Fundamentals of Physics II

Faculty of Physics-Kharazmi University

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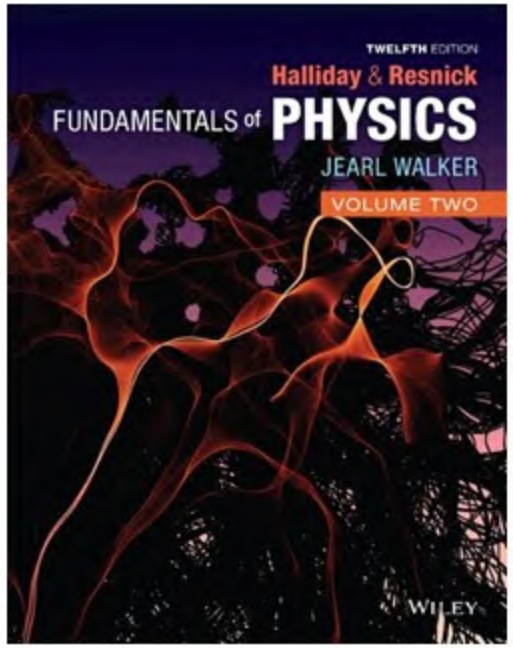
اگر همواره مانند گذشته بیندیشید، همیشه همان
چیزهایی را به‌دست می‌آورید که تاکنون کسب کرده‌اید

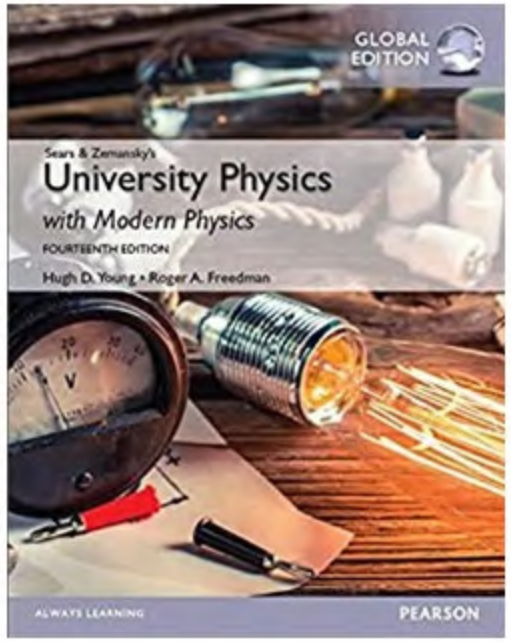
If you always think the way you've always thought, you'll always get what you've always got.

- Vector Algebra
- Coordinate Systems
- Electric charge and Coulomb Law
- Electric Field
- Gauss' Law
- Electric Potential
- Capacitance and Dielectrics
- Current and Resistance
- Magnetic Field
- Ampere's and Biot-Savart's Laws
- Faraday's Law
- Induction
- Magnetism of Matter
- Maxwell's Equations
- Alternating Current
- Electromagnetic Waves

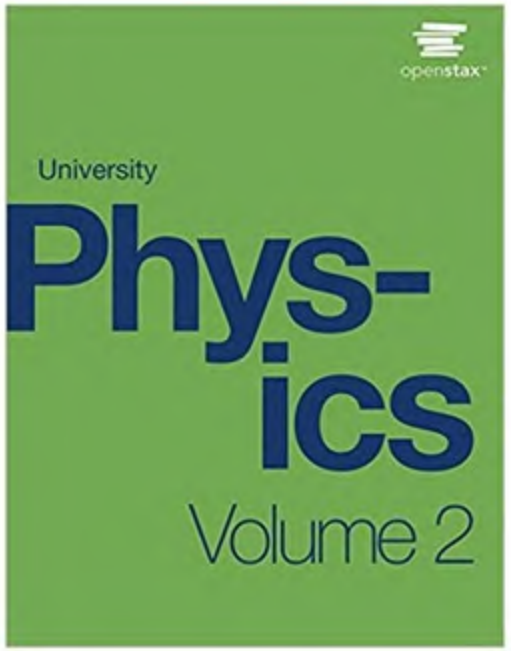
Fundamentals of Physics (12th Ed.)
Halliday, David; Resnick, Robert; Walker, Jearl



