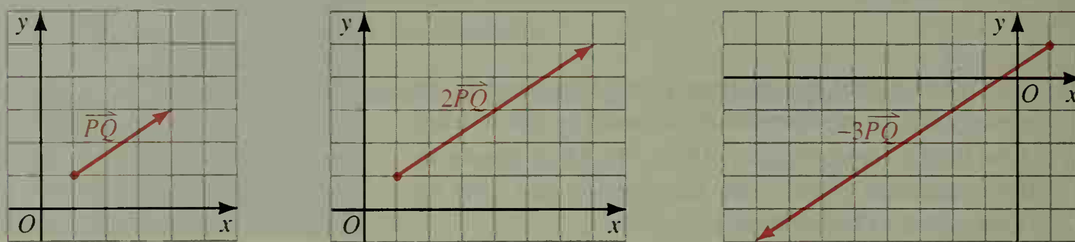
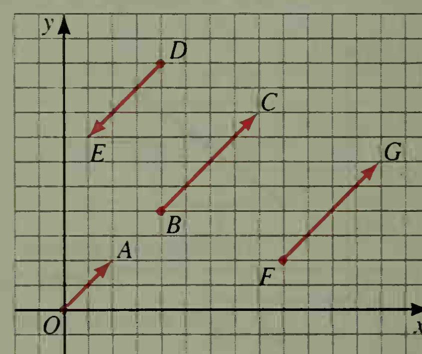
The symbol $2\overrightarrow{PQ}$ represents a vector that has twice the magnitude of $\overrightarrow{PQ}$ and has the same direction. If $\overrightarrow{PQ} = (3, 2)$, it should not surprise you that $2\overrightarrow{PQ} = (2 \cdot 3, 2 \cdot 2) = (6, 4)$. In general, if the vector $\overrightarrow{PQ} = (a, b)$, then $k\overrightarrow{PQ} = (ka, kb)$; $k\overrightarrow{PQ}$ is called a **scalar multiple** of $\overrightarrow{PQ}$. Multiplying a vector by a real number k multiplies the length of the vector by $|k|$. If $k < 0$, the direction of the vector reverses as well. This is illustrated in the diagrams below. What ordered pair represents $-3\overrightarrow{PQ}$?





Two vectors are *perpendicular* if the arrows representing them have perpendicular directions. Two vectors are *parallel* if the arrows representing them have the same direction or opposite directions. All the vectors shown at the right are parallel. Notice that $\overrightarrow{OA}$ and $\overrightarrow{BC}$ are parallel even though the points O, A, B, and C are collinear.

Two vectors are **equal** if they have the same magnitude and the same direction. In the diagram, $\overrightarrow{BC} = \overrightarrow{FG}$.

You can tell by using slopes whether nonvertical vectors are parallel or perpendicular. Example 2 shows how.

Example 2 **a.** Show that $(9, -6)$ and $(-6, 4)$ are parallel.

b. Show that $(9, -6)$ and $(2, 3)$ are perpendicular.

Solution **a.** Slope of $(9, -6)$ is $\frac{-6}{9} = -\frac{2}{3}$.

Slope of $(-6, 4) = \frac{4}{-6} = -\frac{2}{3}$.

Since the slopes are equal, the vectors are parallel.

b. Slope of $(9, -6)$ is $\frac{-6}{9} = -\frac{2}{3}$.

Slope of $(2, 3)$ is $\frac{3}{2}$.

Since $\frac{-2}{3} \cdot \frac{3}{2} = -1$, the vectors are perpendicular.