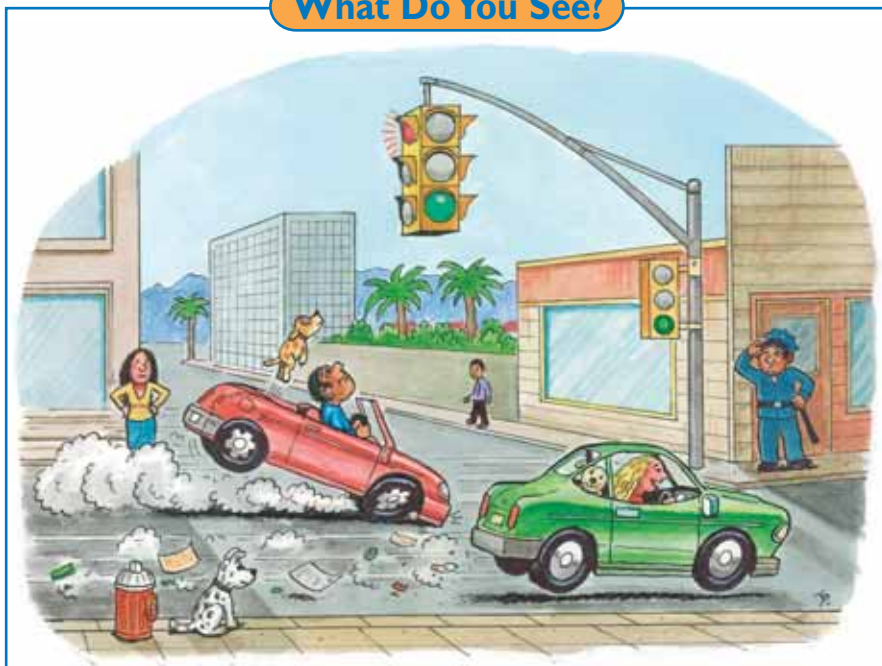




Section 6

Using Models: Intersections with a Yellow Light

What Do You See?



Learning Outcomes

In this section, you will

- **Investigate** the factors that affect the STOP and GO Zones at intersections with traffic lights.
- **Investigate** the factors that result in an Overlap Zone or a Dilemma Zone at intersections with traffic lights.
- **Use** a computer simulation to mathematically model the situations that can occur at an intersection with traffic lights.

What Do You Think?

Some traffic lights stay yellow for three seconds. Others stay yellow for six seconds.

- If all traffic lights stayed yellow the same amount of time, how would this affect drivers' decisions at intersections?
- How could an intersection with a traffic light be dangerous?

Record your ideas about these questions in your *Active Physics* log. Be prepared to discuss your responses with your small group and the class.


Investigate

In this *Investigate*, you will use a computer simulation to model the factors that affect the STOP and GO Zones at an intersection with a yellow light. You will then investigate what happens at an intersection when the STOP and GO Zones do not overlap.


Part A: Variables Affecting STOP and GO Zones at Intersections with Traffic Lights

1. Watch the video of an intersection, carefully noting what happens when the light turns yellow.

 a) Are there vehicles that you think should have stopped?

 b) Were there vehicles that stopped, but you think should have continued through the intersection?


2. Watch the video a second time. This time pay attention to the position of the vehicles at the moment the light turns yellow.

 a) Can you identify a “cutoff” point for a vehicle to make it through the intersection before the light turns red?

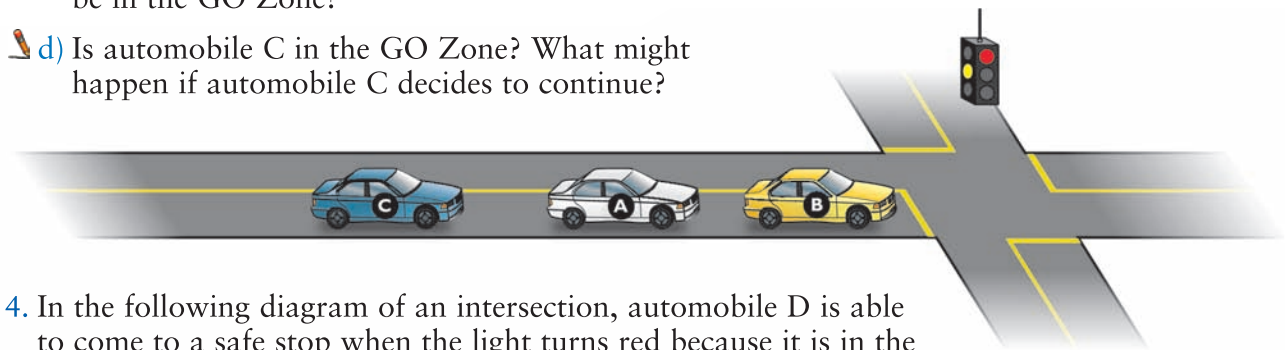
3. The diagram below shows the position of three automobiles at the moment a light turns yellow. Assume all three automobiles are moving with the same speed. Automobile A is able to make it through the intersection before the light turns red. It is in the GO Zone. Automobile C may not be able to make it through during the yellow light. The light may turn red before automobile C gets to the intersection.

 a) Will automobile B be able to make it through during the yellow light?


 b) Is automobile B in the GO Zone? Explain your answer.

