University of Anbar

College of Science

Department of Applied Geology

First Year

General Physics

جامعة الانبار

كلية العلوم

قسم علوم الجيولجيا التطبيقية

المرحلة الاولى

الفيزياء العامة

Chapter One

Vectors

الفصل الاول المتجهات

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Physics and Measurments

علم الفيزياء هو علم تجريبي يهتم بكشف أسرار الطبيعة عن الكون والقوانين التي تحكمه ويتم التوصل اليها عن طريق القياسات والملاحظات لدى ظاهرة طبيعية

فعلم الفيزياء هو علم القياس — Science of Measurments

[عندما تستطيع قياس ما تتكلم عنه وتعبر عنه بالارقام فانك اذا تعرف شيئاً عنه، ولكن عندما لا تستطيع التعبير عنه بالارقام فان معرفتك غير كافية وتعتبر البداية]

العالم الشهير: كلفن

1.2 Physical Quantity

لتعريف الكمية الفيزيائية فانه يجب اولاً ان نعرف طريقة قياس هذه الكمية او طريقة حسابها رياضياً من كميات أخرى

فعلى سبيل المثال يمكن تعريف المسافة والزمن بواسطة وصف الطريقة لقياس كلاً منهما وبالتالي بالامكان تعريف سرعة جسم متحرك بواسطة خارج قسمة المسافة على الزمن

$$v = \frac{x}{t}$$

- v: Velocity سرعة الجسم (m/s , Km/h ...)
- x: distance المسافة (m , Km , cm) ...
- t: Time الزمن (s, h, m) [دقيقة، ساعة، ثانية] ...

في هذه الحالة فان كلاً من المسافة والزمن هما كميتان فيزيائيتان أساسيتان x,t بينما السرعة v فهي كمية فيزيائية مشتقة

وهناك كميات أساسية ومنها بالامكان ايجاد الكميات الفيزيائية المشتقة فمثلاً في علم الميكانيك فان الكميات الاساسية التي تستخدم هي [الكتلة، الطول، الزمن]

1.3 Unit systems الانظمة الوحدات

Two systems of units are used 1) The metric system measure Length in meter ----
2) British system make use of the foot, inch ----

The metric system is the most widely used, it will be used in this Lectures

The metric system was formalized in 1971 into The international system of units (SI)

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2022

Find:-

$\vec{a} = 3i + 5j$ what is the magnitude and direction of vector sum?
$\vec{b} = 2i + 4j$

$r_x = a_x + b_x \implies r_x = 3 + 2 = 5$
$r_y = a_y + b_y \implies r_y = 2 + 4 = 6$

$\vec{r} = \sqrt{r_x^2 + r_y^2} = \sqrt{(5)^2 + (6)^2} = \sqrt{25+36}$
$= 7.8\ m$

$\theta = \tan^{-1}\frac{r_y}{r_x} = \tan^{-1}\frac{6}{5} = 16.1$

Find:- $\vec{a} = 3i + 5j$ $\vec{a} \times \vec{b} =$
$\vec{b} = 2i + 4j$ $\vec{a} \cdot \vec{b} =$

$a \cdot b = ab\cos\theta$
$a \times b = ab\sin\theta$

$|a| = \sqrt{a_x^2 + a_y^2}$ $|\vec{b}| = \sqrt{b_x^2 + b_y^2}$
$= \sqrt{(3)^2 + (5)^2}$ $|\vec{b}| = \sqrt{(2)^2 + (4)^2}$
$= 5.8$ $= 4.4$

$a \cdot b = (3i + 5j) \cdot (2i + 4j)$ $\begin{vmatrix} 3i & 5j \\ 2i & 4j \end{vmatrix}$
$= (3i \cdot 2i) + (3i \cdot 4j) + (5j \cdot 2i) + (5j \cdot 4j)$

$i \cdot i = 1$ $i \times i = 0$

$a \times b = ab\sin\theta$
$\sin\theta = \frac{a \times b}{|a||b|}$

$a \times b = (3i + 5j) \times (2i + 4$
$= 3i \times 2i + 3i \times 4j$
$+ 5j \times 2i + 5j \times 4j$
$= 12K - 10K = 2$

$\sin\theta = \frac{2}{25.52}$

EXAMPLE:

In this Figure show us the following three vectors:

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

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

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

And what is their vector sum $\vec{r}$ which is also shown?

We can add the three vectors by components, axis by axis, and then combine the components to write the vector sum.

Calculations: For the x axis, we add the x components of $\vec{a}$ and to get the x component of the vector sum $\vec{r}$

$+ \; - \; +$

$\hat{i} \quad \hat{k} \quad \hat{j}$

[illegible]

unit vector

$$r_x = a_x + b_x + c_x$$

$$= 4.2\text{m} - 1.6\text{m} + 0 = 2.6\text{m}$$

Similarly, for the y-axis $r_y = a_y + b_y + c_y$

$$= -1.5\text{m} + 2.9\text{m} - 3.7\text{m} = -2.3\text{m}$$

We then combine these components of $\vec{r}$ to write the vector in unit-vector notation:

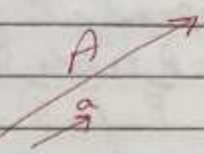
$$\vec{r} = (2.6m)\hat{i} - (2.3m)\hat{j}$$

Where (2.6 m) $\hat{i}$ is the vector component of along the x-axis and (2.3 m)$\hat{j}$ is th along the y axis. Figure (b) shows one way to arrange these vector components form $\vec{r}$.

