

Vectors and Vector Operations

- Points

- Space

- Coordinate system(s)

- Vectors

dimensionless

That which has no part. -Euclid

Represented by ordered pair

(a, b, c)

Point

(a, b, c, d, e, f, g, h)

- Points
- **Space**
- Coordinate system(s)
- Vectors

number of classes of
these objects will tell you the
number of dimensions of space {

space of fruits
space of students
space of cars

Set with some added structure

This must be where
Transformers lived

- ~~made out of~~
points
- all the points are unique
- space can be described for any set of objects

- Points
- Space
- **Coordinate system(s)**
- Vectors

type of
— Space with defined
properties (geometric)

Cartesian
polar
Cylindrical
Spherical

Mathematicians

- Points *Objects that follow certain rules.*
- Space
- Coordinate system(s)
- Vectors

Physicists

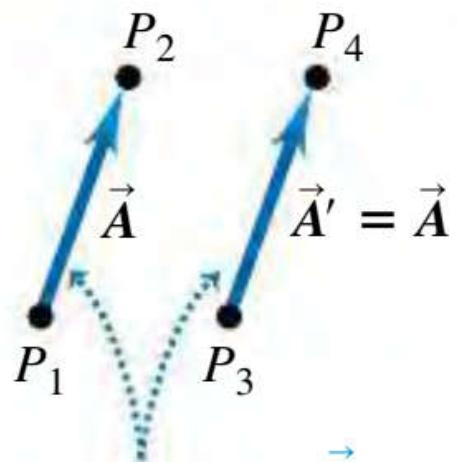
tools to represent quantities specific in direction.

Computer scientists

- array of object
- points in dataset

- Points
- Space
- Coordinate system(s)
- **Vectors**

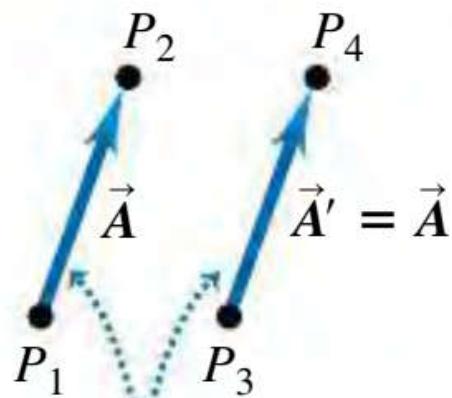
Vectors can exist between any two points



Vectors may also contain information of the evolution

Displacements \vec{A} and \vec{A}'
are equal because they
have the same length
and direction.

Vectors can exist between any two points

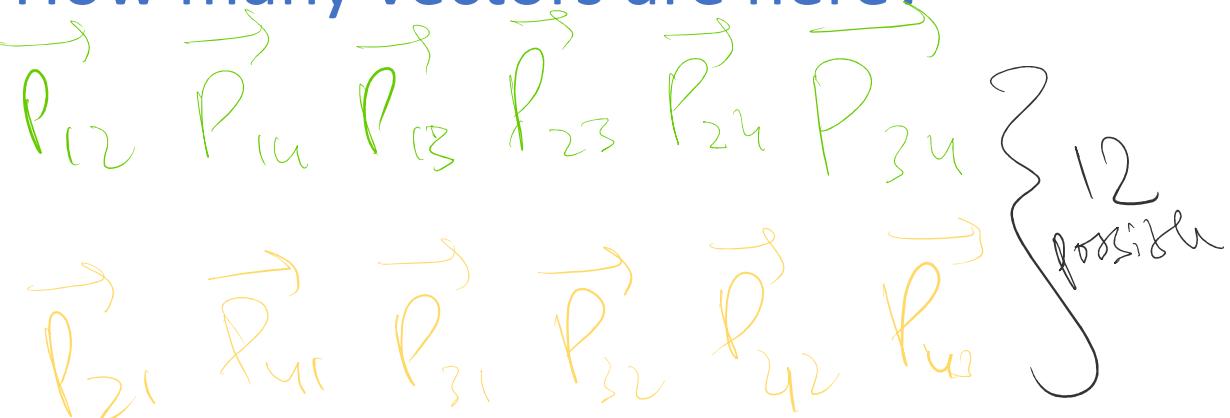


Displacements \vec{A} and \vec{A}' are equal because they have the same length and direction.

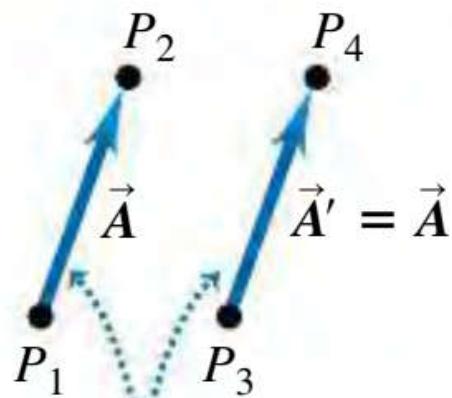
negative
vector

Vectors may also contain information of the evolution

How many vectors are here?

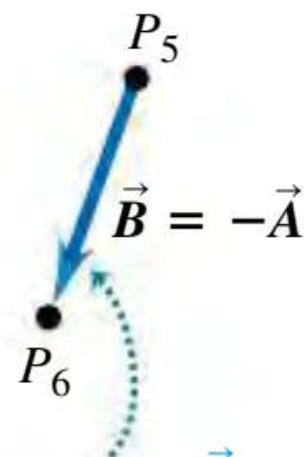


Vectors can exist between any two points



Displacements \vec{A} and \vec{A}' are equal because they have the same length and direction.

