Lab: Relative Velocity (Speed)

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OBJECTIVES:

- Determine average velocity (speed).
- Predict the relative velocities (speeds) of the two objects traveling in the same and in the opposite directions.
- Experimentally measure the relative velocities (speeds) and compare with predictions.

EQUIPMENT:

2 Constant Velocity cars

1 Battery dummy

1 stopwatch

1 meter stick or measuring tape

PROCEDURE:

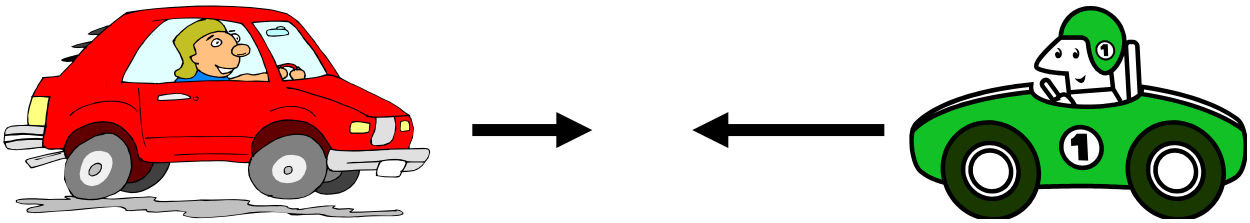
1. Determine the average velocity (speed) in **cm/s** of each of the two vehicles you are using in this laboratory activity. **Explain what you did to determine the average speeds.**

   Vehicle 1: _____ cm/s

   Vehicle 2: _____ cm/s

Moving Opposite Directions – Toward Each Other

If you know the average speeds of two different vehicles, then you can determine what their **relative speed** will be as they move toward each other from some specified distance away.



2. Based on the average speeds that you determined for your two vehicles, what do you predict the relative speed of the vehicles to be as they approach each other from opposite directions? (i.e., At what rate should they close in on each other?) _____ cm/s. Record this value in the data table.
3. Place the two cars facing each other 300 cm apart. Turn on both cars and release at the same time. Measure the amount of time it takes for the two vehicles to meet. Use two timers and perform two trials.
4. Average the four time values together and record in the data table.
5. Divide the distance apart by the average time to meet in order to calculate the relative speed (v = d/t).
6. Repeat this process for closing distances of 600 cm and 900 cm.

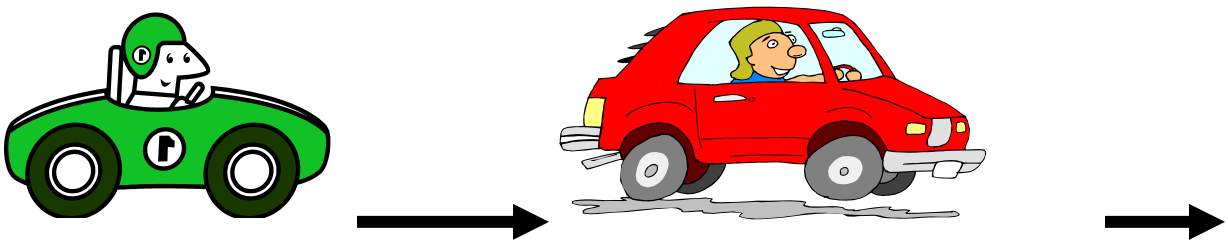
Distance Apart (cm)	Predicted Relative Speed (cm/s)	Time to Meet (s)				Average Time (s)	Measured Relative Speed (cm/s)
		Trial 1		Trial 2			
		Timer 1	Timer 2	Timer 1	Timer 2		
300							
600							
900							

7. Make a statement comparing your predicted relative speed with the measured relative speeds.

8. What are some possible reasons why they may not be exactly the same?

Moving Same Direction – Faster Car in Back:

It is also possible to investigate relative speed when the cars are traveling in the same direction with the faster car catching up to the slower car, as shown below.



9. Based on the average speeds that you determined for your two vehicles, what do you expect the relative speed to be as the faster vehicle catches up to the slower one from behind? (i.e., At what rate does the faster vehicle close in on the other vehicle?) _____ cm/s. Record this value in the data table.
10. Place the two cars facing the same direction with the front end of the faster rear car 100 cm behind the back end of the slower front car. Turn on both cars and release at the same time. Measure the amount of time it takes for the faster rear car to catch up to the slower front car. Use two timers and perform two trials.
11. Average the four time values together and record in the data table.
12. Divide the distance apart by the average time to meet in order to calculate the relative speed (v = d/t).
13. Repeat this process for closing distances of 200 cm and 300 cm.

