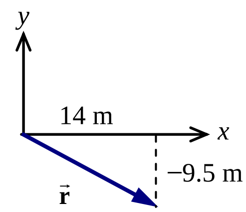
Chapter 3:
Solutions of Homework Problems
Vectors in Physics

12. **Picture the Problem**: The given vector components correspond to the vector $\vec{\mathbf{r}}$ as drawn at right.



(a) Use the inverse tangent function to find the distance angle θ:

$\theta = \tan^{-1}\left(\dfrac{-9.5m}{14m}\right) = \boxed{-34°}$ or 34° below the +*x* axis

(b) Use the Pythagorean Theorem to determine the magnitude of $\vec{\mathbf{r}}$:

$$r = \sqrt{r_x^2 + r_y^2} = \sqrt{(14\text{ m})^2 + (-9.5\text{ m})^2}$$

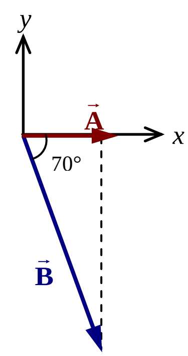
$$r = \boxed{17\text{ m}}$$

(c) If both r_x and r_y are doubled, the direction will remain the same but the magnitude will double:

$$\theta = \tan^{-1}\left(\frac{-9.5m \times 2}{14m \times 2}\right) = \boxed{-34°}$$

$$r = \sqrt{(28\text{ m})^2 + (-19\text{ m})^2} = \boxed{34\text{ m}}$$

15. **Picture the Problem**: The two vectors $\vec{\mathbf{A}}$ (length 50 units) and $\vec{\mathbf{B}}$ (length 120 units) are drawn at right.



Solution: 1. (a) Find B_x:

$$B_x = (120\text{ units})\cos 70° = \underline{\underline{41\text{ units}}}$$

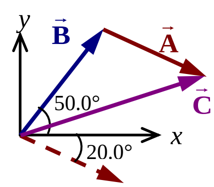
2. Since the vector $\vec{\mathbf{A}}$ points entirely in the *x* direction, we can see that A_x = 50 units and that vector $\boxed{\vec{\mathbf{A}}}$ has the greater *x* component.

3. (b) Find B_y:

$$B_x = (120\text{ units})\sin 70° = \underline{\underline{113\text{ units}}}$$

4. The vector $\vec{\mathbf{A}}$ has no *y* component, so it is clear that vector $\boxed{\vec{\mathbf{B}}}$ has the greater *y* component. However, if one takes into account that the y-component of B is negative, then it follows that it smaller than zero, and hence $\vec{\mathbf{A}}$ has the greater y-component.

20. The two vectors $\vec{\mathbf{A}}$ (length 40.0 m) and $\vec{\mathbf{B}}$ (length 75.0 m) are drawn at right.



(a) A sketch (not to scale) of the vectors and their sum is shown at right.

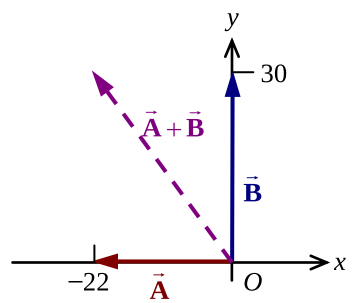
(b) Add the *x* components: $C_x = A_x + B_x = (40.0\text{ m})\cos(-20.0°) + (75.0\text{ m})\cos(50.0°) = \underline{\underline{85.8\text{ m}}}$

Add the *y* components: $C_y = A_y + B_y = (40.0\text{ m})\sin(-20.0°) + (75.0\text{ m})\sin(50.0°) = \underline{\underline{43.8\text{ m}}}$

Find the magnitude of $\vec{\mathbf{C}}$: $C = \sqrt{C_x^2 + C_y^2} = \sqrt{(85.8\text{ m})^2 + (43.8\text{ m})^2} = \boxed{96.3\text{ m}}$