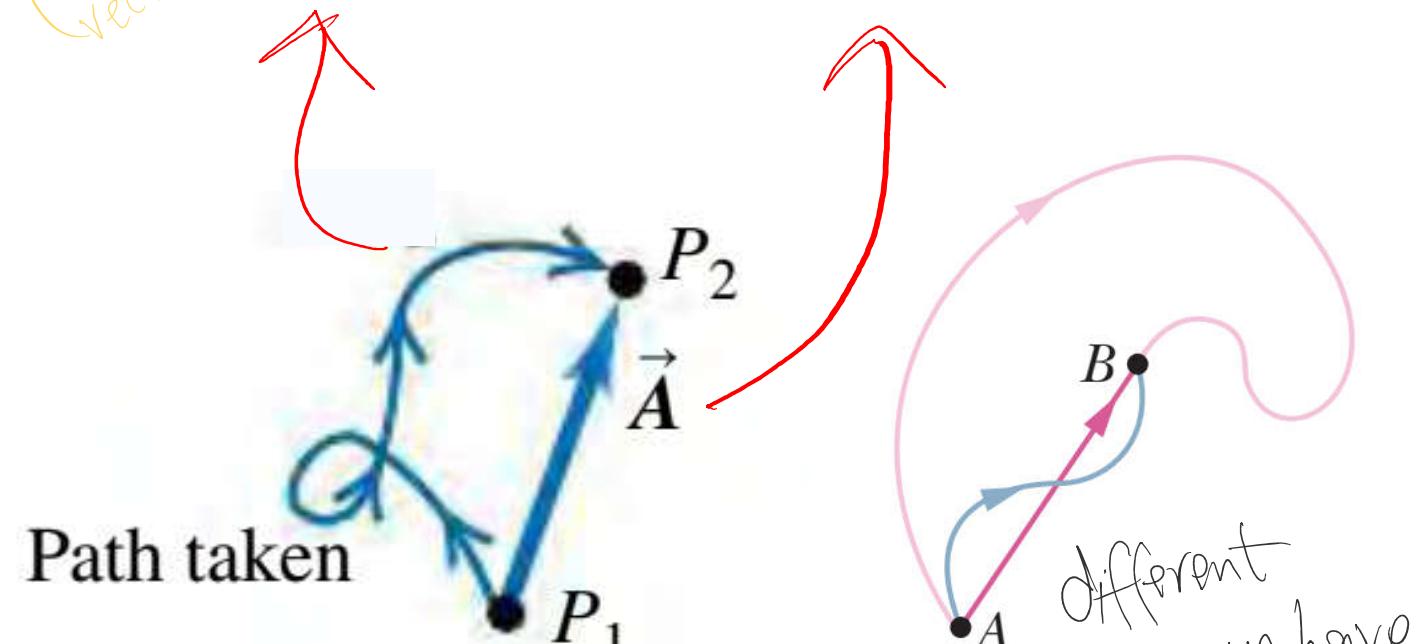
Vectors may also contain information of the evolution



Displacement \vec{B} has the same magnitude as \vec{A} but opposite direction; \vec{B} is the negative of \vec{A} .