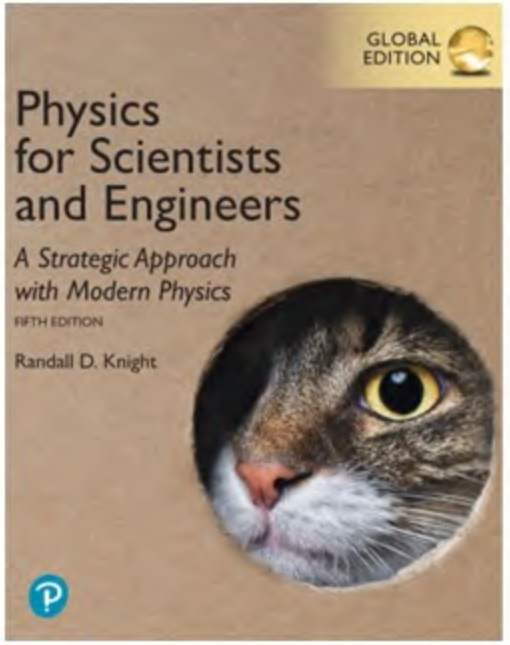
University Physics with Modern Physics (14th Global Ed.)
Hugh D. Young, Roger A. Freedman



University Physics Volume 2
Samuel J. Ling, Jeff Sanny, William Moebs



P H Y S I C S For Scientists and Engineers, 5e, (2023)
Randall D. Knight



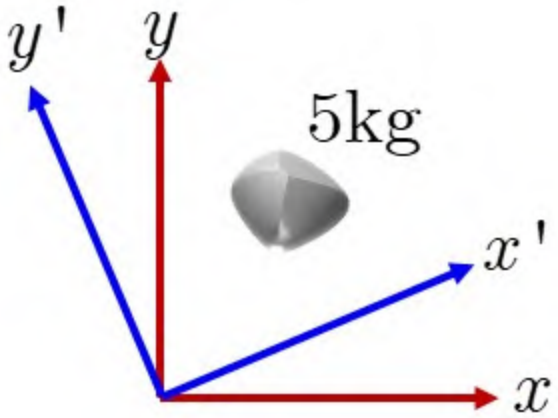
Lecture 1:

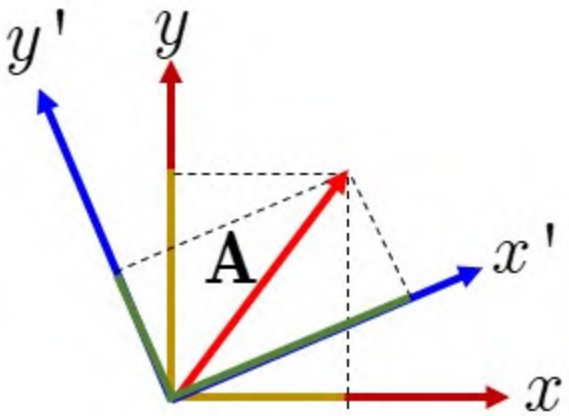
Vector Algebra Part1

- ❑ Basic Definitions
- ❑ Vector Addition: Geometric Approach
- ❑ Multiplying a Vector by a Scalar
- ❑ Vector Subtraction
- ❑ Scalar Product
- ❑ Vector Product

- ❑ تعاریف
- ❑ جمع برداری: روش هندسی
- ❑ ضرب عدد در بردار
- ❑ تفریق بردارها
- ❑ حاصل‌ضرب نرده‌ای
- ❑ حاصل‌ضرب برداری

- Scalars
- Vectors
- Tenors





$$A_{x'} = A_x \cos\theta + A_y \sin\theta$$
$$A_{y'} = -A_x \sin\theta + A_y \cos\theta$$

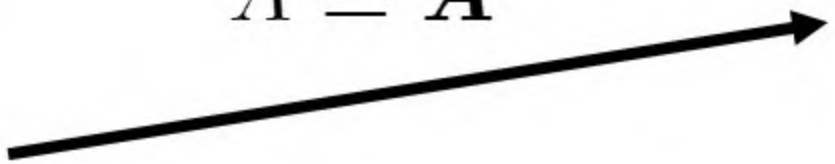
- A scalar is a quantity defined only by its magnitude and remains unchanged regardless of the coordinate system.
- We define a vector as a quantity whose components change according to a specific rule when the coordinate system is rotated.
- Tensors are quantities that change according to a different specific rule under the rotation of the coordinate system.

You will explore these rules in more detail in other courses.

- A tensor of rank zero is called a scalar.
- A tensor of rank one is called a vector.
- A tensor of rank two is simply called a tensor.
- A tensor of rank three is called a third-rank tensor.