تعريف Aunit Vector is a Vector that has amagnitude of exactly [1] in a particular direction

1.7 The unit Vector

A unit Vector is avector having a magnitude of unity and its used to describe adirection in space.



a المتجه Á يمكن تمثيله بمقدار المتجه A مضروب في متجه الوحدة a

$$\acute{A} = aA$$

كذلك يمكن تمثيل متجهات الوحدة (ijk) لمحاور الاحداثيات العمودية rectangular Coordinate system (x, y, z) in figure 1.4

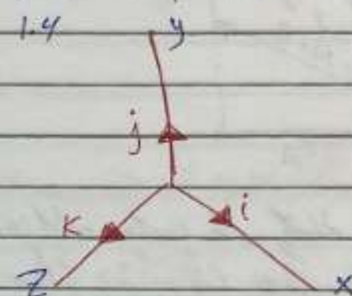


Figure 1.4

i = a unit vector along the X axis
j = aunit Vector along The Y axis
K = aunit vector along The Z axis

1.8 Components of avector

Any vector A Laying in xy plane Can be resloved into two Components one in the x direction and the other in the y direction as show in Figure 1.5

$$A_x = A\cos\theta$$
$$A_y = A\sin\theta$$

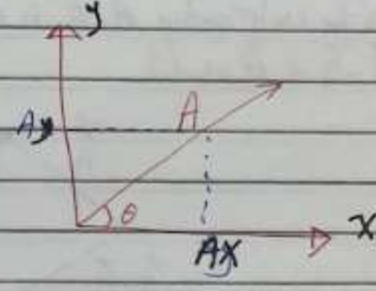


Figure 1-5

عند التعامل مع عدة متجهات فإننا نحتاج الى تحليل كل متجه الى مركبته بالنسبة الى محاور الاسناد (x,y) وهذا يبسط ايجاد المحصلة بدلاً من استخدام الطرق البيانية لايجاد المحصلة

The magnitude of the vector $\acute{A}$

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

Q 5

$\vec{A} = 2\hat{i} - 2\hat{j} + \hat{k}$
$\vec{B} = 12\hat{i} + 4\hat{j} - 3\hat{k}$ find The angle between The vectors

$\vec{a}\cdot\vec{b} = |\vec{a}||\vec{b}|\cos\theta$

$|\vec{a}| = \sqrt{a_x^2 + a_y^2 + a_z^2} = \sqrt{(2)^2 + (-2)^2 + (1)^2} = 2.45$

$|\vec{b}| = \sqrt{b_x^2 + b_y^2 + b_z^2} = \sqrt{(12)^2 + (4)^2 + (-3)^2} = 13$

$\vec{a}\cdot\vec{b} = (2\hat{i} - 2\hat{j} + \hat{k})\cdot(12\hat{j} + 4\hat{j} - 3\hat{k})$

$= (2\hat{i}\cdot 12\hat{i}) + 2\hat{i}\cdot 4\hat{j} + (2\hat{i}\cdot - 3\hat{k})$

$+ (-2\hat{j}\cdot 12\hat{j}) + (-2\hat{j}\cdot 4\hat{j}) + (-2\hat{j} \times -3\hat{k})$

$+ (\hat{k}\cdot 12\hat{j}) + (\hat{k}\cdot 4\hat{j}) + (\hat{k}\cdot -3\hat{k})$

$= 24(1) + 8 - 6(0) - 24(1) - 12(0) + 6(0) + 12(0) + 4(0) - 3(1)$

$= \cancel{24} + 8 \cancel{- 6} \cancel{- 24} \cancel{- 12} \cancel{+ 6} + 12 + 4 - 3 = +8 + 4 - 3$
$= 12 - 3 = 9$

$\vec{a}\cdot\vec{b} = 9$

$\hat{i}\cdot\hat{i} = 1$ $\quad \hat{i}\times\hat{i} = 0$
$\hat{j}\cdot\hat{j} = 1$ $\quad \hat{j}\times\hat{j} = 0$
$\hat{k}\cdot\hat{k} = 1$ $\quad \hat{k}\times\hat{k} = 0$

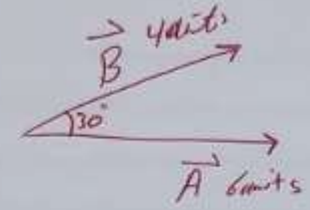
$\cos\theta = \dfrac{\vec{a}\cdot\vec{b}}{|\vec{a}||\vec{b}|}$

$\hat{j}$
$\hat{k} \circlearrowleft \hat{i}$

$\cos\theta = \dfrac{9}{2.45 \times 13} = \dfrac{9}{31.85}$

$\cos\theta = 0.28$
$\theta = \cos^{-1} 0.28 = 73.5$

Q1:-



ملاحظة مهمة :-
دائما تكون بينية θ
$\vec{A}$ داخلية $\vec{B}$

$$\vec{A} \times \vec{B} = |\vec{A}|\,|\vec{B}| \sin\theta$$

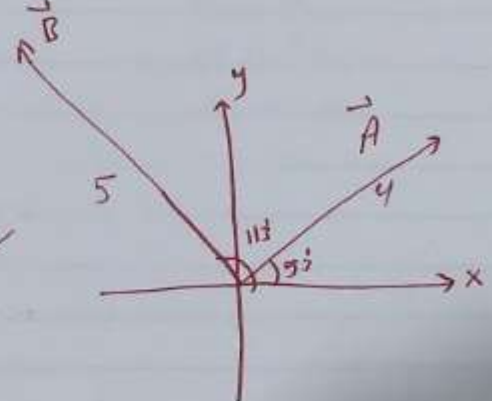
هذا الضرب الاتجاهي

$$= 6 \times 4 \times \sin 30$$

$$= 6 \times \cancel{4}^{2} \times \frac{1}{\cancel{2}}$$

$$= 12 \text{ units}$$

Q2:-



$$\vec{A} \cdot \vec{B} = |\vec{A}|\,|\vec{B}| \cos\theta$$

الضرب النقطي او القياسي

$$\theta = 113 - 53$$

$$= 60^\circ$$

$$\therefore \vec{A} \cdot \vec{B} = |4|\,|5| \cos 60$$

$$= 4 \times 5 \times \frac{1}{2}$$

$$= 10 \text{ units}$$

The direction of the vector to The X-axis

$$\theta = \tan^{-1} \frac{A_y}{A_x}$$

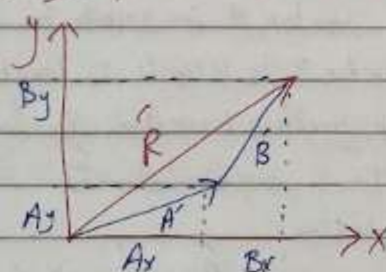
A vector $\vec{A}$ lying in the xy plane, having rectangular components A_x, A_y Can be expressed in a unit vector notation

