



GENERAL PHYSICS 1

Chapter 1

Our Groups



قناة الاكاديمية



Telegram

Chapter -1-Units, Physical Quantities, and Vectors

- 1.1 The Nature of Physics
- 1.2 Solving Problems in Physics
- 1.3 Standards and Units
- 1.4 Unit Consistency and Conversions
- 1.5 Uncertainty and Significant figures
- 1.7 Vectors and Scalars
- 1.8 Components of Vectors
- 1.9 Unit Vectors
- 1.10 Products of Vectors

1.1 The Nature of Physics

Physics is an **experimental** science in which physicists seek patterns that relate the phenomena of nature.

الفيزياء هي علم تجريبي يبحث فيه علماء الفيزياء عن أنماط تتعلق بظواهر الطبيعة.

The patterns are called (**Physical theories**.)

تسمى الأنماط النظريات الفيزيائية.

A very well established or widely used theory is called a **physical law or principle**.

تسمى النظرية الراسخة جدا أو المستخدمة على نطاق واسع قانونا أو مبدأ فيزيائيا.

According to legend, Galileo investigated falling objects by dropping them from the Leaning Tower of Pisa, Italy, ...



... and he studied pendulum motion by observing the swinging chandelier in the adjacent cathedral.

1.2 Solving Problems in Physics

All of the **Problem-Solving Strategies** and **Examples** in this book will follow these four steps :

ستتبع جميع استراتيجيات وأمثلة حل المشكلات في هذا الكتاب هذه الخطوات الأربع:

Identify → the relevant concepts, target variables, and known quantities, as stated or implied in the problem.

التحديد ← المفاهيم ذات الصلة والمتغيرات المستهدفة والكميات المعروفة, كما هو مذكور أو ضمني في المشكلة.

Setup the problem → Choose the equations that you'll use to solve the problem, and draw a sketch of the situation.

قم بإعداد المشكلة ← اختر المعادلات التي ستستخدمها لحل المشكلة, وارسم رسماً للموقف.

Execute the solution → This is where you "do the math."

التنفيذ ← هذا هو المكان الذي تقوم فيه بالرياضيات.

Evaluate your answer → Compare your answer with your estimates, and reconsider things if there's a discrepancy.

قيم إجابتك ← قارن إجابتك مع تقديراتك, وأعد النظر في أمور إذا كان هناك تباين.

idealized Models

To simplify the analysis of

a) a baseball in flight, we use

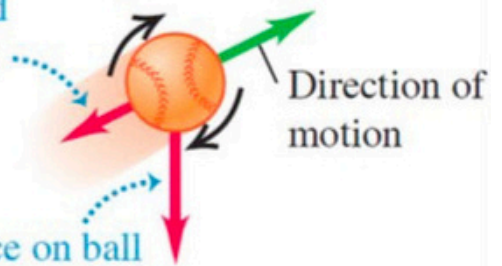
b) an idealized model.

(a) A real baseball in flight

A baseball spins and has a complex shape.

Air resistance and wind exert forces on the ball.

Gravitational force on ball depends on altitude.

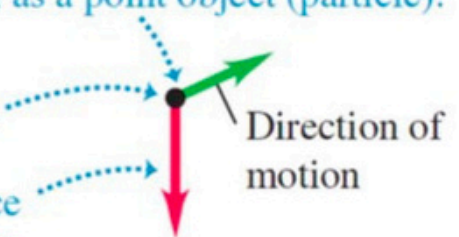


(b) An idealized model of the baseball

Treat the baseball as a point object (particle).

No air resistance.

Gravitational force on ball is constant.



1.3 Standards and Units

Length, time, and mass are three **fundamental** quantities of physics.

الطول والوقت والكتلة هي ثلاث كميات أساسية من الفيزياء.

The **International System** (SI for **Système International**) is the most widely used system of units.

in SI units, length is measured in **meters**, time in **seconds**, and mass in **kilograms**.

في وحدات SI, يقاس الطول بالأمتار والوقت بالثواني, والكتلة بالكيلوغرامات.



Unit Prefixes

Prefixes can be used to create larger and smaller units for the fundamental quantities. Some examples are:

يمكن استخدام البادئات لإنشاء وحدات أكبر وأصغر للكميات الأساسية.

$1 \mu\text{m} = 10^{-6} \text{ m}$ (size of some bacteria and living cells)

$1 \text{ km} = 10^3 \text{ m}$ (a 10-minute walk)

$1 \text{ mg} = 10^{-6} \text{ kg}$ (mass of a grain of salt)

$1 \text{ g} = 10^{-3} \text{ kg}$ (mass of a paper clip)

$1 \text{ ns} = 10^{-9} \text{ s}$ (time for light to travel 0.3 m)

1.4 Unit Consistency and Conversions

An equation must be **dimensionally consistent**. Terms to be added or equated must **always** have the same units.

(Be sure you're adding "apples to apples.")

يجب أن تكون المعادلة متسقة الأبعاد. يجب أن يكون للمصطلحات التي سيتم إضافتها أو معادلتها دائماً نفس الوحدات. (تأكد من إضافة "التفاح إلى التفاح.")

Always carry units through calculations.

احمل الوحدات دائماً من خلال الحسابات.

Convert to standard units as necessary, by forming a ratio of the same physical quantity in two different units, and using it as a multiplier.

حول إلى وحدات قياسية حسب الضرورة، عن طريق تشكيل نسبة من نفس الكمية الفيزيائية في وحدتين مختلفتين، واستخدامه كمضاعف.

For example, to find the number of seconds in 3 min, we write:

$$3 \text{ min} = (3 \text{ min}) \left(\frac{60 \text{ s}}{1 \text{ min}} \right) = 180 \text{ s}$$

Question 1

The world land speed record is 1,227.99 km/h. Express this speed in meters per second (m/s).

Solution

Use the conversion factors:

$$1 \text{ km} = 1000 \text{ m}$$

$$1 \text{ h} = 3600 \text{ s}$$

Therefore,

$$1,227.99 \text{ km/h} \times 1000 \text{ m/1 km} \times 1 \text{ h/3600 s} = 1,227,990 \text{ m/3600 s} = 341.11 \text{ m/s}$$

Question 2

A diamond has a volume of 1.84 in³. Determine its volume in:

1. Cubic centimeters (cm³)
2. Cubic meters (m³)

Solution: Since 1 in = 2.54 cm, the cubic conversion is $1 \text{ in}^3 = (2.54)^3 \text{ cm}^3 = 16.387 \text{ cm}^3$. Thus, $1.84 \text{ in}^3 \times (2.54 \text{ cm} / 1 \text{ in})^3 = 30.15 \text{ cm}^3$.

