

PH 221 Week 5

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This activity is Problem 22 of Chapter 2 from the *Student Workbook for Physics for Scientists and Engineers*.

R5-1: Toy Rocket Launch

A toy rocket is launched straight up with constant acceleration a . It runs out of fuel at time t .

- (a) Is the rocket at its maximum height the instant it runs out of fuel? Explain briefly.
- (b) What assumptions would you make in order to solve this problem?
- (c) What is the name of motion under the influence of only gravity? How would you write the vector for acceleration due to gravity?
- (d) Draw a motion diagram for this problem. You should have three identified points in the motion: launch, out of fuel, maximum height. We'll call these points 1, 2, and 3 to have consistent definitions.
 - Using subscripts, define quantities: y , v_y , and t at each of the three points,
 - Describe the acceleration a_1 during the interval from point 1 to point 2, and acceleration a_2 during the interval from point 2 to point 3.
 - Identify each quantity as Unknown or Known:
 - Was it given numerically?
 - Was it given symbolically?
 - Can we reason that it must be zero?
 - Be careful with signs!
- (e) Draw qualitatively accurate graphs of the acceleration vs. time and the velocity vs. time.

Suppose we want to know the maximum height of the rocket.

- (f) This is a two-part problem. Use your knowledge of calculus and motion to write *kinematic equations* for the first part of the motion. Use the given (symbolic) values for a_1 and t_2 to determine—again symbolically—the two unknown quantities at point 2.
- (g) Use your knowledge of calculus and motion to write similar *kinematic equations* for the second interval of the motion. Just write the equations; don't solve it yet.
- (h) Now, substitute the known information from previous parts of the question into your equations from part (g). Find y_3 in terms of quantities given in the problem and the constant g .