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

ملاحظة: يمكننا استخدام طريقة تحليل المتجهات في جمع متجهين $\vec{A}$ ، $\vec{B}$ كما في الشكل التالي

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

$$\vec{B} = B_x i + B_y \hat{j}$$



$$\vec{R} = \vec{A} + \vec{B} = (A_x + B_x) i + (A_y + B_y) j$$

Example

Find the sum of Two vectors $\vec{A}$ and $\vec{B}$ giving By

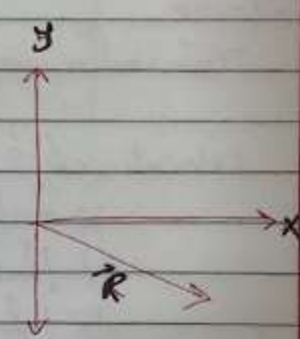
$$\vec{A} = 3i + 4j$$

and $\vec{B} = 2i - 5j$

Solution

Note that $A_x = 3$, $A_y = 4$

$B_x = 2$, $B_y = -5$



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

$$= (3+2)i + (4-5)j = 5i - j$$

The magnitude of vector $\vec{R}$ is

$$R = \sqrt{R_x^2 + R_y^2} = \sqrt{25+1} = \sqrt{26} = 5.1$$

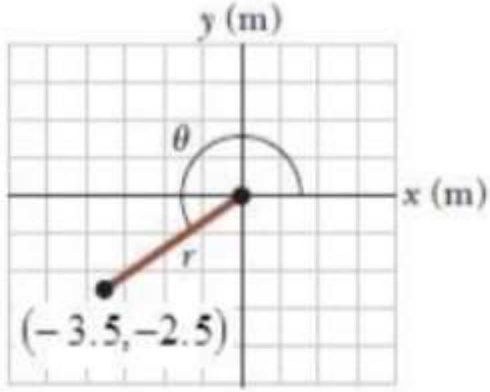
The direction of $\vec{R}$ with respect to X axis is

$$\theta = \tan^{-1} \frac{R_y}{R_x}$$

$$= \tan^{-1} \frac{-1}{5} = -11^\circ$$

اذا كانت المحاور الكارتيزية لنقطة تقع في المستوي (x, y) هي $(-3.5, -2.5)$ كما موضح في الشكل المجاور عين المحاور القطبية لهذه النقطة , علما ان $\tan 35.53^{\circ} = 0.714$.

الحل:



$$r = \sqrt{x^2 + y^2}$$
$$r = \sqrt{(-3.5)^2 + (-2.5)^2}$$
$$r = 4.3\ m$$

ولتعيين اتجاه المتجه $\vec{r}$ نستعمل العلاقة الاتية:

$$\tan\theta = \frac{y}{x} = \frac{-2.5m}{-3.5m} = 0.714$$

$$\tan 35.53^{\circ} = 0.714$$

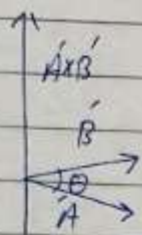
بما ان θ واقعة في الرابع الثالث , نلاحظ الشكل فان $\theta = 35.53 + 180 = 215.53^{\circ}$

اذن المحاور القطبية(r, θ) للنقطة $(-3.5, -2.5)$ تساوي $(4.3m, 215.53^{\circ})$.

1.8.2: The Vector product

الضرب الاتجاهي

يعرف الضرب الاتجاهي Vector product بـ Cross product وتكون نتيجة الضرب الاتجاهي لمتجهين كمية متجهة مثل هذا المتجه $\vec{C} = \vec{A}\times\vec{B}$ ويكون عمودي على كل من المتجهين $\vec{A}$، $\vec{B}$ واتجاهه دوران برغي من المتجه $\vec{A}$ الى المتجه $\vec{B}$ كما في الشكل التالي



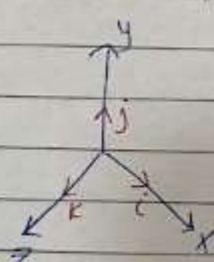
$$\vec{A}\times\vec{B} = AB\sin\theta$$

$$\vec{A}\times\vec{B} = (A_x i + A_y j + A_z k)\times(B_x i + B_y j + B_z k)$$

to evaluted this product we use the fact that angle between the unit vector i j k is 90°

مهمة

$i\times i = 0$	$i\times j = k$	$i\times k = -j$
$j\times j = 0$	$j\times k = i$	$j\times i = -k$
$k\times k = 0$	$k\times i = j$	$k\times j = -i$



$$\vec{A}\times\vec{B} = (A_yB_z - A_zB_y)i + (A_zB_x - A_xB_z)j + (A_xB_y - A_yB_x)k$$

حسب الـ matrix رياضيا

$$\begin{array}{ccc} i & j & k \end{array}$$
$$\begin{vmatrix} A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

$i(A_yB_z - A_zB_y) + j(A_zB_x - A_xB_z) + k(A_xB_y - A_yB_x)$

if $\vec{C} = \vec{A}\times\vec{B}$, the components of $\vec{C}$ are given by

$$C_x = A_yB_z - A_zB_y$$
$$C_y = A_zB_x - A_xB_z$$
$$C_z = A_xB_y - A_yB_x$$

$\vec{C}$ متجه ثالث جديد من الممكن ان يكون عمودي على المتجه $\vec{A}$ والمتجه $\vec{B}$

ضرب المصفوفات رياضيا

Solution

a) $\acute{A}+\acute{B} = (3i-2j)+(-i-4j) = 2i-6j$

b) $\acute{A}-\acute{B} = (3i-2j)-(-i-4j) = 4i+2j$

c) $|\check{A}+\check{B}| = \sqrt{2^2+(-6)^2} = 6.32$

d) $|\check{A}-\check{B}| = \sqrt{(4)^2+(2)^2} = 4.47$

e) for $\acute{A}+\acute{B}$, $\theta = \tan^{-1}\frac{-6}{2} = -71.6^\circ = 288^\circ$

For $\acute{A}-\acute{B}$, $\theta = \tan^{-1}\frac{2}{4} = 26.6^\circ$

Example:-

A vector $\vec{A}$ has a negative x component 3 units in length and positive y component 2 units in length a) Determine an expression for $\vec{A}$ in unit vector notation

b) Determine the magnitude and direction of $\acute{A}$

c) What vector $\acute{B}$ when added to $\acute{A}$ gives a resultant vector with no x components and negative y component 4 units in length ?

