of its trajectory? What is the velocity value at the peak? What is the acceleration value at the peak?

Scoring Rubric:

The Laboratory

K8. Two-Stage Rocket Lab	Score
____ Included, labeled and organized all parts of the lab report. ____ Data section includes velocity-time graph for the given motion; strategic coordinates (at the end of fuel stages; at the peak, explosion time) are shown on the graph. Slopes and areas are accurately calculated; work is labeled and clearly shown for each calculation; work is organized; units are stated. Results of calculations are accurately summarized in table form. ____ Conclusion/Discussion uses words to summarize the analysis; responses to post-lab questions are accurate, thorough and clear.	____/____

Connections to The Physics Classroom Tutorial:

The following readings are a suitable accompaniment to this lab:

<http://www.physicsclassroom.com/Class/1DKin/u1l3c.cfm>

<http://www.physicsclassroom.com/Class/1DKin/u1l4d.cfm>

<http://www.physicsclassroom.com/Class/1DKin/u1l4e.cfm>

Connections to Minds on Physics Internet Modules:

Sublevel 8 of the Kinematic Graphing module is a suitable accompaniment to this lab:

<http://www.physicsclassroom.com/mop/module.cfm>