Kinematics I

I. Definitions

A. **Kinematics** is the _____ of _____.

B. **A Particle** is an object of _____

_____ and _____ _____ (point).

Position Vector

1. **Definition:**

   The **vector** that **<u>defines</u>** the _____ of a

   _____ with respect to a _____

   _____.

2. **Symbol -**

3. **Units -**

4. **2-D Graphical and Analytical Representation**

5. The **position vector** is _____ _____

as it depends on the **arbitrary** **choice** of a

_____ _____

Displacement Vector

1. **Definition:**

   The _____ in the _____

   _____ of a particle.

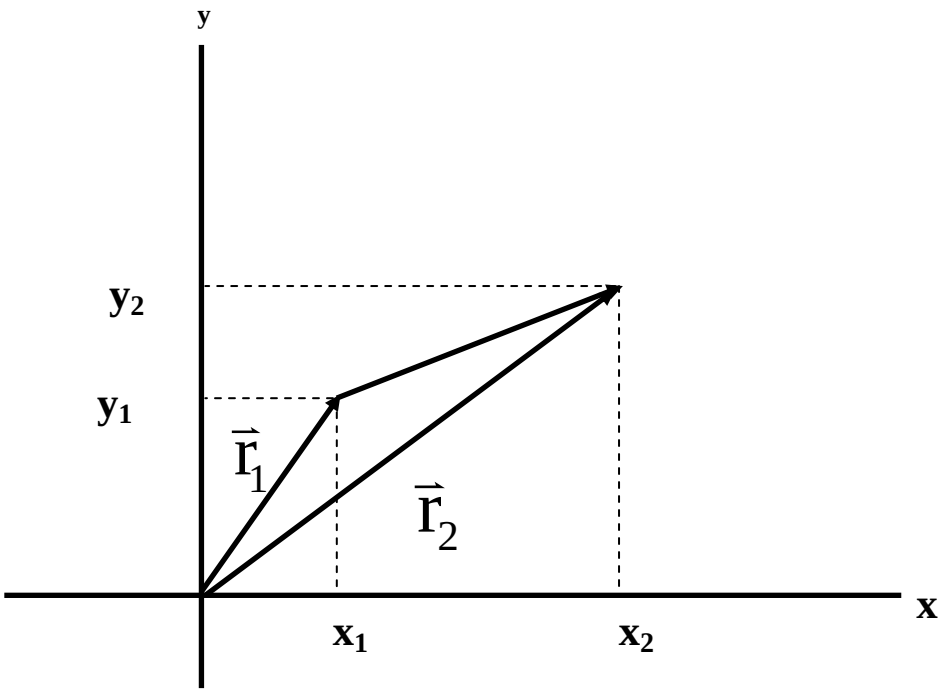
2. **Symbol -**

3. **Formula:**

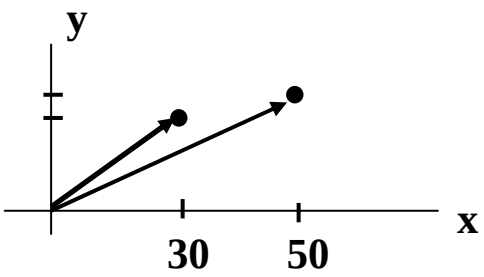
4. **Units -**

2-D Problems

From our study of vectors, we have that for 2-D problems:



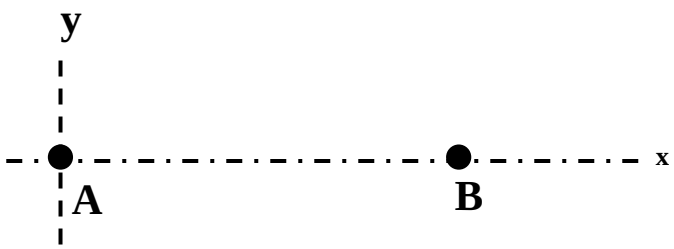
Example: A baseball is initially located 50 feet from the batter at a height of 5 feet. A short time latter the ball is 30 feet from the batter at a height of 4 feet. What is the baseball's displacement?



Note: Graphically, the **displacement vector** is the **vector** that you have **<u>to add</u>** to **position vector 1** to get to **position vector 2**.

Displacement is **NOT** the same as **distance**! Distance is ALWAYS a positive scalar quantity while displacement is a **vector quantity**.