To convert cubic centimeters to cubic meters: 1 cm = 10⁻² m, so $1 \text{ cm}^3 = (10^{-2})^3 \text{ m}^3 = 10^{-6} \text{ m}^3$. Therefore, $30.15 \text{ cm}^3 \times (10^{-2} \text{ m} / 1 \text{ cm})^3 = 3.015 \times 10^{-5} \text{ m}^3$.

1.5 Uncertainty and Significant figures

The uncertainty of a measured quantity is indicated by its number of **significant figures**.

يشار إلى عدم اليقين في الكمية المقاسة من خلال عدد الأرقام الهامة.

For multiplication and division, the answer can have no more significant figures than the **smallest** number of significant in the factors.

بالنسبة للضرب والقسمة, لا يمكن أن يكون للإجابة أرقام أكثر أهمية من أصغر عدد مهم في العوامل.

For addition and subtraction, the number of significant figures is determined by the term having the fewest digits to the right of the decimal point.

بالنسبة للجمع والطرح, يتم تحديد عدد الأرقام الهامة من خلال المصطلح الذي يحتوي على أقل عدد من الأرقام على يمين النقطة العشرية.

As this train mishap illustrates, even a small percent error can have spectacular results!

كما يوضح حادث القطار هذا, حتى خطأ نسبة مئوية صغيرة يمكن أن يكون له نتائج مذهلة!



What do significant figures indicate about a measured quantity?

- A. Its exact value
- B. Its uncertainty**
- C. Its unit
- D. Its conversion factor

Which rule is used when multiplying or dividing measured quantities?

- A. Use the fewest decimal places.
- B. Use the greatest number of significant figures.
- C. Use the smallest number of significant figures.**
- D. Always use three significant figures.

Which rule is used when adding or subtracting measured quantities?

- A. Use the smallest number of significant figures.
- B. Use the fewest digits to the right of the decimal point.**
- C. Use the greatest number of decimal places.
- D. Always round to one significant figure.

Calculate $12.5 \div 2.5$ using the correct number of significant figures.

- A. 5.00
- B. 5.0
- C. 5
- D. 5.00

Solution: Step 1: Divide the numbers $12.5 \div 2.5 = 5$ Step 2: Count significant figures
 • 12.5 has 3 significant figures. • 2.5 has 2 significant figures. **For multiplication and division, the answer must have the same number of significant figures as the factor with the fewest significant figures.** The smallest number is 2 significant figures. So we write: $5 = 5.0$ because 5.0 has 2 significant figures.

Calculate $12.35 + 4.2$ using the correct number of significant figures.

- A. 16.55
- B. 16.6
- C. 16.5
- D. 17

Solution: Step 1: Add the numbers $12.35 + 4.2 = 16.55$ Step 2: Look at the decimal places 12.35 has 2 digits to the right of the decimal point. 4.2 has 1 digit to the right of the decimal point. **For addition and subtraction, the answer must have the same number of decimal places as the number with the fewest decimal places.** The fewest is 1 decimal place. Therefore, round 16.55 to 1 decimal place:

$$16.55 \rightarrow 16.6$$

1.7 Vectors and Scalars

A **scalar quantity** can be described by a **single number**.

يمكن وصف الكمية العددية برقم واحد.

A **vector quantity** has both a **magnitude** and a **direction** in space.

الكمية المتجهة لها حجم واتجاه في الفضاء.

In this book, a vector quantity is represented in boldface italic type with an arrow over it: $\vec{A}$

في هذا الكتاب، يتم تمثيل كمية المتجهات في نوع مائل غامق مع سهم فوقها: $\vec{A}$

The magnitude of $\vec{A}$ is written as A or $|\vec{A}|$

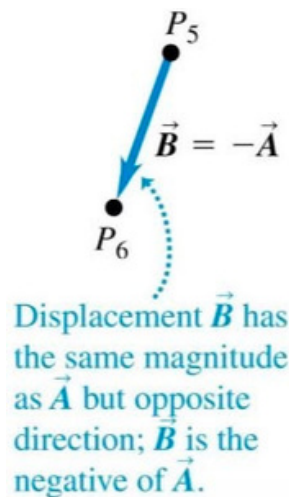
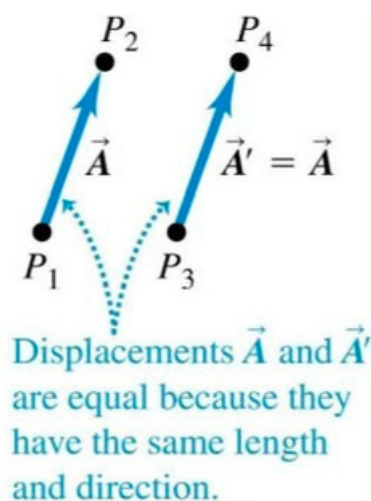
الحجم A مكتوب على أنه A أو A

Drawing Vectors

Draw a vector as a line with an arrowhead at its tip.

The **length** of the line shows the Vector's **magnitude**.

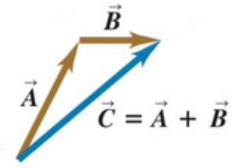
The **direction** of the line shows the vector's **direction**.



Adding Two Vectors Graphically (1 of 3)

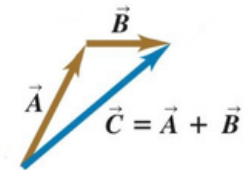
(a) We can add two vectors by placing them head to tail.

يمكننا جمع متجهين بوضعهما من الرأس إلى الذيل



(b) Adding them in reverse order gives the same result: $\vec{A} + \vec{B} = \vec{B} + \vec{A}$. The order doesn't matter in vector addition.