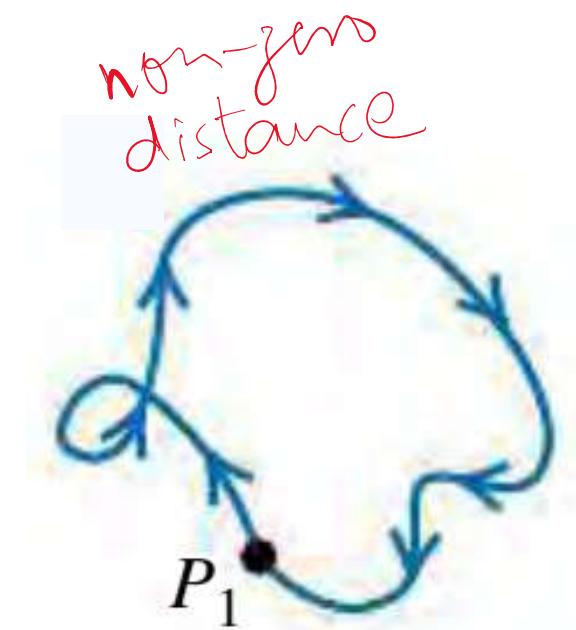
Lecture 2

Distance and Displacement



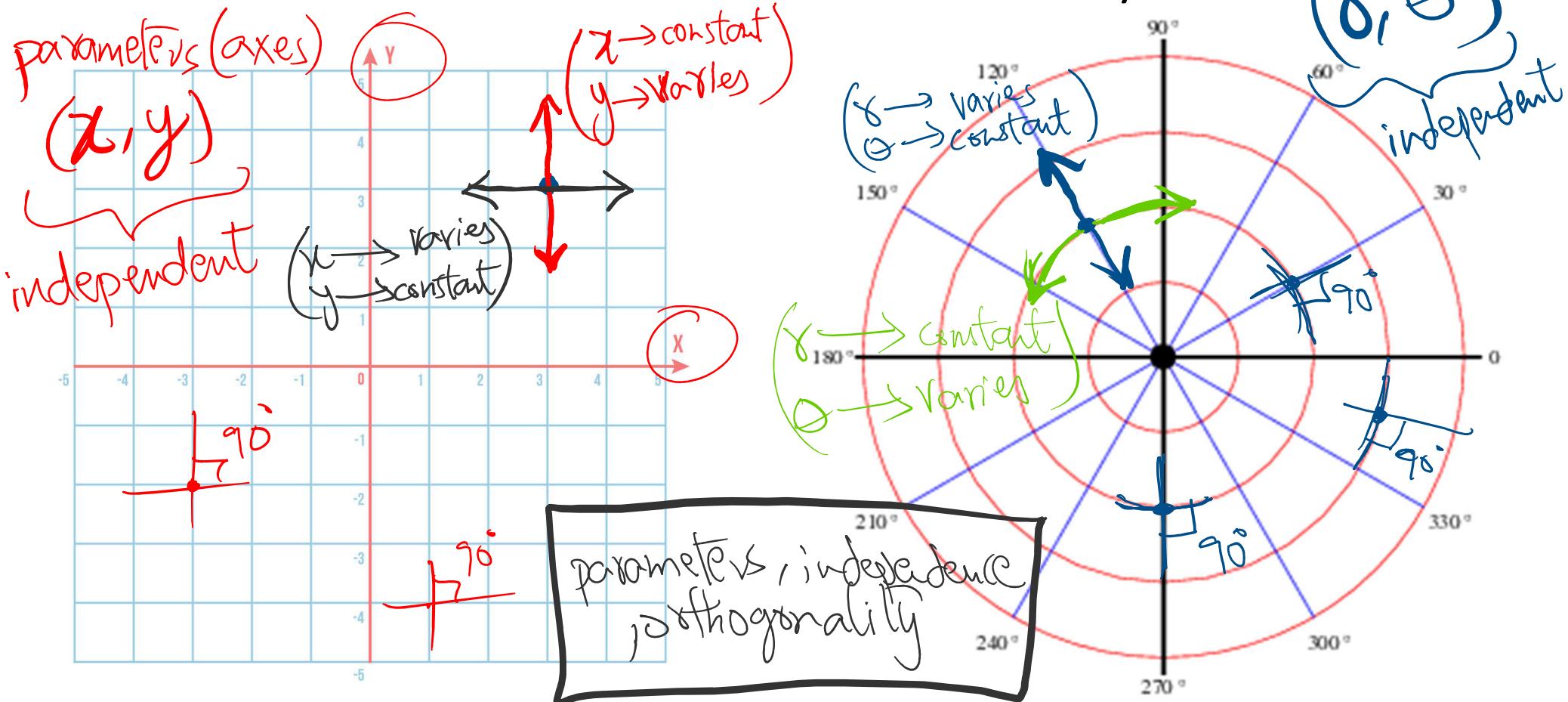
Path taken

different paths may have different distance values

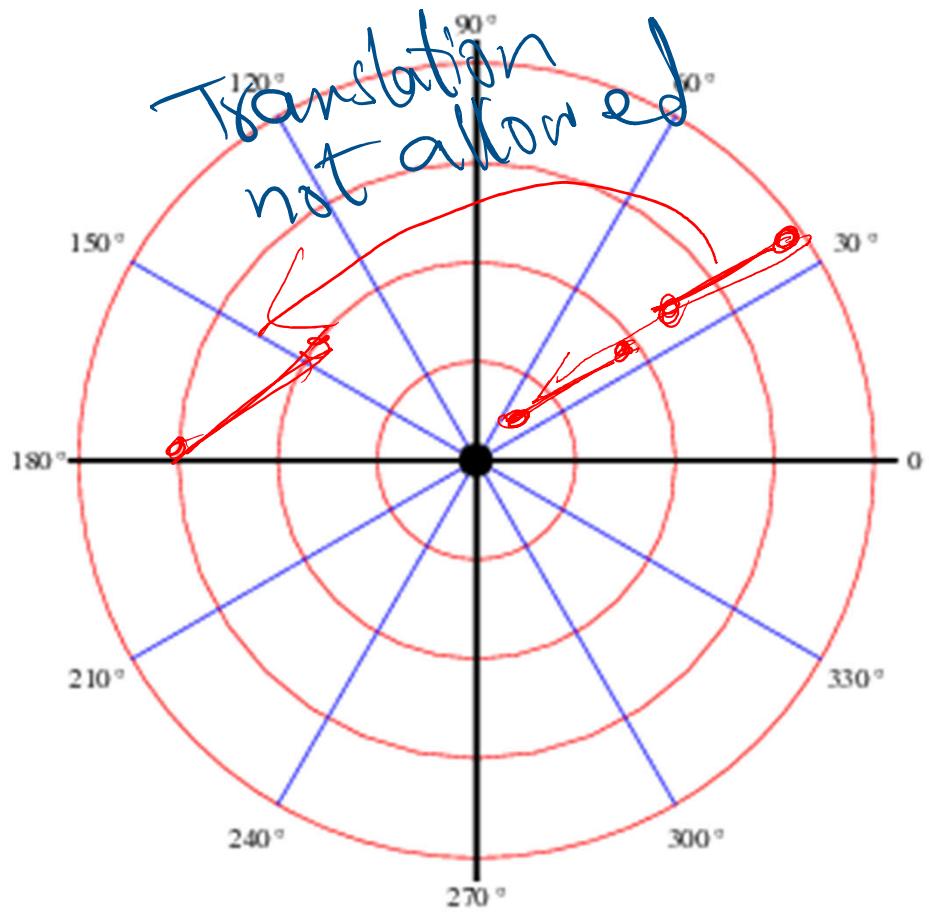
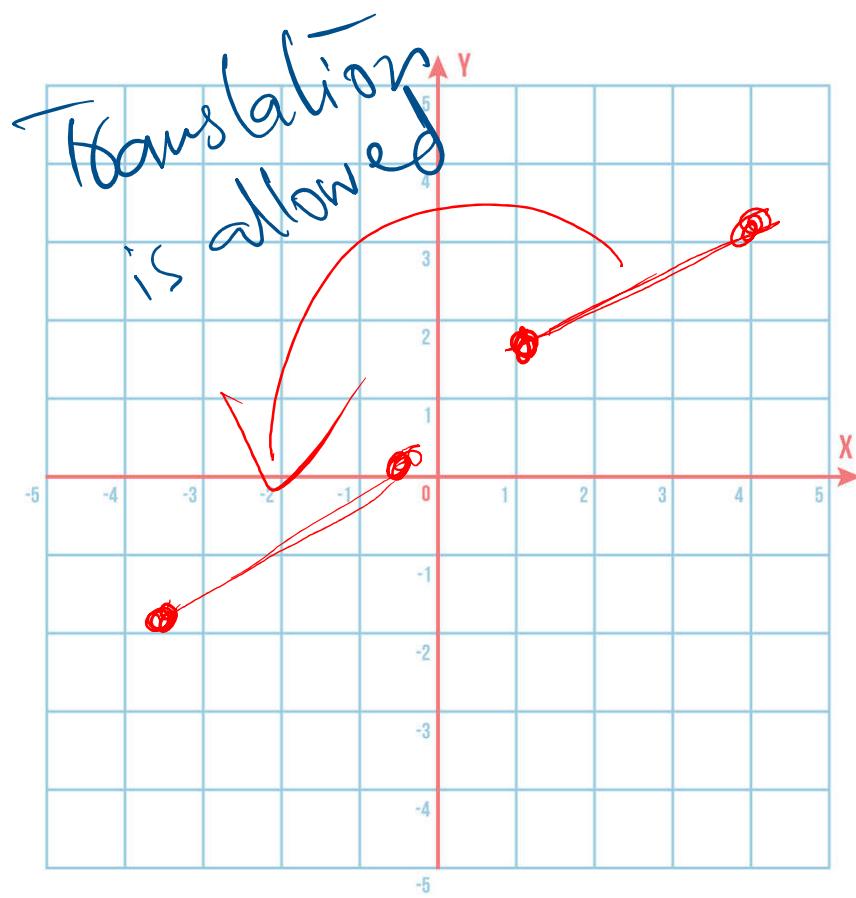