Example: A runner runs 100m from point A to point B. The runner then runs 100m from point B to point A.



a) What is the distance covered?

b) What is the runner's displacement?

Average Velocity

1. **Definition:**

The average time rate of change of the position vector.

equivalently

The **displacement vector** divided by the change in **time**.

2. **Symbol -**

3. **Formula -** **V**

4. **Units -**

5. Important Facts:

a) To calculate the average velocity, you must **first** find the **displacement vector**.

b) The **direction** of the **average velocity** is the **SAME** as the **direction** of the **displacement vector**.

Reason: Dividing by Δt is the same as multiplying by the scalar $(1/\Delta t)$ which is > 0 !!

c) **Average Velocity** is a **VECTOR** and is **NOT** the same as Average **Speed**!

Average Speed ≡

Example: Assume that our runner in the previous example on displacement covered the distance in 30s.

a) What was the runner's average speed?

b) What was the runner's average velocity?

Question: What is the average velocity and average speed of a runner who runs the 400m on a circular track in 50s?

Instantaneous Velocity

1. Definition:

The Instantaneous Velocity is the _____ _____

of _____ of the _____

_____.

Note: Unless specified otherwise in a problem, velocity means **instantaneous VELOCITY**.

2. Symbol -

3. Formula -

4. Units -

5. Graphical Representation: For 1-D motion, the velocity of an object at a specific point in time is the _____ of the _____ _____ on a **position-time graph** at that point.

6. Because velocity is defined in terms of the **position vector**, it depends on the **observer's frame** of **reference** (coordinate axis).

Average Acceleration

1. **Definition -**

The _____ in _____ over the

_____ in _____.

2. **Symbol -**

3. **Formula -** **a**

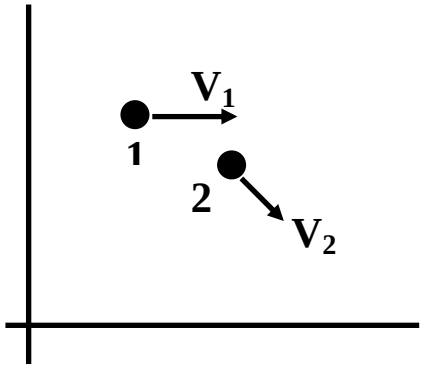
4. **Units -**

5. The **direction** of the **average acceleration vector** is the

_____ as the _____ in the

_____ vector ( ). This is a

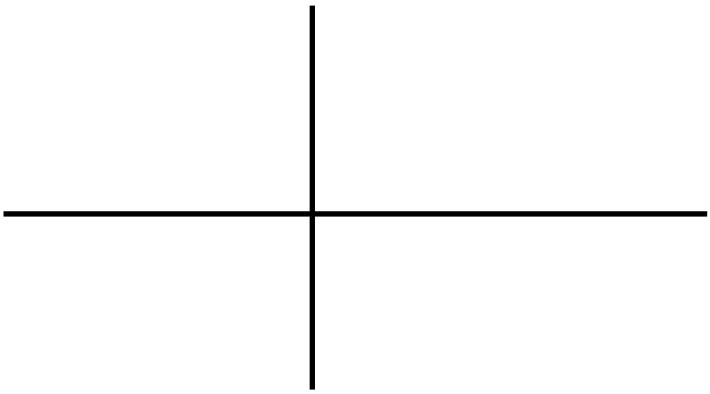
consequence of multiplying a vector by a scalar.



Example: A ball initially is traveling at 20 m/s in the positive x-direction. Five seconds latter the ball is traveling at 20 m/s in the +y-direction.

a) What is the change in the speed of the ball?

b) What is the change in the velocity of the ball?



c) What is the average acceleration of the ball?

Note: It was the **direction** of the **velocity** vector that **changed** on average and **not** its **magnitude** (**speed**). **Either** change causes **acceleration**!

Instantaneous Acceleration

1. **Definition -**

The Instantaneous Acceleration is the _____

_____ of _____ of the

_____ vector.

2. **Symbol -**

3. **Formula -** a

4. **units -**

5. **Graphically** for **<u>1-D problems</u>**, the instantaneous acceleration

is the _____ of the _____

_____ for a **<u>velocity-time graph</u>**.