Solution:-

$A_x = -3$ units & $A_y = 2$ units

a) $\vec{A} = A_x i + A_y j = -3i+2j$ units

b) $|\check{A}| = \sqrt{A_x^2+A_y^2} = \sqrt{(-3)^2+(2)^2} = 3.61$ units

$\theta = \tan^{-1}\frac{2}{-3} = 33.7^\circ$ (relative to the x-axis)

c) $R_x = 0$, $R_y = -4$ Since $\acute{R} = \acute{A}+\acute{B}$

$\acute{B} = \acute{R}-\acute{A}$

$B_x = R_x - A_x = 0-(-3) = 3$

$B_y = R_y - A_y = -4-2 = -6$

There fore

$\vec{B} = B_x i + B_y j = (3i-6j)$ units

Example:

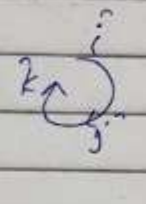
if $\vec{C} = \vec{A} \times \vec{B}$ where $\vec{A} = 3i - 4j$

$\vec{B} = -2i + 3k$

what is $\vec{C}$?

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

$= (3i - 4j) \times (-2i + 3k)$



which, by distributive law, becomes

$\vec{C} = -(3i \times 2i) + (3i \times 3k) + (4j \times 2i) - (4j \times 3k)$

$\vec{C} = \quad 0 \quad -9j \quad -8k \quad -12i$

تذكر
المحاضرة السابقة 3
P No (15)

$\vec{C} = 0 - 9j - 8k - 12i$

$= -12i - 9j - 8k$

The vector $\vec{C}$ is perpendicular to both vectors $\vec{A}$ and $\vec{B}$

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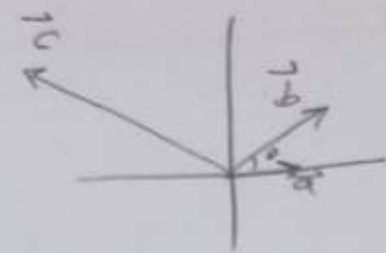
[redacted]

Q2/
3/

$\vec{a} = 3.7 i$

$\vec{b} = 1.6\hat{i} + 2.9\hat{j}$

$\vec{c} = -4.2\hat{i} + 1.5\hat{j}$



$r_x = a_x + b_x + c_x$

$= 3.7 + 1.6 + (-4.2)$

$= 3.7 + 1.6 - 4.2$

$= 1.1 m$

$r_y = a_y + b_y + c_y$

$= 0 + 2.9 + 1.5$

$= 4.4 m$

$\vec{r} = (1.1\hat{i} + 4.4\hat{j})m$

oR $(1.1m)\hat{i} + (4.4m)\hat{j}$

$\vec{r}$ magnitude is $r = \sqrt{(1.1m)^2 + (4.4m)^2}$

$= \sqrt{1.21 + 19.36}$

$= 4.5 m$

The direction is

$\theta = \tan^{-1}\frac{r_y}{r_x} = \frac{4.4}{1.21}$

We can also answer the question by giving the magnitude and an angle for $\vec{r}$

$r = \sqrt{r_x^2 + r_y^2}$

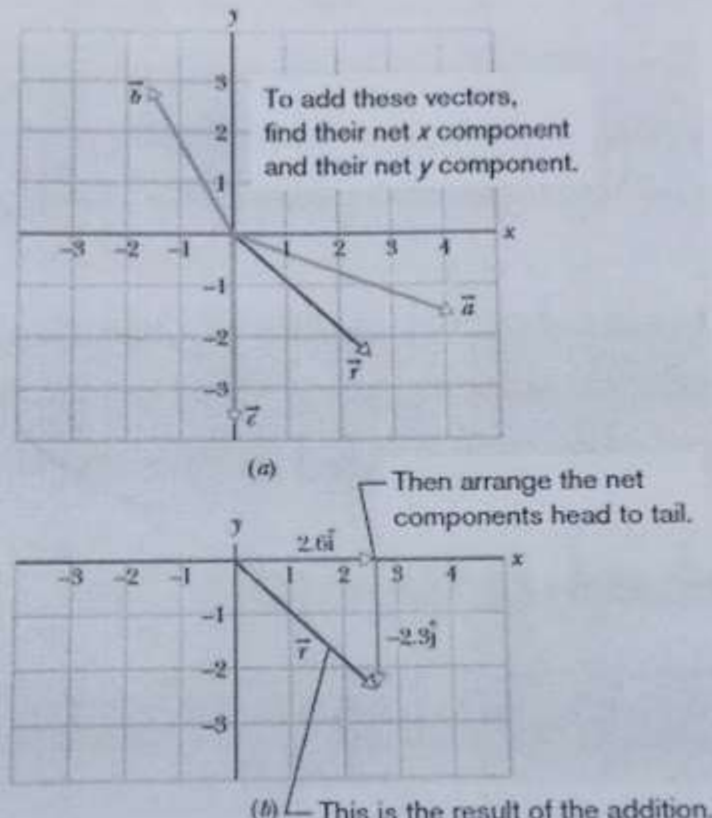
.From Eq[redacted], the magnitude is

حسب نظرية فيثاغورس

$$r = \sqrt{(2.6m)^2 + (-2.3m)^2} \approx 3.5\text{m}$$

and the angle (measured from the +x direction) is

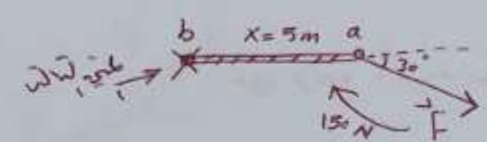
$\theta = \tan^{-1}\frac{-2.3m}{2.6m}$ = - 41° where the minus sign means clockwise.



