FUNDAMENTALS OF PHYSICS

10TH ED CHAPTER 4 "MOTION IN TWO & THREE DIMENSION"

BY

ENGR. HASSAN KHALID

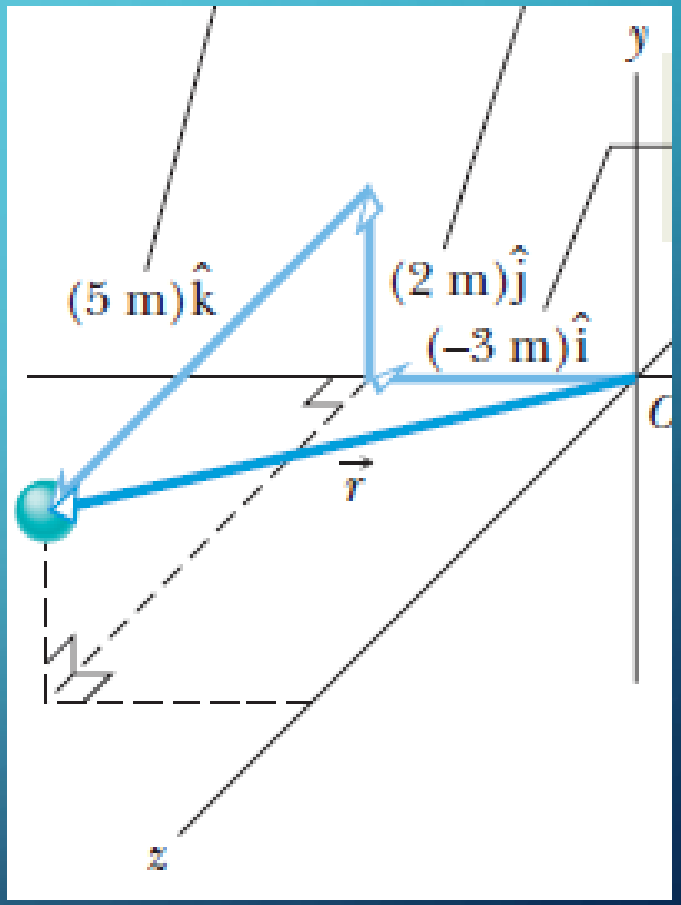
POSITION AND DISPLACEMENT

- In Physics
  - Motion in physics are classified in two or three dimensions
  - For example
    - Turns taken by fighter pilots during dog fights in a very quick manner might cause loss of consciousness
    - Motion taken in three dimensions are probably difficult to understand
    - Its easy to drive a car free way in one dimension as compared to landing a plane

- One way to represent the position of particle in three dimension is to extend vector (**r**) in form of unit vectors
- Consider the position of particle placed on given points (-3, 2, 5) meters from origin
- If the particle change its position then

$$\vec{r} = x\hat{i} + y\hat{j} + z\hat{k},$$

$$\Delta\vec{r} = \vec{r}_2 - \vec{r}_1.$$



AVERAGE VELOCITY

If a particle moves through a displacement $\Delta\vec{r}$ in a time interval Δt, then its **average velocity** $\vec{v}_{avg}$ is

$$\text{average velocity} = \frac{\text{displacement}}{\text{time interval}},$$

or

$$\vec{v}_{avg} = \frac{\Delta\vec{r}}{\Delta t}. \qquad (4\text{-}8)$$

$$\vec{v}_{avg} = \frac{\Delta x\hat{i} + \Delta y\hat{j} + \Delta z\hat{k}}{\Delta t}$$

AVERAGE INSTANTANEOUS VELOCITY

- When the value of (v) approaches in limit as (V) shrinks the time approaches zero and we called it instantaneous velocity

$$\vec{v} = \frac{d\vec{r}}{dt}.$$

The direction of the instantaneous velocity $\vec{v}$ of a particle is always tangent to the particle's path at the particle's position.

