PHYS 111
1^{ST} semester 1439-1440

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Lecture 1

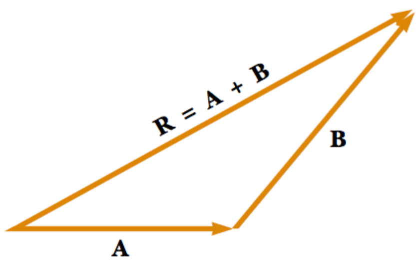
3.2 Vector and Scalar Quantities

- 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.

3.3 Some Properties of Vectors

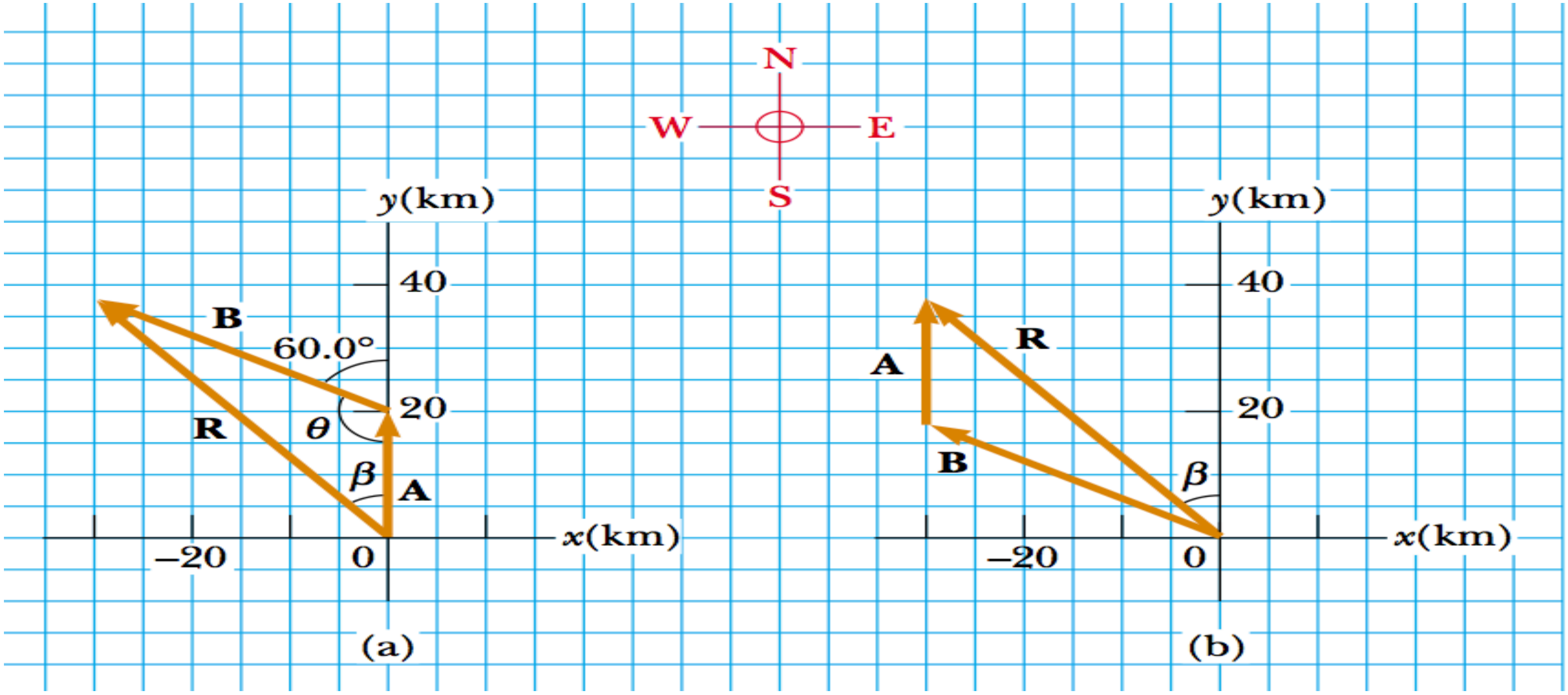
- **Equality of Two Vectors**
  - **A** = **B** only if *A* = *B* and if **A** and **B** point in the same direction along parallel lines.
- **Adding Vectors**
  - The **resultant vector R** = **A** + **B** is the vector drawn from the tail of **A** to the tip of **B**.
  - The **commutative law of addition: 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*.

Example 3.2: **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 3.12a. Find the magnitude and direction of the car's resultant displacement.