Zero displacement

Vectors are drawn in coordinates systems

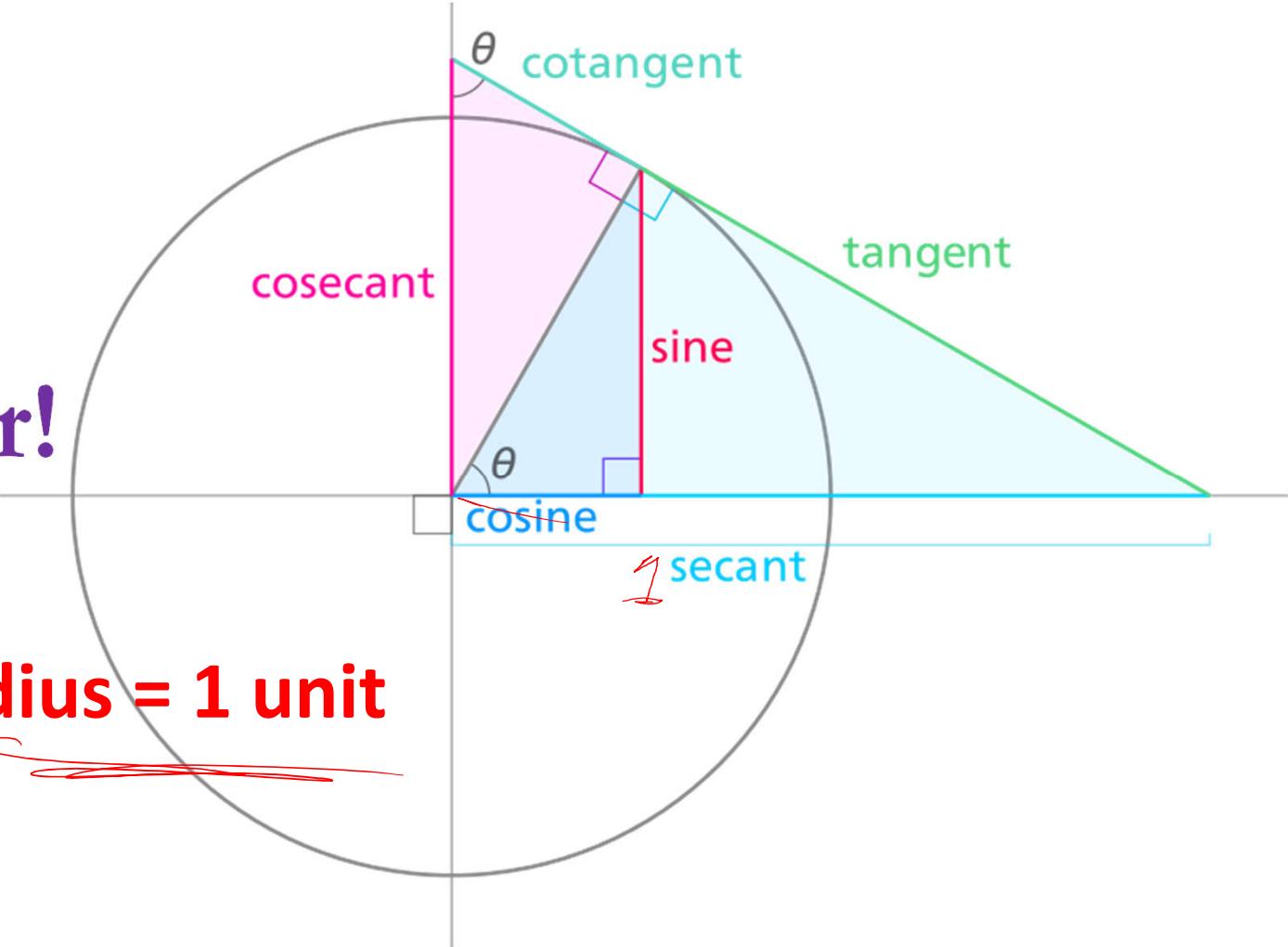


Vectors are drawn in coordinates systems



A gentle Reminder!

Unit circle; **radius = 1 unit**

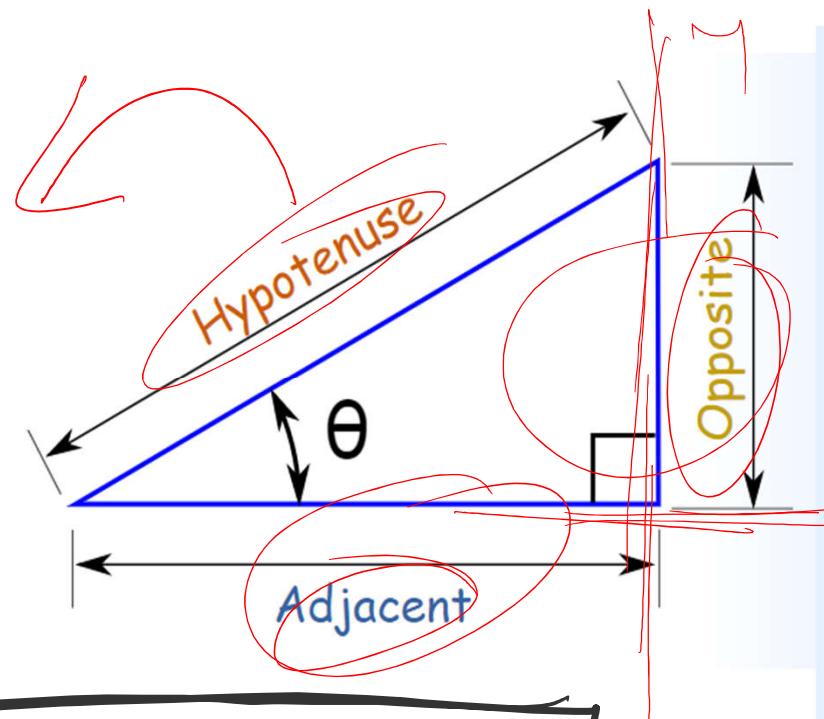


still just a reminder!

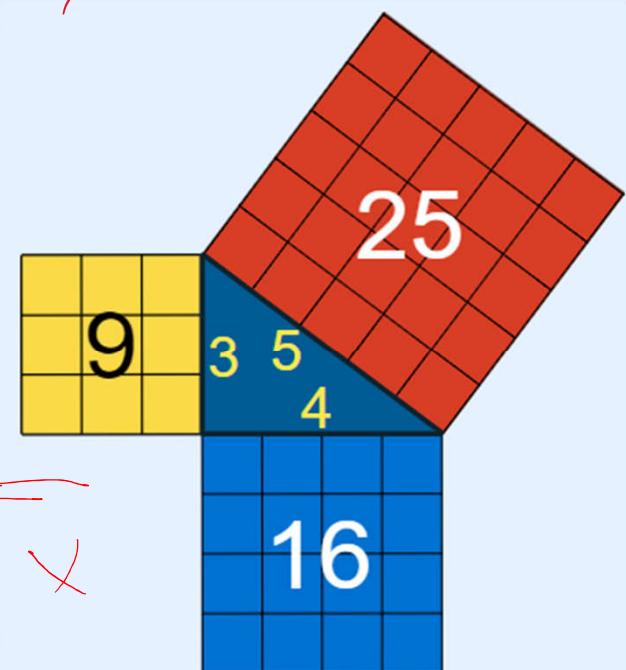
$$\sin \theta = \frac{\text{Opposite}}{\text{Hypotenuse}}$$

