

Parallel and Perpendicular Lines

Parallel lines are coplanar lines that do not intersect. Nonvertical parallel lines have the same slope. Two lines that intersect to form a right angle are **perpendicular lines**. Two nonvertical lines are perpendicular if and only if the product of their slopes is -1 .

Example 1 Determine which of the lines are parallel and which are perpendicular.

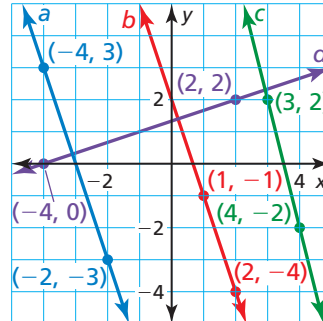
Find the slope of each line.

Line *a*: $m = \frac{3 - (-3)}{-4 - (-2)} = -3$

Line *b*: $m = \frac{-1 - (-4)}{1 - 2} = -3$

Line *c*: $m = \frac{2 - (-2)}{3 - 4} = -4$

Line *d*: $m = \frac{2 - 0}{2 - (-4)} = \frac{1}{3}$

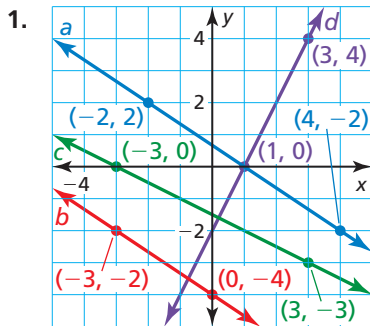


► Because lines *a* and *b* have the same slope, lines *a* and *b* are parallel. Because $\frac{1}{3}(-3) = -1$, lines *a* and *d* are perpendicular and lines *b* and *d* are perpendicular.

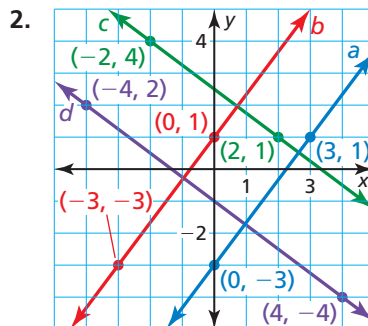
Practice

Check your answers at BigIdeasMath.com.

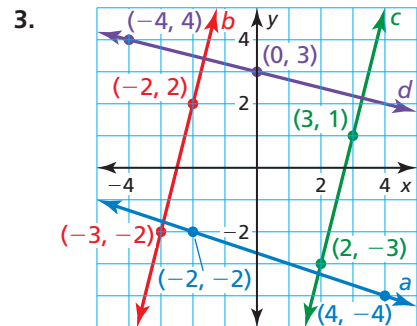
Determine which of the lines are parallel and which are perpendicular.



$a \parallel b, c \perp d$



$a \parallel b, c \parallel d, a \perp c, a \perp d, b \perp c, b \perp d$



$b \parallel c, b \perp d, c \perp d$

4. **GEOMETRY** The vertices of a quadrilateral are $A(-5, 3)$, $B(2, 2)$, $C(4, -3)$, and $D(-2, -2)$. Is the quadrilateral a parallelogram? Explain your reasoning.

no; If opposite sides are parallel (have the same slope), then the quadrilateral is a parallelogram. The slope of \overline{AB} is $-\frac{1}{7}$ and the slope of \overline{DC} is $-\frac{1}{6}$; the slope of \overline{BC} is $-\frac{5}{2}$ and the slope of \overline{AD} is $-\frac{5}{3}$. Because opposite sides have different slopes, they are not parallel.

5. **GEOMETRY** The vertices of a parallelogram are $J(-5, 0)$, $K(1, 4)$, $L(3, 1)$, and $M(-3, -3)$. Is the parallelogram a rectangle? Explain your reasoning.

yes; If the adjacent sides are perpendicular (the product of their slopes is -1), then the parallelogram is a rectangle. The slope of \overline{JK} is $\frac{2}{3}$, the slope of \overline{KL} is $-\frac{3}{2}$, the slope of \overline{ML} is $\frac{2}{3}$, and the slope of \overline{JM} is $-\frac{3}{2}$. Because adjacent sides have slopes whose product is -1 , they are perpendicular.