## Chapter 3

## Perpendicular and Parallel Lines

## Section 7

## Perpendicular Lines in the Coordinate Plane

## GOAL 1: Slope of Perpendicular Lines

In the activity below, you will trace a piece of paper to draw perpendicular lines on a coordinate grid. Points where grid lines cross are called lattice points.

## ACTIVITY <br> Developing Concepts

## Investigating Slopes of Perpendicular Lines

(1) Put the corner of a piece of paper on a lattice point. Rotate the corner so each edge passes through another lattice point but neither edge is vertical. Trace the edges.
(2) Find the slope of each line.
(3) Multiply the slopes.
(4) Repeat Steps 1-3 with the paper at a different angle.


In the activity you may have discovered the following.

## POSTULATE

POStULATE 18 Slopes of Perpendicular Lines
In a coordinate plane, two nonvertical lines are perpendicular if and only if the product of their slopes is $\mathbf{- 1}$.

Vertical and horizontal lines are perpendicular.

product of slopes $=2\left(-\frac{1}{2}\right)=-1$

Notice that the slopes are also $\qquad$ OPPOSITE RECIPROCALS $\qquad$ .

Example 1: Deciding Whether Lines are Perpendicular

Decide whether the following lines are perpendicular.


$$
\begin{aligned}
& \frac{1-3}{3-0}=\frac{-2}{3} \\
& \frac{-3-3}{-4-0}=\frac{-6}{-4}=\frac{3}{2}
\end{aligned} \begin{aligned}
& \text { opec. } \\
& \text { sect } \\
& \text { are }
\end{aligned}
$$

Example 2: Deciding Whether Lines are Perpendicular

Decide whether $\overleftrightarrow{A C}$ and $\overleftrightarrow{\mathrm{DB}}$ are perpendicular.


$$
\left.\begin{array}{l}
\frac{6}{3} \rightarrow \frac{2}{1} \\
\frac{-3}{6} \rightarrow \frac{-1}{2}
\end{array}\right\rangle \begin{aligned}
& \text { opp cup. } \\
& \begin{array}{l}
\frac{\Delta y}{a^{c e}}
\end{array}>
\end{aligned}
$$

## Example 3: Deciding Whether Lines are Perpendicular

Decide whether the lines are perpendicular.

$$
\begin{array}{rlrl}
\text { line } h: y=\frac{3}{4} x+2 & \text { line } j: y=-\frac{4}{3} x-3 \\
m=\frac{3}{4} & m=\frac{-4}{3} \\
\text { Opp. recup, } \Rightarrow \text { are }
\end{array}
$$

## Example 4: Deciding Whether Lines are Perpendicular

Decide whether the lines are perpendicular.

$$
\text { line } \begin{aligned}
& r: 4 x+5 y=2 \\
&-4 x \\
& \frac{5 y}{}=\frac{-4 x}{5}+\frac{2}{5} \\
& y=-\frac{4}{5} x+\frac{2}{5} \\
& m=-\frac{4}{5}
\end{aligned}
$$

$$
\text { line s: } \begin{aligned}
-5 x & +4 y=-5 \\
y y & =\frac{-5 x}{4}+\frac{3}{4} \\
y & =\frac{-5}{4} x+\frac{3}{4} \\
m & =-\frac{5}{4}
\end{aligned}
$$

## GOAL 2: Writing Equations of Perpendicular Lines

Example 5: Writing the Equation of a Perpendicular Line

$$
m=-2 \Rightarrow 1 \text { slope }=\frac{1}{2}
$$

Line $I_{1}$ has the equation $y=-2 x+1$. Find an equation of the line $I_{2}$ that passes through $\mathrm{P}(4,0)$ and is perpendicular to $I_{1}$. First you must find the slope, $m_{2}$.


## RAY TRACING

Computer illustrators use ray tracing to make accurate reflections. To figure out what to show in the mirror, the computer traces a ray of light as it reflects off the mirror. This calculation has many steps. One of the first steps is to find the equation of a lines perpendicular to the mirror.


Example 6: Writing the Equation of a Perpendicular Line

$$
m=\frac{3}{2} \Rightarrow\left(1 \text { siope }=\frac{-2}{3}\right)
$$

The equation $y=\frac{3}{2} x+3$ represents a mirror. A ray of light hits the mirror at $(-2,0)$. What is the equation of the line $p$ that is perpendicular to the mirror at this point?


Top view of mirror