Similarly, for higher-rank tensors, we name them according to their rank (e.g., a fourth-rank tensor, a fifth-rank tensor, and so on).

$$\vec{A} \equiv \boldsymbol{A}$$



Magnitude of a vector $\left|\vec{A}\right| = \left|\boldsymbol{A}\right| = A$ **اندازه‌ی بردار**

دو بردار را مساوی گوییم هر گاه اندازه و جهت یکسان داشته باشند

Two vectors are considered equal if they have the same magnitude (length) and the same direction.

$$\boldsymbol{A} = \boldsymbol{B} \Leftrightarrow A = B\,; \quad A \uparrow\uparrow B$$

دو بردار را نامساوی گوییم هر گاه اندازه یا جهت آن‌ها یکسان نباشد

Two vectors are considered unequal if their magnitudes or directions are not identical

$$\boldsymbol{A} \neq \boldsymbol{B}$$

The zero vector has a magnitude of zero and an undefined direction. It is uniquely represented by the number zero.

$$\vec{O} = 0$$

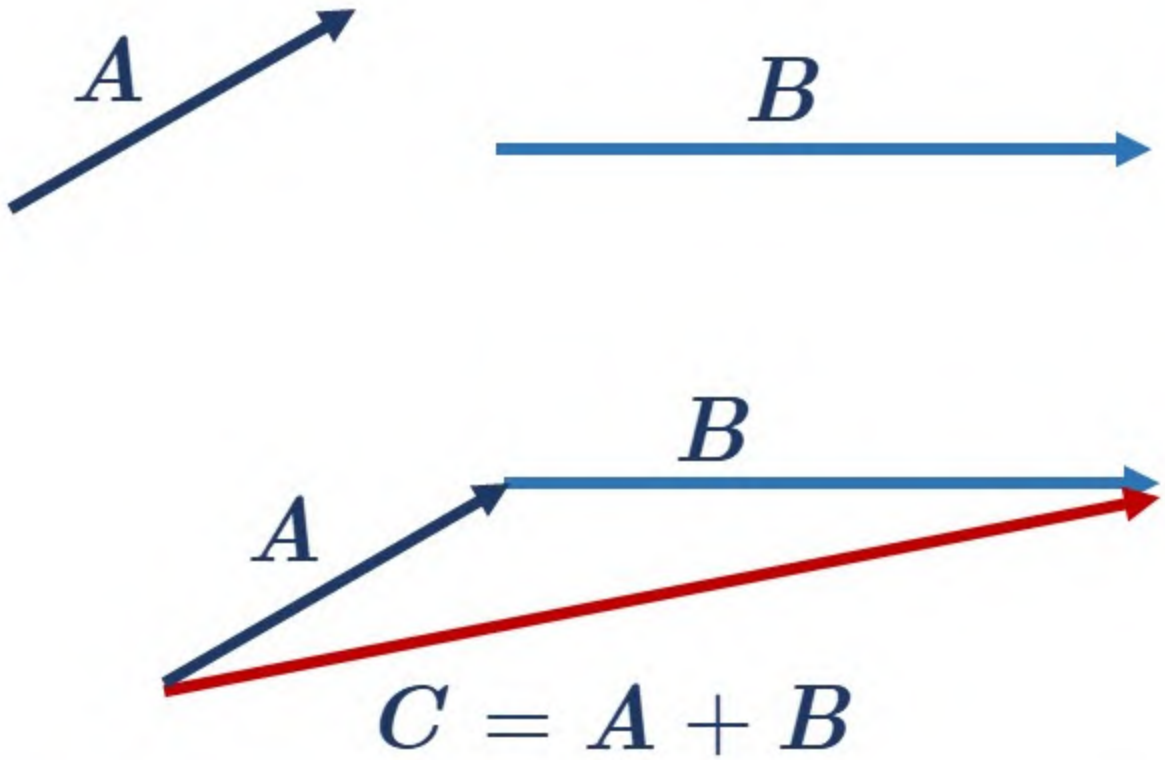
Unit Vector بردار واحد (بردار یکه)

A unit vector is defined as a vector whose magnitude equals one and is often used to indicate direction.

$\hat{u}$ "u-hat"