AVERAGE ACCELERATION AND INSTANTANEOUS ACCELERATION

When a particle's velocity changes from $\vec{v}_1$ to $\vec{v}_2$ in a time interval Δt, its **average acceleration** $\vec{a}_{avg}$ during Δt is

$$\text{average acceleration} = \frac{\text{change in velocity}}{\text{time interval}},$$

$$\vec{a}_{avg} = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t} = \frac{\Delta \vec{v}}{\Delta t}.$$

$$\vec{a} = a_x \hat{i} + a_y \hat{j} + a_z \hat{k},$$

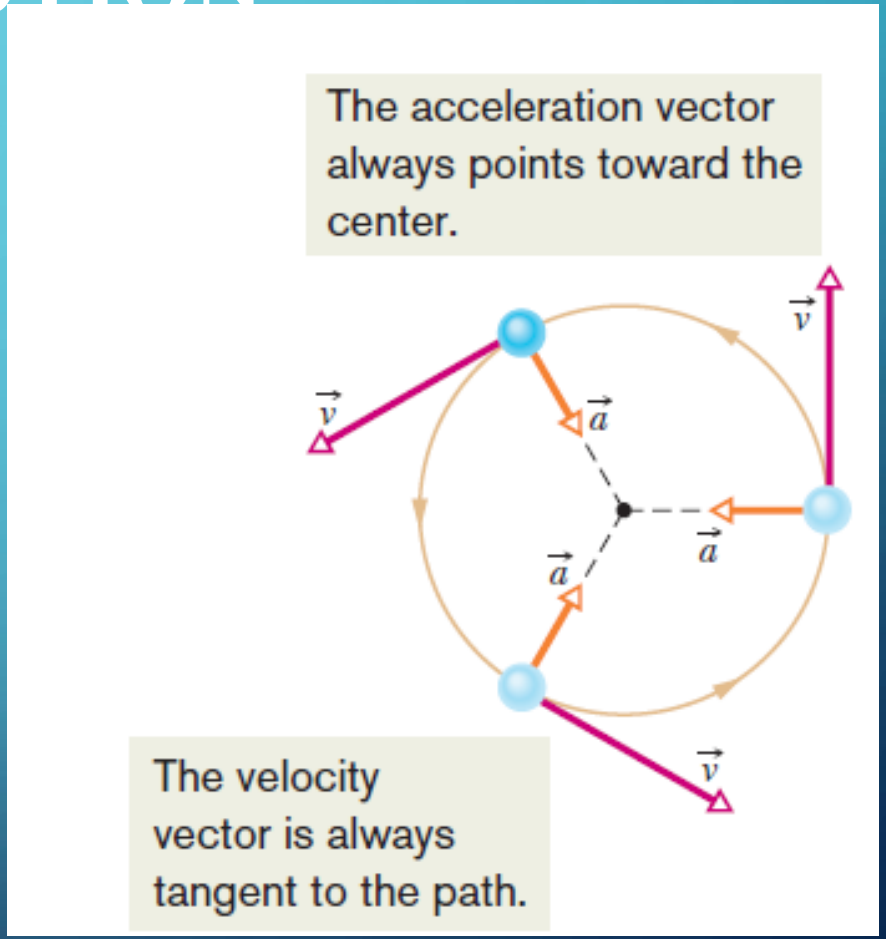
$$a_x = \frac{dv_x}{dt}, \quad a_y = \frac{dv_y}{dt}, \quad \text{and} \quad a_z = \frac{dv_z}{dt}.$$

PROJECTILE MOTION

- Look on board and listen carefully

UNIFORM CIRCULAR MOTION

- A particle is in **uniform circular motion** if it travels around a circle or a circular arc at constant (*uniform*) speed. Although the speed does not vary, *the particle is accelerating* because the velocity changes in direction



- The acceleration is always directed *radially inward.* Because of this, the acceleration associated with uniform circular motion is called a **centripetal** (meaning “center seeking”) **acceleration.**
- When a body is accelerating out of the circle its centrifugal acceleration