2) There is a force $\vec{F}$ equal to 150N in the crowbar ab, at point a which is away from the Relation axis 5m, Note the figuer

** مقدار العزم لانه فيه تدوير

$X = 5m$
= الازاحة
وتمثل ذراع القوة / البعد العمودي
بين خط عمل القوة ومحور الدوران



$$|\vec{F} \times \vec{x}| = |\vec{F}||\vec{x}| \sin\theta$$
$$= 150 \times 5 \times \sin 30$$
$$= 150 \times 5 \times \frac{1}{2}$$
$$= 375\ N.m$$

Example:- The polar coordinates of a point are $r = 5.5m$ and $\theta = 240°$, what are the rectangular coordinates of this point?

Solution

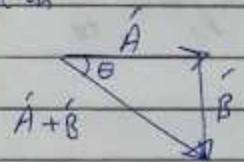
$x = r\cos\theta \quad = 5.5 \cos 240 \quad = -2.75\ cm$

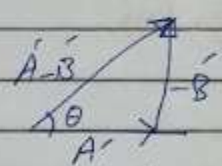
$y = r\sin\theta \quad = 5.5 \sin 240 \quad = -4.76\ cm$

X Example:-

Vector $\acute{A}$ is 3 units in length and points alonge the positive x axis, Vector $\acute{B}$ is 4 units in length and points alonge the Negative y axis, Use graphical methods to find the magnitude and direction of the vector (a) $\acute{A} + \acute{B}$, (b) $\acute{A} - \acute{B}$

Solution





$|\check{A} + \check{B}| = 5$ $\qquad$ $|\check{A} - \check{B}| = 5$

$\theta = -53°$ $\qquad$ $\theta = 53°$

Example:-

Two vectors are given by $\acute{A} = 3i - 2j$

$\acute{B} = -i - 4j$

Calculate: a) $\acute{A} + \acute{B}$

b) $\acute{A} - \acute{B}$

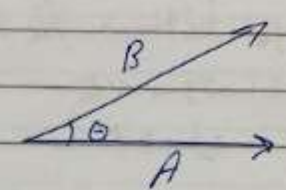
c) $|\check{A} + \check{B}|$

d) $|\check{A} - \check{B}|$

e) The direction of $\acute{A} + \acute{B}$ and $|\check{A} - \check{B}|$

1.8. Product of a vectors - ضرب المتجهات

There are Two Kinds of vector Product,
the first one is called (Scalar product) or [dot Product] because the result for the Product is scalar Quantity,
The seconed is Called (Vector Product) or [Cross product] because the resullt is a Vector prependicular to the plane of the Two Vectors



ينتج من الضرب القياسي كمية قياسية وينتج من الضرب الاتجاهي كمية متجهة

1.8.1 The Scalar Product الضرب القياسي او النقطي

يعرف الضرب القياسي Scalar Product بالضرب النقطي dot Product وتكون نتيجة الضرب القياسي كمية قياسية وتكون قيمة الضرب موجبة إذا كانت الزاوية المحصورة بين المتجهين 0 و 90 درجة وتكون النتيجة سالبة اذا كانت الزاوية المحصورة بين المتجهين 90 و 180 درجة وتساوي صفر اذا كانت الزاوية 90

$\vec{A}\cdot\vec{B}$ = +ve When $0 \geq \theta > 90°$ [illegible]

$\vec{A}\cdot\vec{B}$ = -ve When $90° < \theta \leq 180°$

$\vec{A}\cdot\vec{B}$ = Zero When $\theta = 0$

يعرف الضرب القياسي لمتجهين $\vec{A}, \vec{B}$ بأنه حاصل ضرب مقدار المتجه الاول $\vec{A}$ في مقدار المتجه الثاني $\vec{B}$ في جيب تمام الزاوية المحصورة بينهما

$$\vec{A}\cdot\vec{B} = |A|\,|B| \cos\theta$$

يمكن ايجاد قيمة الضرب القياسي لمتجهين باستخدام مركبات كل منهما كما يأتي

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

$\vec{B} = B_x i + B_y j + B_z k$

The scalar product is

$\vec{A}\cdot\vec{B} = (A_x i + A_y j + A_z k)\cdot(B_x i + B_y j + B_z k)$

نضرب وكلا حدود $\vec{A}$ في كل حدود $\vec{B}$ ينتج الاتي

$\vec{A}\cdot\vec{B} = (A_x i\, B_x i + A_x i\, B_y j + A_x i\, B_z k + A_y j\, B_x i + A_y j\, B_y j + A_y j\, B_z k + A_z k\, B_x i$
$+ A_z k\, B_y j + A_z k\, B_z k)$

Therefore

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

Multiplying a vector by a vector ⇒ Scalar Product (dot product)
⇒ Vector Product (Cross product)

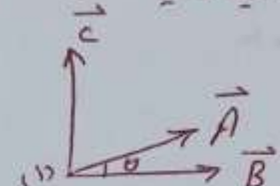
1) scalar product الضرب القياسي (dot product)

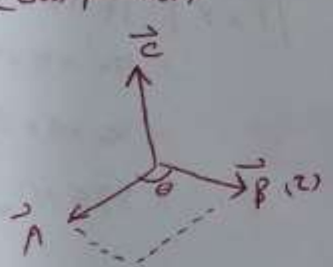
$\vec{a} \cdot \vec{b} = |\vec{a}| \, |\vec{b}| \cos\theta$ متجه x متجه = كمية قياسية