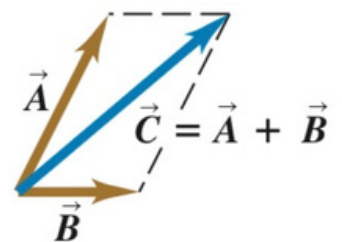
جمعها بترتيب عكسي يعطي نفس النتيجة
 $\vec{A} + \vec{B} = \vec{B} + \vec{A}$. الترتيب لا يهم في جمع المتجهات



Adding Two Vectors Graphically (2 of 3)

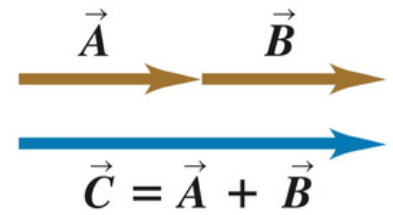
(c) We can also add two vectors by placing them tail to tail and constructing a parallelogram.

يمكننا ايضا جمع متجهين بوضعهما بحيث يكون من الذيل إلى الذيل وإنشاء متوازي اضلاع



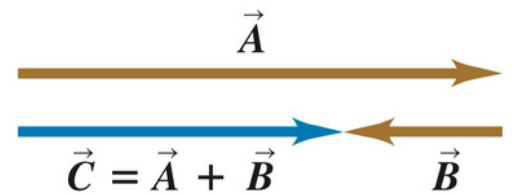
Adding Two Vectors Graphically (3 of 3)

(a) only when vectors $\vec{A}$ and $\vec{B}$ are parallel does the magnitude of their vectors sum $\vec{C}$ equal the sum of their magnitude: $C = A + B$
 فقط عندما يكون المتجهان $\vec{A}$ و $\vec{B}$ متوازيين يكون مجموع مقدار متجهيهما مساويًا لمجموع مقدارهما: $C = A + B$



(b) when $\vec{A}$ and $\vec{B}$ are antiparallel, the magnitude of their vectors sum $\vec{C}$ equal the difference of their magnitude: $C = |A - B|$

عندما يكون $\vec{A}$ و $\vec{B}$ متعاكسين ، فإن مجموع مقدار متجهيهما يساوي الفرق في مقدارهما: $C = A - B$

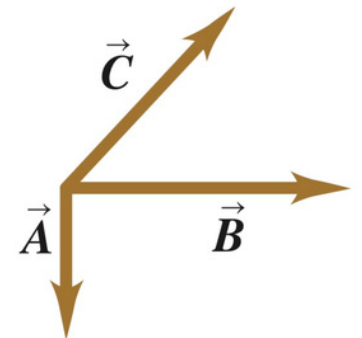


Adding More Than Two Vectors Graphically (1 of 3)

To add several vectors, use the head-to tail method.

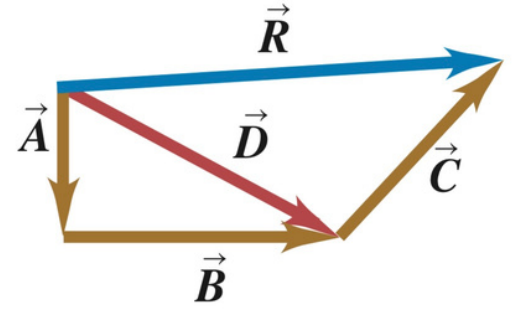
The vectors can be added in any order.

(a) To find the sum of these three vectors
 لإيجاد مجموع هذه المتجهات الثلاثة



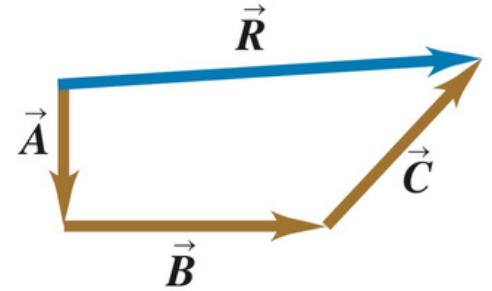
(b) add $\vec{A}$ and $\vec{B}$ to get $\vec{D}$ and then add $\vec{C}$ to $\vec{D}$ to get the final sum (resultant) $\vec{R}$

اجمع $\vec{A}$ و $\vec{B}$ للحصول على $\vec{D}$ ثم اجمع $\vec{C}$ إلى $\vec{D}$ للحصول على المجموع النهائي (المحصل) $\vec{R}$



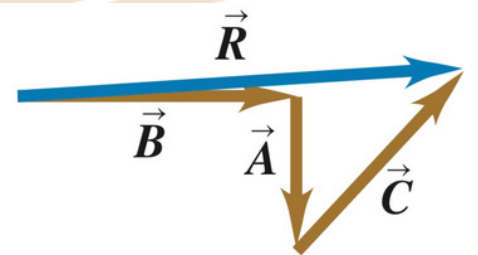
(c) or add $\vec{A}$, $\vec{B}$, and $\vec{C}$ to get $\vec{R}$ directly.

او اجمع $\vec{A}$, $\vec{B}$ و $\vec{C}$ للحصول على $\vec{R}$ مباشرة



(d) or add $\vec{A}$, $\vec{B}$, and $\vec{C}$ in any other order and still get $\vec{R}$.

او اجمع $\vec{A}$, $\vec{B}$ و $\vec{C}$ بأي ترتيب آخر وستظل تحصل على $\vec{R}$

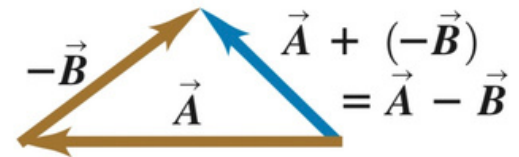


Subtracting Vectors

Subtracting $\vec{B}$ from $\vec{A}$ is equivalent to adding $-\vec{B}$ to $\vec{A}$.

$$\vec{A} - \vec{B} = \vec{A} + (-\vec{B})$$

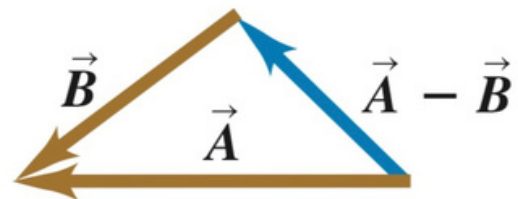
With $\vec{A}$ and $-\vec{B}$ head to tail, $\vec{A} - \vec{B}$ is the vector from the tail of $\vec{A}$ to the head of $-\vec{B}$.



$$\vec{A} + (-\vec{B}) = \vec{A} - \vec{B}$$

مع وجود $\vec{A}$ و $\vec{B}$ وجهها لوجه مع الذيل، فإن $\vec{A} - \vec{B}$ هو المتجه من ذيل $\vec{A}$ إلى رأس $\vec{B}$.

