🐢 THE TORTOISE AND THE HARE 🐇

Inspired by questions found in the UCMP Algebra (Chicago), second edition

In this problem, students extract data from a story in order to write, manipulate, and graph systems of equations. It offers students a context to understand the relationships among data, equations, graphs and solutions.

THE STORY
You know the fable — the tortoise and the hare have a race. In the algebra version, the hare gives the tortoise a 1,000 foot lead. The tortoise runs at a rate of 9 inches per second, while the hare runs at 6 feet per second. There is also a rat in the story. The rat starts 1,200 feet ahead of the hare, but runs back towards the starting line at 2 ft/sec (-2 ft/sec to be precise).

LESSON PLAN
1. Be sure the students correctly write the equations before they move on. Otherwise, their answers for the remainder of the lesson will be incorrect.

2. Allow the students to work freely on the rest of the assignment. Stop and address the class as a whole only when you notice a common problem. For instance, they should know how to solve for x given y, but they may not know that in order to find the time that the rat crosses the finish line, they simply assign zero for the distance and solve the time. It will take students at least two full hours to respond correctly to all components of this problem.

3. Once the students find each of the answers, they should graph them as ordered pairs. If they include the coordinates for each starting point, there should be twelve data points. From here they should see that the points hint at the lines that represent each of the five equations. Also, be sure that they set their domain and range to the proper limits and at a proper scale. Encourage them to fill most of the graph paper.

4. Once the graph is complete, assign the story writing. Stress that the events of the story should be in chronological order. In order to do this, students just need to read the time value for each answer. However, since many won't understand this concept, this is an excellent teachable moment. After the students have submitted their completed stories, discuss the chronology of the story in accordance to the graph. This is the crux of the lesson. Many students do not see the graph as an abstract representation of the relationship between time and distance. They see it as an aerial view of the race. In other words, the critters are running in an open field and the intersections represent when they will collide with each other. You can place a transparency of the graph on the overhead and cover it with a sheet of paper. Incrementally, slide the paper to the right, allowing the left edge to reveal the graph *moment* by *moment*. This trains the students to read the graph from left to right and also establishes the sense of a relationship between the time of the race and the distance of the runners.

Concepts
Writing, graphing and solving systems of equations. Rate and unit conversion.

Time: 2-3 hours

Materials
Graph paper and straightedge.

Preparation
Students should be able to write, manipulate and graph linear equations. They should also have had an introduction to solving systems.

SOLUTIONS

*In order to protect the integrity of these lessons in the classrooms, the solutions have been removed from this version of the project. For a copy of the entire project, including all of the solutions, order **MPJ's Ultimate Math Lessons** at http://www.mathprojects.com or call 1-800-247-6553 to order over the phone.*
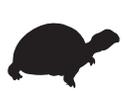
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THE SCENARIO

The Tortoise and the Hare finally have their long awaited rematch. The Tortoise gets a 1,000 foot lead and runs at 9 inches per second. The Hare begins at the starting line and runs at a rate of 6 feet per second. There is also a rat in this race. The Rat starts 1,200 feet ahead of the Hare and runs back towards the starting line at a rate of 2 feet per second.

THE ASSIGNMENT

Write a story about the race. The story should contain the following events and information in chronological order:

1. When will the Tortoise and Hare pass each other and how far will they be from the starting line?
2. When will the Tortoise and Rat pass each other and how far will they be from the starting line?
3. When will the Rat and Hare pass each other and how far will they be from the starting line?
4. After one minute into the race, how far will each runner be?
5. When will the rat cross the starting line?
6. If the race is a quarter-mile long, who will win and what will be the margin of victory (both time and distance)?

Accompanying your story will be the following:

I. Equations for each of the runners, relating time t to distance from the starting line d.
II. A graph of all three equations on the same coordinate plane, with a domain of $0 \leq t \leq 650$ seconds, and a range of $0 \leq d \leq 1500$ feet. Be sure the graph shows all significant data points.
III. An equation and graph for both the one-minute mark and the finish line.

THE CALCULATIONS

Attach your story and graph. Make sure the story is in chronological order.

Write equations for each of the runners, relating time t to distance from the starting line d. Also, include an equation for both the one minute mark and the finish line.
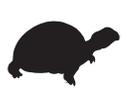
Tortoise: _____

Hare: _____

Rat: _____

One Minute Mark: _____

Finish Line: _____

1. When will the Tortoise and Hare pass each other and how far will they be from the starting line?

Time: _____ seconds

Distance From Start: _____ feet

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2. When will the Tortoise and Rat pass each other and how far will they be from the starting line?

Time: _____ seconds

Distance From Start: _____ feet

3. When will the Rat and Hare pass each other and how far will they be from the starting line?

Time: _____ seconds

Distance From Start: _____ feet

4. After one minute into the race, how far will each runner be?
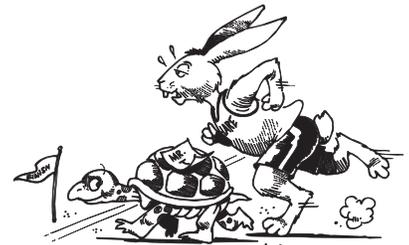
Tortoise: _____ feet

Hare: _____ feet

Rat: _____ feet

5. When will the rat cross the starting line?

Time: _____ seconds

6. If the race is a quarter-mile long, who will win, and what will be the margin of victory (both time and distance)?

Winner: _____

Margin of Victory: _____ seconds

_____ feet