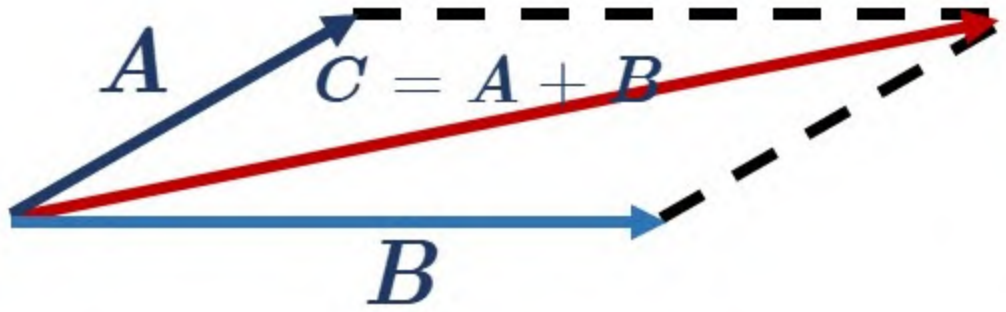
Triangle Law of Vector Addition

قاعده‌ی جمع مثلث



Parallelogram Law of Vector Addition

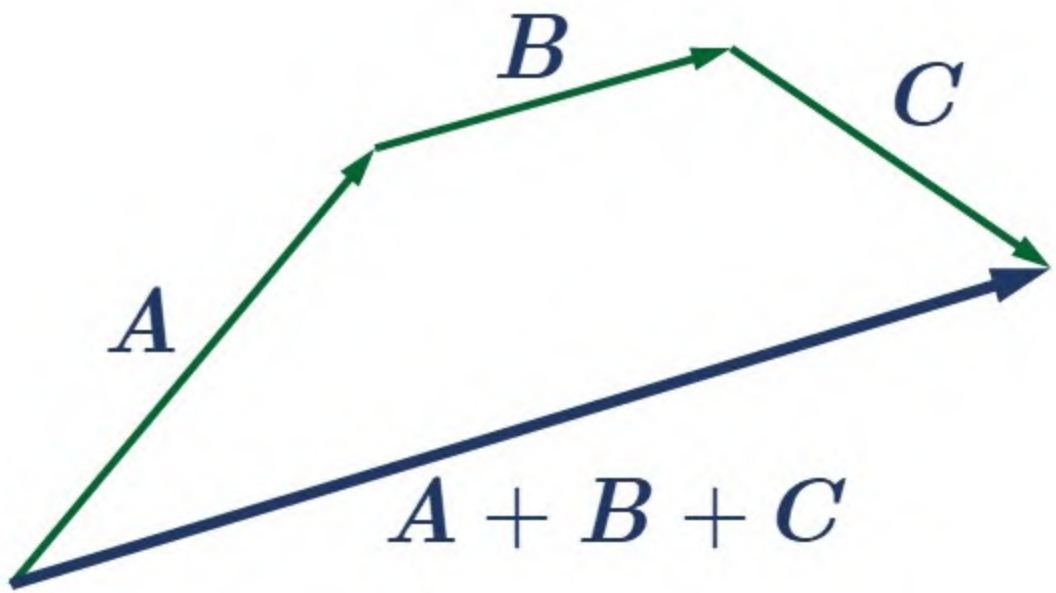
قاعده‌ی جمع متوازی‌الاضلاع



Adding multiple vectors

جمع چند بردار

The addition of multiple vectors can be done using the head-to-tail method.



Commutative law

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

Associative law

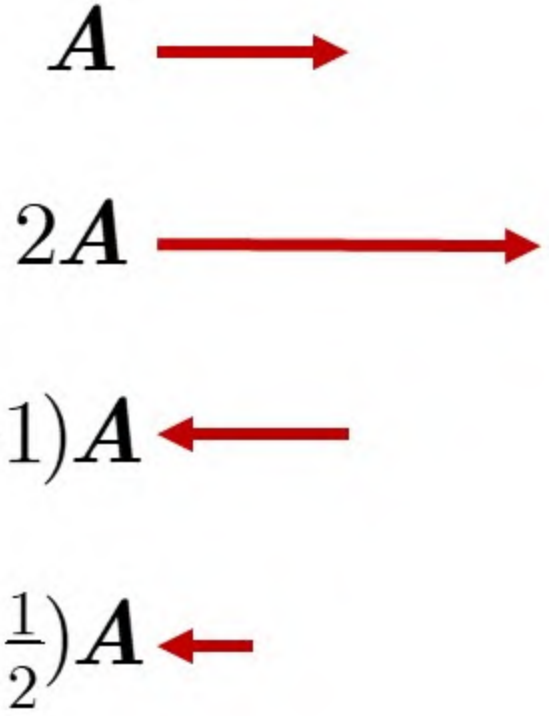
$$\boldsymbol{A} + \left(\boldsymbol{B} + \boldsymbol{C}\right) = \left(\boldsymbol{A} + \boldsymbol{B}\right) + \boldsymbol{C} = \boldsymbol{A} + \boldsymbol{B} + \boldsymbol{C}$$

$\boldsymbol{A}$ is a vector
α is a real number

$$\alpha \boldsymbol{A} = ?$$

$$\left|\alpha \boldsymbol{A}\right| = \left|\alpha\right|\left|\boldsymbol{A}\right| = \left|\alpha\right| A$$

$$if\ \alpha > 0 \Rightarrow \alpha \boldsymbol{A} \uparrow\uparrow \boldsymbol{A}$$
$$if\ \alpha < 0 \Rightarrow \alpha \boldsymbol{A} \uparrow\downarrow \boldsymbol{A}$$



Multiplying a vector by a scalar has the Following Properties:

Distributive over Vector Addition: $$\alpha\Big(\boldsymbol{A}+\boldsymbol{B}\Big)=\alpha\boldsymbol{A}+\alpha\boldsymbol{B}$$

Distributive over Scalar Addition: $$\Big(\alpha+\beta\Big)\boldsymbol{A}=\alpha\boldsymbol{A}+\beta\boldsymbol{A}$$

Associative with Scalar Multiplication: $$\Big(\alpha\Big)\beta\boldsymbol{A}=\Big(\alpha\beta\Big)\boldsymbol{A}=\alpha\beta\boldsymbol{A}$$

The unit vector in the direction of a given vector A:

$$\hat{e}_A = \frac{\boldsymbol{A}}{|\boldsymbol{A}|} = \frac{\boldsymbol{A}}{A}$$

$$\boldsymbol{A} = A\hat{e}_A$$

$$\vec{A} = A\hat{e}_A$$

Negative of a Vector (additive inverse)

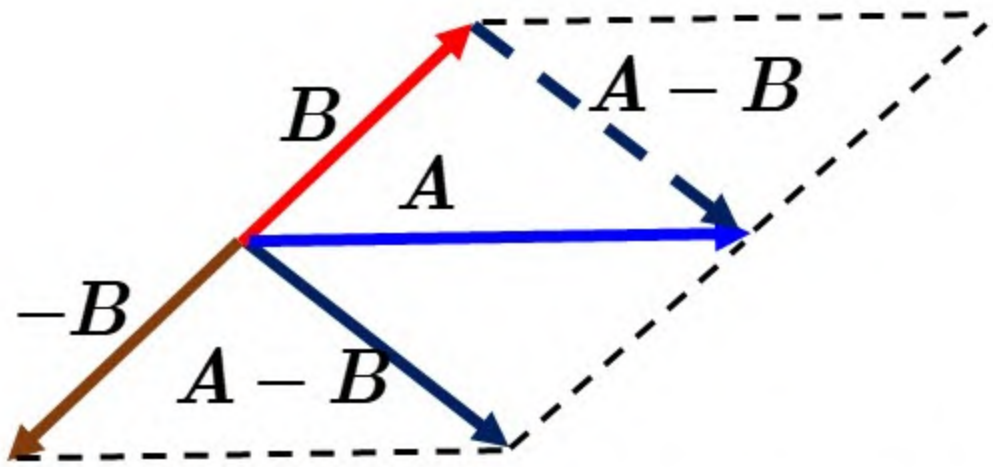
قرینه‌ی یک بردار:

$$(-1)\boldsymbol{A} = -\boldsymbol{A}$$

تفریق دو بردار به صورت حاصل جمع اولی با قرینه‌ی بردار دوم تعریف می‌شود:

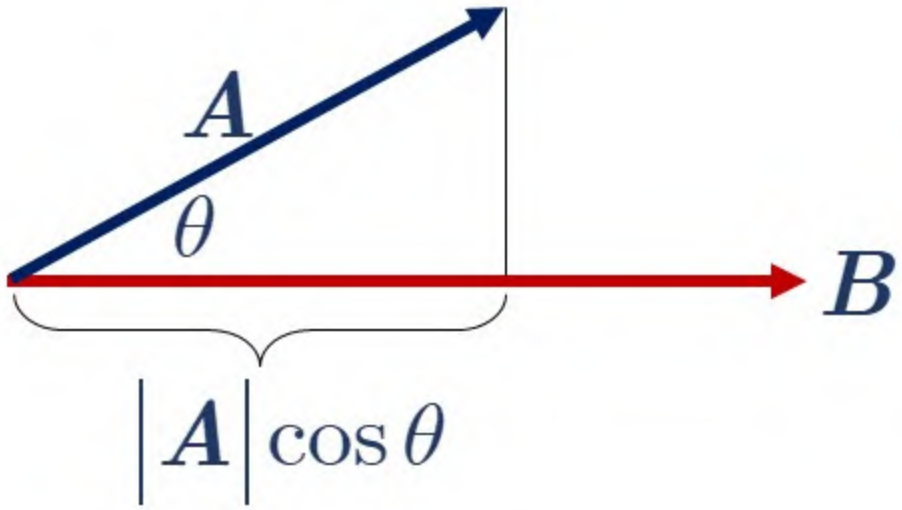
Vector subtraction is defined as the addition of a vector to the negative of another vector.