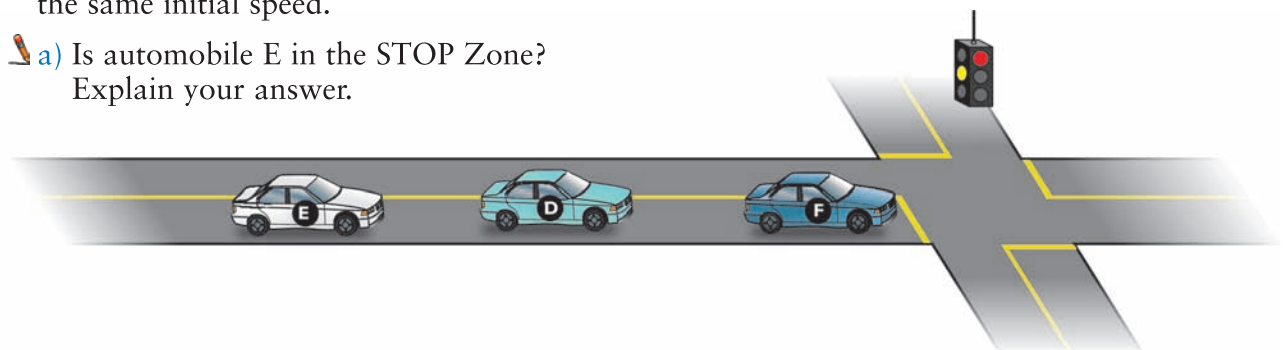
 c) Would any automobile closer to the intersection than automobile A be in the GO Zone?

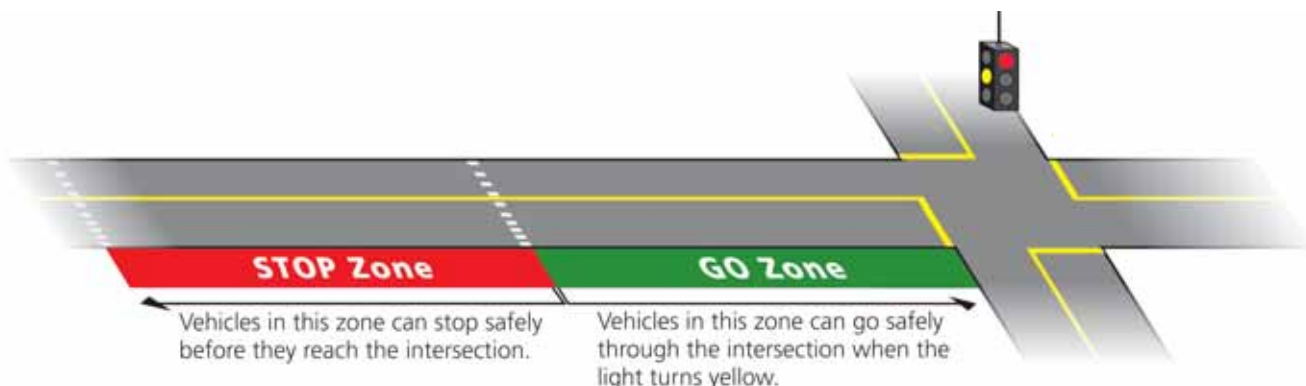
 d) Is automobile C in the GO Zone? What might happen if automobile C decides to continue?



4. In the following diagram of an intersection, automobile D is able to come to a safe stop when the light turns red because it is in the STOP Zone. In this zone, automobiles can stop safely before they reach the intersection. Automobile F is closer to the intersection than automobile D. If the driver of automobile F tries to stop the automobile, he or she may not be able to stop in such a short distance. Again, assume that all the automobiles have the same initial speed.

 a) Is automobile E in the STOP Zone? Explain your answer.





- b) Is automobile F in the STOP Zone? Explain your answer. What might happen if automobile F decides to stop?
- c) Sketch the STOP Zone and GO Zone in your log for the intersections in the diagrams. Place automobiles A, B, C, D, E, and F in the appropriate zones.

5. In order to study the yellow-light problem, transportation engineers use a computer simulation to model how various factors affect the GO Zone and the STOP Zone. In the yellow-light model shown at the right, there are five input variables that can affect the two output variables.

