To do...

- Register i>clicker
- MATLAB office hour today
  - 9 – 5 pm, MEL 1001
- HW 0 due **TODAY**
- HW 1 due **SUN**
- No class/discussion **MON**
- HW 2 due **TUES**
- Grainger office hours start **TUES**

"A fool sees not the same tree that a wise man sees"
William Blake (1757 - 1827)

Recap

- What is statics?

- Pay attention to units!
- Solve problem symbolically
- Equations must be dimensionally homogenous
- 3 significant figures
- 1% accuracy rule (PL)

Chapter 2: Force vectors
Main goals and learning objectives

Define scalars, vectors and vector operations and use them to analyze forces acting on objects

- Add forces and resolve them into components
- Express force and position in Cartesian vector form
- Determine a vector's magnitude and direction
- Introduce the dot product and use it to find the angle between two vectors or the projection of one vector onto another

Scalars and vectors

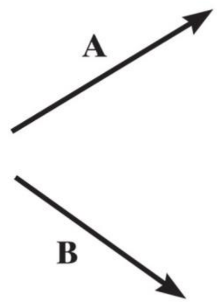
	Scalar	**Vector**
Examples	Mass, Volume, Time	Force, Velocity
Characteristics	It has a magnitude	It has a magnitude and direction
Special notation used in TAM 210/211	None	Bold font or vector symbol Ex: $\boldsymbol{A}$ or $\underset{\sim}{A}$

Multiplication or division of a vector by a scalar

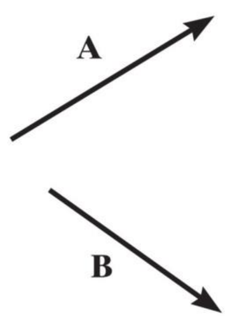
$$\boldsymbol{B} = \alpha\, \boldsymbol{A}$$

Vector addition

All vector quantities obey the parallelogram law of addition $\boldsymbol{R} = \boldsymbol{A} + \boldsymbol{B}$



Commutative law: $\boldsymbol{R} = \boldsymbol{A} + \boldsymbol{B} = \boldsymbol{B} + \boldsymbol{A}$



Associative law: $\boldsymbol{A} + (\boldsymbol{B} + \boldsymbol{C}) = (\boldsymbol{A} + \boldsymbol{B}) + \boldsymbol{C}$

Vector subtraction:

$$\boldsymbol{R} = \boldsymbol{A} - \boldsymbol{B} = \boldsymbol{A} + (-\boldsymbol{B})$$

$(-\boldsymbol{B})$ has the same magnitude as $\boldsymbol{B}$ but is in opposite direction.

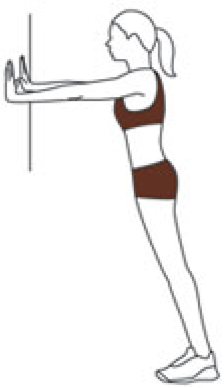
Scalar/Vector multiplication:

