Vectors

Recall

Vector
Any physical quantity that requires both a **magnitude** and a **direction** to be completely described. (e.g. force, velocity)

Scalar
Any physical quantity that requires only a **magnitude** to be completely described. (e.g. mass, temperature)

Scale Diagram
A sketch, drawn to scale, representing a vector quantity. An arrow is drawn such that:

- the arrow's length represents the vector's magnitude (to scale)
- the arrow's direction represents the vector's direction

Example
Draw scale diagrams of each vector:

a. $\vec{v} = 10.0\ m/s\ [N]$

b. $\vec{F} = 150\ N\ [20°\ E\ of\ S]$

c. $\vec{a} = 20\ m/s^2\ [SW]$

Vector Addition (Graphical Method)

The tail-to-head method that was introduced in Physics 30s may be used to add any group of vectors, whether they are parallel, perpendicular, or neither.

Tail-to-Head Method

1. Draw the first vector to scale.

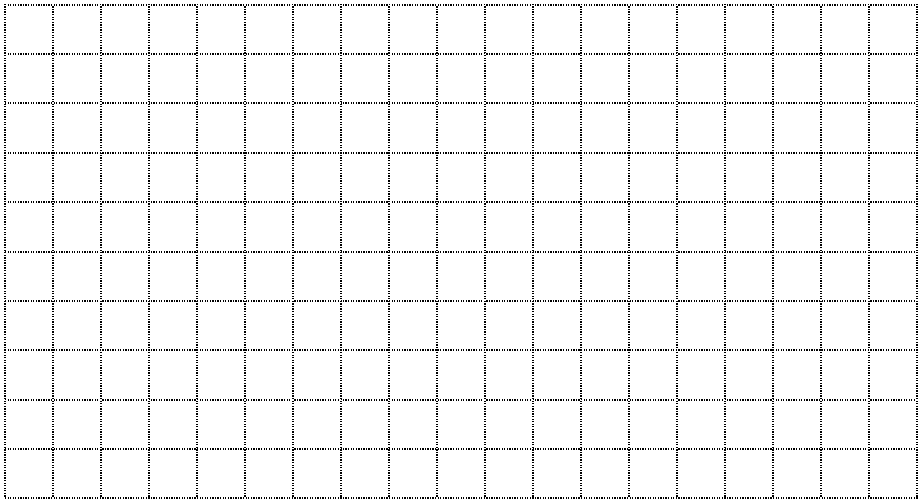
2. Starting from the tip of the first vector, draw the second vector to scale.

3. Continue until all vectors are drawn.

4. The **resultant vector** is drawn from the tail of the first vector to the head of the last vector.

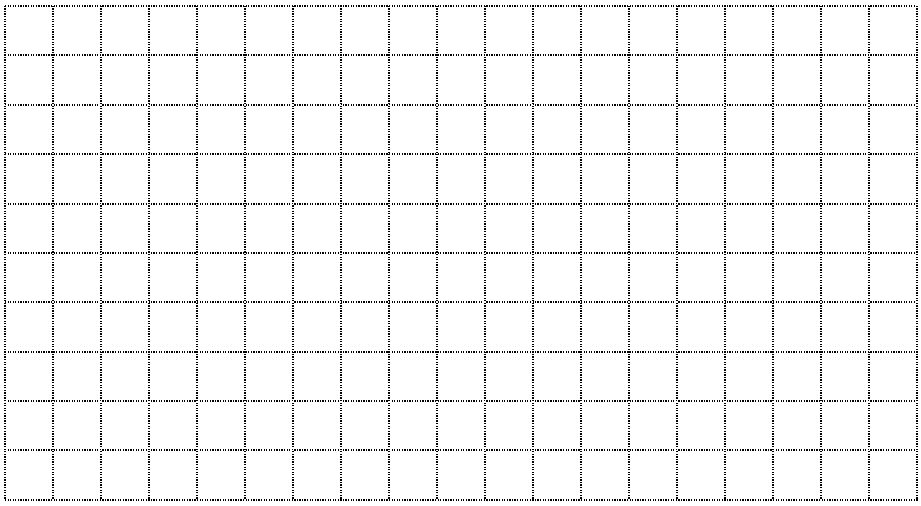
Example 1

$\vec{v_1} = 15\ m/s\ [N]$, $\vec{v_2} = 20\ m/s\ [E]$. Find $\vec{v_1} + \vec{v_2}$.



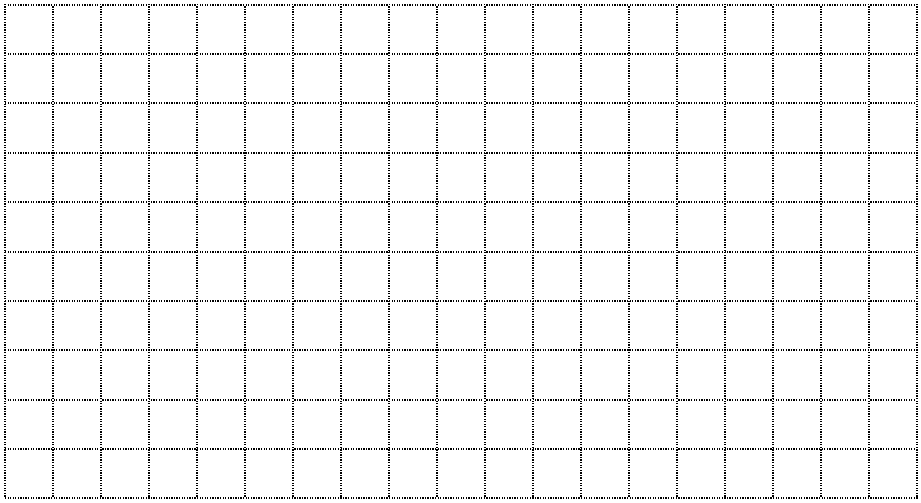
Example 2

$\vec{d_1} = 13\ km\ [E]$, $\vec{d_2} = 18\ km\ [N]$, $\vec{d_3} = 3\ km\ [W]$. Find $\vec{d_1} + \vec{d_2} + \vec{d_3}$.