$$\cos \theta = \frac{\text{Adjacent}}{\text{Hypotenuse}}$$

$$\tan \theta = \frac{\text{Opposite}}{\text{Adjacent}}$$

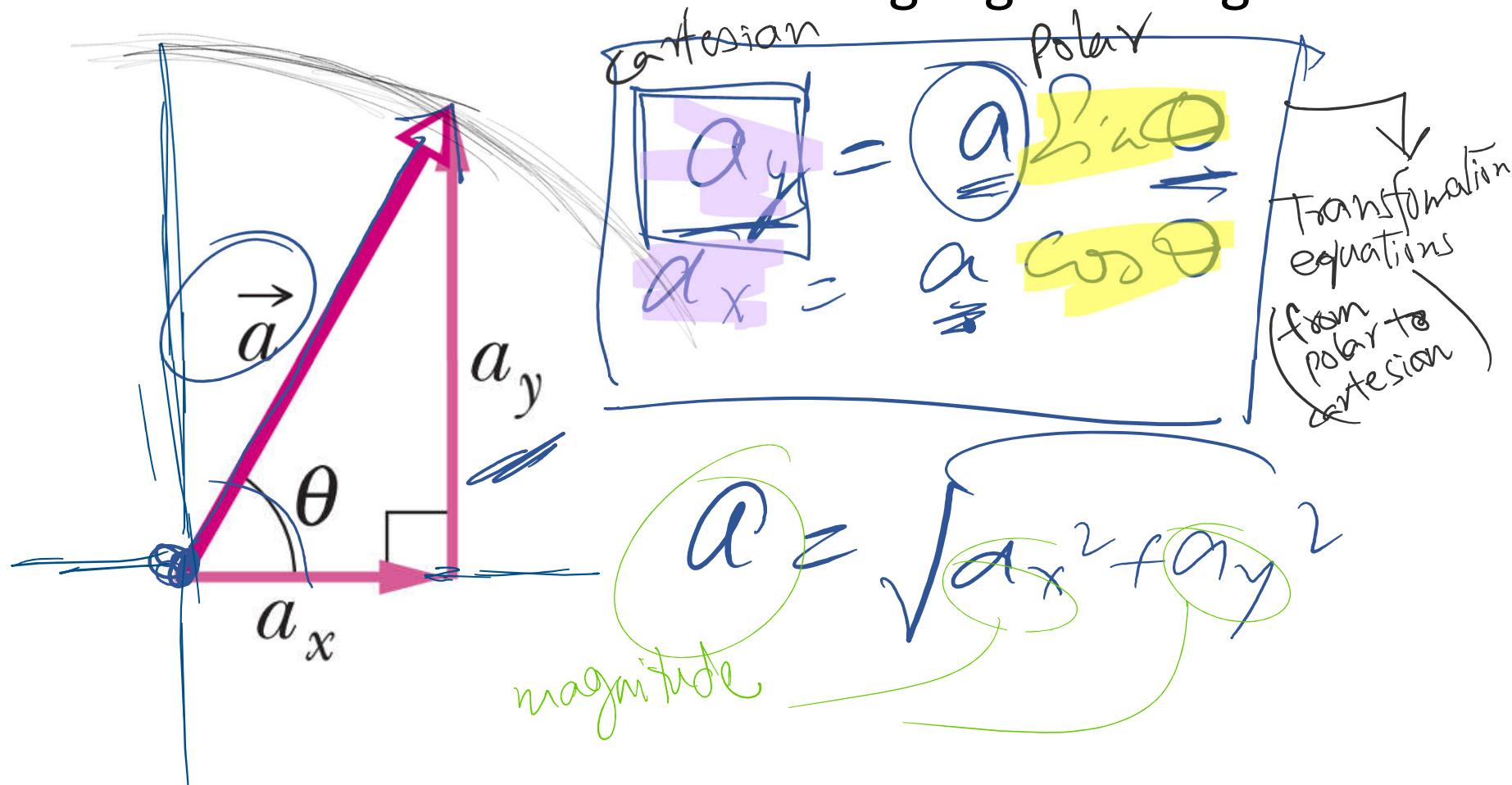


Pythagoras theorem



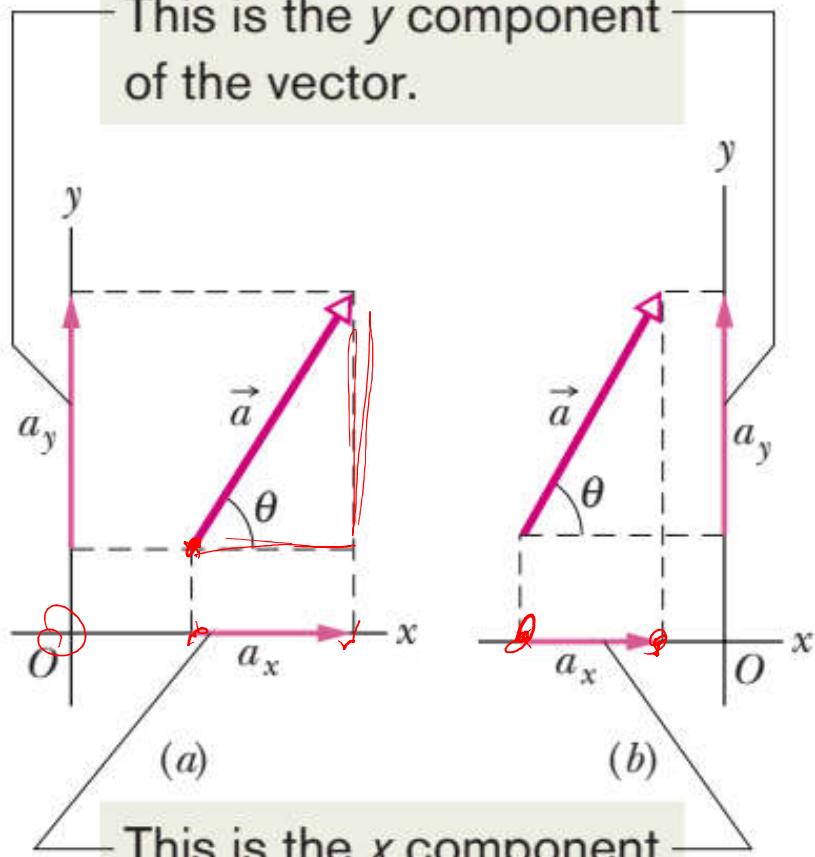
Problem-Solving Tactics, book pg#45

Combined form of a vector using Right-Triangle



Lecture 2

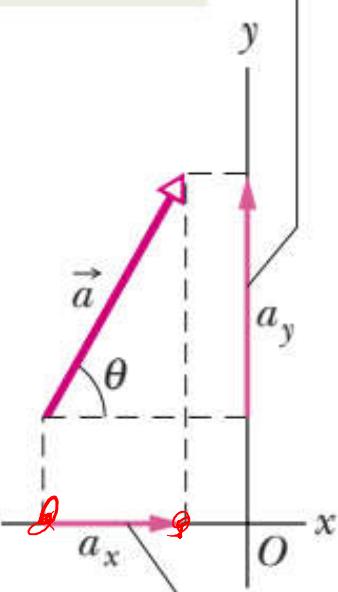
This is the y component
of the vector.



(a)

