

REAL-WORLD TAKEAWAYS

- A rear-view mirror should be angled slightly toward the driver in order to see the area directly behind the car.
- Side-view mirrors will provide the most helpful visibility if they're positioned so that you cannot see the edge of your own car but so that you can see an adjacent car just out of the area reflected in the rear-view mirror.

MATHEMATICAL OBJECTIVES

- Make formal geometric constructions including perpendicular bisectors, parallel lines, and angle reflections

LESSON AT A GLANCE

90 MIN.

LAUNCH		Watch a commercial for an add-on mirror for cars intended to eliminate blind spots. Discuss the goal and function of car mirrors.	5 min.
PART ONE	1	Model a driver's visible region reflected in a rear-view mirror positioned straight back by constructing perpendicular lines and reflecting angles, then explain what adjustments would improve the driver's visibility.	40 min.
	2	Construct the appropriate positions for side view mirrors to create the safest visible region.	45 min.
PART TWO	3	Watch a short video suggesting a good process for appropriately setting side view mirrors. Describe intuitively and geometrically why this reduces blind spots.	15 min.

- L Students watch a commercial for Total View, a small mirror that attaches to a car's side-view mirror and – according to the announcer – “eliminates blind spots.”

DISCUSSION QUESTIONS

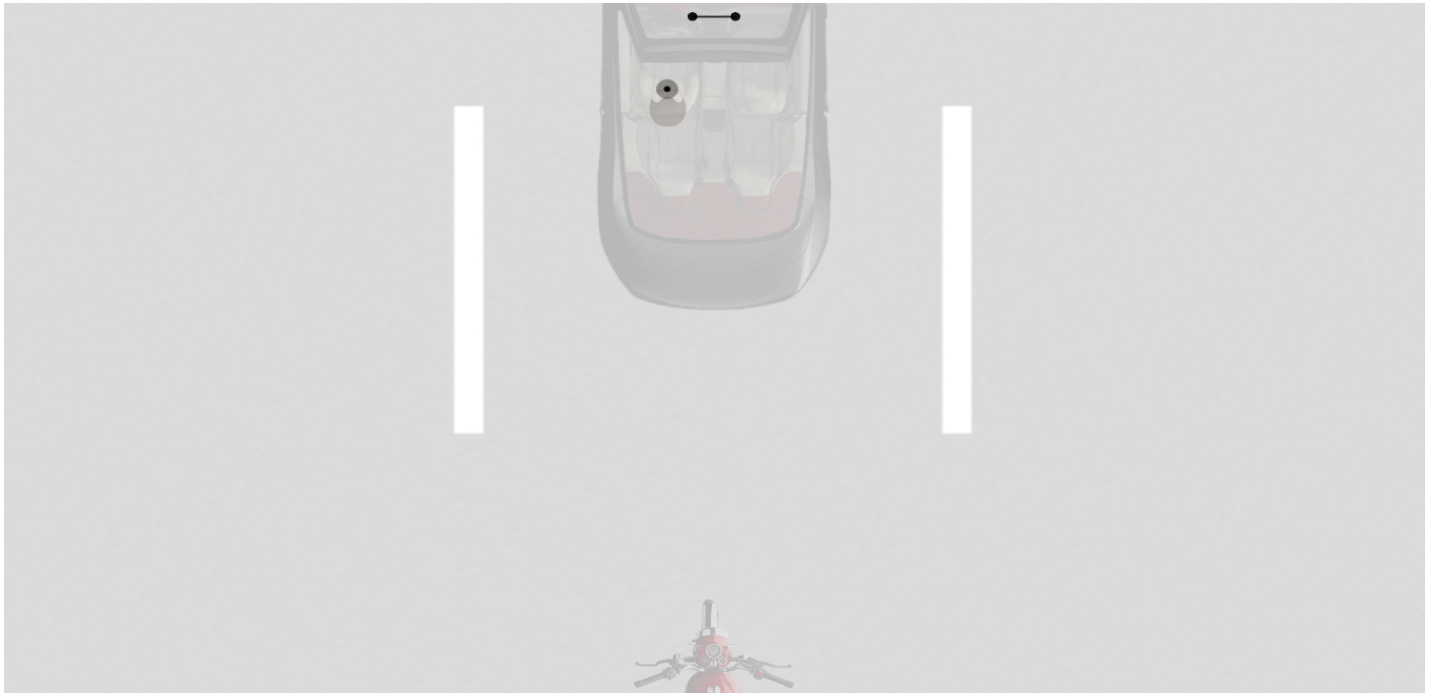
1. What problem are drivers trying to solve with Total View?
2. What are blind spots and why are they so dangerous?
3. How can drivers avoid blind spots?
4. If cars already come with rear and side-view mirrors, why is something like Total View even necessary?

KEY TAKEAWAYS

- Blind spots are areas behind and beside of a car that a driver cannot see. These are dangerous and can cause accidents.
- Even though cars come with three mirrors, eliminating blind spots requires that drivers adjust these mirrors correctly.

- 1 When you're driving, it's important to be aware of what's around you. Imagine a driver positions his rear-view mirror as shown in the diagram below. Construct a model showing the region he'll be able to see behind him.

Do you think this is a good way to position the mirror? If not, how would you suggest the driver adjust it and why?



