Kinematics of Tailgating
Student Activity Guide

Introduction: You're in a hurry, traffic is heavy. How much space should you leave between you and the car ahead? How safe are you as a driver?

Activity One - Traffic Safety and Tailgating

Your teacher will divide you into groups. Discuss the following questions within your group.

Question 1.1: What is the rule for safe following distance between cars?

Question 1.2: Is this a constant or a ratio? Explain your reasoning.

Question 1.3: Why do you think the rule is stated this way?

Using appropriate and available reference materials, research the following. Be sure to keep an accurate bibliography of your references.

Question 1.4: What percentage of traffic accidents are rear-end collisions?

Question 1.5: Find the stopping distance or deceleration rate of at least 3 models of automobiles. Stopping distances will be referenced to a particular velocity - be sure to include both numbers.

Question 1.6: Under what conditions are these tests conducted?

Activity Two - Reaction Time

In this activity, you will use a simple procedure to determine your reaction time. You will need to work with a partner.

Procedure:

Have your partner hold his/her thumb and first finger about a 1/2 inch apart. Hold a ruler so that the 0 mark is just above your partners fingers. You will release the ruler and your partner will close their fingers to catch it. Measure the point at which their fingers close on the ruler. Record this value. Repeat 4 more times and average the distances. Be sure to record all these values. Then switch roles with your partner and record your values.

	Partner	You
Distance 1		
Distance 2		
Distance 3		
Distance 4		
Distance 5		
Average Distance		

Calculations

Question 2.1: Now using the equations for free fall, determine your reaction time and the reaction time of your partner. Record those here:

Question 2.2: Share your values with the class and record the class average and the range of values recorded in the class.

Question 2.3: Do you think your reaction time would be slower or faster when moving your foot? Why?

Question 2.4: How about moving the foot from the accelerator to the brake? Why?

Question 2.5: Besides the driver's reaction time, what other factors might affect the distance required to stop a car? Especially note those conditions which might alter the deceleration data provided by the car manufacturer's that you obtained in Activity One.

Activity Three - A Tailgate Problem

In this activity, you will review the equations for motion which you have studied previously and apply them to a simple tailgating problem.

Question 3.1: From memory, your textbook or notes, recall and record below the basic equations of motion.

Question 3.2: Using the equations above and any necessary unit conversions, fill in the table below for the models of cars you researched in Activity One. Show any work in the space below the table.

	Values calculated	Stopping Distance		Deceleration	
Make of car	from velocity of	(feet)	(meters)	(ft/sec^2)	(m/sec^2)
1:					
2:					
3:					
4:					

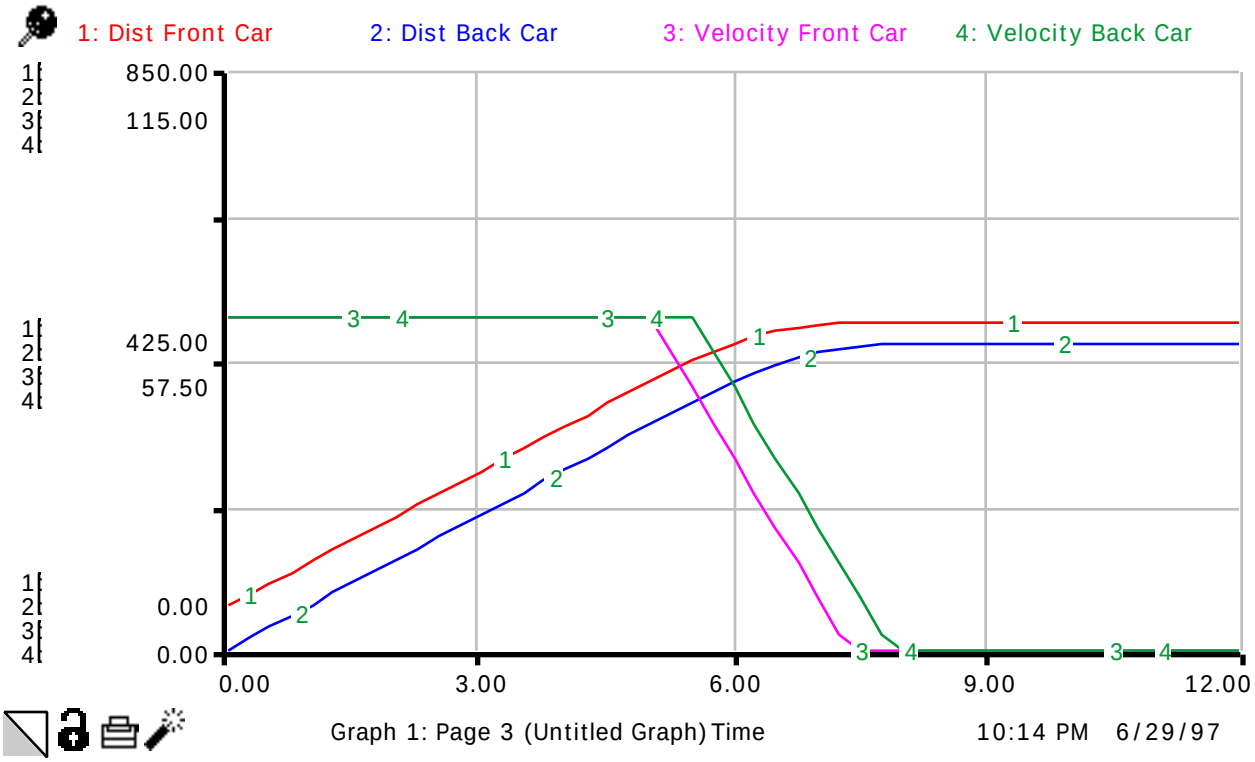
Quesion 3.3: A particular make of car has a deceleration of 9.0 m/s^2 as reported in the literature. Two cars, both of this make, are both traveling down a highway at 60 mph. The front car slams on its brakes. Using the average class reaction time you determined in Activity Two, determine the minimum distance that the second should have been behind the first, in order to avoid a rear-end collision. Show your work in the space below.