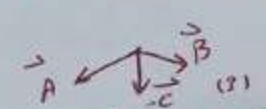
2) The vector product الضرب الاتجاهي متجه x متجه = متجه ثالث جديد باستخدام قاعدة اليد اليمنى لمعرفة اتجاهه (cross product)

$|\vec{a}| \times |\vec{b}| = |\vec{c}|$ متجه جديد ثالث

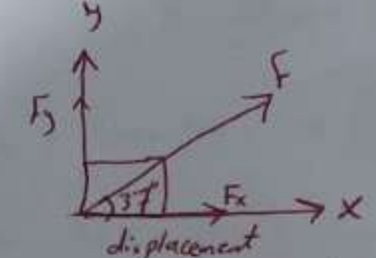
$|\vec{c}| = |\vec{a}| \, |\vec{b}| \sin\theta$







Ex1:- There is a force $\vec{F}$ about 40N in 37° above the axis, its effected on a body and its move it a displacement 10 m, Calculate the Total work created by this force?



Note ال F_x هي تبذل شغل
F_y لا تبذل شغل

$W = \vec{F} \cdot \vec{x}$
$= |\vec{F}| \, |\vec{x}| \cos 37°$
$= 40 \times 10m \cos 37°$
$= 40 \times 10 \times \frac{4}{5}$
$= 320$ Joule

Example:-

A particle moves from apoint in the xy plane having rectangular Coordinates $(-3,-5)$ m to apoint with Coordinates $(-1,8)$ m

a) write vector expression for the position vectors in unit vector form for these two points b) What is the displacement vector?

Solution:-

$\vec{R}_1 = X_1 i + Y_1 j = -3i - 5j$ m

$\vec{R}_2 = X_2 i + Y_2 j = -i + 8j$ m

b) Displacement $\Delta\vec{R} = \vec{R}_2 - \vec{R}_1$

$\Delta\vec{R} = (X_2 - X_1)i + (y_2 - y_1)j$

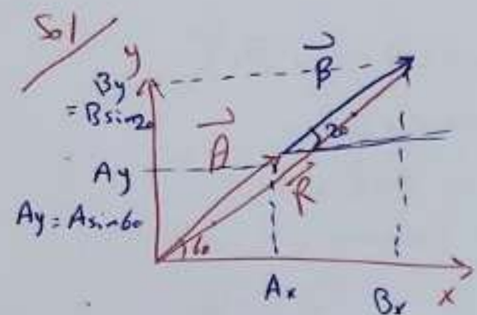
$= -1 - (3i) + 8j - (-5j)$

$= 2i + 13j$ m

Q

if you have Two vectors is equal to 14cm with an angle 60° with x-axis and equal to 20cm with an angle 20° with x-axis decomposed the vectors into their component and calculate the magnitude and direction?

Sol/



$A_x = A\cos 60$ $B_x = B\cos 20$

نجد مركبتي المتجه $\vec{A}$

$\vec{A}_x = \vec{A}\cos 60 = 14 \times \frac{1}{2} = 7\,cm$

$\vec{A}_y = \vec{A}\sin 60 = 14 \times 0.366 = 12.12\,cm$

نجد مركبتي المتجه $\vec{B}$

$\vec{B}_x = \vec{B}\cos 20 = 20 \times 0.49 = 18.8\,cm$

$\vec{B}_y = \vec{B}\sin 20 = 20 \times 0.342 = 6.84\,cm$

(نجد محصلة المركبات x & y) بحاصل جمع المركبات المتشابهة

$R_x = A_x + B_x$
$= 7 + 18.8 = 25.8\,cm$

$R_y = A_y + B_y$
$= 12.12 + 6.84 = 18.96\,cm$

ثم اجد مقدار المتجه المحصل

$R = \sqrt{R_x^2 + R_y^2} = 32\,cm$

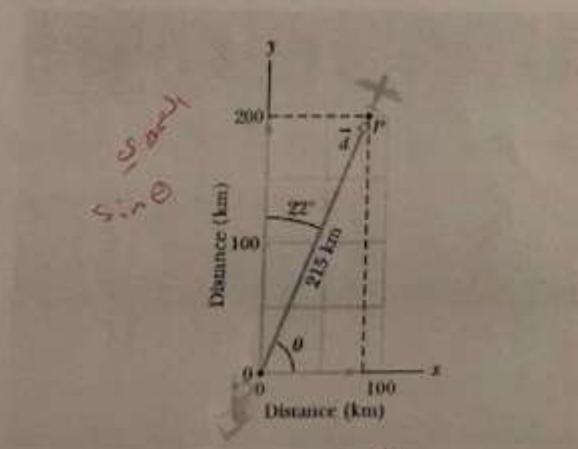
$\tan\theta = \frac{R_y}{R_x}$ ونجد اتجاه R $\Rightarrow \theta = \tan^{-1} = 36°$

EXAMPLE:

A small airplane leaves an airport on an overcast day and is later sighted 215 km away, in a direction making an angle of 22°east of due north. How far east and north is the airplane from the airport when sighted?

NOTE: We are given the magnitude (215 km) and the angle (22° east of due north) of a vector and need to find the components of the vector.

Calculations: We draw ***xy*** coordinate system with the positive direction of *x* due east and that of *y* due north (in the below Figure).For convenience, the origin is placed at the airport. The airplane's displacement $\vec{d}$ points from the origin to where the airplane is sighted.