Yellow-Light Model

INPUT		OUTPUT
yellow-light time (t_y).....		
driver response time (t_r).....		GO Zone →
speed of vehicle (v).....		
negative acceleration (a).....		STOP Zone →
width of intersection (w).....		

- a) In your log, list the five variables shown in the model.
- b) You will first study how the variables affect the GO Zone. Copy the table at the right into your log.
- c) Predict how increasing or decreasing each variable affects the size of the GO Zone.

Variable	Change		Predicted effect of change on GO Zone	Actual effect of change on GO Zone
t_y	yellow-light time	increase t_y		
		decrease t_y		
t_r	response time	increase t_r		
		decrease t_r		
v	speed limit	increase v		
		decrease v		
a	negative acceleration	increase a		
		decrease a		
w	width of intersection	increase w		
		decrease w		

Remember to consider one variable at a time. The other four variables will stay constant. For example, if the time the light is yellow increases from 3 s to 3.5 s, how will the boundaries and size of the GO Zone change? Will the zone increase or decrease? Record your predictions.

6. Look at the copies of the following spreadsheets.

	A	B	C	D	E	F	G
1	INPUT VARIABLES					OUTPUT	
2							
3	yellow-light time (t_y)	3	seconds				GO Zone
4	human-response time (t_r)	1	seconds	YELLOW	53	meters	STOP Zone
5	speed of vehicle (v)	20	m/s	LIGHT	60	meters	
6	negative acceleration rate (a)	5	m/s/s	MODEL			
7	width of intersection (w)	7	meters				
8							
9							

	A	B	C	D	E	F	G
1	INPUT VARIABLES					OUTPUT	
2							
3	yellow-light time (t_y)	3.5	seconds				
4	human-response time (t_r)	1	seconds	YELLOW	63	meters	GO Zone
5	speed of vehicle (v)	20	m/s	LIGHT	60	meters	STOP Zone
6	negative acceleration rate (a)	5	m/s/s	MODEL			
7	width of intersection (w)	7	meters				
8							
9							

- What is the distance of the GO Zone if the yellow-light time is 3 s?
 - What happens to the GO Zone when the yellow-light time is increased to 3.5 s?
 - Would increasing the yellow-light time allow you to get through the intersection from a further distance away? Explain your answer in your log.
 - Record the effect of changing the yellow-light time in your log.
7. Use a computer spreadsheet program to obtain quantitative data (numbers you can use to test your predictions). Remember to change only one variable at a time. For each variable you investigate, record the following:
- Did the effect of the change of the variable make sense to you? Explain your answer.
 - Record the effect of changing each variable in your *Active Physics* log. How did the actual effect compare with your predictions in Step 5.c)?



- c) Look for a pattern in your results and try to determine how the GO Zone is calculated by the spreadsheet. Click on the cell that gives the GO Zone value. Look at the formula bar and convert this notation to an equation. Record this equation in your log.

	E	F	G
		OUTPUT	
	$= (B5*B3)-B7$	meters	GO Zone
	$= (B5*B4)+(B5^2)/(2*B6)$	meters	STOP Zone

- d) Discuss with your group and explain why the yellow-light time, speed, and the width of the intersection appear in the equation for the GO Zone. Record this information in your log.
- e) Why do the reaction time and negative acceleration not appear in the equation? Why do these two variables have no effect on the GO Zone?

8. Now you will investigate how changing each variable will affect the STOP Zone.

- a) Record your predictions in a chart similar to the one you used for the GO Zone.
- b) Use the spreadsheet investigation to find the actual effect of each variable on the STOP Zone. Record the effect in your chart.
- c) Compare your prediction with the actual effect. Do your results make sense to you? Explain your answer.

9. Look for patterns in your results and try to determine how the STOP Zone is calculated by the spreadsheet.

- a) Click on the cell that gives the STOP Zone value. Look at the formula bar and convert this notation to an equation. Record this equation in your log.
- b) Discuss the relationship with your group and explain why the yellow-light time and the width of the intersection do not appear in the equation for the STOP Zone.

