Title: Cars Overtaking and Colliding Activity

Things you need:

partner, stop watch, measuring tape, masking tape, fast constant velocity car, slow constant velocity car

Activity 1

Objective: Determine the time and the final position at which a fast and slow car collide when the cars begin facing opposite each other at 2 meters apart.

Using the measuring tape your group can determine the velocity magnitude of each car. You will need a stop watch, measuring tape, and both the fast and slow cars. You can mark 1 meter on the ground and then clock the time it takes each car to travel the 1 meter distance. You can clock each car three different times and then average the three together to get an average time for each car to complete the 1 meter. To average the time, add the three times and divide by 3. $t_{average} = \frac{t_1+t_2+t_3}{3}$

Slow Car $t_{average}$ = _______ seconds

$Fast\ Car$ $t_{average}$ = _______ seconds

Use the equation $\bar{v} = \frac{\boldsymbol{\Delta x}}{\boldsymbol{t}}$ to determine the velocity of each car. For this scenario, simply divide your average time into 1. $\bar{v} = \frac{1}{t_{average}}$. Report your results in meters per second.

$\bar{v}_{slow}$ = ___________ m/s $\bar{v}_{fast}$ = ______________m/s *Positive and negative matters here.

Next you will create a constant velocity equation $x_f = \bar{v}t + x_i$ for each car. $\bar{v}$ and x_i are known quantities and will differ within the two equations. x_f and $\bar{v}$ are currently unknown quantities and will remain represented as variables until you solve for them. Assume the fast car begins at position 0 meters and the slow car begins at position 2 meters.

x_f denotes final position; x_i denotes initial position; t represents the elapsed time from when the cars begin to move until colliding head on. Fill in the blanks below.

Slow Car	Fast Car
$x_f = \bar{v}t + x_i$	$x_f = \bar{v}t + x_i$
$x_{f,slow} = \bar{v}_{slow}t + x_{i,slow}$	$x_{f,fast} = \bar{v}_{fast}t + x_{i,fast}$
$x_{f,slow} =$ ______$t +$ _______	$x_{f,fast} =$ ______$t +$ _______

Since x_f will be the same in both equations, you can set expressions equal to one another and then solve for t.

$$x_{f,slow} = x_{f,fast}$$

$$\bar{v}_{slow}t + x_{i,slow} = \bar{v}_{fast}t + x_{i,fast}$$

$$\_\_\_\_\_\_t + \_\_\_\_\_\_ = \_\_\_\_\_\_t + \_\_\_\_\_\_$$

$t =$ ____________ sec.

Once you have solved for t using the correct steps, you can choose either the slow or fast car original constant velocity equation to solve for the position at which the cars collide.

For practice and to verify your answer, use both original constant velocity equations to find x_f.

$x_{f,slow} = \bar{v}_{slow}t + x_{i,slow}$

$x_{f,slow} =$ ______ $t +$ ______

$x_{f,slow} =$ ________ meters

$x_{f,fast} = \bar{v}_{fast}t + x_{i,fast}$

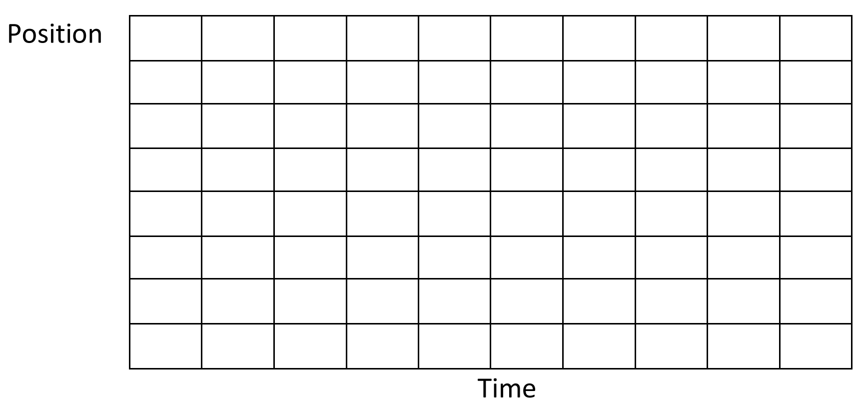
$x_{f,fast} =$ ______ $t +$ ______

$x_{f,fast} =$ _________ meters

Check your prediction by marking the collision final position x_f with tape and release the cars at the same time at their respective starting positions. You will need a partner to accomplish this task. The instructor should be present when you check your prediction.