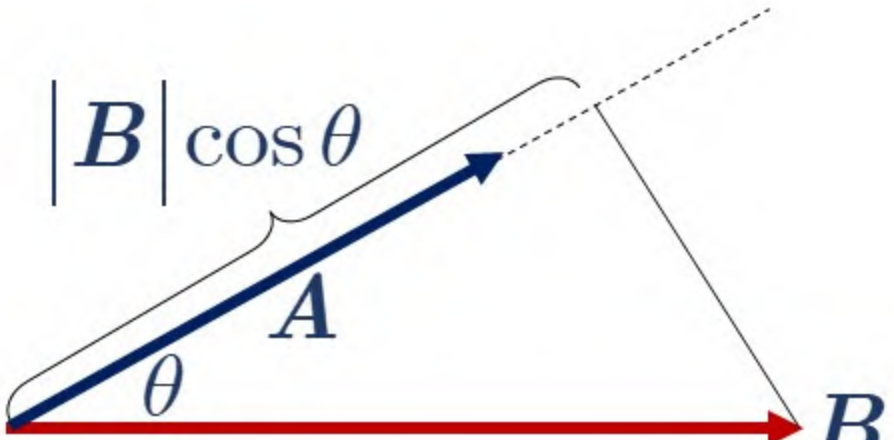
$$\boldsymbol{A} - \boldsymbol{B} = \boldsymbol{A} + (-1)\boldsymbol{B}$$



- ضرب اسکالر (عددی-نرده‌ای)-ضرب نقطه‌ای-ضرب داخلی
- Scalar Product - Dot Product
- ضرب برداری -ضرب چلیپایی
- Vector Product - Cross Product

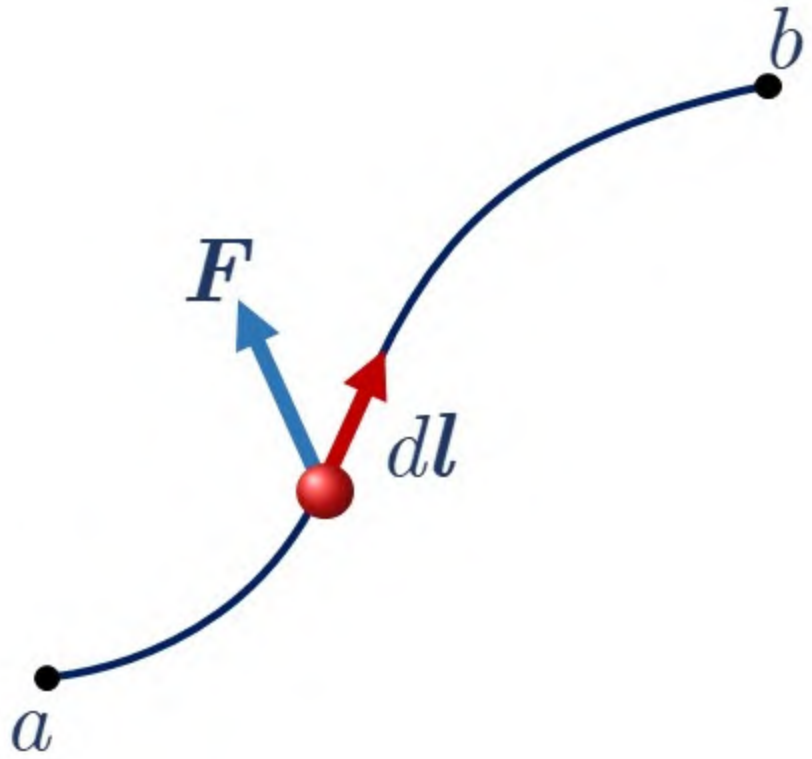
$$\boldsymbol{A}\cdot\boldsymbol{B} = |\boldsymbol{A}||\boldsymbol{B}|\cos\theta = AB\cos\theta$$





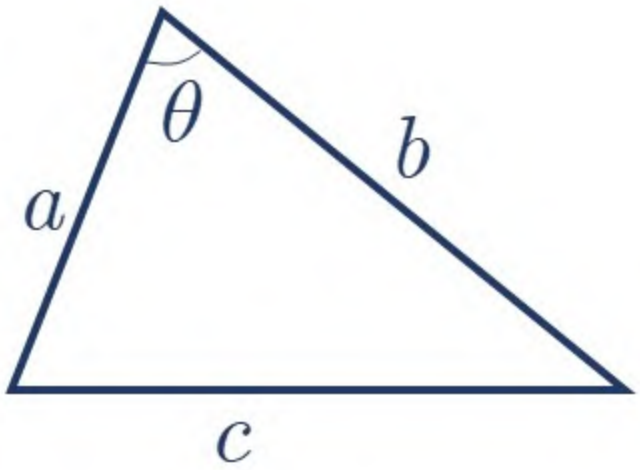
Commutative property $A \cdot B = B \cdot A$