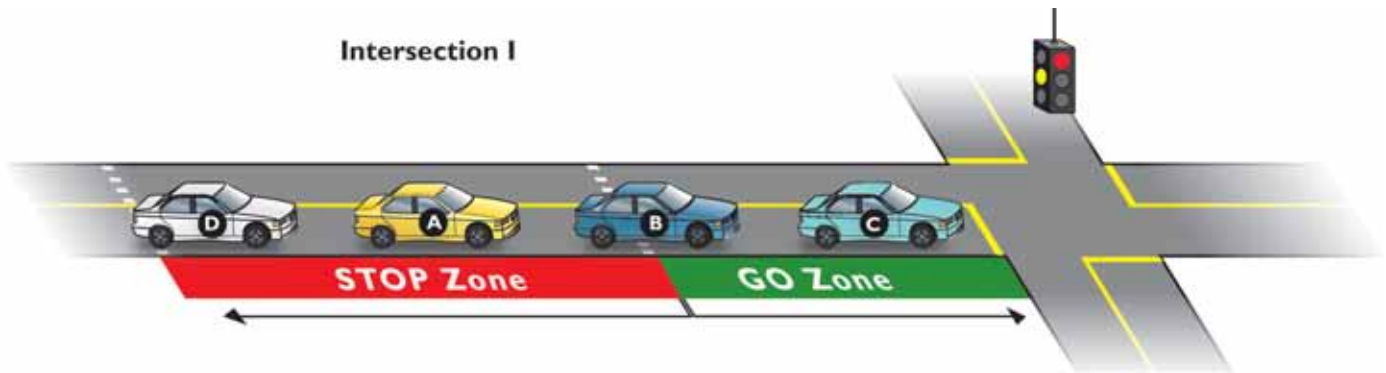
- c) Why do the reaction time, velocity, and negative acceleration appear in the equation? Why do the other two variables have no effect on the STOP Zone?



Part B: Yellow-Light Dilemma

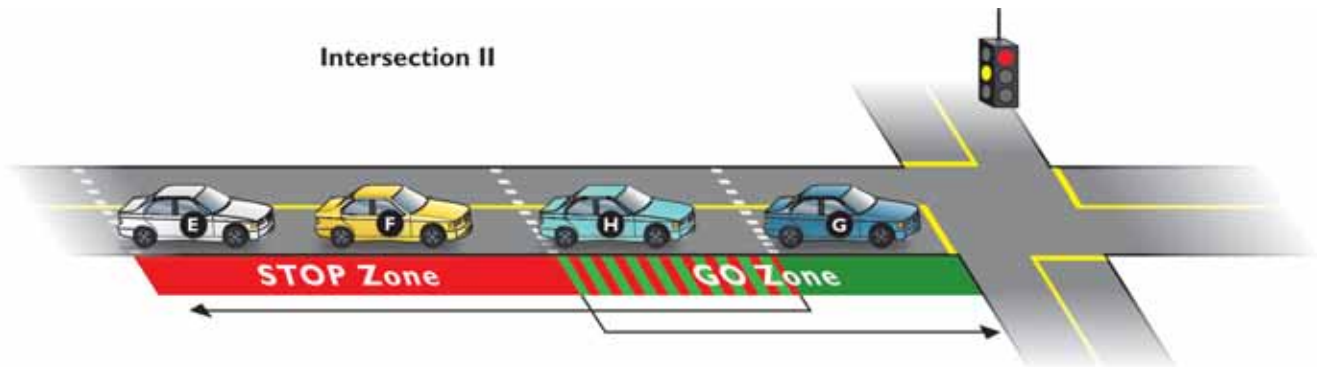
1. Imagine that you are at Intersection I shown in the diagram below.

- a) Would you go or stop if the light turned yellow when you were driving in automobile A? Automobile B? Automobile C? Automobile D?



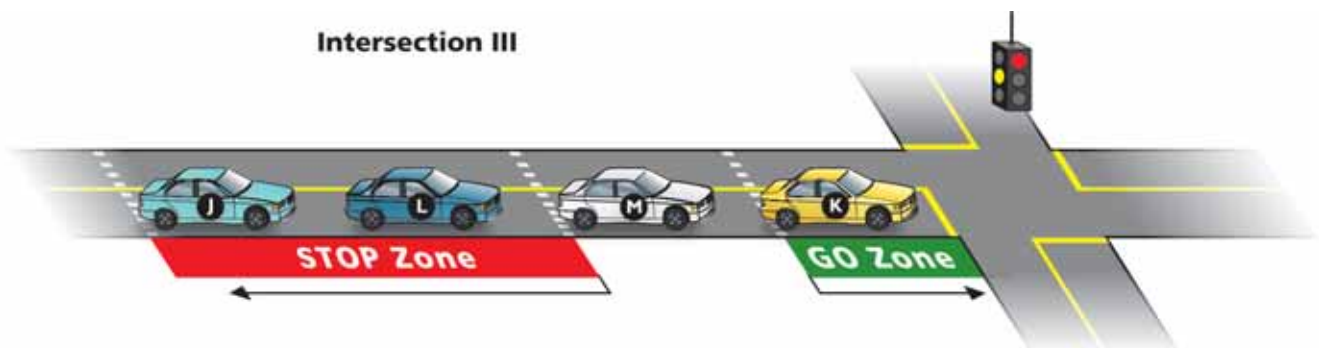
2. Imagine that you are at Intersection II.