With $\vec{A}$ and $\vec{B}$ head to head, $\vec{A} - \vec{B}$ is the vector from the tail of $\vec{A}$ to the tail of $\vec{B}$.



$$\vec{A} - \vec{B}$$

مع وجود $\vec{A}$ و $\vec{B}$ وجهها لوجه، $\vec{A} - \vec{B}$ هو المتجه من ذيل $\vec{A}$ إلى ذيل $\vec{B}$.

Multiplying a Vector by a Scalar

If c is a scalar, the product $c\vec{A}$ has magnitude $|c| A$.

إذا كان c عدديا، فإن المنتج $c\vec{A}$ له حجم

The figure illustrates multiplication of a vector by

a) a positive scalar.

b) a negative scalar.

يوضح الشكل ضرب المتجه بواسطة عدد إيجابي
و عدد سلمي.

(a) Multiplying a Vector by a positive scalar changes the magnitude (length) of the vector but not its direction.

ضرب المتجه في عددي موجب يغير حجم
(طول) المتجه ولكن ليس اتجاهه.



(b) Multiplying a Vector by a negative scalar changes its magnitude and reverses its direction.

ضرب المتجه في عددي سلمي يغير
حجمه ويعكس اتجاهه



$-3A$ is three times as long as A and points in the opposite direction.

$-3A$ أطول بثلاث مرات من A ويشير
في الاتجاه المعاكس.

Addition of Two Vectors at Right Angles



To add two vectors that are at right angles, first add the vectors graphically.

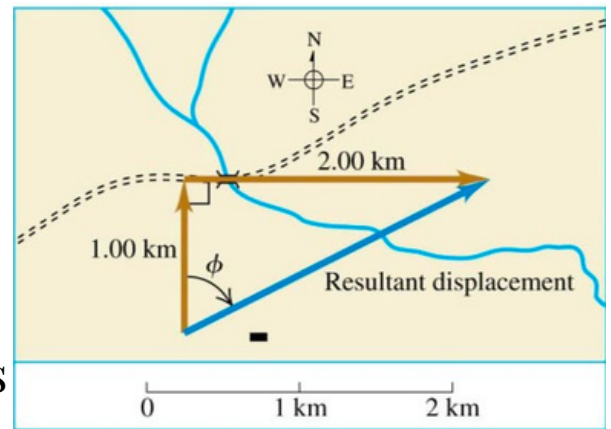
إضافة متجهين في زوايا قائمة، أضف أولاً المتجهات بيانياً.

Then use trigonometry to find the magnitude and direction of the sum.

ثم استخدم علم المثلثات للعثور على حجم واتجاه المجموع.

In the figure, cross-country skier ends up 2.24 km from her starting point, in a direction of 63.4 degrees east of north.

في الشكل، ينتهي الأمر بالمتزلج عبر البلاد على بعد 2.24 كم من نقطة انطلاقها، في اتجاه 63.4 درجة من الشمال.



Question 5

A cross-country skier travels **1.00 km north** and then **2.00 km east** across a horizontal snowfield (Refer to **previous slide** image). How far is she from her starting point, and in what direction?

Solution:

Step 1: Find the displacement Using the Pythagorean theorem: $d = \sqrt{(1.00 \text{ km})^2 + (2.00 \text{ km})^2}$ $d = \sqrt{1.00 + 4.00}$ $d = \sqrt{5.00}$ $d = 2.24 \text{ km}$

Step 2: Find the direction

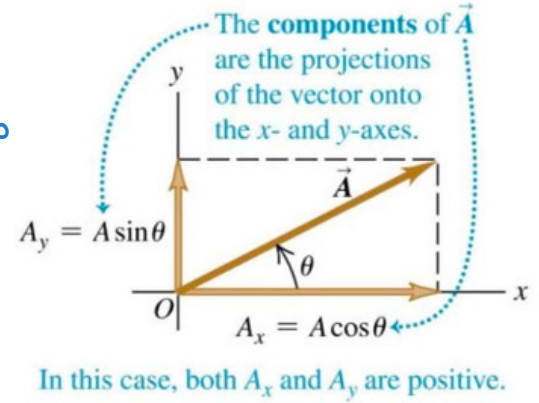
Measure the angle east of north: $\tan \theta = \text{east/north}$ $\tan \theta = 2.00/1.00 = 2.00$ $\theta = \tan^{-1}(2.00)$ $\theta = 63.4^\circ$

1.88 Components of a Vector

Adding vectors graphically provide limited accuracy. Vectors components provide a general method for adding vectors.

توفر إضافة المتجهات بياناً دقة محدودة. توفر مكونات المتجهات طريقة عامة لإضافة المتجهات. Any vector can be represented by an x-component A_x and a y-component A_y .

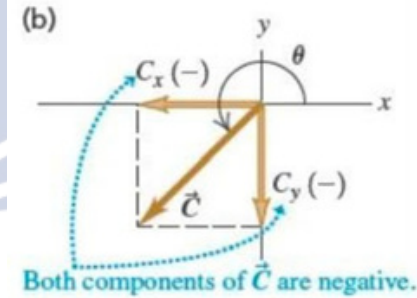
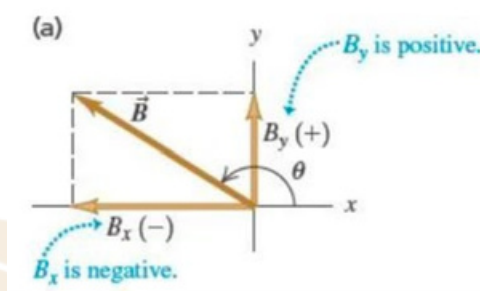
يمكن تمثيل أي متجه بواسطة A_x component-x و A_y component-y



Positive and Negative Components

The components of a vector may be positive or negative numbers, as shown in the figures.

قد تكون مكونات المتجه أرقاماً موجبة أو سالبة، كما هو موضح في الأرقام.



