Phys 111
General Physics (2)

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PHYS 111

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Lecture 1

Content (Phys111)

Vector and Scalar Quantities

A scalar quantity:

is completely specified by a single value with an appropriate unit and has no direction.

Examples: volume, mass, speed, and time intervals.

A vector quantity

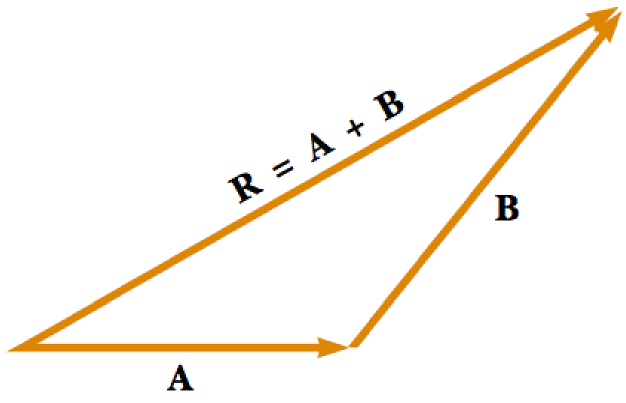
is completely specified by a number and appropriate units plus a direction.

Examples: displacement, velocity, and force.

Some Properties of Vectors

Equality of Two Vectors
- **A** = **B** only if *A* = *B* and if **A** and **B** point in the same direction along parallel lines.

- **Adding Vectors**
- The **resultant vector R** = **A** + **B** is the vector drawn from the tail of **A** to the tip of **B**.
- The **commutative law of addition: A+B=B+A**
- The **associative law of addition: A+(B+C)=(A+B)+C**



- **Negative of a Vector**
- **A**+(-**A**)=0. The vectors **A** and -**A** have the same magnitude but point in opposite directions.

- **Subtracting Vectors**
- **A-B=A+**(-**B**)

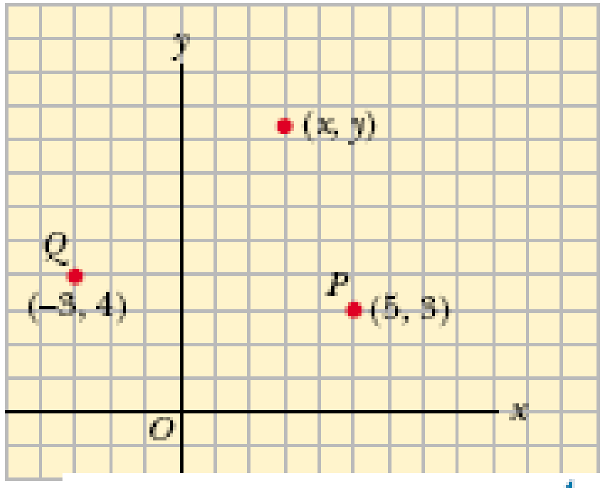
- **Multiplying a Vector by a Scalar**
- The product *m***A** is a vector that has the same direction as **A** and magnitude *mA*.

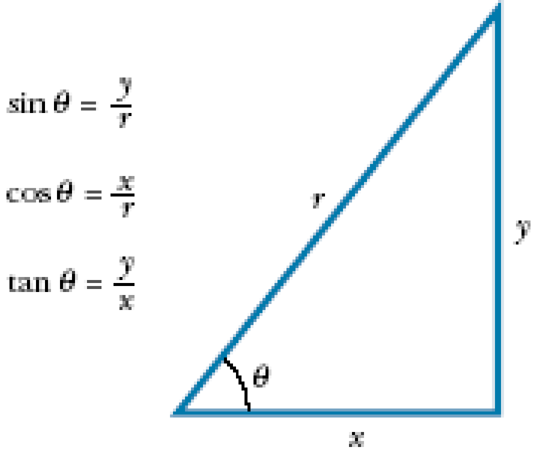
- المتجهات : (Vectors)

- نظم الإحداثيات (Coordinate Systems)