$$\alpha(\boldsymbol{A} + \boldsymbol{B})$$

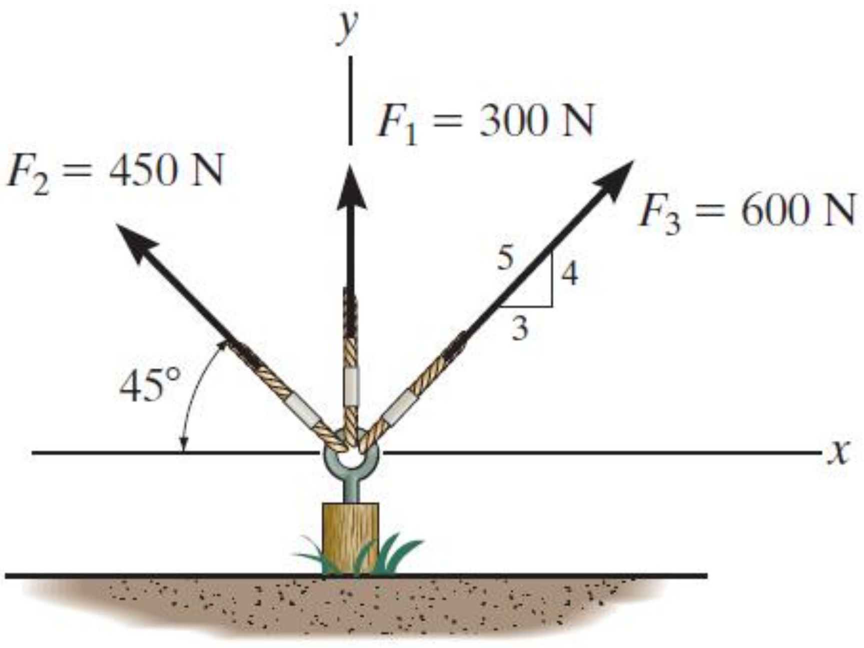
$$(\alpha + \beta)\boldsymbol{A}$$

Force vectors

A force—the action of one body on another—can be treated as a vector, since forces obey all the rules that vectors do.



Example



Given: Three concurrent forces acting on a tent post.

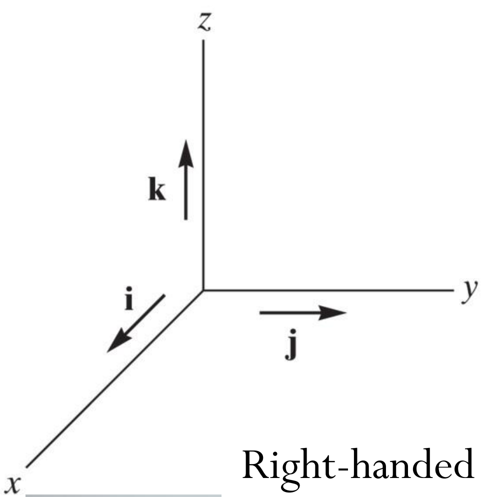
Find: The magnitude and angle of the resultant force.

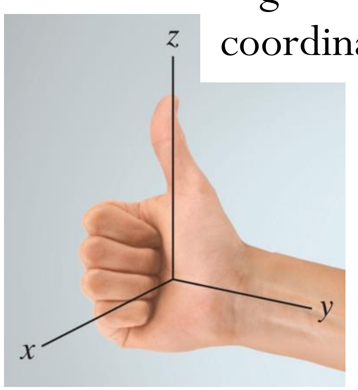
Cartesian vectors

Rectangular coordinate system: formed by 3 mutually perpendicular axes, the *x, y, z* axes, with unit vectors $\hat{i}$, $\hat{j}$, $\hat{k}$ in these directions.

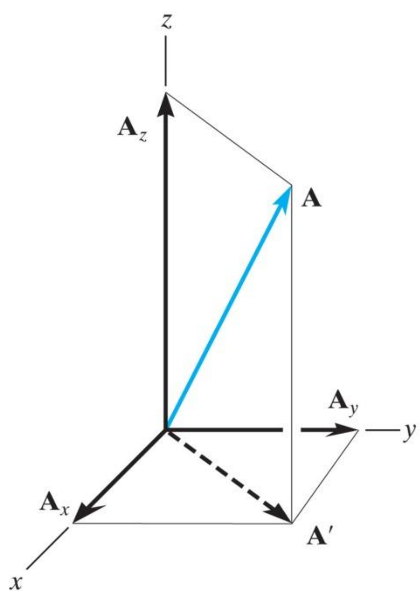
Note that we use the special notation "^" to identify *basis vectors* (instead of the "~" notation)

$$(\hat{i},\ \hat{j},\ \hat{k}) \text{ or } (\boldsymbol{i},\ \boldsymbol{j},\ \boldsymbol{k})$$