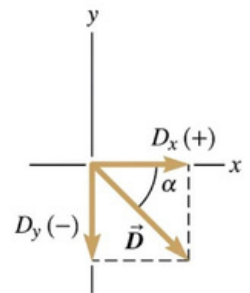
Finding Components

We can calculate the components of a vector from its magnitude and direction.

يمكننا حساب مكونات المتجه من حجمه واتجاهه.

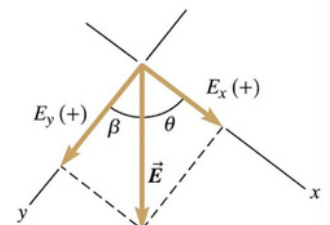
(a) Angle α is measured in the wrong sense from the +x-axis, so in Eqs. (1.5) we must use $-\alpha$

تقاس الزاوية ألفا بالمعنى الخاطئ من المحور +x، لذلك في Eqs (1.5) يجب أن نستخدم $-\alpha$



(b) Angle β is measured from the +y-axis, not from the +x-axis.

تقاس Angle بيتا من المحور +y، وليس من المحور +x



Question 6

For each vector below, determine its **x- and y-components**.

- (a) Vector D has a magnitude of 3.00 m and makes an angle of $\alpha = 45.0^\circ$.
 (b) Vector E has a magnitude of 4.50 m and makes an angle of $\beta = 37.0^\circ$.

Use the diagrams provided, **in previous slide**, to determine the appropriate signs of the x- and y-components.

Solution:

$$D_x = (3.00) \cos 45^\circ = +2.12 \text{ m}$$

$$D_y = -(3.00) \sin 45^\circ = -2.12 \text{ m}$$

$$E_x = (4.50) \sin 37^\circ = +2.71 \text{ m}$$

$$E_y = (4.50) \cos 37^\circ = +3.59 \text{ m}$$

Calculations Using Components

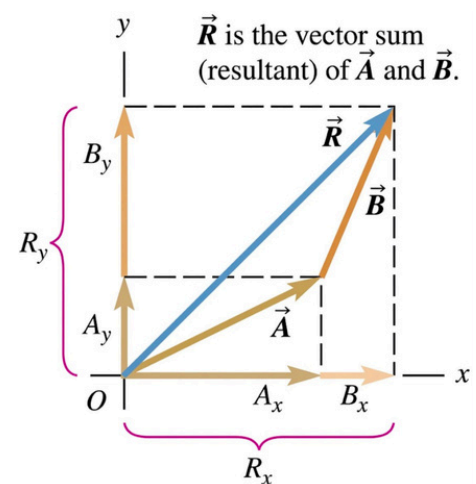
We can use the components of a vector to find its magnitude and direction: $A = \sqrt{A_x^2 + A_y^2}$ and $\tan \theta = \frac{A_y}{A_x}$

يمكننا استخدام مكونات المتجه للعثور على حجمه واتجاهه باستخدام المعادلة

We can use the components of a set of vector to find the components of their sum :

$$R_x = A_x + B_x + C_x + \dots, R_y = A_y + B_y + C_y + \dots$$

يمكننا استخدام مكونات مجموعة من المتجهات للعثور على مكونات مجموعها



The components of $\vec{R}$ are the sums of the components of $\vec{A}$ and $\vec{B}$:

$$R_y = A_y + B_y \quad R_x = A_x + B_x$$

Three hikers are searching for a hidden treasure in the center of a large, flat field. Each hiker is given a compass, a measuring tape, and a calculator. They are told that the treasure can be found by following these three displacements, in any order:

- 72.4 m, 32.0° east of north
- 57.3 m, 36.0° south of west
- 17.8 m due south

One hiker decides to calculate the **resultant displacement** before starting to walk. What displacement should she follow to reach the treasure directly?

Solution: Draw the vectors and find their components

$$A_x = 72.4 \sin 32.0^\circ = 38.42 \text{ m}$$

$$A_y = 72.4 \cos 32.0^\circ = 61.36 \text{ m}$$

$$B_x = -57.3 \cos 36.0^\circ = -46.36 \text{ m}$$

$$B_y = -57.3 \sin 36.0^\circ = -33.68 \text{ m}$$

$$C_x = 0$$

$$C_y = -17.8 \text{ m}$$

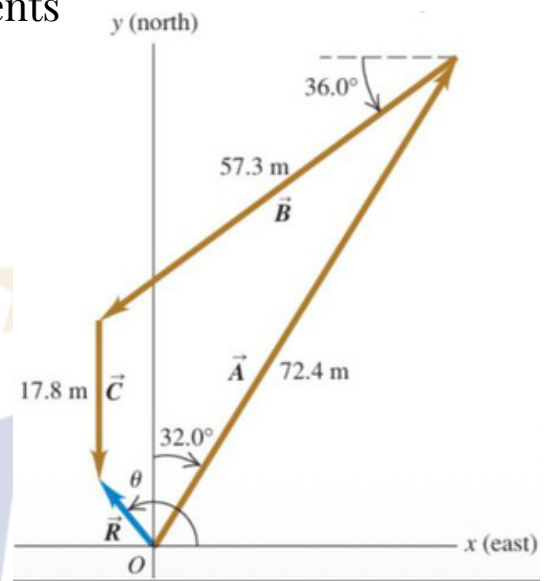
$$R_x = 38.42 - 46.36 = -7.94 \text{ m}$$

$$R_y = 61.36 - 33.68 - 17.8 = 9.88 \text{ m}$$

$$R = \sqrt{((-7.94)^2 + (9.88)^2)} = 12.68 \text{ m}$$

$$\theta = \tan^{-1}(7.94 / 9.88) = 38.8^\circ$$

$$R = 12.7 \text{ m west of north at } 38.8^\circ$$



1.9 Unit Vectors

A **unit vector** has a magnitude of 1 with no units.

متجه الوحدة مقداره يساوي 1 ولا يحمل أي وحدة قياس.