- a) Would you go or stop if the light turned yellow when you were driving in automobile E? Automobile F? Automobile G? Automobile H?



3. Imagine you are at Intersection III.

- a) Would you go or stop if the light turned yellow when you were driving in automobile J? Automobile K? Automobile L? Automobile M?











4. Compare the GO Zone and the STOP Zone for Intersections I, II, and III.
 - a) How are the intersections different?
 - b) In Intersection II, if the light turned yellow when you were between the GO Zone and the STOP Zone, what would your choices be? Which choice(s) would be safe? Explain your answer.
 - c) In Intersection III, if the light turned yellow when you were in the space between the STOP Zone and the GO Zone, what would your choices be? Which choice(s) would be safe? Explain your answer.
 - d) When both choices are safe, the space between the GO and STOP Zones is called the Overlap Zone. When neither choice is clearly safe, it is called the Dilemma Zone. Intersections with a Dilemma Zone are not safe. Which intersection has an Overlap Zone and which has a Dilemma Zone?
5. Use a computer spreadsheet program, similar to the one you used in *Part A*. There is an additional outcome that tells you whether the intersection is safe and has an Overlap Zone or is unsafe and has a Dilemma Zone. Use the spreadsheet to determine ways in which an unsafe intersection can be made into a safe intersection. Which variables, when adjusted incorrectly, could make the intersection unsafe?

	A	B	C	D	E	F	G
1	INPUT VARIABLES					OUTPUT	
2							
3	yellow-light time (t_y)	3.7	seconds				
4	human-response time (t_r)	1.2	seconds	YELLOW	64	meters	GO Zone
5	speed of vehicle (v)	20	m/s	LIGHT	64	meters	STOP Zone
6	negative acceleration rate (a)	5	m/s/s	MODEL	0	meters	Overlap Zone
7	width of intersection (w)	10	meters				Safe
8							
9							
10							
11	yellow-light time (t_y)	3.7	seconds				
12	human-response time (t_r)	1.2	seconds	YELLOW	101	meters	GO Zone
13	speed of vehicle (v)	30	m/s	LIGHT	126	meters	STOP Zone
14	negative acceleration rate (a)	5	m/s/s	MODEL	-25	meters	Dilemma Zone
15	width of intersection (w)	10	meters				Unsafe
16							

- a) How does the spreadsheet determine whether the intersection is safe? What is the relationship between the GO Zone and the STOP Zone at an unsafe intersection?
- b) Use the sample spreadsheet shown above. Is there an Overlap or Dilemma Zone at 20 m/s (45 mi/h)?

-  c) What happens to the GO Zone and the STOP Zone when the speed is increased to 30 m/s (65 mi/h)? Is there still an Overlap Zone or Dilemma Zone?
 -  d) Now lower the speed to 10 m/s (20 mi/h). Is the intersection safer now? Explain your answer.
6. Continue your investigation by resetting the speed to its original value of 20 m/s. Adjust the yellow-light time and determine its effect on the Dilemma and Overlap Zones.
-  a) Record the results of this investigation in your log. (Include the changes you make to the variable as well as their effect on the zones.)
7. What effect do reaction time, negative acceleration, and width of the intersection have on the safety of the intersection? Does changing any of these variables create a Dilemma Zone? Conduct investigations with your spreadsheet.
-  a) Record the results in your log. (Include the changes you make to the variable as well as their effect on the zones.)
8. More than one variable change can eliminate a Dilemma Zone and replace it with an Overlap Zone.
-  a) Of the five variables, explain the ease or difficulty in changing each one to make the intersection safer. For example, why might you suggest changing the yellow-light time rather than changing the width of the intersection?
9. The yellow-light problem is based on a simple model and only provides approximate calculations. It does not include other factors such as whether the road is flat or the length of the automobile.
-  a) How does the length of the automobile affect the model? Which outputs are affected by the length of the automobile?





Physics Talk

MODELS

The arrival of spring, the movements of birds flying in the air, and the power of a storm have been observed by humans for thousands of years. Some creative people have tried to communicate what they have experienced through music, dance, painting, and sculpture. Invisible things like love, suspicion, and suspense have also been portrayed by creative artists. Physicists often rely on mathematical models to better understand the world. It is one of the reasons, you keep being asked, “Is there an equation?” A mathematical equation does not need to have anything to do with the real world. For example, the equation $x + y = 10$ tells you that the two numbers x and y must add up to 10. It does not have to relate to any real objects. The physics equation $d = vt$ tells you mathematically that there is a relationship between a distance traveled (d) and an object’s velocity (v).

