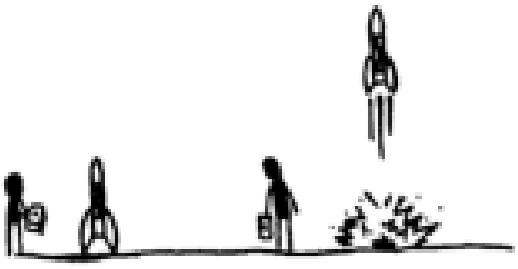
NAME _____ DATE _____

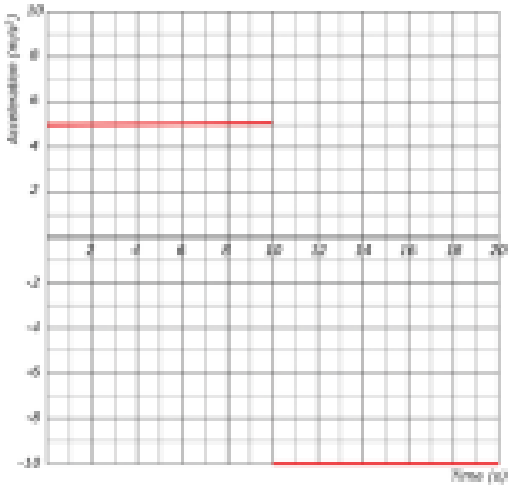
Scenario

A rocket fires its engines to launch straight up from rest with an upward acceleration of 5 m/s² for 10 seconds. After this time, the engine shuts off and the rocket freely falls straight down back to Earth's surface.



Using Representations

PART A: Draw a graph of the acceleration as a function of time from $t = 0$ seconds to $t = 20$ seconds.



PART B: Draw a graph of the velocity as a function of time from $t = 0$ seconds to $t = 20$ seconds.

Quantitative Analysis

PART C: Using the kinematics equation $y = y_0 + v_{y0}t + \frac{1}{2}a_y t^2$, a classmate writes out the following solution to find the time when the rocket lands back on Earth. Explain in one sentence, using terms such as *acceleration, velocity, position, constant, changing,* and *zero,* why the solution below is incorrect.

$$y = y_0 + v_{y0}t + \frac{1}{2}a_y t^2$$

$$0 = 0 + \left(0\tfrac{m}{s}\right)t + \tfrac{1}{2}\left(5\tfrac{m}{s^2}\right)t^2$$

The student is assuming that the acceleration is constant for the entire time and does not include the free-fall portion of the motion.

Argumentation

PART D: From your velocity vs. time graph in Part B, determine the time when the rocket reaches its maximum height.

Time for the rocket to reach its maximum height = 15 seconds

Explain how you determined your answer.

The rocket continues upward until it reaches a velocity of zero meters per second. The slope of the velocity vs. time graph is 5 m/s/s for the first 10 seconds and then -10m/s/s. The velocity vs. time graph crosses the horizontal axis at t = 15 seconds. T = 15 seconds is where the velocity changes direction.

PART E: Make a claim about the numerical value of the rocket's maximum height.

The rocket's maximum height is equal to 375 m

Evidence: What physical feature of the velocity vs. time graph supports your claim?

The area under the velocity vs. time graph is equal to the displacement of the rocket. At t = 15 seconds, height = 375 meters.