

# PHY 101 LECTURE NOTE

- by

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# KINEMATICS

- This is the branch of classical mechanics which describes the motion of points, bodies (objects) and systems of bodies (group of Objects) without consideration of the causes of motion.

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- Kinematic as a field of study is often referred to as “geometry of motion”.
- Classical mechanics is the study of motion of bodies ( including a special case in which the bodies remain at rest)

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- in accordance with the general principles first enunciated by Sir Isaac Newton on the *Philosophiae Naturalis Principia mathematica* (1687) commonly known as the *Principia*.

# Converting between the Cartesian and Polar Coordinates

- $x$  and  $y$  are used in representing the Cartesian Coordinates while  $r$  and  $\theta$  values are used for the Polar Coordinates.
- $\sin \theta = \text{opp/hyp} = y/r$
- $\cos \theta = \text{adj/hyp} = x/r$
- $\tan \theta = \text{opp/adj} = y/x$

cont

$$\sin \theta = \frac{\textit{opp}}{\textit{hypo}} = \frac{y}{r} \quad (1)$$

$$\cos \theta = \frac{\textit{adj}}{\textit{hypo}} = \frac{x}{r} \quad (2)$$

$$\tan \theta = \frac{\textit{opp}}{\textit{adj}} = \frac{y}{x} \quad (3)$$

$$r^2 = x^2 + y^2 \quad (4)$$

# Question 1

- The Cartesian coordinates of a point xy-planes are  $(x,y) = (3.50\text{m}, 2.50\text{m})$ , Find the polar coordinates of the point.
- From equation 4

$$r^2 = x^2 + y^2 \quad (4)$$

cont

$$r^2 = (3.5)^2 + (2.5)^2 \quad (5)$$

$$r = 4.3m \quad (6)$$



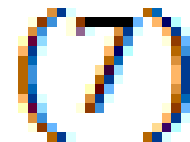
# For the angle $\theta$

- Using any of the equations 1 to 3
- $\tan \theta = y/x$
- $\tan \theta = 3.50/2.50$
- $\theta = \arctan 0.714$
- $\theta = 35.5$  degree
- $R < \theta = 4.30 < 35.5$  degree
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# Motion in one dimension

- The study of the causes of motion is called dynamics while the study of motion itself without an concern to the cause is called kinematics.
- It can be 1- D, 2- D or 3 -D
- The displacement of an object is defined as its change in position.

$$\Delta x \equiv x_f - x_i$$



# cont

- $x_f$  denotes the initial position of the object
- $x_i$  denotes the final position of the object
- $\Delta x$  denotes change

# Velocity

- Average Speed of an object is the length of path it travels divided by the total elapsed time.
- Average Speed = Path Length/elapsed time

$$v = \frac{d}{\Delta t} \quad (8)$$

# cont

- The average velocity of an object is defined as the displacement of an object divided by the total time
- Average Velocity = displacement/ elapse time

$$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i} \quad (9)$$

# Note

- Average velocity can either be positive or negative (Average speed is always +ve) because we are in one dimension and the sign tells us the direction.

# acceleration

- The change of an object's velocity is called acceleration.

$$\bar{a} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i} \quad (10)$$

# Instantaneous acceleration

- This is defined by taking the limit as the end point gets closer and closer.

$$a \equiv \lim_{\Delta t \rightarrow 0} \frac{\Delta v}{\Delta t} \quad (11)$$

$$v = v_0 + at \quad (12)$$

$$v_i = v_0 \quad \text{and} \quad v_f = v \quad (13)$$



# The average velocity

- Could be calculated using

- $$\bar{v} = \frac{v_0 + v}{2}$$

- $$v^2 = v_0^2 + 2a\Delta x \quad (15)$$

- $$v^2 = v_0^2 + 2as \quad (16)$$

$$\Delta x = v_0 t + \frac{1}{2} a t^2 \quad (17)$$

$$s = ut + \frac{1}{2} a t^2 \quad (18)$$