Yellow-Light Model

You began this section by thinking about what happens as vehicles approach a yellow light. Do the vehicles continue to go through the intersection or do they stop? Some of the vehicles are traveling faster than others. Some of the intersections are larger than others. Some of the yellow lights stay yellow for a briefer time than others. There are many possible situations when a vehicle approaches a yellow light. Physicists can make sense of these by creating a mathematical model for the yellow-light problem.

The first part of model-building was to recognize that the intersection with a yellow light could be modeled with a GO Zone and a STOP Zone. You then used this model to describe whether vehicles could safely proceed through an intersection when the light turns yellow.

The GO Zone

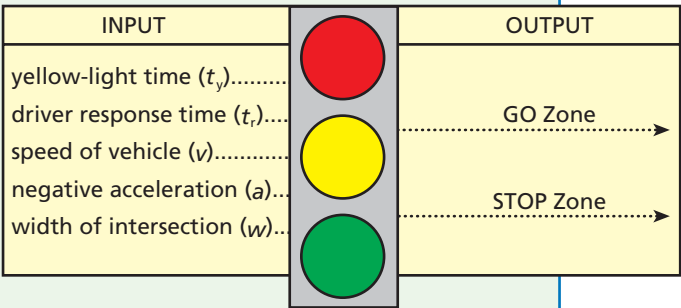
The GO Zone includes all positions where the automobile can safely proceed through the intersection when the light turns yellow. Each position depends on the automobile’s speed, the length of time of the yellow light, and the width of the intersection. You investigated why these variables are important and how they each affect the GO Zone.

The equation for calculating the GO Zone is $GZ = vt_y - w$

where vt_y is the distance the automobile travels while the light is yellow, and w is the width of the intersection.

- The GO Zone increases if the yellow-light time increases. This makes sense because the automobile has a few more seconds to make it safely through the intersection.

Yellow-Light Model



- The GO Zone decreases if the width of the intersection increases because the vehicle has to travel a greater distance to safely go through the intersection at the same speed.
- The GO Zone increases with an increase in speed because the vehicle can travel a greater distance during the time that the light is yellow.
- The braking acceleration does not affect the GO Zone because vehicles trying to go through the intersection do not use the brakes.
- The driver's reaction time is also not important because a driver who is going to continue through the intersection does not have to decide to use the brakes and move from the gas to the brake.

The STOP Zone

The STOP Zone includes all positions where the car can safely stop before reaching the intersection. Each position depends on the vehicle's speed, the braking acceleration, and the driver's reaction time. You investigated why these variables are important and how they each affect the STOP Zone.

The equation for calculating the STOP Zone is $SZ = vt_r + \frac{v^2}{2a}$

where vt_r is the distance the vehicle travels as the driver decides to stop

(the reaction distance), and

$\frac{v^2}{2a}$ is the braking distance.

- The STOP Zone decreases if the speed decreases. A slower-moving vehicle can be closer to the intersection and still stop safely.
- The STOP Zone decreases if the braking acceleration increases. Better brakes means that a vehicle can stop in a shorter distance.
- The STOP Zone decreases if the human reaction time decreases. The faster someone can react and move the foot from the gas to the brake, the smaller the distance required to stop.
- The width of the intersection does not affect the STOP Zone. Because vehicles in the STOP Zone do not enter the intersection, the size of the intersection does not matter.
- The yellow-light time does not affect the STOP Zone. Because you are stopping your vehicle, it does not matter how long the light stays yellow.

Overlap Zone and Dilemma Zone

A properly designed yellow-light intersection must be safe for drivers when they are obeying the posted speed limits. For this reason, the STOP and GO Zones are adjusted so that a driver can either safely stop the vehicle before the intersection when the light turns yellow, or safely proceed through the intersection before the light turns red. The STOP and GO Zones must form an Overlap Zone. In the Overlap Zone, when the light turns yellow, the driver of the vehicle has the choice of either stopping or going through the intersection safely before the light turns red.





In a poorly designed intersection, a Dilemma Zone may exist. The Dilemma Zone is a space between the STOP and GO Zones. In this region, a driver traveling the speed limit cannot safely stop before the intersection or pass through the intersection completely before the light turns red. The driver is faced with the dilemma of choosing between two dangerous options. Fortunately, traffic engineers rarely make errors such as this.

Limitations of the Yellow-Light Model

You began using a simple input/output table based on the model. You input the values for the speed of the vehicle, the width of the intersection, the yellow-light time, the braking acceleration, and the reaction time. The model then provided the output values for the GO Zone and the STOP Zone. You then explored how the model calculated these values. The physics equations of motion were used to determine the values for the GO Zone and the STOP Zone.

The GO Zone and STOP Zone model lets you analyze an intersection much more precisely than merely watching the motion of cars. Most drivers do not know about the GO Zone and the STOP Zone. They have a sense of what to do when the light turns yellow, but have not developed a model in the way that you have. This model helps traffic engineers to determine if an intersection is safe or if it can be made safer by lowering the speed limit or lengthening the yellow-light time.