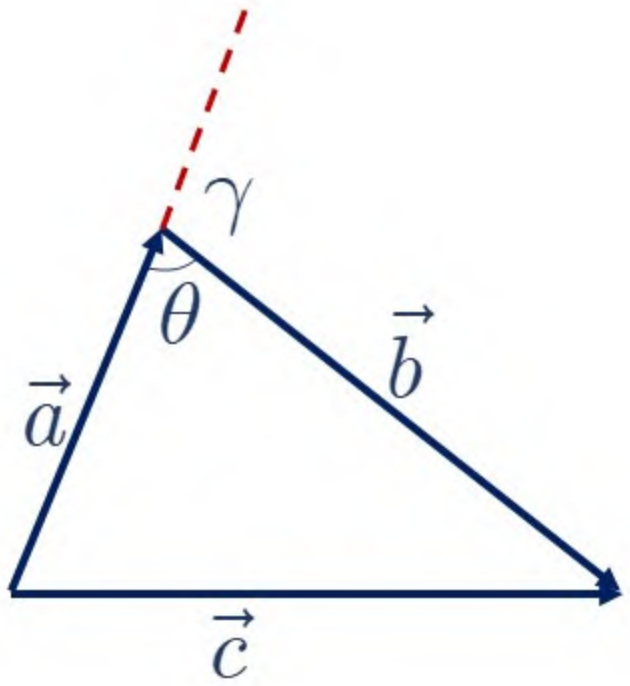
Distributive property $A \cdot \left(B + C \right) = A \cdot B + A \cdot C$



$$dW = \boldsymbol{F} \cdot d\boldsymbol{l}$$

$$W = \int_a^b \boldsymbol{F} \cdot d\boldsymbol{l}$$


θ
a
b
c



$$c^2 = \vec{c}\cdot\vec{c} = \left(\vec{a}+\vec{b}\right)\cdot\left(\vec{a}+\vec{b}\right)$$