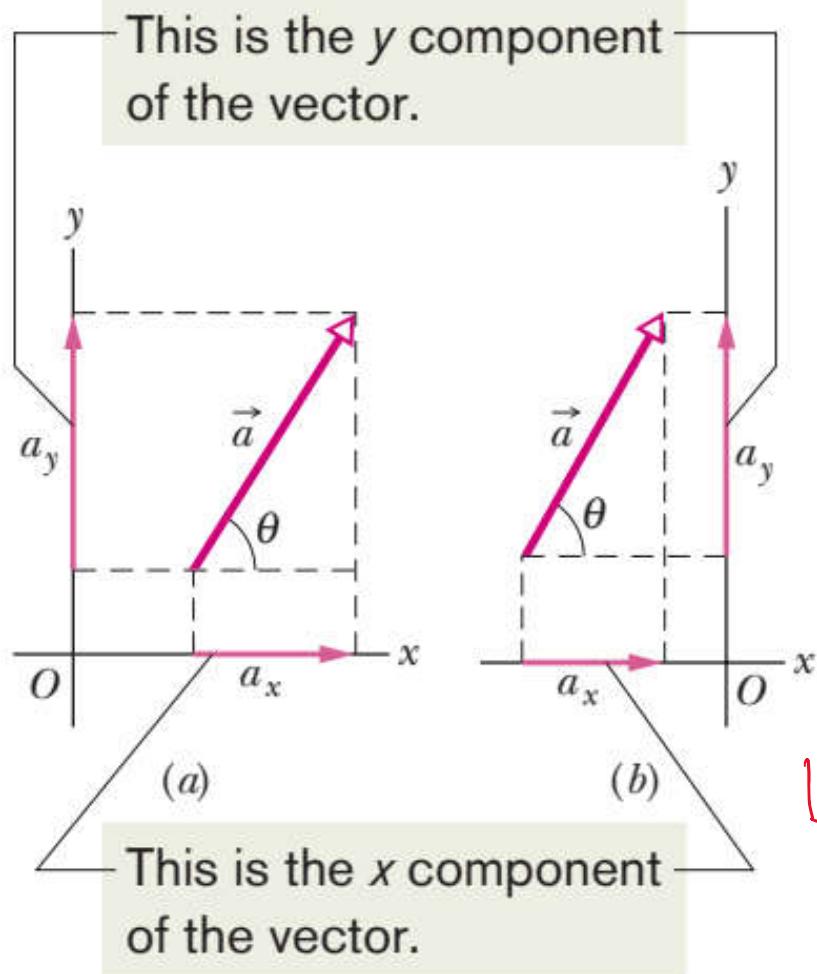
This is the x component
of the vector.

Vectors are essentially
independent of the position



(b)

Lecture 2



Vectors are essentially independent of the position

angle from horizontal

$$a_x = a \cos \theta \quad \text{and} \quad a_y = a \sin \theta,$$

$$a = \sqrt{a_x^2 + a_y^2} \quad \tan \theta = \frac{a_y}{a_x}$$

length direction
tan repeats some angles.

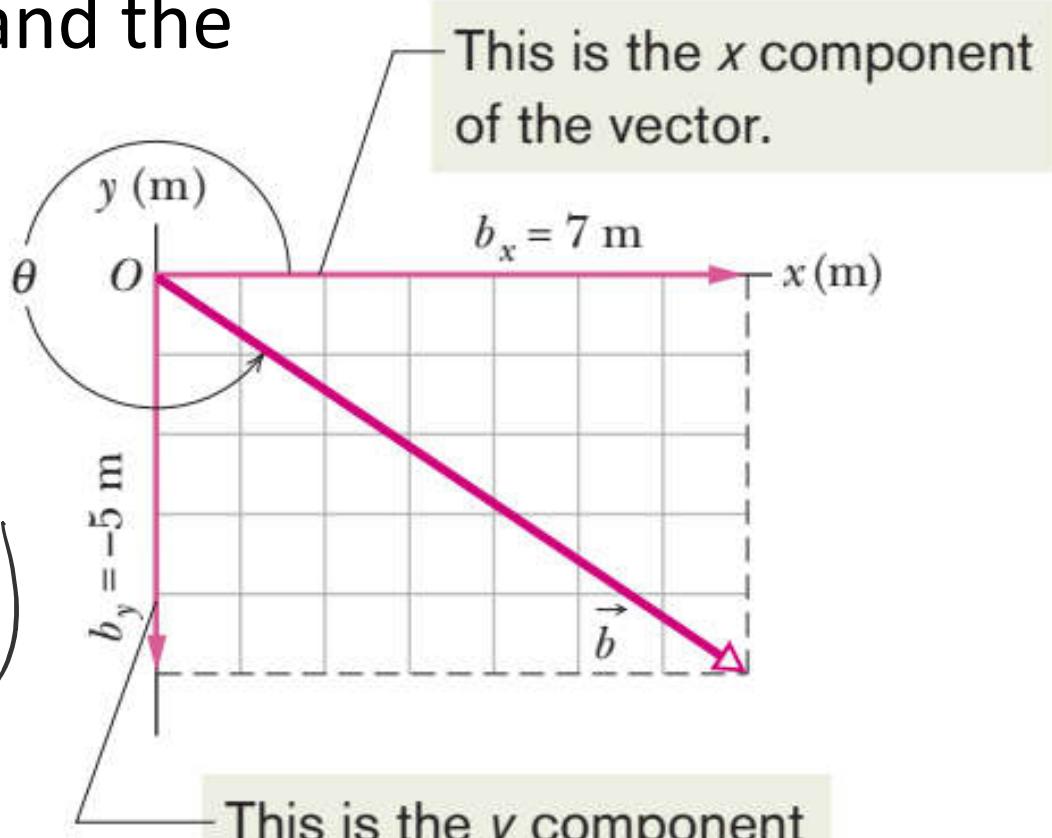
Lecture 2

Find length of the vector \vec{b} and the unknown angle θ .

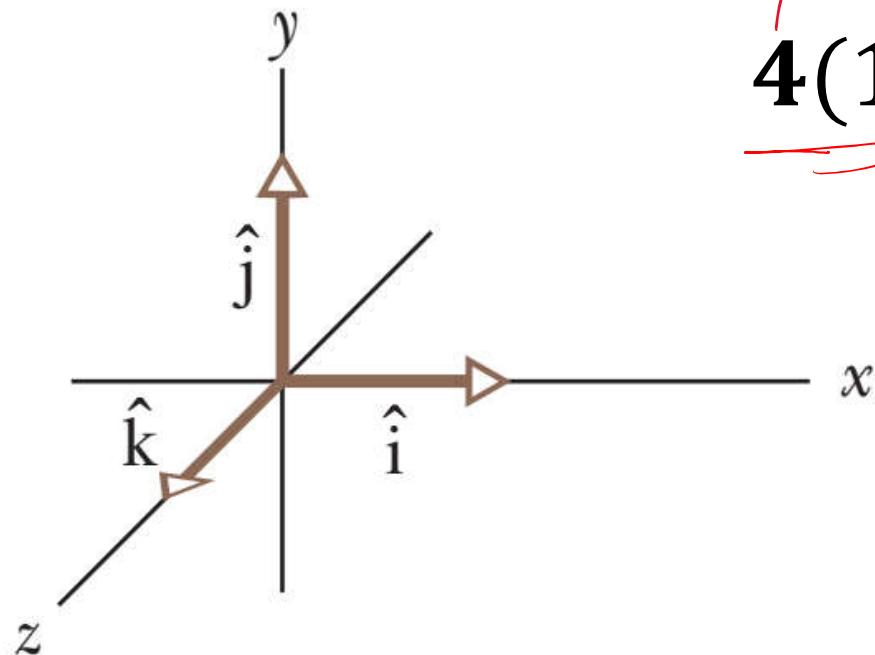
$$b = \sqrt{b_x^2 + b_y^2}$$

$$\tan \theta = \frac{b_y}{b_x} \Rightarrow \theta = \tan^{-1}\left(\frac{b_y}{b_x}\right)$$

