Bad Bobby likes to throw things at people. He has dead aim and always throws at a horizontal component of velocity of 18 m/s (ignore vertical components in this problem). One day he decides to try a drive-by (he’s seriously bad). From a car moving straight down the street at a steady 12 m/s, he throws a rock directly at Sweet Sally who is standing still and minding her own business 14 m away. Bobby is directly opposite Sally (i.e. at his closest approach to her) when he lets loose. Fortunately, Bobby has never taken Physics 3; he misses. Let’s see how.

(Questions in parentheses are supposed to be guides to your thinking, hints as to how to go about solving the problem.)

1. Draw a diagram. I recommend establishing a coordinate system fixed in the earth(the earth frame) and arranging it so the path of the car is along the y-axis. I’d also put Sally (who is fixed in the earth frame) on the x-axis. (What are Sally’s coordinates?) (Where is Bobby when he throws?)

2. Make an argument that results in the conclusion that the velocity of the rock in the earth frame is a sum of two particular vectors. Use that ol’ math lingo to express yourself. Add to your diagram. (This is the trickiest part. If you are really detailed, you may want to draw another diagram to show the relationship between the car frame and the earth frame. But if you are even modestly clever in how you set up the earth frame, the earth frame and the car frame will be coincident at the moment of release.)

3. Use a dotted line in your diagram to show the path of the rock over the ground (as seen from above; we’re not considering vertical motion) and compute the speed of the rock along this path. (It isn’t 18 m/s, is it? No. So is it greater than or less than 18 m/s?)

4. Find the point of closest approach of the rock to Sweet Sally and add a dotted line from that point to Sally. Compute the distance of the rock from Sally at that point. (Hint: Use similar triangles to avoid using trig. Or use trig. Knock yourself out.) Please call this distance $d$. This is the distance by which Bobby’s evil rock misses our heroine. (Okay, another hint: To use the similar triangles, you’ll have to mentally flip one of them over to see what to see which ratios to equate.)

5. Doing no further calculations (!!!), show on your diagram the position of the car (and Bad Bobby, since he’s in the car) at the moment the rock is closest to Sweet Sally. Explain your reasoning.

This is not a difficult problem, but it brings together many different ideas from the last two weeks, and may pose a challenge for that reason. I’ll be gone for the weekend and unavailable to help you out, so work together!