To find the components of $\vec{d}$, we use Eq. 1-5 with θ =68° =(90° -22°)

d_x =d cos θ = (215Km)(cos 68°)=81 km

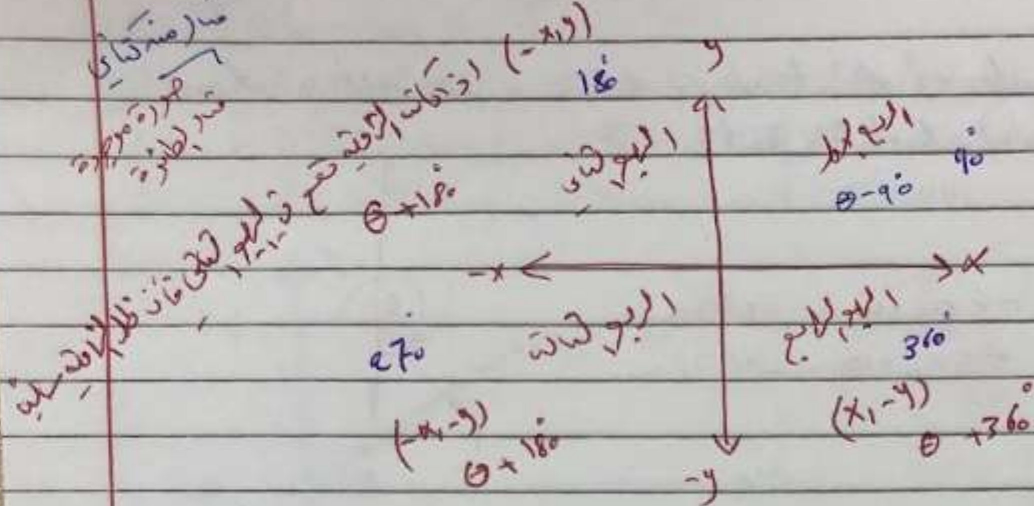
d sinθ

d_y= d $\cancel{\cos}$ θ = $(215km)(\sin 68°)$= 199km ≈2.0*10² km

Thus, the airplane is 81 km east and

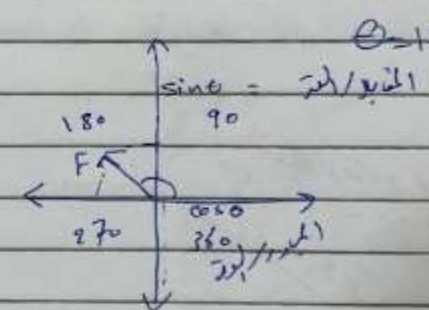
2.0* 10² km north of the airport.

ملاحظات:-



Q :- جد مركبتي القوة F والتي مقدارها 25N وتعمل زاوية 127 مع محور x علماً ان
$\cos 37 = 0.8$, $\sin 37 = 0.6$

$\theta = 127$

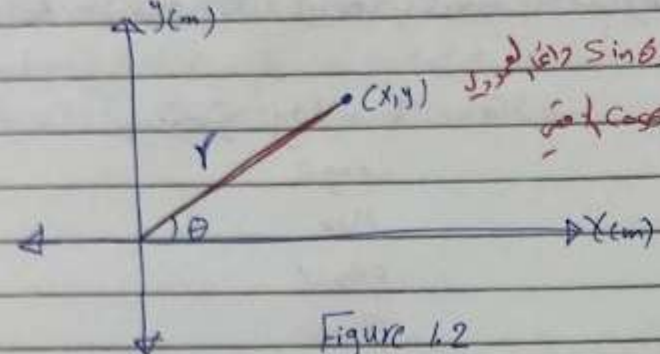


نطرح منها زاوية 90 لكي نحصل على الاصلية
$127 - 90 = 37$
نحلل F الى مركبتين افقية وعمودية
$F_x = F\cos\theta$
$F_y = F\sin\theta$

$F_x = 25\cos 37 = 20N$
$F_y = 25\sin 37 = 15N$

1.5.2 The Polar Coordinate الإحداثيات القطبية

It is more convenient to use the polar coordinate system (r, θ).
Where r is the distance from the origin to the point of rectangular coordinate (x, y) and θ is the angle between r and the x-axis



$\sin\theta = \frac{\text{المقابل}}{\text{الوتر}} = \frac{y}{r}$

$\cos\theta = \frac{\text{المجاور}}{\text{الوتر}} = \frac{x}{r}$

$\tan\theta = \frac{\text{المقابل}}{\text{المجاور}} = \frac{y}{x}$

Figure 1.2

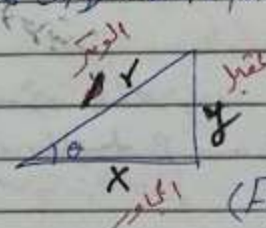
1.5.3 The relation between coordinates

The relation between the rectangular coordinates (x, y) and the polar coordinates (r, θ) is shown in figure 1.3 where,

$$x = r\cos\theta \quad \text{---} (1)$$

and

$$y = r\sin\theta \quad \text{---} (2)$$



(Figure 1.3)

Squaring and adding equations (1) and (2) we get

$$r = \sqrt{x^2 + y^2} \quad \text{---} (3)$$

Dividing eq (1) and (2) we get,

$$\tan\theta = \frac{y}{x} \quad \text{---} (4)$$

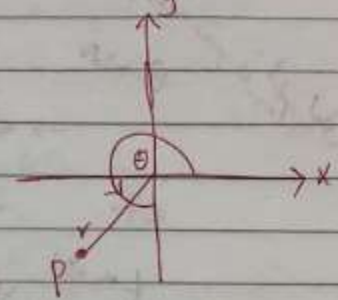
علاقة بين الإحداثيات القطبية والكارتيزية

$\tan\theta = \frac{\text{المقابل}}{\text{المجاور}} = \frac{y}{x}$

phase

Examples:-

The polar coordinates of a point are $r = 5.5$ cm and $\theta = 240^\circ$ what are The Cartesian coordinate of this point?