Question 3.4: Vehicle car lengths vary, but an average length would be about 16 ft. Translate the distance above into the number of car lengths that should have been between the cars.

Activity Four - The Tailgate Graph

Before actually using the tailgate model, you will interpret a copy of the graph. Then when you use the model, you will be able to interpret your results quickly.

For the graph below, both drivers were traveling at 45 mph and both had a deceleration rate of 28 ft/sec^2.



Refer to the graph to answer the following questions:

Question 4.1: Why is the y-intercept for the distance of the front car larger than that of the back car?

Question 4.2: Why are the velocity graphs flat at the beginning?

Question 4.3: At what time does the front driver apply the brakes? What is your evidence?

Question 4.4: Why do the velocity graphs have a downward slope in the second part of the graph?

Question 4.5: Why do the distance graphs curve and then go flat?

Question 4.6: Do these cars collide? What is your evidence?

Activity Five - Tailgate Model: Car Length vs. Velocity

In this activity you will use a STELLA model to investigate the relationship between velocity and the number of car lengths between vehicles that permits safe driving.

Your teacher will assign you to one of 11 groups. Together the class should choose one reaction time and one deceleration rate to use so that class data can be compared.

Use the model to determine the maximum velocity which two cars can travel at for your assigned car length. For simplicity, both cars should be traveling at the same velocity. Record your value in the table below and fill in the rest of the table with data supplied by other groups in the class.

Reaction time: _____ Deceleration Value: _____

Max. Velocity (mph)	Actual Max. Velocity (mph)	Separation Dist. (Car lengths)
25		
30		
35		
40		
45		
50		
55		
60		
65		
70		
75		

Now graph the car length vs. maximum safe velocity

Question 5.1: What relationship appears to exist between car length and maximum safe velocity?

Question 5.2: Does the rule you described in Activity One hold?

Question 5.3: What limitations were set in this experiment?

Question 5.4: For each of the factors mentioned in question 3, suggest how variations in that factor may improve the following distance or make it worse.

Question 5.5: In an actual driving situation, which of these factors are you aware of?

Activity Six - Tailgate Model: Worst Case Scenario

In this activity you will use a STELLA model to investigate factors which affect tailgating safety. In particular, you will be looking for the worst combinations of factors and determining the best car length to velocity ratio in these cases.

Look back at your answers to question 4.4 in Activity Four.

Question 6.1: What was varied and what stayed the same?

Question 6.2: What other factors in the model could be varied?

There are thousands of possible combinations in this model. In an organized and reasonable manner, suggest in writing how the class might investigate the other factors (relative car velocities, decelerations and reaction times) to determine the safest following distance in worse combinations of conditions and still avoid collisions.

Use the model to perform the variations assigned to you. Be sure to keep accurate records of your results.

After the class has finished, report your data to the class. As a class organize and summarize this data by using spreadsheets or graphs. Record the summary below.

Question 6.3: How do these results compare to the rule?

Question 6.4: What factors which were not included in the model could affect your results? How might they affect them?

Question 6.5: Considering your results and these additional factors, would you change the rule and how?

Activity Seven - Tailgating: Safety First!!

In this activity you will work with a group of students to design a public safety announcement (PSA) about the dangers of tailgating. You should use any data you acquired in this unit to date as well as additional resources. You may use any method (poster, overhead, video, audio or hypermedia) to present your PSA.

You and your group are junior members of an advertising firm. You have a chance to get the advertising contract with the State Department of Transportation and that could mean promotions for all of you. First, you must prepare a sample PSA, no longer than 1 min in length, which promotes traffic safety by focusing on the dangers of tailgating. You are competing with other advertising firms and all groups will present their ads on the same day. A decision about the awarding of the contract will be made at the end of the presentations.