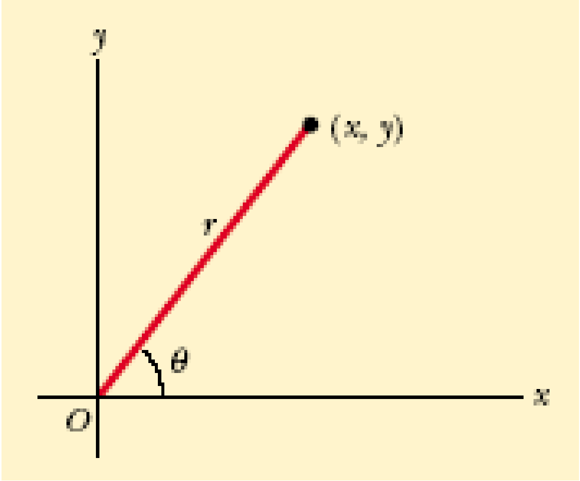
نحتاج في حياتنا العملية إلى تحديد موقع جسم ما في الفراغ سواءً كان ساكناً أم متحركاً، ولتحديد موقع هذا الجسم فإننا نستعين بما يعرف بالإحداثيات ***Coordinates***، وهناك نوعان من الإحداثيات التي سوف نستخدمها وهما ***Rectangular coordinates*** و *polar coordinates*.

الإحداثيات الكارتيزية (X,Y)





الإحداثيات القطبية (r,θ)



$\tan\theta = y/x$

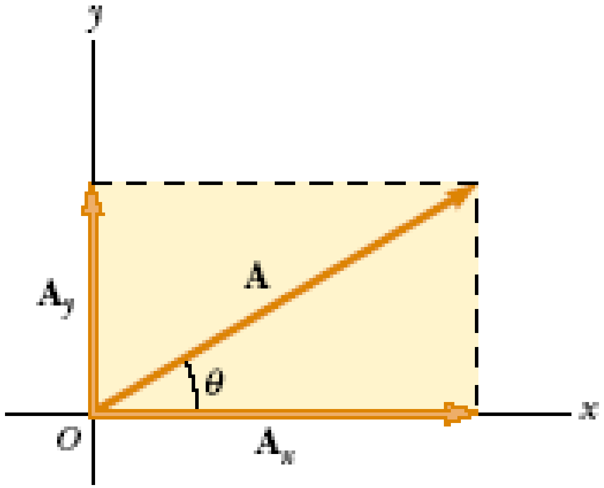
$x = r\cos\theta$

$r = \sqrt{x^2 + y^2}$

$y = r\sin\theta$

- مكونات (مركبات) المتجه ومتجه الوحدة:

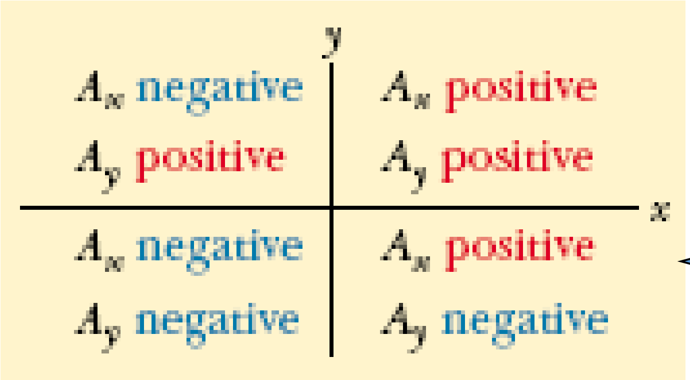
Components of a vector and unit vector



- يمكن تحليل أي متجه (A) إلى مركبة سينية (A_x) على المحور السيني (x) ومركبة صادية (A_y)على المحور الصادي (y) حيث؛