All models have limitations. The GO Zone and STOP Zone models that you developed do not take into account the length of the vehicle. You can expand the model by including this variable. The model does not include the colors of the vehicles. A person viewing an intersection may notice that an ambulance is responding to an emergency or a series of vehicles are part of a procession. This information may help explain the motion of the vehicles. The GO Zone and STOP Zone model does not take either of these situations into account. The colors of the vehicles is not an important factor in determining the GO and STOP Zones. You should always ask yourself where the model is useful and where the model is limited. You should also remind yourself that the model is not the same as the actual event. For example, the equations for the GO Zone and STOP Zone are not the same as vehicles approaching a yellow light.

In this section, you worked with a traffic model. In much of physics, you will be working with models that attempt to describe nature. There will be models that describe how forces affect motion, how light behaves and how something called energy can neither be created nor destroyed. The laws of physics are mathematical models that try to accurately predict what will occur and try to give you a glimpse into how nature works.

Checking Up

1. In this section, the spreadsheet is referred to as a model. What makes it a model?
2. In your own words, describe what is meant by the GO Zone.
3. In your own words, describe what is meant by the STOP Zone.
4. Describe what is meant by the Overlap Zone.
5. Describe what is meant by the Dilemma Zone.

Active Physics

+Math	+Depth	+Concepts	+Exploration
♦♦	♦♦	♦	

Plus

Speed and the Yellow-Light Model

As a driver, you have control over the speed of your automobile. How does that speed affect the GO and STOP Zones for a yellow light?

1. Predict how increases or decreases in speed will affect the GO Zone and STOP Zone.
2. Using a spreadsheet program or a graphing calculator, graph the relationship of the GO Zone vs. different speeds.
3. Graph the relationship of the STOP Zone vs. different speeds.
4. Using a graphing calculator or a spreadsheet program, graph the STOP Zone and the GO Zone vs. speed on the same set of axes. Try different values for the other variables from your earlier work.
5. Indicate the Overlap or Dilemma Zones on your graph.
6. In the *Investigate*, you analyzed how decreasing the speed of the automobile can eliminate the Dilemma Zone. Your graph may indicate that there is a new Dilemma Zone at very low speeds. Explain how this can be.
7. In the *Scenario* for this chapter, the teenager jokes that a yellow light means “step on it.” Would accelerating help you get through a yellow light? Calculate how much it may help.
8. Revise the spreadsheet model to test your answer to the question above. How would an acceleration of your automobile affect the GO Zone? Try to use realistic values of the acceleration and the time you have to accelerate. If you do increase your speed and find yourself in the intersection when the light has turned red, an accident at the faster speed will be much more severe. Assuming you are traveling at the speed limit, calculate how far above the speed limit you may be going to try to “beat the light.”

What Do You Think Now?

At the beginning of this section, you were asked the following:

- If all traffic lights stayed yellow the same amount of time, how would this affect drivers' decisions at intersections?
- How could an intersection with a traffic light be dangerous?

Now that you have investigated the effects of factors on a GO Zone and STOP Zone, what do you think would be the effect of having all lights stay yellow for the same length of time? Explain what could make an intersection with a traffic light dangerous and what can be done to correct the situation. Include the term Dilemma Zone in your explanation.



Physics

Essential Questions

What does it mean?

What factors determine the size of the GO Zone, the STOP Zone, and whether an intersection has a Dilemma Zone?

How do you know?

What measurements can you make to test your understanding of the GO, STOP, Overlap, and Dilemma Zones? In this section, you used equations and calculations on a computer model (spreadsheet) to determine these zones. How could you verify the conclusions from your spreadsheet to determine the zones?

Why do you believe?

Connects with Other Physics Content	Fits with Big Ideas in Science	Meets Physics Requirements
Forces and motion	* Models	Makes mathematical sense

* Physics uses mathematical models to describe physical situations. How do the GO Zone and STOP Zone models help you to improve your understanding of traffic at a yellow-light intersection?

Why should you care?

How can understanding the physics behind the GO, STOP, Overlap, and Dilemma Zones make you a better, more aware, and more informed driver?

Reflecting on the Section and the Challenge

In earlier sections, you learned that an automobile travels a certain distance while you are moving at a constant velocity and deciding whether to stop. You also learned that your automobile travels a certain distance after the brakes have been applied.

In this section, you learned that deciding what to do when you see a yellow light is not a simple decision. It requires a judgment of the distance to the intersection, the width of the intersection, and how much time it will take you to get there at the speed you are traveling. You also need some sense of how well your brakes work and how quickly you can respond. Finally, you need to know the time that the light is yellow before turning red.