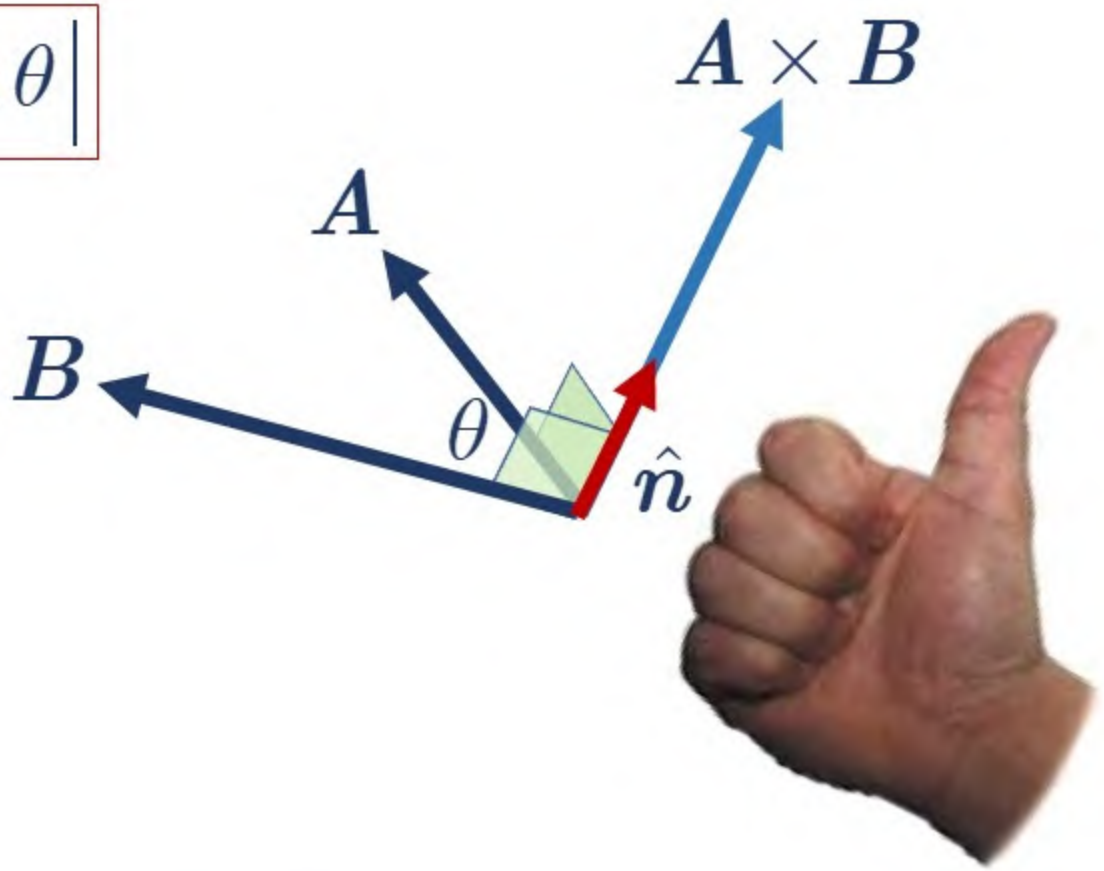
$$= a^2 + 2\vec{a}\cdot\vec{b} + b^2$$

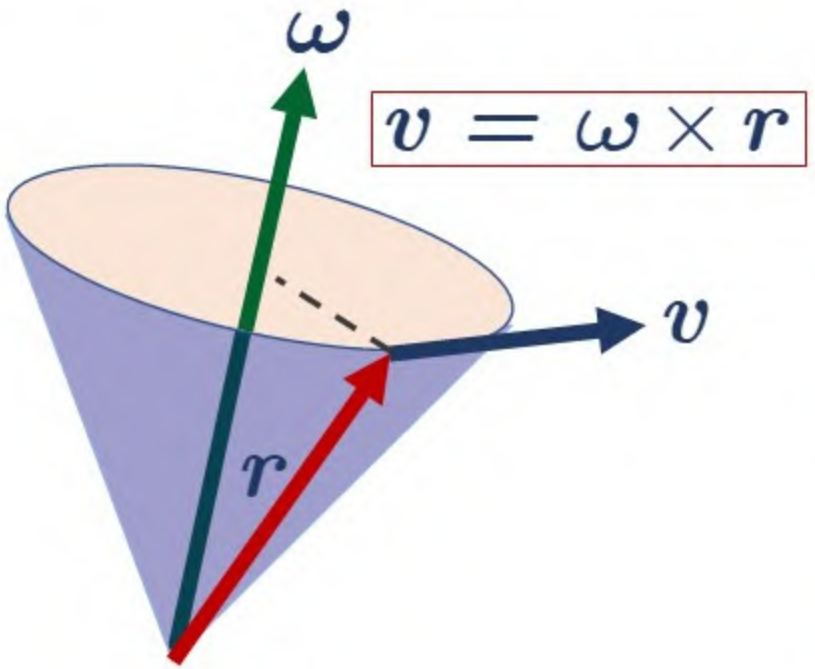
$$= a^2 + 2ab\cos\gamma + b^2$$

$$= a^2 - 2ab\cos\theta + b^2$$

$$\cos\gamma = \cos(\pi-\theta) = -\cos\theta$$

$$\boldsymbol{A} \times \boldsymbol{B} = \hat{\boldsymbol{n}} \left| AB \sin\theta \right|$$





$$F = q\left[E + v \times B\right]$$ Lorentz force نیروی لورنتس

$$L = r \times p$$ Angular momentum تکانه‌ی زاویه‌ای

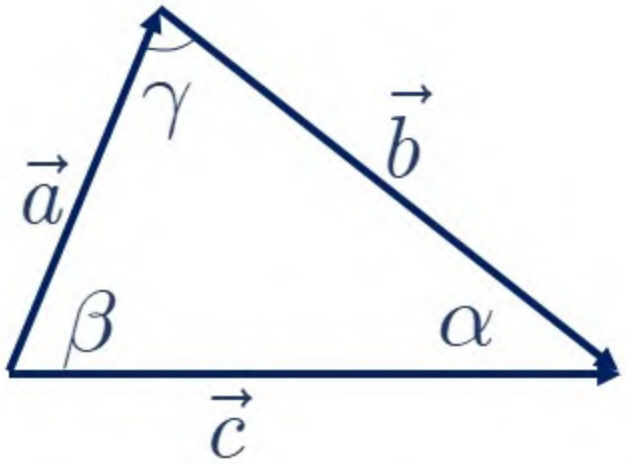
$$\tau = r \times F$$ Torque گشتاور نیرو

Anti-commutative property

$$\boldsymbol{A} \times \boldsymbol{B} = -\boldsymbol{B} \times \boldsymbol{A}$$

Distributive property

$$\boldsymbol{A} \times \left(\boldsymbol{B} + \boldsymbol{C} \right) = \boldsymbol{A} \times \boldsymbol{B} + \boldsymbol{A} \times \boldsymbol{C}$$



$$\textbf{Area} = \frac{1}{2}\left|\vec{a}\times\vec{b}\right| = \frac{1}{2}\left|\vec{b}\times\vec{c}\right| = \frac{1}{2}\left|\vec{a}\times\vec{c}\right|$$

$$\textbf{Area} = \frac{1}{2}ab\sin\gamma = \frac{1}{2}bc\sin\alpha = \frac{1}{2}ac\sin\beta$$

$$\boxed{\frac{\sin\alpha}{a} = \frac{\sin\beta}{b} = \frac{\sin\gamma}{c}}$$

شاد و مهربان باشید

Be happy and kind