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

$$A = \sqrt{A_x^2 + A_y^2} \quad \& \;\; \theta = \tan^{-1}\frac{A_y}{A_x}$$

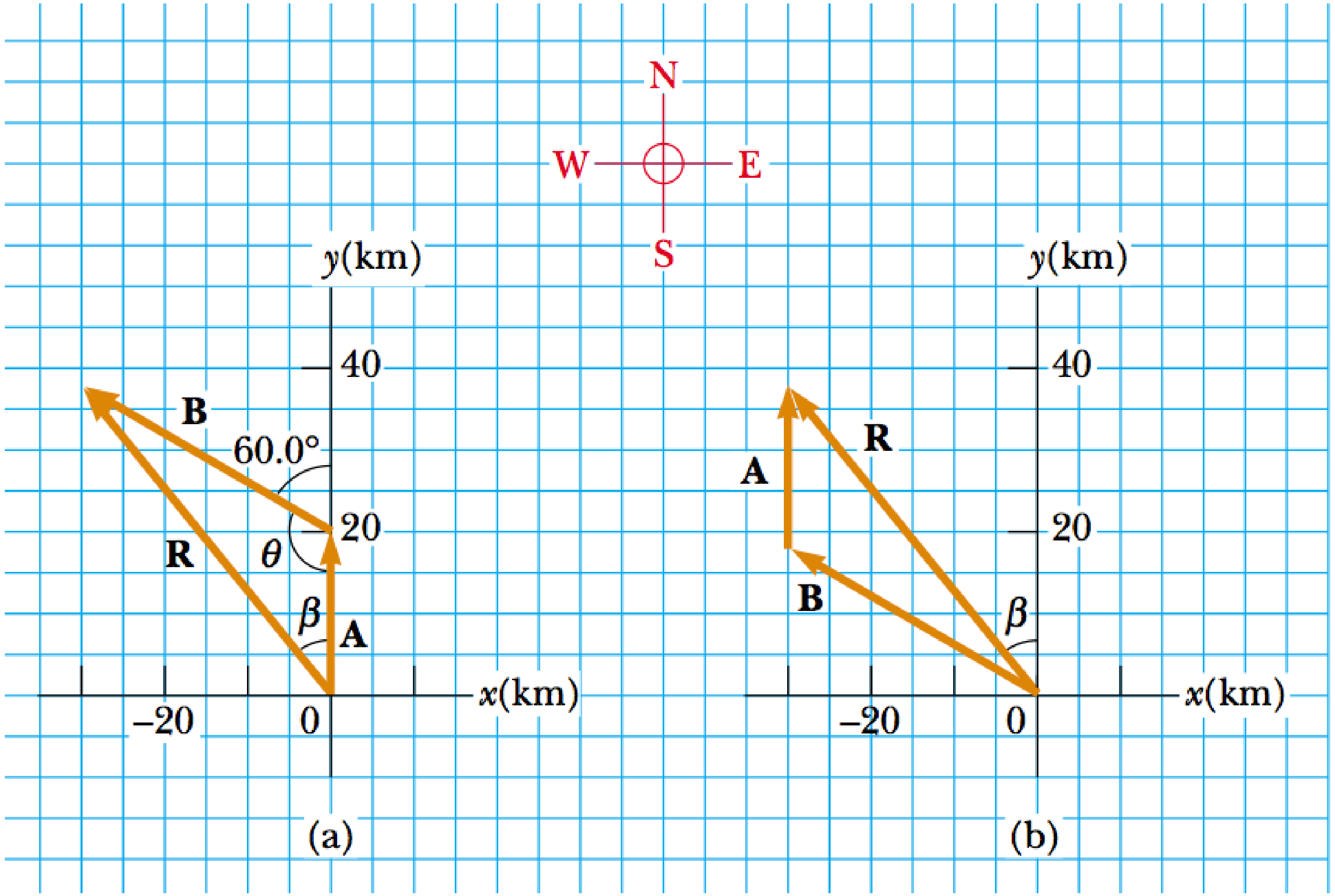


- تعتمد أشارة المركبات السينية والصادية على الزاوية θ، كما هو موضح بالرسم

- ملحوظة هامة: للتعويض بالمعادلات السابقة لحساب المركبة السينية أو الصادية دائما تؤخذ قيمة الزاوية بين المتجه والمحور السيني الموجب

Example : A Vacation Trip

A car travels 20.0 km due north and then 35.0 km in a direction 60.0° west of north, as shown in Figure, Find the magnitude and direction of the car's resultant displacement.



Use $R^2 = A^2 + B^2 - 2AB\cos\theta$ from the law of cosines to find R:

$$R = \sqrt{A^2 + B^2 - 2AB\cos\theta}$$

Substitute numerical values, noting that $\theta = 180° - 60° = 120°$:

$$R = \sqrt{(20.0 \text{ km})^2 + (35.0 \text{ km})^2 - 2(20.0 \text{ km})(35.0 \text{ km})\cos 120°}$$

$$= \boxed{48.2 \text{ km}}$$

Use the law of sines (Appendix B.4) to find the direction of $\vec{\mathbf{R}}$ measured from the northerly direction:

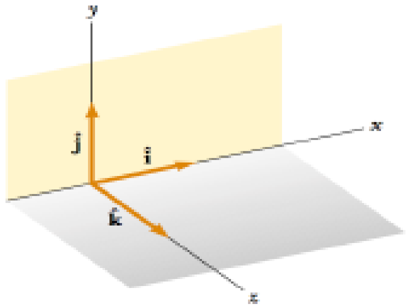
$$\frac{\sin\beta}{B} = \frac{\sin\theta}{R}$$

$$\sin\beta = \frac{B}{R}\sin\theta = \frac{35.0 \text{ km}}{48.2 \text{ km}}\sin 120° = 0.629$$

$$\beta = \boxed{38.9°}$$

The resultant displacement of the car is 48.2 km in a direction 38.9° west of north.