$$\theta =$$



Concept of unit vectors

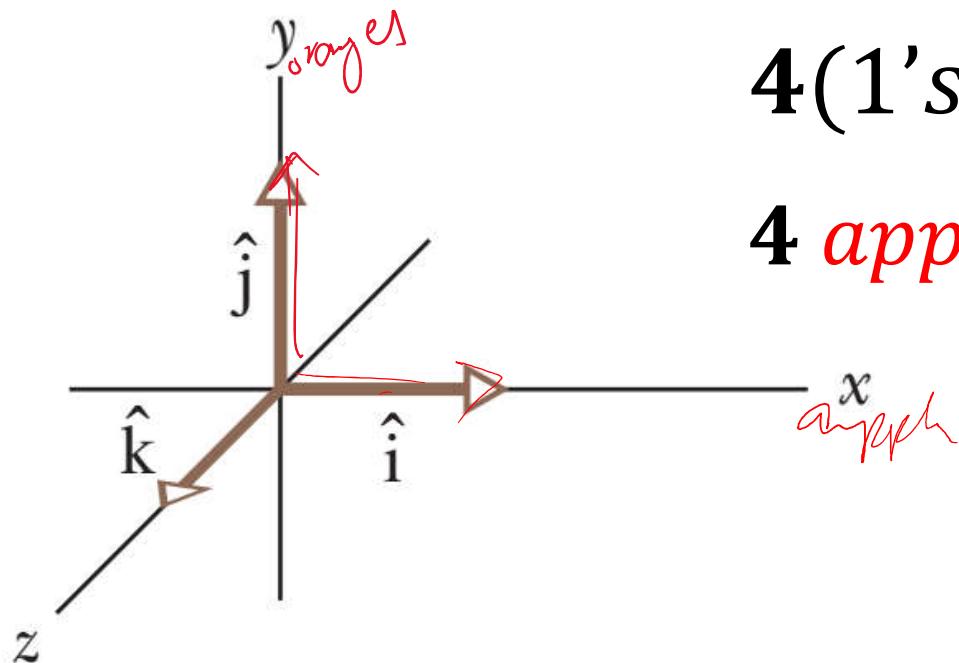


Quantity

$$4(1's) + 3(1's) = 7(1's)$$

unit objects

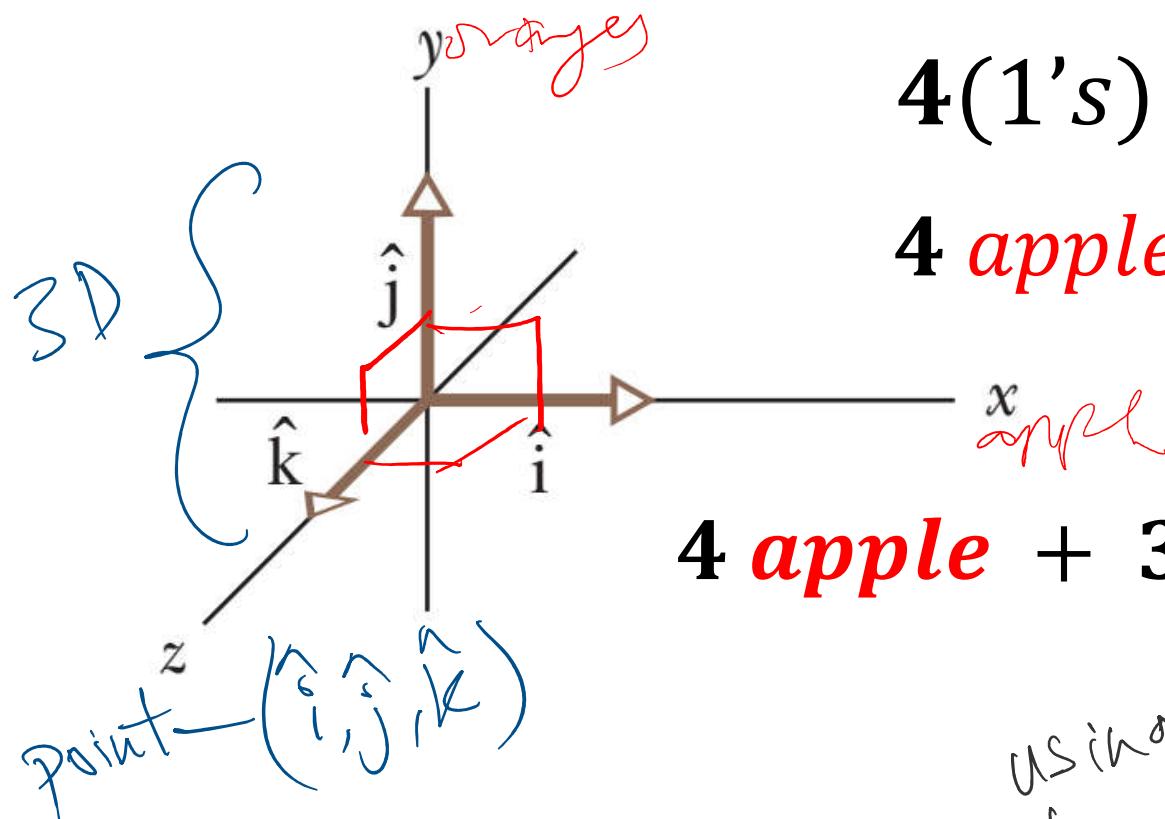
Concept of unit vectors



$$4(1's) + 3(1's) = 7(1's)$$

$$4 \text{ apple} - 3 \text{ apple} = 1 \text{ apple}$$

Concept of unit vectors



$$4(1's) + 3(1's) = 7(1's)$$

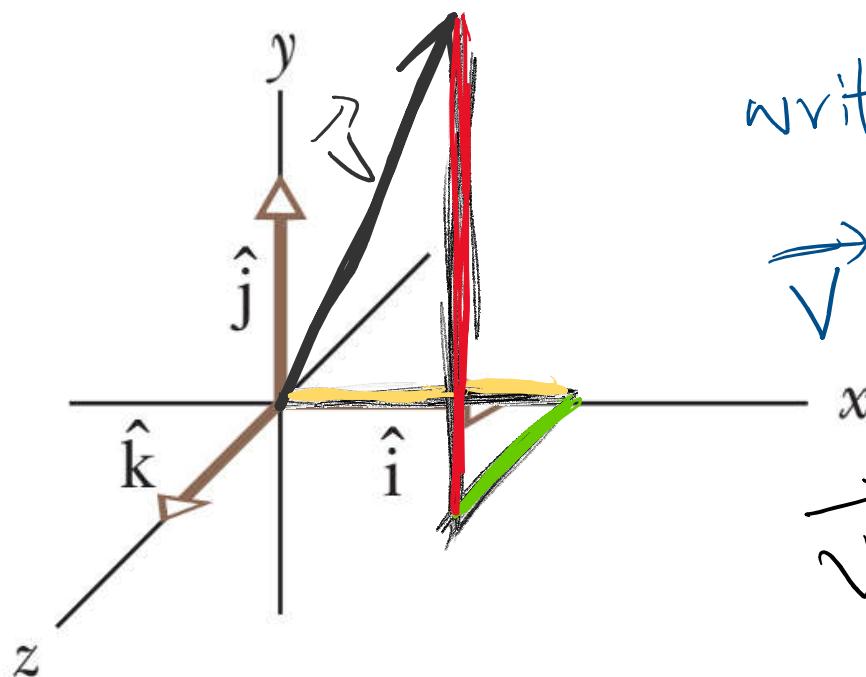
$$4 \text{ apple} - 3 \text{ apple} = 1 \text{ apple}$$