Step 1



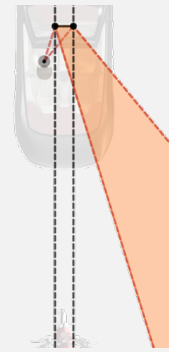
A ray-of-sight travels from the driver's eye to all the points along the mirror (including the leftmost and rightmost points)

Step 2



Each ray bounces off the mirror at the same angle that it entered; it reflects over a line perpendicular to the mirror at the point of intersection

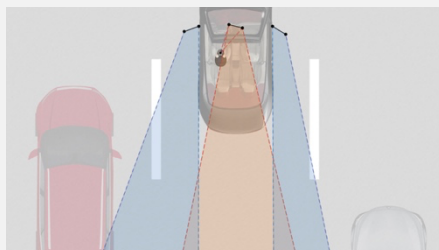
Step 3



The driver will be able to see the region between the innermost and outermost reflected rays, i.e. the region to the right of the car

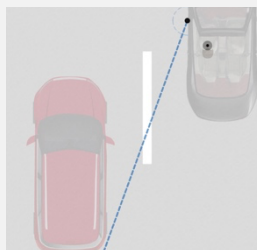
The purpose of a rear-view mirror is to see vehicles behind the car. If someone positioned the rear-view mirror to be perpendicular to the car, the driver would not be able to see what was behind them; they would see a region to the rear and right of the car. This would not be a good way to orient the rear-view mirror. Instead, they should rotate the rear-view mirror towards them (i.e. clockwise). This would rotate the visible region in orange from the right of the car to behind the car.

- 2 In addition to a rear-view mirror, cars also have side-view mirrors. Many drivers position these to see the edges of the car, as shown in the inset below. However, this results in dangerous blind spots. On the diagram below, construct a safer positioning of the left and right mirrors, and shade in the regions that will now be visible to the driver. (Note: the dashed semi-circles represent the mirror radius.)



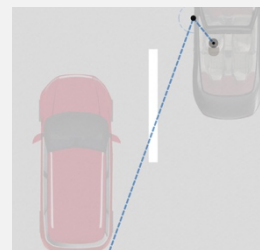
Final Positions, All Mirrors

The following diagrams (steps 1-8) show the process for orienting the driver-side mirror. As part of their answer, students should orient the passenger-side mirror, as well.



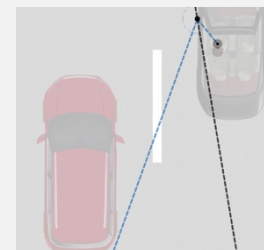
Step 1

Draw the innermost edge of the desired visible region



Step 2

Draw the ray from the driver's eye to the innermost point on the mirror



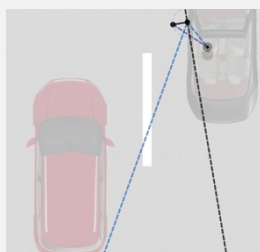
Step 3

Construct the perpendicular bisector through the angle formed by the two rays



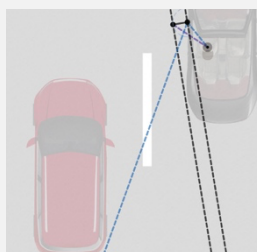
Step 4

Draw the side-view mirror, which will be perpendicular to the perpendicular bisector



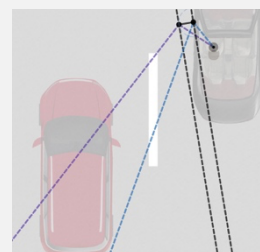
Step 5

Draw the ray from the driver's head to the outermost point on the side-view mirror



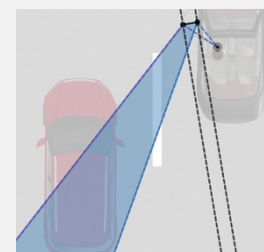
Step 6

Through this point, construct the line perpendicular to the mirror



Step 7

Use the law of reflection to construct the ray from the outermost point on the mirror



Step 8

Shade in the region between the reflected rays; this should include the car in the left lane (i.e. it should reduce the driver-side blind spot)

TEACHING TIP

When it comes to side-view mirrors, the farther away the driver is, the narrower the reflected region will be. For this reason, modern cars use passenger-side mirrors that are slightly curved, increasing the visible region. However, drawing reflected rays is much more difficult with curved surfaces, and all of the mirrors in this lesson are depicted as flat. To compensate for this, the passenger mirror in the diagram is slightly larger than it would be on an actual car.

- 3 Watch the video about how to properly adjust the side mirrors, then describe the process in your own words. Geometrically, why does this method help to reduce the blind spots in the left and right lanes?

Driver-Side Mirror

1. Place head against driver-side window
2. Adjust driver side-view mirror so that it barely shows the left side of the car
3. Move head back to regular position. The driver mirror will now show the region that picks up where the rear-view mirror leaves off, i.e. it will reduce the blind spot

Passenger-Side Mirror

1. Move head to center of the car above the console
2. Adjust passenger side-view mirror so that it barely shows the right side of the car
3. Move head back to regular position. The passenger mirror will now show the region that picks up where the rear-view mirror leaves off

There are two things you can do to change what's visible in the side-view mirror: You can move the mirror or you can move your head. When you follow the steps above to set the driver-side mirror, you start with your head right next to the driver-side window, then adjust the mirror to show the rear-edge of the car. Next, you move your head back to its normal position in the center of the headrest. As you do this, you move your head away from the side-view mirror, which has the effect of "swinging" the reflection outwards from the car. This is what covers the blind-spot. (The same reasoning holds for the passenger-side mirror.)

TEACHING TIP

Traffic accidents are one of the leading causes of death in the United States each year, and with teens especially so. Consider taking students to the parking lot and having them practice adjusting the mirrors on an actual car. (If your school offers drivers' ed, they may have vehicles you can use. Otherwise perhaps you could find some other faculty members to unlock their cars and act as chaperones.)