You also know that it is important for traffic engineers to make sure that an intersection has an Overlap Zone and not a Dilemma Zone between the STOP and GO Zones.

You now know which factors affect the zones at an intersection. You know any intersection can be made safer by lowering the speed limit or by lengthening the yellow-light time. You also know how these zones may change if your reaction time is slower or if your negative acceleration is being affected by bad weather or road conditions. Part of the *Chapter Challenge* is to explain these factors and how they affect your reaction time based on your investigations and conclusions.

Physics to Go

1. An *Active Physics* student group is studying an intersection. The width of the intersection is measured by pacing and is found to be approximately 15-m wide. The yellow-light time for the intersection is 4 s. The speed limit on this road is 30 mi/h (approximately 15 m/s). The speed of an automobile decreases by 5 m/s every second during negative acceleration. Assume that the people who are driving the automobiles have a reaction time of 1 s.

- a) Calculate the GO Zone using the math equation on the computer spreadsheet. Use a calculator. To guide you, the first two steps are provided for you.

GO Zone = (velocity \times yellow-light time) – width of intersection

$$GZ = vt_y - w$$

$$GZ = (15 \text{ m/s})(4 \text{ s}) - 15 \text{ m}$$

$$GZ =$$

- b) Calculate the STOP Zone using the math equation on the computer spreadsheet. Use a calculator to help you.

STOP Zone = (velocity \times reaction time) + velocity²/(2 \times negative acceleration)

$$SZ = vt_r + \frac{v^2}{2a}$$

- c) Make a sketch of the intersection and label both the GO Zone and the STOP Zone. Include the dimensions of the intersection and each zone.
2. Some people disregard the 30 mi/h speed limit (15 m/s) and travel at 60 mi/h (30 m/s) on the road described in *Question 1*.
 - a) Use the spreadsheet or calculator to calculate STOP and GO Zones at 60 mi/h. Sketch the intersection marking both zones. Explain the danger of driving at this speed.
 - b) How would a decrease in the speed limit to 20 mi/h (about 10 m/s) affect the STOP and GO Zones in *Question 1*? Use the spreadsheet or calculator to calculate both, then sketch the intersection, marking both zones.
 3. A person is listening to loud music while driving. Explain why the increase in reaction time caused by the music does not affect the GO Zone. Explain how it affects the STOP Zone.
 4. An automobile has worn tires and bad brakes. How will this affect the GO Zone and the STOP Zone at a yellow light?
 5. Sometimes, when a light turns red at an intersection, the light for the traffic on the cross street does not turn green for a couple of seconds. What is the reason for this delay?
 6. In the 1960s, the traffic engineers in a city experimented with a traffic light that featured a clock. As you approached an intersection with a green light, in the space for the yellow light there was a countdown: ..., 5, 4, 3, 2, 1, 0. When the clock reached “0” the light turned yellow.



This experiment was never implemented, and not even the city where this experiment was done uses the countdown to the yellow light today. Why do you think the traffic engineers decided this countdown was not a good idea? How does such a countdown affect the STOP and GO Zones of the oncoming traffic?

7. With the grid below, compute the GO and STOP Zones for each intersection. Also, determine if each intersection is safe and describe how you know it is safe.

Intersection	A	B	C	D	E
Yellow-light time	3.0 s	4.0 s	3.0 s	3.0 s	3.5 s
Reaction time	1.2 s	1.2 s	1.0 s	1.8 s	1.2 s
Speed of automobile	20 m/s	20 m/s	20 m/s	20 m/s	15 m/s
Acceleration	-7 m/s^2	-7 m/s^2	-7 m/s^2	-7 m/s^2	-7 m/s^2
Width of intersection	12 m	8 m	12 m	12 m	12 m

8. Do you think it would be a good idea to paint lines at all intersections showing the boundaries of the STOP and GO Zones? Explain your answer.

9. *Preparing for the Chapter Challenge*

Write a pretend letter to your parents, asking to borrow their car. You must try to convince them based on what you have learned in this section about intersections. Be sure to explain what you have learned about the STOP, GO, Overlap and Dilemma Zones.

Inquiring Further

Study a real intersection

Now that you know how the length of the yellow-light time and other factors affect the safety of a traffic intersection, you are ready to study an actual intersection.

- Choose a traffic intersection in your neighborhood and measure the yellow-light time.
- Obtain the width of the intersection from a local police officer or from the municipal government.
- Assume that the driver's reaction time is 1.0 s and the negative acceleration is 5 m/s^2 every second. Run the spreadsheet program with this data and find the STOP and GO Zones. You may also use a calculator and the appropriate equations.
- Draw a sketch of the intersection and include the GO Zone and the STOP Zone.
- From your data, does a Dilemma Zone or an Overlap Zone exist? Is the intersection safe?