$$4 \text{ apple} + 3 \text{ oranges} =$$

using
Pythagoras
theorem

$\sqrt{5}$ apples

Concept of unit vectors



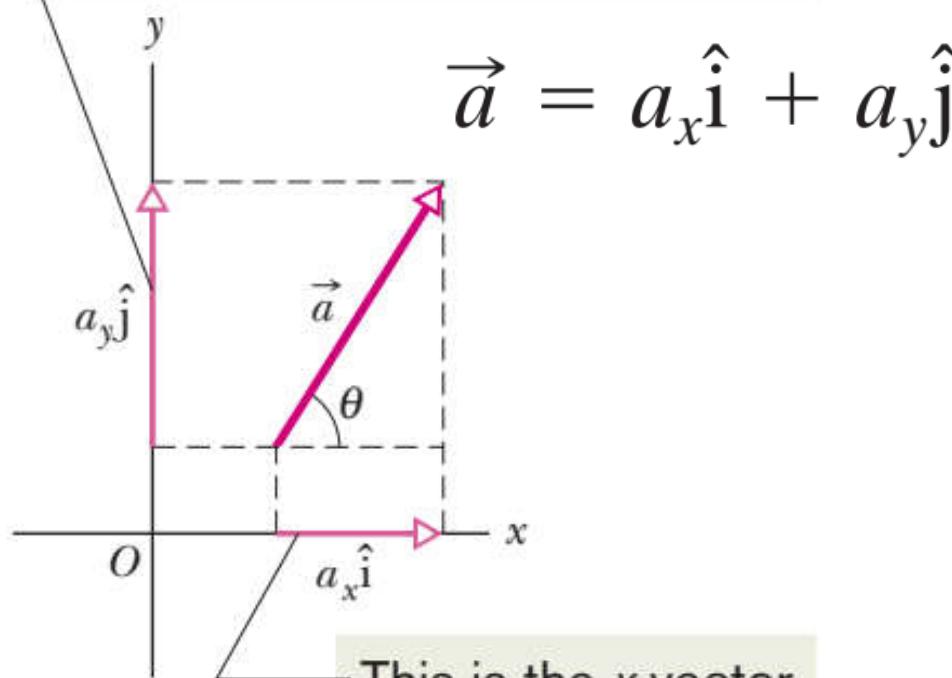
writing a vector in 3D

$$\vec{v} = V_x \hat{i} + V_y \hat{j} + V_z \hat{k}$$

$$\vec{v} = V_y \hat{j} + V_z \hat{k} + V_x \hat{i}$$

Lecture 2

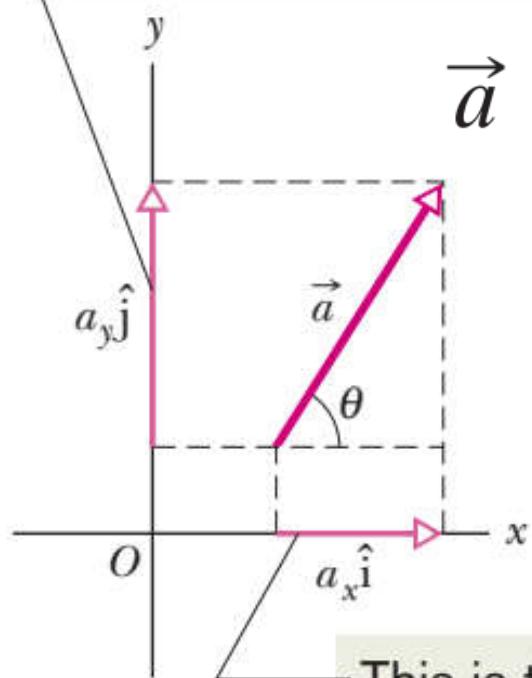
This is the y vector component.



(a) This is the x vector component.

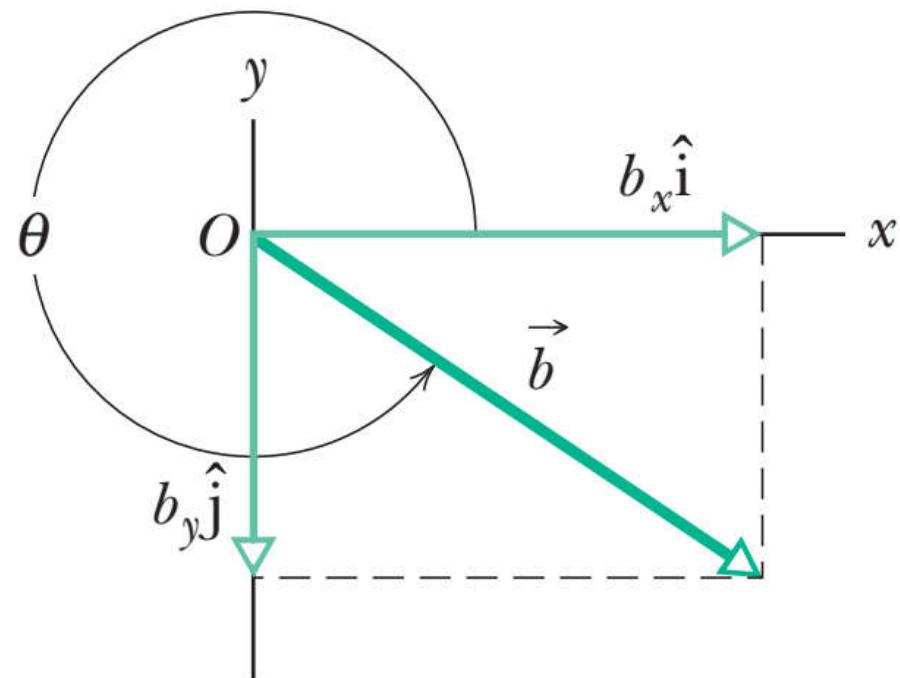
Lecture 2

This is the y vector component.



This is the x vector component.

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



$$\vec{b} = b_x \hat{i} + b_y \hat{j}$$

Homework: Problems(4,10)

$$\vec{a} = (4.2 \text{ m})\hat{i} - (1.5 \text{ m})\hat{j},$$

$$\vec{b} = (-1.6 \text{ m})\hat{i} + (2.9 \text{ m})\hat{j},$$

$$\vec{c} = (-3.7 \text{ m})\hat{j}.$$

$$\vec{R} = \vec{R}_x + \vec{R}_y$$

