# LECTURE #2 – SUMMARY

## Vector Addition

To add two vectors, place them head-to-tail. The vector sum is the vector from the tail of the first to the head of the second.

- commutative → order is not important: $\vec{C} = \vec{A} + \vec{B} = \vec{B} + \vec{A}$
- associative → grouping is not important: $\vec{S} = \vec{A} + \vec{B} + \vec{C} = (\vec{A} + \vec{B}) + \vec{C} = \vec{A} + (\vec{B} + \vec{C})$

## Vector Subtraction

Subtraction of a vector just means adding the negative of this vector, i.e., adding a vector of the same length but opposite direction: $\Delta\vec{r} = \vec{r}_2 - \vec{r}_1 = \vec{r}_2 + (-\vec{r}_1)$

The new position vector is $\vec{r}_2 = \vec{r}_1 + \Delta\vec{r}$ where $\Delta\vec{r}$ is the displacement vector.

## Scalar Multiplication

e.g. $3\vec{B}$ is a vector in the same direction as $\vec{B}$,having 3 times the magnitude of $\vec{B}$

## Unit Vectors

The unit vector in the direction of $\vec{B}$ is $n\vec{B}$, such that the magnitude of $n\vec{B}$ is 1 (no units), i.e., $\hat{b} = n\vec{B}$ with $|\hat{b}| = |n\vec{B}| = 1$.

## Vectors in 2-D

The x and y coordinate axes define a coordinate system in a plane. We can define unit vectors along the x and y axes as $\hat{i}$ and $\hat{j}$, with length 1 and no units.

position vector: $\vec{P} = x_1\hat{i} + y_1\hat{j}$ (vector starts at origin)

For vector $\vec{A}$ in a plane: $\vec{A} = A_x\hat{i} + A_y\hat{j} = A\cos\theta\hat{i} + A\sin\theta\hat{j}$,

with $A = \sqrt{A_x^2 + A_y^2} = |\vec{A}|$, $\theta = \tan^{-1}(A_y/A_x)$.

## Vectors in 3-D

Add a third axis to x-y coordinate system using the Right Hand Rule (RHR).

In a 3-D co-ordinate system, $\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$ with $A = \sqrt{A_x^2 + A_y^2 + A_z^2} = |\vec{A}|$.

$\vec{A} = \vec{B} + \vec{C} + \vec{D} + \vec{E}$ is a set of eqns for: (1) x, (2) y, and (3) z components.

## Components vs. Coordinates (in 2-D)

coordinates = pair of numbers specifying a given position in a coordinate system
components (of a vector) = the lengths of a vector in the coordinate system
These are equivalent if the vector starts at the origin.

## Section I.3 Differentiation and Integration

## Differentiation

Mathematically: $\dfrac{dx}{dt} = \lim\limits_{\Delta t \to 0} \dfrac{x(t+\Delta t) - x(t)}{\Delta t} = \lim\limits_{\Delta t \to 0} \dfrac{\Delta x}{\Delta t}$

Geometrically: = slope of line through $(x,t)$ and $(x(t+\Delta t), t+\Delta t)$ as $\Delta t \to 0$

e.g. for $x(t) = at^m$, the derivative is $\dfrac{dx(t)}{dt} = mat^{m-1}$