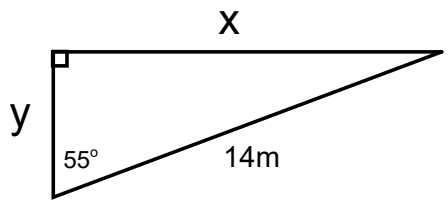
Warm Up Find the values for x and y.



Motion

Unit One - Kinematics

(Part 1 - Motion in a Straight Line, Part 2 - Motion in Two Dimensions)

(kinematics: the study of motion)

BIG IDEAS

- Motion involves a change in the position of an object over time.
- Motion can be described using mathematical relationships.
- Many technologies that apply concepts related to kinematics have societal and environmental implications.

Key Concepts

Part 1 - Motion in a Straight Line (One Dimension)

Learning Goal:

By the end of today, I will be able to explain how distance, position, and displacement are different.

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Part 1 - Motion in a Straight Line

Section 1.1 - Distance, Position and Displacement

Kinematics is the study of MOTION.

Motion is the CHANGE in an object's location as measured by a particular observer.

Why is the OBSERVER important with respect to discussing the MOTION of an object?

Consider the speed at which I am traveling as I sit here on this desk.

How fast am I travelling?

With respect to you, the observers in this room, 0 m/s, with respect to an observer on the SUN, 29,800m/s.

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When discussing the Motion of an object we need to have WORDS that reflect exactly what we are trying to communicate. There are numerous words in the English language that have multiple meanings in our day to day lives. We are going to focus four words in particular for this unit.

Distance vs **Displacement**

and

Speed vs **Velocity**

To distinguish the differences between these sets of words, we need to define what is a SCALAR and a VECTOR quantity.

A **SCALAR** is quantity that only has a magnitude (size);

5m/s or 40km.

A **VECTOR** is a quantity that has BOTH magnitude and direction;

25m/s due North or 60km N30°E

Direction can be described using compass directions, bearings, left/right, up/down, positive/negative, etc.

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Distance vs Displacement

Distance (d) is the total length of the path traveled by an object in motion. (SCALAR)

Displacement (Δd) is the NET change in position of an object in motion, usually over a specific interval. (VECTOR)

Position is the Displacement from a fixed reference point.

Example: The length of this room is _____.

If I walk from the *center* toward the cupboards, what is my Distance traveled, my Displacement and my relative position to the white boards on the wall (zero reference)?

Distance (d): Displacement (Δd): Position:

If I walk back to the center, what is my Distance traveled and my Displacement?

Distance (d): Displacement (Δd): Position:

If I walk to the white board, what is my Distance traveled, my Displacement and my position?

Distance (d): Displacement (Δd): Position:

If I return to HALFWAY to the center of the room,what is my Distance traveled, my Displacement and my position?

Distance (d): Displacement (Δd): Position:

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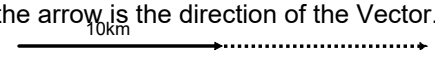
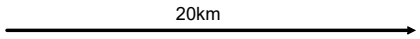
To visually illustrate a VECTOR concept like DISPLACEMENT we use a
"Vector Scale Diagram".

A Vector Scale Diagram is essentially an ARROW with a specific scale; a larger arrow means a larger vector magnitude, the direction of the arrow is the direction of the Vector.

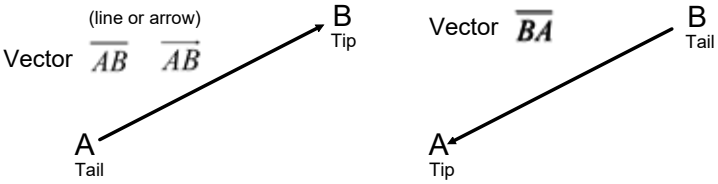


10km due East



20km due East

The beginning of the Vector is called the TAIL and the end of the Vector is
called the TIP; vectors are generally traveled from Tail to Tip.



$$\overline{AB} = -\overline{BA} \qquad -\overline{AB} = \overline{BA}$$

Note: a Negative sign implies we are traveling in the opposite given direction.