Solution:-

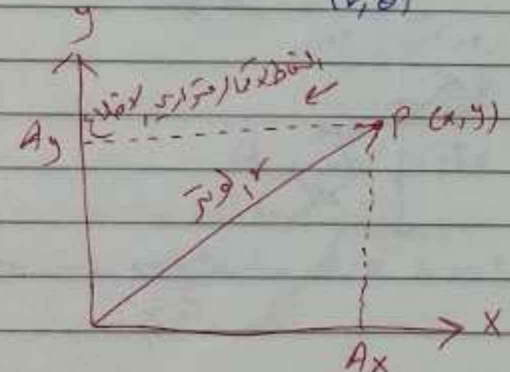
$X = r\cos\theta = 5.5\cos 240^\circ = -2.75$ cm

$y = r\sin\theta = 5.5\sin 240^\circ = -4.76$ cm

للتوضيح :- Notes

الاحداثيات

قطبية (r, θ) — كارتيزية (X, y)



لإيجاد r $r = \sqrt{Ax^2 + Ay^2}$

$\tan\theta = \frac{y}{x}$

لإيجاد θ $\theta = \tan^{-1}\frac{y}{x}$

حسب نظرية فيثاغورس

1.4 Vector and Scalar المتجه وغير المتجه

جميع الكميات الفيزيائية (أساسية او مشتقة) يمكن تقسيمها الى نوعين.
الاول الكمية القياسية Scalar والثانية الكمية المتجهة Vector
ال Scalar يمكن تحديدها بمقدارها فقط مثل كتلة جسم 5kg
ال Vector نحتاج ان نحدد اتجاهها بالاضافة لمقدارها مثل سرعة الريح 10 km/h شرقاً

كمية متجهة Vector Quantity	Scalar Quantity كمية قياسية
Displacement	Length
Velocity	Mass
Force	Speed
Acceleration	Power
Field	Energy
Momentum	Work

1.5 Coordinate System الاحداثيات

لتحديد موقع جسم ما سواء كان ساكناً او متحركاً نستعين بالاحداثيات Coordinates
وهناك نوعان من الاحداثيات وهما Polar Coordinate and Rectangular coordinate
الاحداثيات القطبية والاحداثيات الكارتيزية

1.5.1 The Rectangular Coordinates

The rectangular Cordinate system in Two dimension is show in figuer(1.1)
This coordinate system is Consist of a fixed refrence point (0,0) which called (The origin)

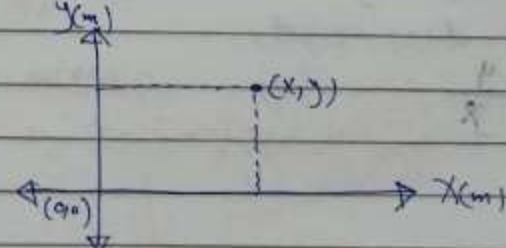
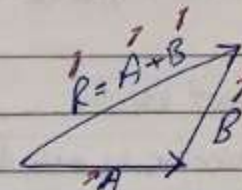


Figure 1.1

1.6. Properties of Vectors



[figure 1.3]

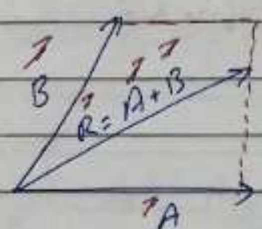
1.6.1. Vector addition

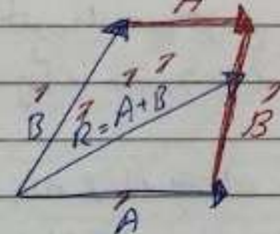
only vectors representing The same Physical quantities Can be added,
To add vector $\vec{A}$ to vector $\vec{B}$ as shown in figure 1.3, The resulting Vector $\vec{R}$ is

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

Notice That The vector addition obyes the commutative law, ie

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



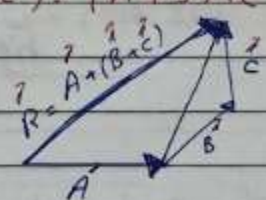


المحصلة تمثيله متجه :-
مابين رأس المتجه الأول و
ذيل المتجه الثاني

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

Notice that the Vector addition obeys The associative law, i.e.

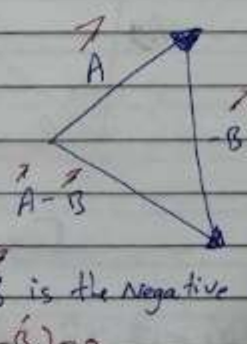
$$\vec{A} + (\vec{B} + \vec{C}) = (\vec{A} + \vec{B}) + \vec{C}$$



1.6.2. Vector subtraction

The vector subtraction $\vec{A} - \vec{B}$ is evaluted as the vector subtraction i.e.

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



where The Vector $-\vec{B}$ is the Negative vector of $\vec{B}$

$$\vec{B} + (-\vec{B}) = 0$$

The angle between the Two vectors is

$$\cos\theta = \frac{\vec{A}\cdot\vec{B}}{|A|\,|B|} = \frac{A_xB_x + A_yB_y + A_zB_z}{|A|\,|B|}$$

Example:-

Find the angle between the Two vectors

$\vec{A} = 2i + 3j + 4k$

$\vec{B} = i - 2j + 3k$

Solution

$$\cos\theta = \frac{A_xB_x + A_yB_y + A_zB_z}{|A|\,|B|}$$

$A_xB_x + A_yB_y + A_zB_z = (2)(1) + (3)(-2) + (4)(3) = 8$

$|A| = \sqrt{2^2 + 3^2 + 4^2} = \sqrt{29}$

$|B| = \sqrt{(1)^2 + (-2)^2 + 3^2} = \sqrt{14}$

$\cos\theta = \frac{18}{\sqrt{29}\,\sqrt{14}} \Rightarrow \theta = 66.6^\circ$

Mass: The S.I. unit of mas is Kilogram (Kg)
Time: The S.I. unit of Time is second (s)
Length: The S.I. unit of Length is Meter (m)
Temperature: The S.I. unit of Temperature is Kelvin (K)
Electric current: The S.I. unit of electric current is Ampere (A)
Number of Particles: The S.I. unit of it is mole (mol)
intensity: The S.I. unit of it is Candela (cd)

REFERENCE

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2- FUNDAMENTALS OF PHYSICS HALLIDAY & RESNICK 9th EDITION Jearl Walker Cleveland State University