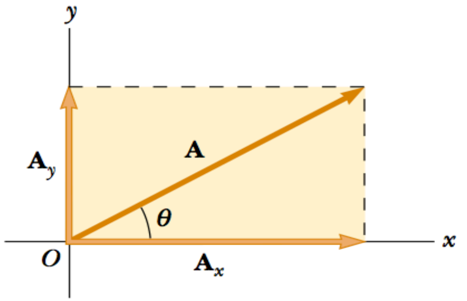


3.4 Components of a Vector and Unit Vectors

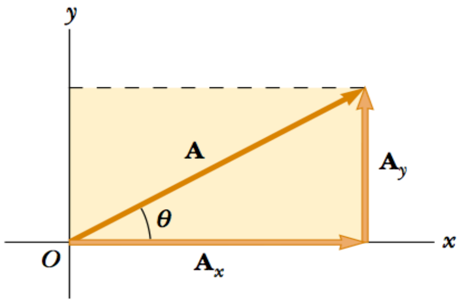
- $\mathbf{A} = \mathbf{A}_x + \mathbf{A}_y$
- The components of **A** are
  - $A_x = A \cos \theta$
  - $A_y = A \sin \theta$
- The magnitude and direction of **A** are

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

$$\theta = \tan^{-1}\left(\frac{A_y}{A_x}\right)$$

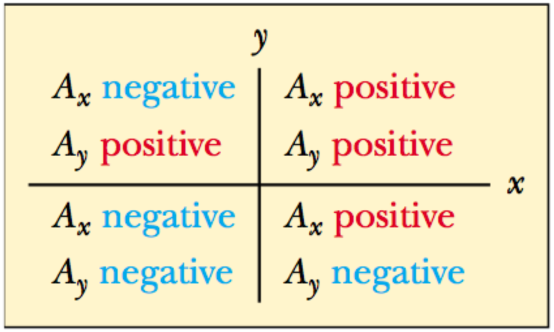


(a)



(b)

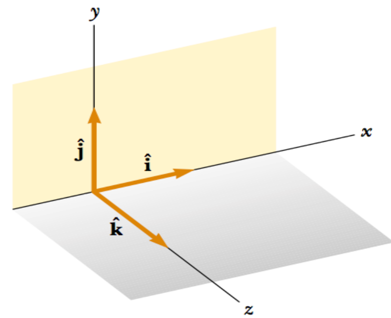
- The signs of the components Ax and A_y depend on the angle θ.



3.4 Components of a Vector and Unit Vectors

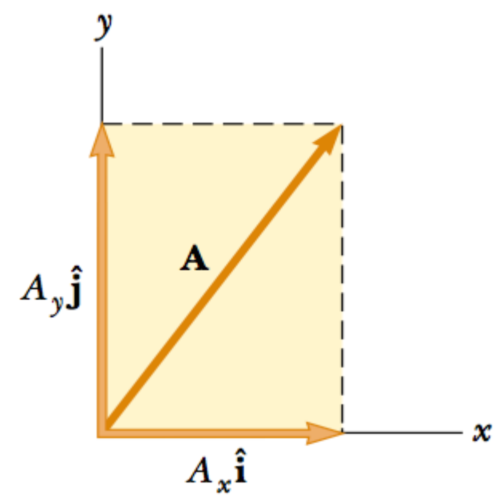
- **Unit Vectors**

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



- 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

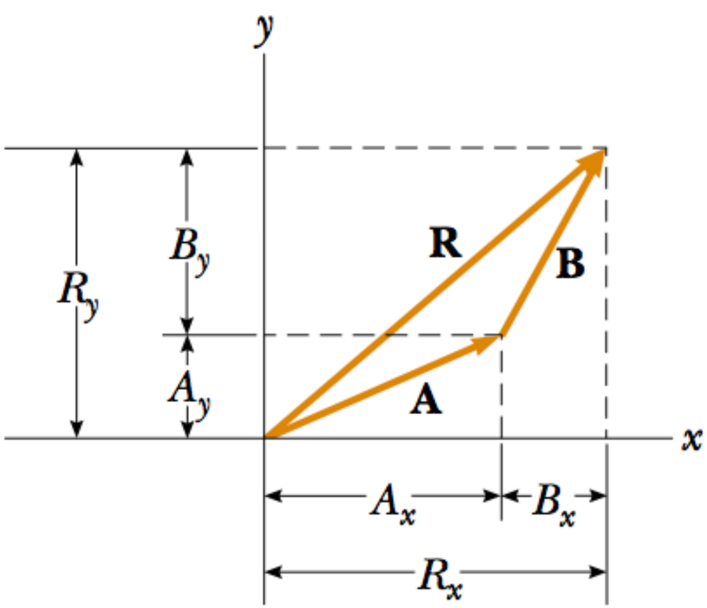
$$\mathbf{R} = (A_x\hat{\mathbf{i}} + A_y\hat{\mathbf{j}}) + (B_x\hat{\mathbf{i}} + B_y\hat{\mathbf{j}})$$

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

- 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

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

Example 3.4 **The Resultant Displacement**

A particle undergoes three consecutive displacements: $\mathbf{d}_1 = (15\hat{\mathbf{i}} + 30\hat{\mathbf{j}} + 12\hat{\mathbf{k}})$ cm, $\mathbf{d}_2 = (23\hat{\mathbf{i}} - 14\hat{\mathbf{j}} - 5.0\hat{\mathbf{k}})$ cm and $\mathbf{d}_3 = (-13\hat{\mathbf{i}} + 15\hat{\mathbf{j}})$ cm. Find the components of the resultant displacement and its magnitude.