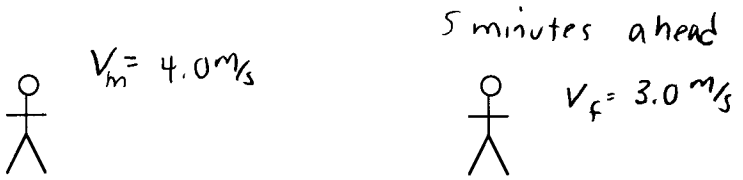
Group Problem

You and your friend run outdoors about 10 miles every day no matter what the weather (well, almost). Today the temperature is a brisk 10° F with a wind chill of -10° F. Your friend, a real running fanatic, insists that it is a great day to run. You agree to this madness as long as you both begin at your house and end the run at her nice warm house in a way that neither of you has to wait in the cold. You know that she runs at a very consistent pace with an average speed of 3.0 m/s, while your average speed is a consistent 4.0 m/s. Your friend finishes warming up first so she can get a head start. The plan is that she will arrive at her house first so that she can unlock the door before you arrive. Five minutes later, you notice that she dropped her keys. If she finishes her run first she will have to stand around in the cold and will not be happy. How far from your house will you be when you catch up to her if you leave immediately, run at your usual pace, and don't forget to take her keys?

Context-Rich Problems: Solutions Outline for Group Problem #1
(Put group number and names of people present at the end of the problem).

FOCUS the PROBLEM
Draw a picture of the situation including ALL the information given in the problem.



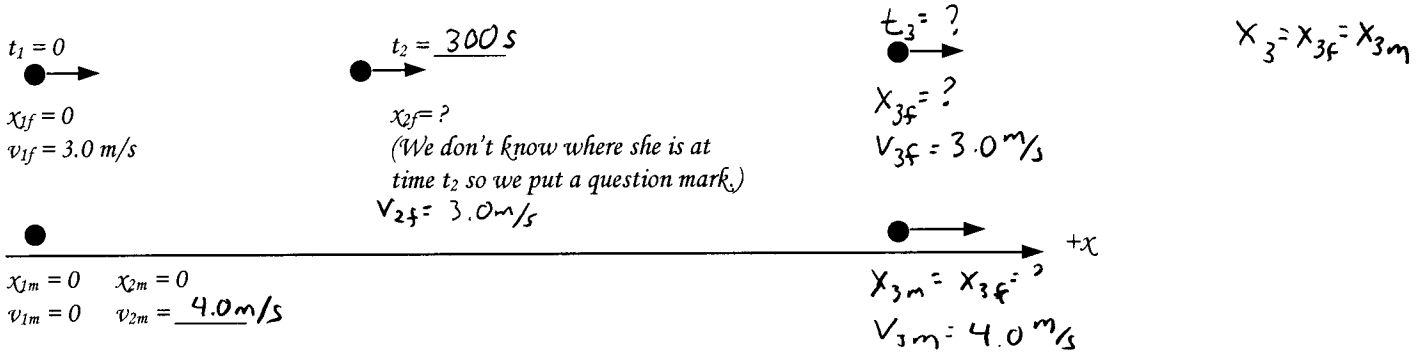
Here you are.
What should you write about you?

Here is your friend.
What should you write about her?

(Have you written all of the information in the problem into this section?)
Question(s): What is the problem asking you to find?
(Be specific and write in plain English?) How far from my house will I be when I catch up to my friend.

Approach: Outline the approach you will use.
(Write something here so that someone else could read it and know what you are doing.)
use definition of velocity with a constant velocity for me and my friend.

DESCRIBE the PHYSICS
Draw physics diagram(s) and define ALL quantities uniquely.
(This may be the most important step so I will help you with it.) There are three important times. (1) The time your friend leaves, (2) the time you leave, and (3) the time you catch your friend. We will label those three times with subscripts 1, 2, and 3 respectively. There are two important people, you and your friend. We will label those with subscripts "m" for "me" and "f" for "friend". At each point in time you need to write what the time is, what the velocity is for both you and your friend and what the location is for both you and your friend, all with different subscripts. This needs to all be drawn on a "motion diagram" with x and y axes labeled. You should fill in the blanks below and add any other information that should be in this "motion diagram."



(You can also write down things that are equal here, like $x_{1m} = x_{2m}$. Can you write down any more variables from the above diagram that are the same? Every variable defined should have a value associated with it or a question mark indicating you don't know it.)
Which of your defined quantities is your Target variable(s)? *Write down which of the variables above will answer the question you are trying to solve. In this example, there is only one target variable, so only one thing should be written down using the exact subcripts you used in the above diagram.* X_3

Quantitative Relationships: Write equations you will use to solve this problem.
(The only equation you will need here is the definition of veloocity, so write $v = (x_2 - x_1)/(t_2 - t_1)$

$$V = \frac{x_2 - x_1}{t_2 - t_1}$$

PLAN the SOLUTION

Construct Specific Equations (Same Number as Unknowns)

Start with an equation with the target variable in it and use the exact notation and subscripts you defined in the previous part of the problem. Keep track of the number of variables which are unknown and keep adding equations until the number of equations is equal to the number of unknowns. Do all the algebra first so that at the end you have a single equation which solves for your target variable. I have written the first equation for you.

$v_{2m} = (x_{3m} - x_{2m})/(t_3 - t_2)$

Now I use the fact that $x_{2m} = 0$ to write: Unknowns

$v_{2m} = x_{3m}/(t_3 - t_2)$ (1) x_{3m}, t_3

Since I have one equation and two unknonws, I need to write another equation. Since t_3 is the unknown, the next equation should contain the variable t_3. Keep writing equations and unknowns until the number of equations equals the number of unknowns. Then do the algebra so that you have only one equation left which solves for your target variable in terms of things you know.

$$V_{1f} = \frac{x_{3f} - x_{1f}}{t_3 - t_1}$$

Since $x_{3f} = x_{3m}$, and $t_1 = 0$, and $x_{1f} = 0$

(2) $$V_{2f} = \frac{x_{3m}}{t_3} \Rightarrow t_3 = \frac{x_{3m}}{V_{2f}}$$

Now 2 equations, 2 unknowns

Plug (2) into (1)

$$V_{2m} = \frac{x_{3m}}{\frac{x_{3m}}{V_{2f}} - t_2}$$

$$\frac{V_{2m}}{V_{2f}} x_{3m} - V_{2m} t_2 = x_{3m}$$

$$x_{3m} = \frac{-V_{2m} t_2}{\left(1 - \frac{V_{2m}}{V_{2f}}\right)}$$

Check Units

Use dimemsional analysis to make sure your answer has the correct dimensions. Use symbols like [L] for length and [T] for time.

$$\frac{\frac{[L]}{[T]}[T]}{1 - \frac{[L]/[T]}{[L]/[T]}} = [L] \text{ ok}$$

EXECUTE the PLAN

Calculate Target Quantity(ies)

Now just plug in numbers into the equation you derived in the last section.

$$x_{3m} = \frac{(-4.0\ m/s)(300\ s)}{\left(1 - \frac{4.0\ m/s}{3.0\ m/s}\right)}$$

$$= 3600\ m$$

EVALUATE the ANSWER

Answer the questions below completely and thoroughly.

Is Answer Properly Stated?

Yes, this is meters from hump (3.6 km)

Is Answer Unreasonable?

No, this is about 2.3 miles

Is Answer Complete?

Yes, It answers the question.

When you get to here, you're done!

(extra space if needed)

Write your Group Number here and the names of the group members who are present.

Discussion Section:_____

Group Number:_____

Name:_____

Name:_____

Name:_____

Name:_____