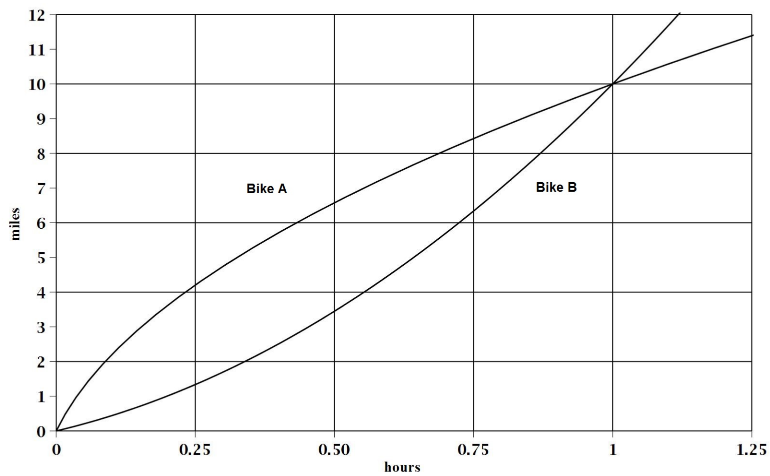
# Worksheet for Week 2: Distance and Speed

Speed is the **rate of change** of distance. In this worksheet we look at this relationship using graphs. Since speed is the rate of change of distance, on the distance graph it should be related to a **slope**.

1. Consider the graph below, which shows how the positions of two bicycles change as time passes.




(a) Compute the average speed of Bike A from 15 to 30 minutes (so 0.25 to 0.5 hours). The answer will not be exact as you have only a graph and not the actual equations for the position functions.

(b) Now draw the line whose slope represents the speed you computed above on the graph.

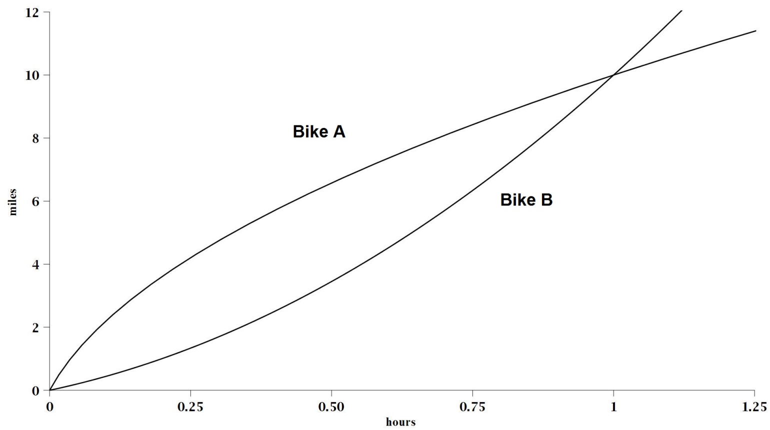
(c) Compute the average speed of Bike B from 30 to 31 minutes. This may be more difficult to do than part (a). Why?

(d) Now draw the line whose slope is the speed you computed in part (c). You can compute the slope of a line using any two points on the line. Recompute the average speed of Bike B from 30 to 31 minutes by computing the slope of that line as best as you can.

(e) The correct answer to parts (c) and (d) is approximately 10.1 miles per hour. Which of your answers above was closer? Why?

(f) If you want to compute the speed of Bike A at 30 minutes, what can you do? How is this related to a slope?

2. Here is the graph again. This time you will not be doing numerical computations so the grid lines have been removed for a cleaner look.




(a) Which bike is moving faster at 15 minutes? How do you know?

(b) Which bike is moving faster at at $t = 1$?

(c) At the end of one hour which bike is ahead? How can you tell?

3. Notice that a steeper curve on the graph corresponds to a higher velocity. A steep curve means that the position is changing quickly, which means the bike is moving fast. Refer to the graph on the previous page to answer the following questions.

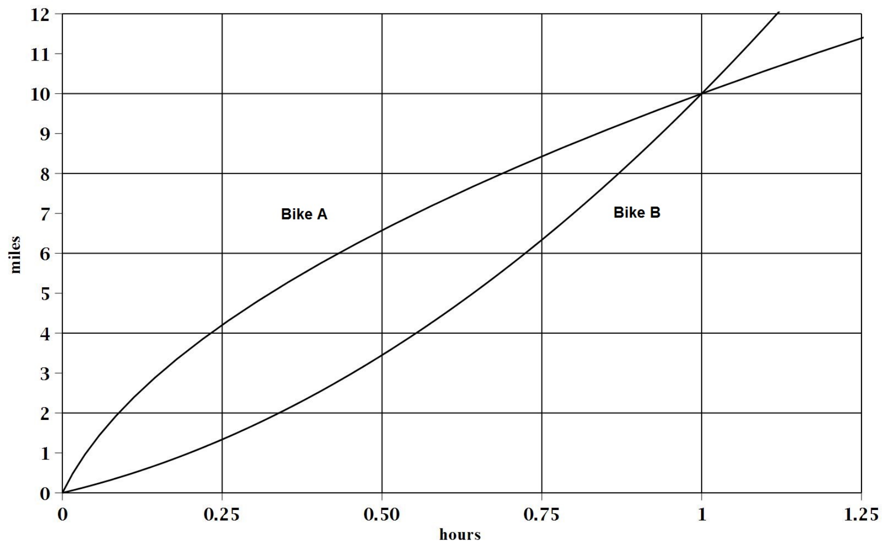
   (a) According to the graph, during the second half-hour of the bike ride, when is Bike A moving the fastest?

   (b) At about what time does Bike B start catching up with Bike A? That is, when does the distance between the bikes start to shrink?

   (c) Do you think there is an a time when the bikes are moving at exactly the same velocity? Either estimate that time by looking at the graph, or explain why there can't be such a time.

   (d) Are the questions and answers to parts (3b) and (3c) related? Why or why not?

4. At the end of this question you will sketch graphs of their speeds. First, we will start collecting some information. Here is the graph from the first page - again with grids for easier computation.




(a) Calculate their speeds when they start out as best as you can. By now you know these have to be slopes of tangent lines at the origin. Make sure you draw your tangents carefully.

(b) Calculate their common speed at the time you found in Question 3(c).

(c) Approximate their speeds at the end of one hour.

(d) Are their speeds increasing or decreasing through the journey. Use the information you collected to sketch their speed graphs on the right. This will be very approximate. You can compare your answers with the actual speed graphs in the solutions later.