Find the direction of $\vec{\mathbf{C}}$: $\theta_C = \tan^{-1}\left(\dfrac{C_y}{C_x}\right) = \tan^{-1}\left(\dfrac{43.8\text{ m}}{85.8\text{ m}}\right) = \boxed{27.0°}$

24. The vectors involved in the problem are depicted at right.



Set the length of $\vec{\mathbf{A}}+\vec{\mathbf{B}}$ equal to 37 units:

$$37=\sqrt{A^2+B^2}$$
$$37^2=A^2+B^2$$

Solve for B:

$$B=\sqrt{37^2-A^2}=\sqrt{37^2-(-22)^2}=\boxed{30\text{ units}}$$

29. The vector $\vec{\mathbf{A}}$ has a length of 6.1 m and points in the negative x direction.

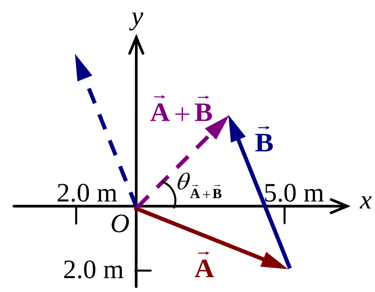
Note that in order to multiply a vector by a scalar, you need only multiply each component of the vector by the same scalar.

(a) Multiply each component of $\vec{\mathbf{A}}$ by −3.7:

$$\vec{\mathbf{A}}=(-6.1\text{ m})\hat{\mathbf{x}}$$
$$-3.7\vec{\mathbf{A}}=\left[(-3.7)(-6.1\text{ m})\right]\hat{\mathbf{x}}=(23\text{ m})\hat{\mathbf{x}}\ \text{ so } A_x=\boxed{23\text{ m}}$$

(b) Since $\vec{\mathbf{A}}$ has only one component, its magnitude is simply $\boxed{23\text{ m}}$.

31. **Picture the Problem**: The vectors involved in the problem are depicted at right.



(a) Find the direction of $\vec{\mathbf{A}}$ from its components:

$$\theta_{\vec{\mathbf{A}}}=\tan^{-1}\left(\frac{-2.0\text{ m}}{5.0\text{ m}}\right)=\boxed{-22°}$$

Find the magnitude of $\vec{\mathbf{A}}$:

$$A=\sqrt{(5.0\text{ m})^2+(-2.0\text{ m})^2}=\boxed{5.4\text{ m}}$$

(b) Find the direction of $\vec{\mathbf{B}}$ from its components:

$$\theta_{\vec{\mathbf{B}}}=\tan^{-1}\left(\frac{5.0\text{ m}}{-2.0\text{ m}}\right)=-68°+180°=\boxed{110°}$$

Find the magnitude of $\vec{\mathbf{B}}$:

$$B=\sqrt{(-2.0\text{ m})^2+(5.0\text{ m})^2}=\boxed{5.4\text{ m}}$$

(c) Find the components of $\vec{\mathbf{A}}+\vec{\mathbf{B}}$:

$$\vec{\mathbf{A}}+\vec{\mathbf{B}}=(5.0-2.0\text{ m})\hat{\mathbf{x}}+(-2.0+5.0\text{ m})\hat{\mathbf{y}}=(3.0\text{ m})\hat{\mathbf{x}}+(3.0\text{ m})\hat{\mathbf{y}}$$

Find the direction of $\vec{\mathbf{A}}+\vec{\mathbf{B}}$ from its components:

$$\theta_{\vec{\mathbf{A}}+\vec{\mathbf{B}}}=\tan^{-1}\left(\frac{3.0\text{ m}}{3.0\text{ m}}\right)=\boxed{45°}$$

Find the magnitude of $\vec{\mathbf{A}}+\vec{\mathbf{B}}$:

$$\left|\vec{\mathbf{A}}+\vec{\mathbf{B}}\right|=\sqrt{(3.0\text{ m})^2+(3.0\text{ m})^2}=\boxed{4.2\text{ m}}$$