Example 3

$\overrightarrow{F_1} = 100\ N\ [25°\ W\ of\ S]$, $\overrightarrow{F_2} = 150\ \text{N}\ [E]$. Find $\overrightarrow{F_1} + \overrightarrow{F_2}$.



Example 4

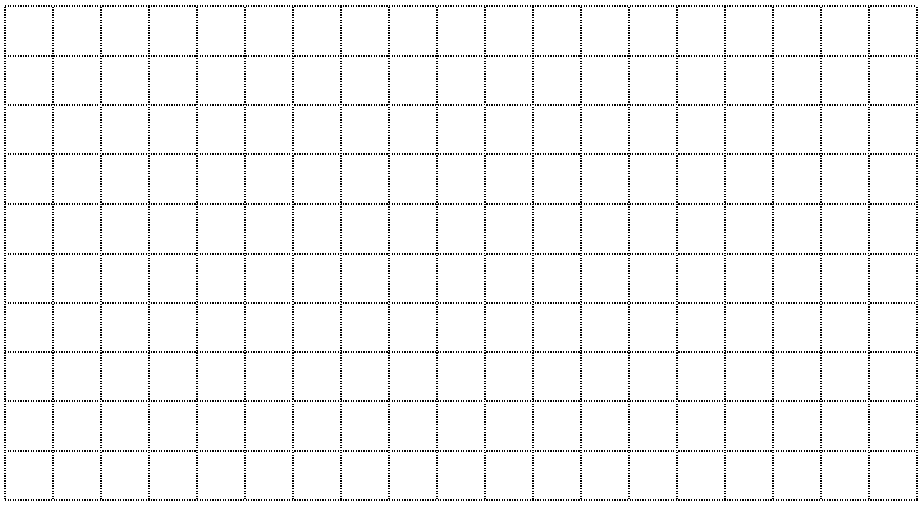
Find $\overrightarrow{F_1} - \overrightarrow{F_2}$.

Recall

$\overrightarrow{F_1} - \overrightarrow{F_2} = \overrightarrow{F_1} + \left(-\overrightarrow{F_2}\right)$

$+\left(-\overrightarrow{F_2}\right)$ means **add the opposite** of $\overrightarrow{F_2}$. The opposite of a vector has the same magnitude but **opposite** direction. (e.g. If $\overrightarrow{F_2} = 150\ N\ [E]$ then $-\overrightarrow{F_2} = 150\ N\ [W]$)

Therefore, $\overrightarrow{F_1} - \overrightarrow{F_2}$ is:



Vector Subtraction

To subtract one vector from another you must **add its opposite**.

$$\vec{a} - \vec{b} = \vec{a} + \left(-\vec{b}\right)$$

Homework
Vectors Worksheet #1

Vectors Worksheet #1

1. Which of the following actions is permissible when you are graphically adding one vector to another: move the vector, rotate the vector, change the vector's length?

2. In your own words, write a clear definition of the resultant of two or more vectors. Do not tell how to find it, but tell what it represents.

3. How is the resultant displacement affected when two displacement vectors are added in a different order?

4. A vector drawn 15 *mm* long represents a velocity of 30 *m/s*. How long should you draw a vector to represent a velocity of 20 *m/s*?

5. A vector that is 1 *cm* long represents a displacement of 5 *km*. How many kilometers are represented by a 3 *cm* vector drawn to the same scale?

6. What is the largest possible displacement resulting from two displacements with magnitudes 3 *m* and 4 *m*? What is the smallest possible resultant? Draw sketches to demonstrate your answers.

7. How does the resultant displacement change as the angle between two vectors increases from 0° to 180°?

8. Graphically find the sum of the following sets of vectors whose lengths and directions are shown in figure 4-12.

   a. D and A
   b. C and D
   c. C and A
   d. E and F
   e. A, C, and D

9. Graphically find the difference of the following pairs of vectors whose length and direction are shown in figure 4-12.

   a. C – A
   b. B – D
   c. E – F

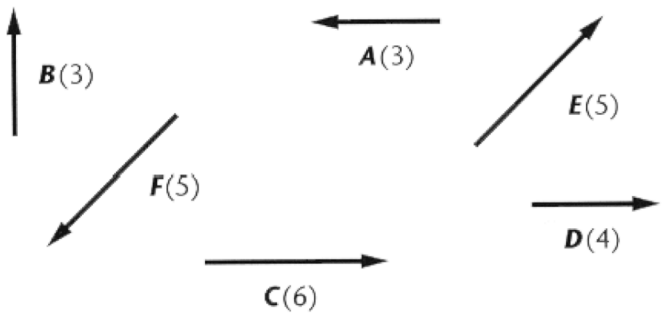


FIGURE 4–12

Vectors Worksheet #1 Key

1. Allowed: move without changing length or direction.

2. Answers vary. The resultant is the vector sum of two or more vectors. It represents the quantity that results from adding the vectors.

3. It is not affected.

4. 10 *mm*

5. 15 *km*

6. The largest is 7 m, the smallest is 1 m.

7. As the angle increases from $0°$ to $180°$, the magnitude of the resultant increases.