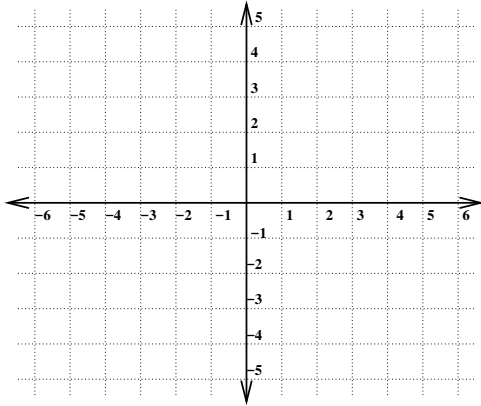## Appendix J.1: Vectors

Definition: A **vector** is a quantity that has both a magnitude and a direction. A **two-dimensional vector** is an ordered pair $\mathbf{a} = \langle a_1, a_2 \rangle$ of real numbers. The numbers a_1 and a_2 are called the **components** of $\mathbf{a}$.

Example: Graph the vector $\langle 3, 4 \rangle$.

Example: For the points, $A(1, -2)$ and $B(5, 4)$, find $\overrightarrow{AB}$ and $\overrightarrow{BA}$.

Definition: Given two points $J(a_1, a_2)$ and $K(b_1, b_2)$, then the vector represended by

$$\overrightarrow{JK} =$$

Definition: The **magnitude** or **length** of a vector $\mathbf{a} = \langle a_1, a_2 \rangle$ is

$$|\mathbf{a}| =$$

Example: Find the length of these vectors.

A) $\langle 4, 6 \rangle$

B) $\langle 0, 0 \rangle$

Scalar Multiplication: If c is a scalar and $\mathbf{a} = \langle a_1, a_2 \rangle$, then we define the vector $c\mathbf{a}$ as

$$c\mathbf{a} =$$

$$|c\mathbf{a}| =$$

Definition: Two vectors, **a** and **b** are said to be **parallel** if there is some scalar c such that $\mathbf{a} = c\mathbf{b}$

Vector Addition/Subtraction: If $\mathbf{a} = \langle a_1, a_2 \rangle$ and $\mathbf{b} = \langle b_1, b_2 \rangle$ then the vector $\mathbf{a} + \mathbf{b}$ and $\mathbf{a} - \mathbf{b}$ are defined as

$\mathbf{a} + \mathbf{b} =$

$\mathbf{a} - \mathbf{b} =$

Example: Compute the following for $\mathbf{a} = \langle 3, 4 \rangle$, $\mathbf{b} = \langle 6, 2 \rangle$, $\mathbf{c} = \langle -2, 5 \rangle$

A) $\mathbf{a} + \mathbf{b}$

B) $2\mathbf{a} + 3\mathbf{b}$

C) $\mathbf{a} - 2\mathbf{b}$

Example: Compute the following for $\mathbf{a} = \langle 3, 4 \rangle$, $\mathbf{b} = \langle 6, 2 \rangle$, $\mathbf{c} = \langle -2, 5 \rangle$

D) $3\mathbf{a} - 2\mathbf{c} + \mathbf{b}$

Definition: A **unit** vector is a vector of length 1. The vectors $\mathbf{i} = \langle 1, 0 \rangle$ and $\mathbf{j} = \langle 0, 1 \rangle$ are referred to as the **standard basis vectors** for the xy plane.

Example: Find a vector of length 7 that is in the same direction as $\mathbf{a} = \langle 3, 4 \rangle$

Example: Given the points $P(1, 5)$ and $Q(3, 10)$. Find a vector of length 4 that is in the same direction as $\overrightarrow{QP}$.

Example: A pilot is flying in the direction of N60^{o}W at a speed of 250km/hr.

A) Find the velocity vector.

B) If there is a wind blowing in the direction of N45^{o}E at 30km/hr,
find the true course and ground speed of the plane.

Example: A 50lb weight hangs from 2 wires. Find the tensions(forces) T_1 and T_2 in both wires and their magnitudes.