3.4 Components of a Vector and Unit Vectors

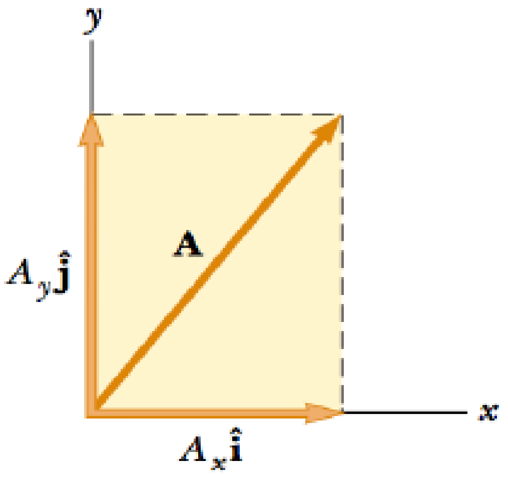


- **Unit Vectors**

$$|\hat{\mathbf{i}}| = |\hat{\mathbf{j}}| = |\hat{\mathbf{k}}| = 1.$$

- The unit vector notation for the vector **A** is

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



- The resultant vector **R=A+B** is

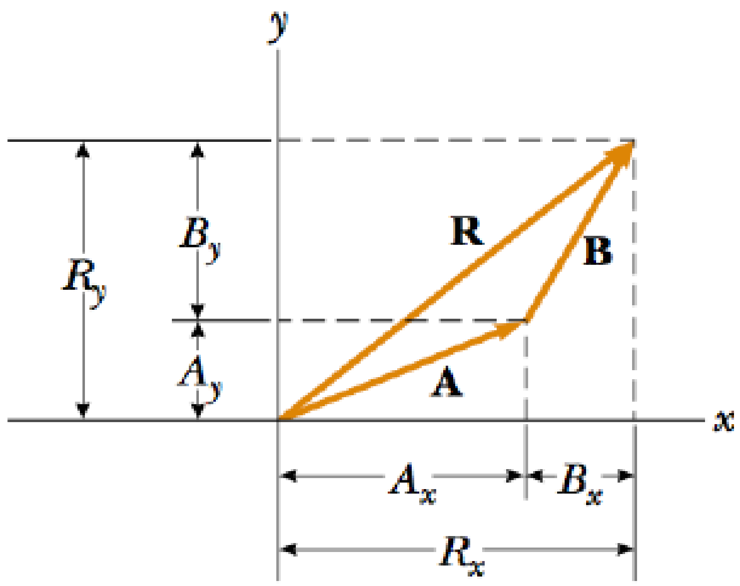
$$\mathbf{R} = (A_x\hat{\mathbf{i}} + A_y\hat{\mathbf{j}}) + (B_x\hat{\mathbf{i}} + B_y\hat{\mathbf{j}})$$

$$\mathbf{R} = (A_x + B_x)\hat{\mathbf{i}} + (A_y + B_y)\hat{\mathbf{j}}$$

- The magnitude of **R** and the angle

$$R = \sqrt{R_x^2 + R_y^2} = \sqrt{(A_x + B_x)^2 + (A_y + B_y)^2}$$

$$\tan\theta = \frac{R_y}{R_x} = \frac{A_y + B_y}{A_x + B_x}$$



Example 3.3 The Sum of Two Vectors

Find the sum of two vectors **A** and **B** lying in the *xy* plane and given by

$$\mathbf{A} = (2.0\hat{\mathbf{i}} + 2.0\hat{\mathbf{j}})\ \text{m} \qquad \text{and} \qquad \mathbf{B} = (2.0\hat{\mathbf{i}} - 4.0\hat{\mathbf{j}})\ \text{m}$$

$$\vec{\mathbf{R}} = \vec{\mathbf{A}} + \vec{\mathbf{B}} = (2.0 + 2.0)\hat{\mathbf{i}}\ \text{m} + (2.0 - 4.0)\hat{\mathbf{j}}\ \text{m}$$

$$R_x = 4.0\ \text{m} \qquad R_y = -2.0\ \text{m}$$

$$R = \sqrt{R_x^{\,2} + R_y^{\,2}} = \sqrt{(4.0\ \text{m})^2 + (-2.0\ \text{m})^2} = \sqrt{20}\ \text{m} = \boxed{4.5\ \text{m}}$$

$$\tan\theta = \frac{R_y}{R_x} = \frac{-2.0\ \text{m}}{4.0\ \text{m}} = -0.50$$