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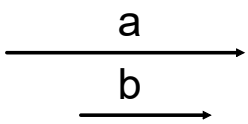
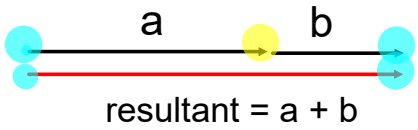
Adding Vectors

- when we add vectors, we place them "tip to tail"

- the "resultant" is the vector that goes from start to finish in a straight line





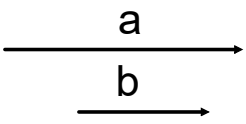
resultant = a + b

1 Dimension

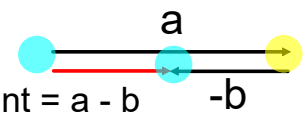
Subtracting Vectors

- when we subtract vectors, it is usually easiest to see the problem by adding the negative vector, and then we place them "tip to tail"

- the "resultant" is the vector that goes from start to finish in a straight line



$a - b = a + (-b)$

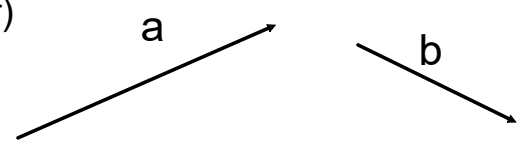


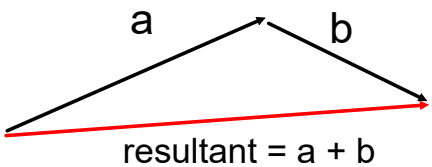
resultant = a - b

1 Dimension

Adding and Subtracting - 2 Dimensions

(more on this later)

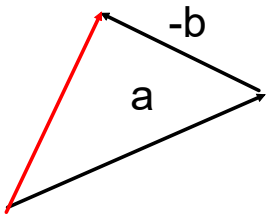




resultant = a + b

resultant = a - b

or = a + (-b)



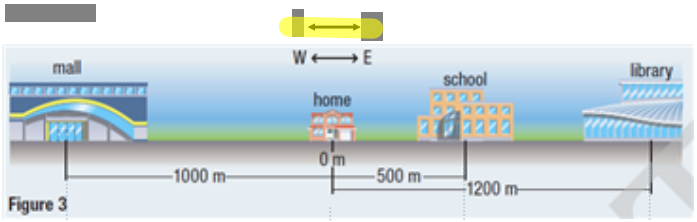


Figure 3

Imagine that you walk from home to school in a straight-line route. What is your displacement and your relative position from home?

$\Delta\vec{d} = \vec{d}_{school} - \vec{d}_{home}$

Position:

What is your displacement if you walk from your school to the library and your relative position from home?

$\Delta\vec{d} = \vec{d}_{library} - \vec{d}_{school}$

Position:

What is your displacement if you walk from the library to the mall and your relative position from your home?

$\Delta\vec{d}_T = \Delta\vec{d}_1 + \Delta\vec{d}_2$

Position:

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1.1 Questions

1. Which of the following quantities are vectors, and which are scalars? Be sure to explain the reasoning for your answer. K/U C
   (a) A bird flies a distance of 20 m.
   (b) A train is travelling at 100 km/h due north.
   (c) It takes an athlete 10.37 s to run 100 m.
2. Explain the following in your own words: K/U C
   (a) the difference between position and displacement
   (b) the difference between distance and displacement
3. What is the displacement of a locomotive that changes its position from 25 m [W] to 76 m [W]? TI
4. A car changes its position from 52 km [W] to 139 km [E]. What is the car's displacement? TI
5. Determine the total displacement for each of the following motions by algebraic methods and by using scale diagrams. TI C
   (a) $\Delta\vec{d}_1 = 10$ m [W]; $\Delta\vec{d}_2 = 3.0$ m [W]
   (b) $\Delta\vec{d}_1 = 10$ m [W]; $\Delta\vec{d}_2 = 3.0$ m [E]
   (c) $\Delta\vec{d}_1 = 28$ m [N]; $\Delta\vec{d}_2 = 7.0$ m [S]
   (d) $\Delta\vec{d}_1 = 7.0$ km [W]; $\Delta\vec{d}_2 = 12$ km [E]; $\Delta\vec{d}_3 = 5.0$ km [W]
6. A person walks 10 paces forward followed by 3 paces forward, and finally 8 paces backwards. TI C
   (a) Draw a vector scale diagram representing this person's motion. Use a scale of 1 cm = 1 pace.
   (b) Check your answer by pacing out this motion yourself. How close is your experimental result to that predicted by your vector scale diagram?

$$\Delta\vec{d}_T = \Delta\vec{d}_1 + \Delta\vec{d}_2$$

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