How close was your prediction to the actual collision position in centimeters? ________ cm

On the grid lines provided below, graph the motion of each car. Remember that the average velocity $\bar{v}$ is the slope and can either be positive or negative; x_i is the y-intercept.



Activity 2

Objective: Determine the time and position at which a fast car will overtake a slow car when the slow car begins .5 meters ahead of the fast car. Both cars travel in the same direction.

If you use the same constant velocity cars from Activity 1, you may use the same velocity magnitudes.

$\bar{v}_{slow}$ = __________ m/s $\bar{v}_{fast}$ = _____________m/s *Positive and negative matter.

Again you will create a constant velocity equation $x_f = \bar{v}t + x_i$ for each car. The initial starting position and direction of the slow car should differ from Activity 1. Fill in the blanks.

Fill in the blanks below.

Slow Car

$x_f = \bar{v}t + x_i$

$x_{f,slow} = \bar{v}_{slow}t + x_{i,slow}$

$x_{f,slow} =$ _____ $t +$ ______

Fast Car

$x_f = \bar{v}t + x_i$

$x_{f,fast} = \bar{v}_{fast}t + x_{i,fast}$

$x_{f,fast} =$ _____ $t +$ ______

Since x_f will be the same in each equation, you can set expressions equal to one another and solve for t.

$$x_{f,slow} = x_{f,fast}$$

$$\bar{v}_{slow}t + x_{i,slow} = \bar{v}_{fast}t + x_{i,fast}$$

_____ $t +$ ______ $=$ _____ $t +$ ______

$t =$ ___________ sec.

Once you have solved for t using the correct steps, you can choose either the slow or fast car original constant velocity equation to solve for the overtaking position.

For practice and to verify your answer, use both original constant velocity equations to find x_f.

$x_{f,slow} = \bar{v}_{slow}t + x_{i,slow}$

$x_{f,slow} =$ _____ $t +$ ______

$x_{f,slow} =$ _______ meters

$x_{f,fast} = \bar{v}_{fast}t + x_{i,fast}$

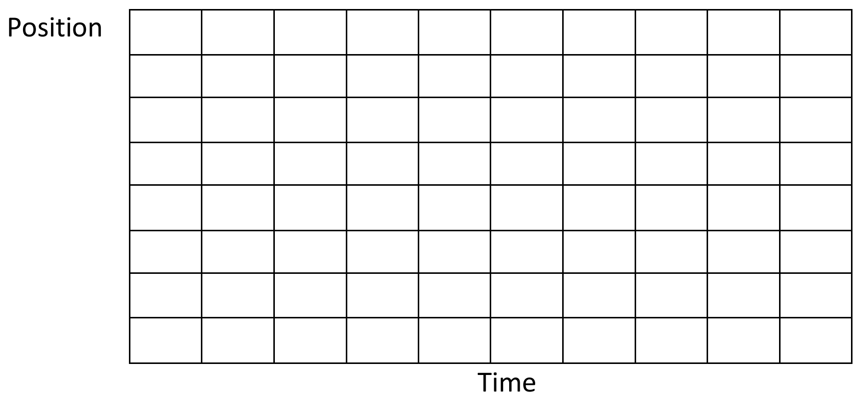
$x_{f,fast} =$ _____ $t +$ ______

$x_{f,fast} =$ ________ meters

Check your prediction by marking the overtake position x_f with tape and release the cars at the same time at their respective starting positions. You will need a partner to accomplish this task. The instructor should be present when you check your prediction.

How close was your prediction to the actual overtaking position in centimeters? _______ cm

On the grid lines provided below, graph the motion of each car. Remember that the average velocity $\bar{v}$ is the slope and can either be positive or negative; x_i is the y-intercept.



If your predictions were not 100% accurate, what were some potential sources of error that led to the inaccuracies? Explain.

Would the results have been the same if the cars began 2 meters apart but the initial positions of each car were different in activity 1? For example, if the fast car began at position 3 meters and the slow car at position 5 meters heading toward each other. Explain.