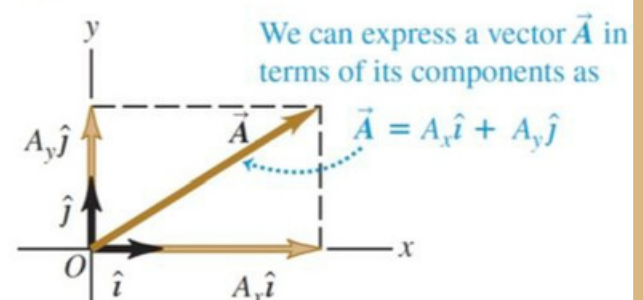
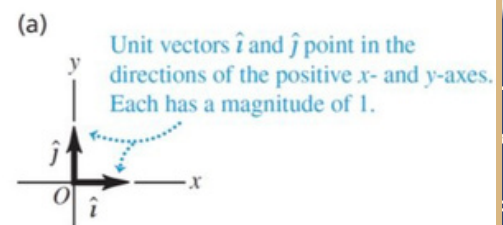
The unit vector $\hat{i}$ points in the +x-direction, $\hat{j}$ points in the +y-direction, and $\hat{k}$ points in the +z-direction.

يشير متجه الوحدة $\hat{i}$ إلى الاتجاه الموجب لمحور x، ويشير $\hat{j}$ إلى الاتجاه الموجب لمحور y، ويشير $\hat{k}$ إلى الاتجاه الموجب لمحور z.

Any vector can be expressed in terms of its components as

يمكن التعبير عن أي متجه بدلالة مركباته كما يلي

$$\vec{A} = A_x \hat{i} + A_y \hat{j} + A_z \hat{k}$$



Question 8

Given the two displacement vectors:

$$\mathbf{D} = (5.00\mathbf{i} + 2.00\mathbf{j} - 3.00\mathbf{k}) \text{ m}$$

$$\mathbf{E} = (2.00\mathbf{i} - 4.00\mathbf{j} + 6.00\mathbf{k}) \text{ m}$$

Find the magnitude of the displacement vector $\mathbf{D} - 3\mathbf{E}$.

Solution:

Step 1: Find $3\mathbf{E}$

$$3\mathbf{E} = 3(2\mathbf{i} - 4\mathbf{j} + 6\mathbf{k})$$

$$3\mathbf{E} = 6\mathbf{i} - 12\mathbf{j} + 18\mathbf{k}$$

Step 2: Find $\mathbf{D} - 3\mathbf{E}$

$$\mathbf{D} - 3\mathbf{E} = (5\mathbf{i} + 2\mathbf{j} - 3\mathbf{k}) - (6\mathbf{i} - 12\mathbf{j} + 18\mathbf{k})$$

$$\mathbf{D} - 3\mathbf{E} = -\mathbf{i} + 14\mathbf{j} - 21\mathbf{k}$$

Step 3: Find the magnitude

$$|\mathbf{D} - 3\mathbf{E}| = \sqrt{(-1)^2 + (14)^2 + (-21)^2}$$

$$= \sqrt{1 + 196 + 441}$$

$$= \sqrt{638}$$

$$|\mathbf{D} - 3\mathbf{E}| \approx 25.26 \text{ m}$$

(a) The Scalar Product (1 of 2)

Scalar (dot) product of vectors $\vec{A}$ and $\vec{B}$

$$\vec{A} \cdot \vec{B} = AB \cos \phi = |\vec{A}| |\vec{B}| \cos \phi$$

Magnitudes of $\vec{A}$ and $\vec{B}$

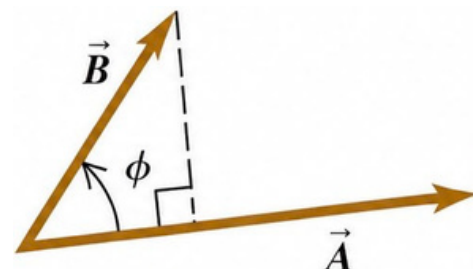
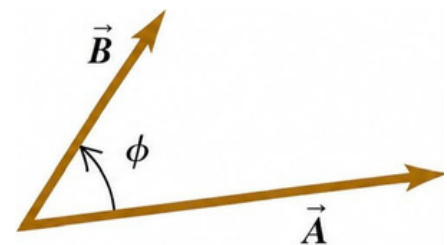
Angle between $\vec{A}$ and $\vec{B}$ when placed tail to tail

(a) Place the vectors tail to tail.

ضع المتجهين بحيث يلتقي ذيل كل منهما مع الآخر.

(b) $\mathbf{A} \cdot \mathbf{B}$ equals $A(B \cos \phi)$.

(Magnitude of $\vec{A}$) $\times$ (Component of $\mathbf{B}$ in direction of $\mathbf{A}$)



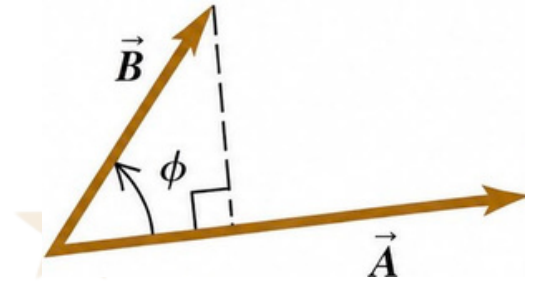
The Scalar product (2 of 2)

The scalar product can be positive, negative, or zero, depending on the angle between A and B.

يمكن أن يكون الضرب القياسي موجبًا أو سالبًا أو صفرًا، وذلك حسب الزاوية بين المتجهين A و B.

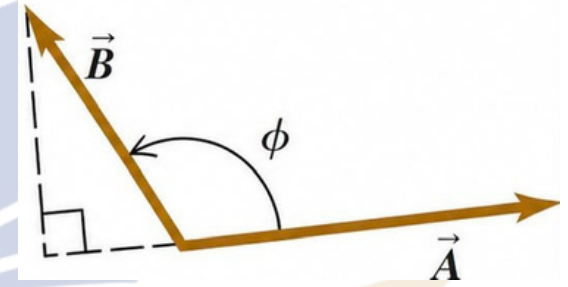
(a) If ϕ is between 0° and 90° , $A \cdot B$ is positive because $B \cos \phi > 0$.

إذا كانت الزاوية ϕ بين 0° و 90° فإن الضرب القياسي $A \cdot B$ يكون موجبًا.



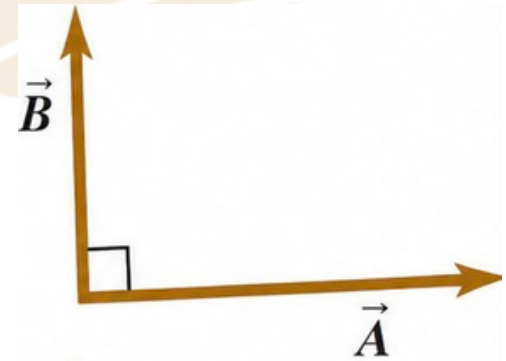
(b) If ϕ is between 90° and 180° , $A \cdot B$ is negative because $B \cos \phi < 0$.