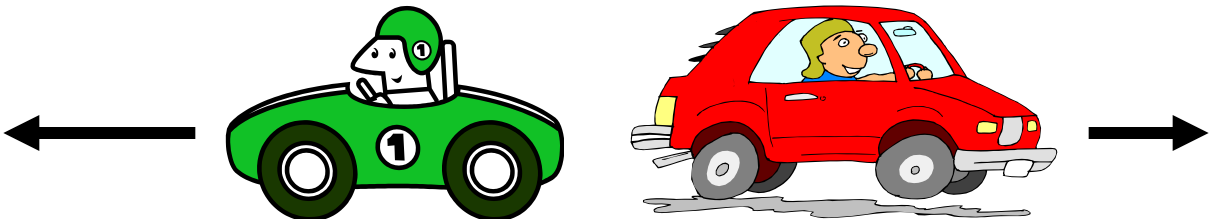
Distance Apart (cm)	Predicted Relative Speed (cm/s)	Time to Meet (s)				Average Time (s)	Measured Relative Speed (cm/s)
		Trial 1		Trial 2			
		Timer 1	Timer 2	Timer 1	Timer 2		
100							
200							
300							

14. Make a statement comparing your predicted relative speed with the measured relative speeds.

15. What are some possible reasons why they may not be exactly the same?

Moving Opposite Directions – Away From Each Other:

It is also possible to investigate relative speed when the cars are traveling in opposite directions away from each other, as shown below. One way to do this is to start the cars some specified distance apart, release them at the same time, and then visually locate the positions of the cars at some specified time after release. The change in the distance apart divided by the time will be their relative speed.



16. Based on the average speeds that you determined for your two vehicles, what do you expect the **relative speed** of the vehicles to be as they move away from each other? (i.e., At what rate should the distance between them increase?) _____ cm/s. Record this value in the data table.
17. Begin each run with the fronts of the cars some specified distance apart. Use tape to mark the starting positions. Record this initial distance apart in the data table.
18. Release the cars at the same time and have spotters note the positions of the fronts of the cars 2 seconds after release. Measure their new distance apart and record in the data table. Perform another trial and record in the data table. Average the two distances and record in the table.
19. Subtract the initial distance apart from the final distance apart to obtain the change in distance apart. Divide the average change in distance apart by the time to determine their relative speed.
20. Repeat this process for running times of 4 and 6 seconds.

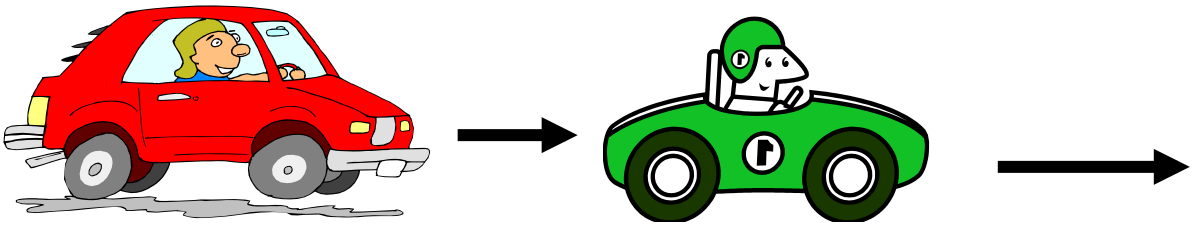
Initial Distance Apart (cm)	Predicted Relative Speed (cm/s)	Running Time (s)	Final Distance Apart (cm)		Average Distance Apart (cm)	Change in Distance Apart (cm)	Measured Relative Speed (cm/s)
			Trial 1	Trial 2			
		2					
		4					
		6					

21. Make a statement comparing your predicted relative speed with the measured relative speeds.

22. What are some possible reasons why they may not be exactly the same?

Moving Same Direction – Faster Car in Front:

It is also possible to investigate relative speed when the cars are traveling in the same direction and the faster car is in front pulls away from the slower rear car, as shown below. One way to do this is to again start the cars some specified distance apart, release them at the same time, and then visually locate the positions of the cars at some specified time after release. The change in the distance apart divided by the time will be their relative speed.



23. Based on the average speeds that you determined for your two vehicles, what do you expect the relative speed to be as the faster vehicle runs away from the slower one? (i.e., At what rate does the faster vehicle leave the other vehicle behind?) _____ cm/s. Record this value in the data table.
24. Begin each run with the fronts of the cars some specified distance apart. Use tape to mark the starting positions. Record this initial distance apart in the data table.
25. Place the two cars facing the same direction at their starting positions. Release the cars at the same time and have spotters note the positions of the fronts of the cars 2 seconds after release. Measure their new distance apart and record in the data table. Perform another trial and record in the data table. Average the two distances and record in the table.
26. Subtract the initial distance apart from the final distance apart to obtain the change in distance apart. Divide the average change in distance apart by the time to determine their relative speed.
27. Repeat this process for running times of 4 and 6 seconds.

Initial Distance Apart (cm)	Predicted Relative Speed (cm/s)	Running Time (s)	Final Distance Apart (cm)		Average Distance Apart (cm)	Change in Distance Apart (cm)	Measured Relative Speed (cm/s)
			Trial 1	Trial 2			
		2					
		4					
		6					

28. Make a statement comparing your predicted relative speed with the measured relative speeds.

29. What are some possible reasons why they may not be exactly the same?