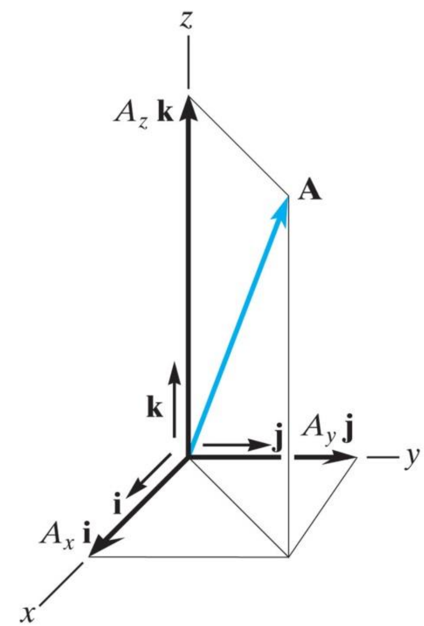


Right-handed coordinate system



Rectangular components of a vector

$\boldsymbol{A} =$

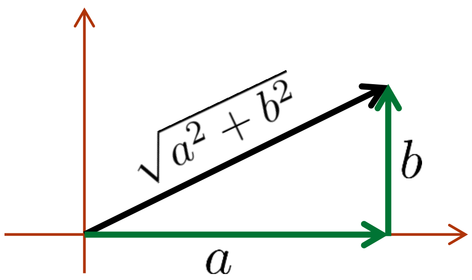


Cartesian vector representation

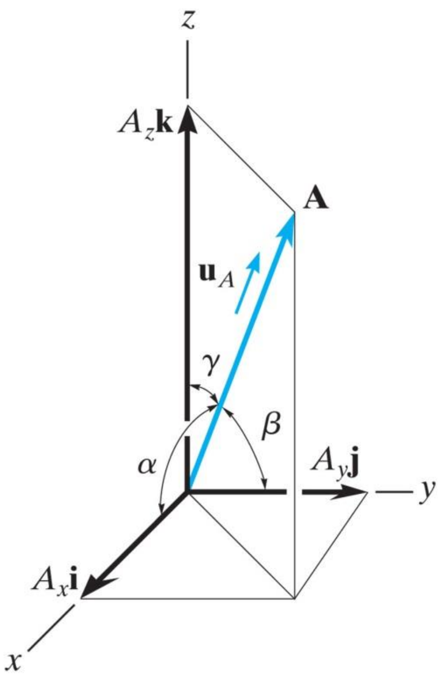
$\boldsymbol{A} =$

Magnitude of Cartesian vectors

$$A = |\boldsymbol{A}| = \sqrt{A_x^2 + A_y^2 + A_z^2}$$



Direction of Cartesian vectors



Expressing the direction using a unit vector:

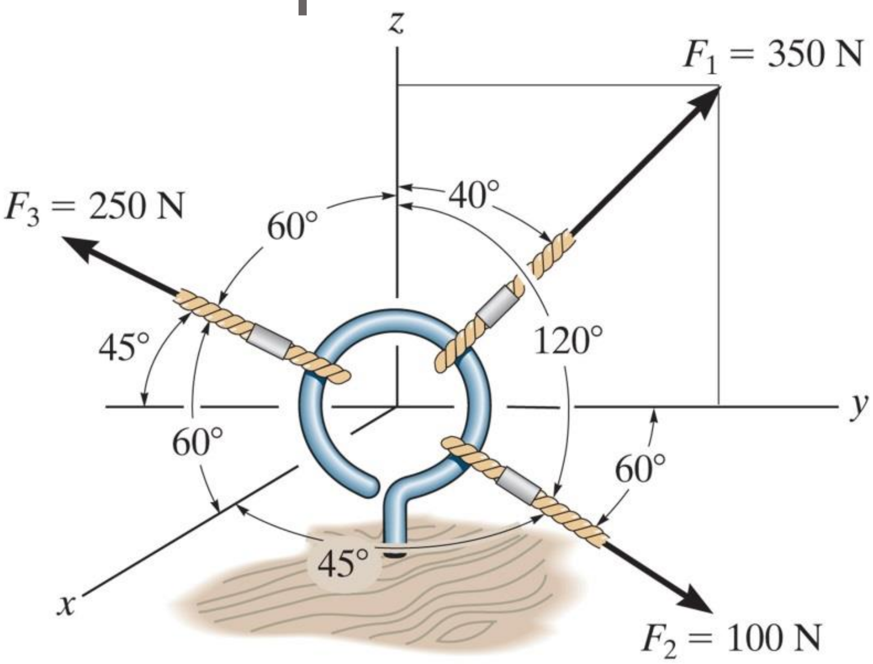
$$\boldsymbol{u}_A = \frac{\boldsymbol{A}}{A}$$

Direction cosines are the components of the unit vector:

Addition of Cartesian vectors

$$\boldsymbol{R} = \boldsymbol{A} + \boldsymbol{B} =$$

Example



The cables attached to the screw eye are subjected to the three forces shown.

(a) Express each force vector using the Cartesian vector form (components form).

(b) Determine the magnitude of the resultant force vector

(c) Determine the direction cosines of the resultant force vector