إذا كانت الزاوية ϕ بين 90° و 180° فإن الضرب القياسي $A \cdot B$ يكون سالبًا.



(c) if $\phi = 90^\circ$, $A \cdot B = 0$ because B has zero component in the direction of A.

إذا كانت الزاوية $\phi = 90^\circ$ فإن $A \cdot B = 0$ لأن المتجه B ليس له أي مركبة في اتجاه المتجه A.



Question 9

Two vectors **A** and **B** are shown.

The magnitude of vector **A** is **4.00** and vector **B** is **5.00**.

Find the scalar product (dot product) of the two vectors, $A \cdot B$.

Solution:

The angle between the two vectors is:

$$\varphi = 130.0^\circ - 53.0^\circ = 77.0^\circ$$

The scalar product is given by:

$$A \cdot B = |A||B| \cos \varphi$$

Substitute the values:

$$A \cdot B = (4.00)(5.00) \cos(77.0^\circ)$$

$$A \cdot B = 20.00 \times 0.225$$

$$A \cdot B = 4.50$$

Calculating a Scalar Product Using Components

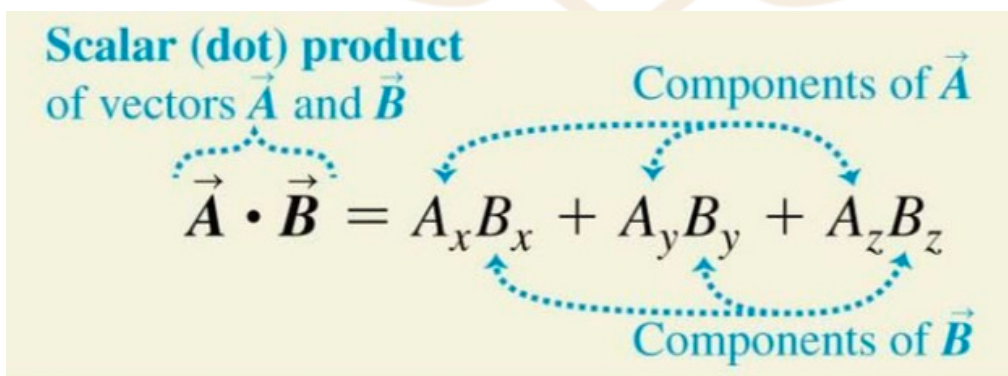
In terms of components:

Scalar (dot) product of vectors $\vec{A}$ and $\vec{B}$

Components of $\vec{A}$

$$\vec{A} \cdot \vec{B} = A_x B_x + A_y B_y + A_z B_z$$

Components of $\vec{B}$



The scalar product of two vectors is the sum of the products of their respective components.

الناتج العددي لمتجهين هو مجموع منتجات مكونات كل منهما.

Question 10

Find the angle between the vectors

$$A = 2.00\mathbf{i} + 3.00\mathbf{j} + 1.00\mathbf{k} \quad \text{and}$$

$$B = -4.00\mathbf{i} + 2.00\mathbf{j} - 1.00\mathbf{k}$$

Solution:

Use the formula:

$$\cos \theta = (A \cdot B) / (|A||B|)$$

1. Dot product: $A \cdot B = (2)(-4) + (3)(2) + (1)(-1) = -8 + 6 - 1 = -3$

2. Magnitudes: $|A| = \sqrt{2^2 + 3^2 + 1^2} = \sqrt{14}$

$$|B| = \sqrt{(-4)^2 + 2^2 + (-1)^2} = \sqrt{21}$$

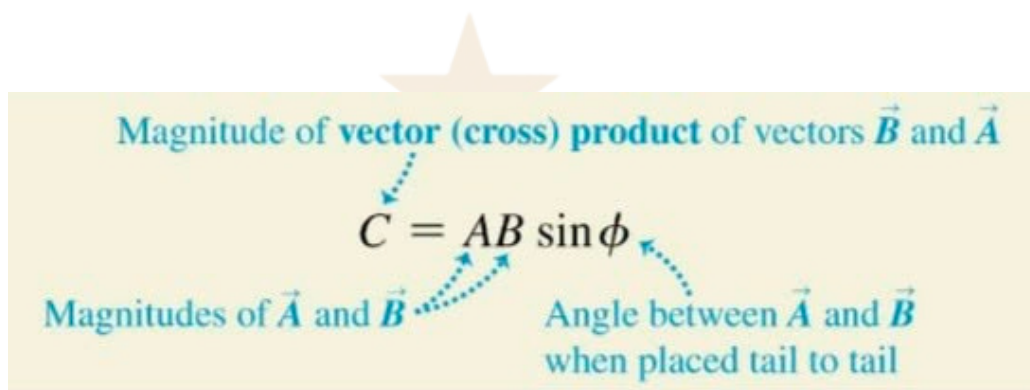
3. Find angle: $\cos \theta = -3 / (\sqrt{14} \times \sqrt{21})$

$$\theta \approx 100^\circ$$

The Vector Product

If the vector product (“cross product”) of two vectors is $\mathbf{C} = \mathbf{A} \times \mathbf{B}$ then:

إذا كان الضرب الاتجاهي (أو الضرب المتجهي) بين متجهين هو:



Magnitude of vector (cross) product of vectors $\vec{B}$ and $\vec{A}$

$$C = AB \sin \phi$$

Magnitudes of $\vec{A}$ and $\vec{B}$

Angle between $\vec{A}$ and $\vec{B}$ when placed tail to tail

The direction of the vector product can be found using the right-hand rule:

ويتم تحديد اتجاه المتجه الناتج باستخدام قاعدة اليد اليمنى

1. Place $\vec{A}$ and $\vec{B}$ tail to tail.
ضع المتجهين $\vec{A}$ و $\vec{B}$ بحيث تكون نقطة بداية كل منهما عند نفس النقطة

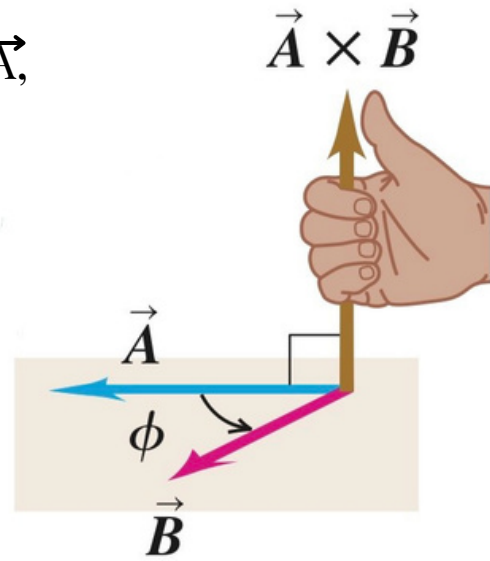
2. Point fingers of right hand along $\vec{A}$,
with palm facing $\vec{B}$.

وجه أصابع يدك اليمنى في اتجاه $\vec{A}$ بحيث تكون راحة اليد مواجهة للمتجه $\vec{B}$

3. Curl fingers toward $\vec{B}$.
اثني أصابعك باتجاه $\vec{B}$

4. Thumb points in direction of $\vec{A} \times \vec{B}$.

يشير الإبهام إلى اتجاه حاصل الضرب $\vec{A} \times \vec{B}$ الاتجاهي



The Vector Product is Anticommutative

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

1. Place $\vec{B}$ and $\vec{A}$ tail to tail.

ضع المتجهين $\vec{B}$ و $\vec{A}$ بحيث تكون نقطة بداية كل منهما عند نفس النقطة

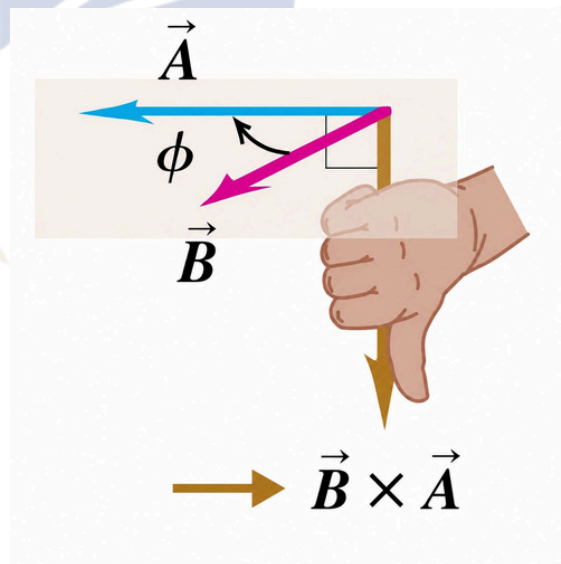
2. Point fingers of right hand along $\vec{B}$, with palm facing $\vec{A}$.

وجه أصابع يدك اليمنى في اتجاه $\vec{B}$ بحيث تكون راحة اليد مواجهة للمتجه $\vec{A}$

3. Curl fingers toward $\vec{A}$.
اثني أصابعك باتجاه $\vec{A}$

4. Thumb points in direction of $\vec{B} \times \vec{A}$.

يشير الإبهام إلى اتجاه $\vec{B} \times \vec{A}$

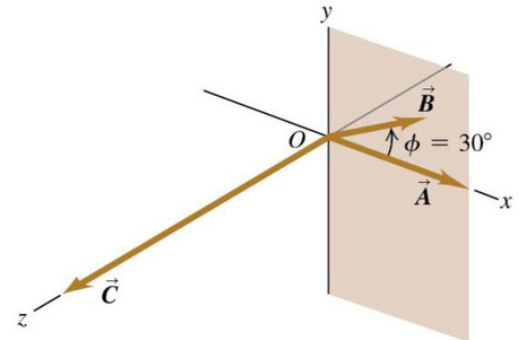


5. $\vec{B} \times \vec{A}$ has same magnitude as $\vec{A} \times \vec{B}$ but points in opposite direction.

Calculating the Vector Product

Use $AB \sin \phi$ to find the magnitude and the right-hand rule to find the direction

استخدم $AB \sin$ للعثور على الحجم والقاعدة اليمنى للعثور على الاتجاه



Question 11

Vector A has a magnitude of 6 units and points along the +x-axis. Vector B has a magnitude of 4 units and lies in the xy-plane, making an angle of 30° with the +x-axis.

Solution:

$$\vec{A} = (6, 0, 0)$$

$$\vec{B} = (2\sqrt{3}, 2, 0)$$

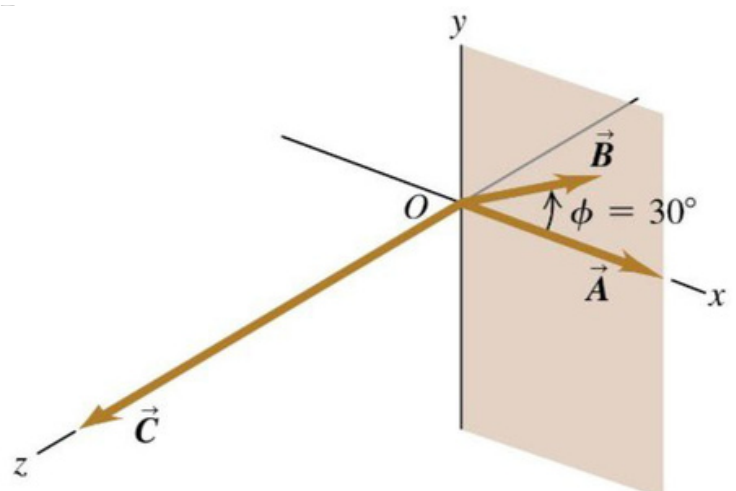
$$C_x = A_y \times B_z - A_z \times B_y = 0$$

$$C_y = A_z \times B_x - A_x \times B_z = 0$$

$$C_z = A_x \times B_y - A_y \times B_x = 12$$

$$\vec{C} = (C_x, C_y, C_z) = (0, 0, 12)$$

$$\vec{C} = 12\hat{k}$$





ARMS
ACADEMY

GENERAL PHYSICS 1

Chapter 1



استثمر في تعليمك اليوم ، لتحصد
ثمار ذلك غداً



Our Groups



قناة الاكاديمية



Telegram