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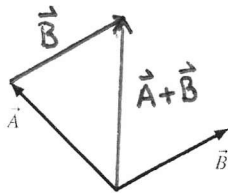
Vectors and Coordinate Systems

3.1 Vectors

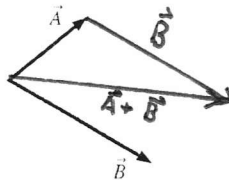
3.2 Properties of Vectors

Exercises 1–3: Draw and label the vector sum $\vec{A} + \vec{B}$.

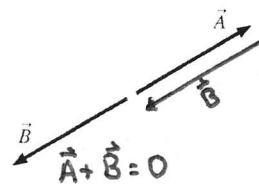
1.



2.

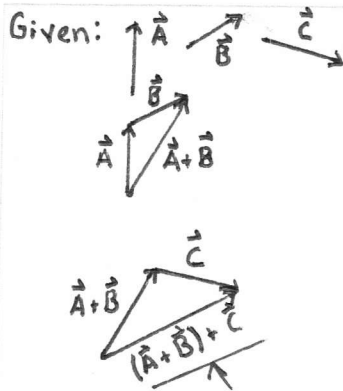


3.



4. Use a figure and the properties of vector addition to show that vector addition is associative. That is, show that

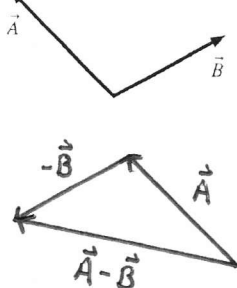
$$(\vec{A} + \vec{B}) + \vec{C} = \vec{A} + (\vec{B} + \vec{C})$$



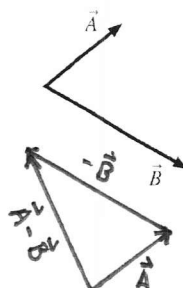
The figure shows that $(\vec{A} + \vec{B}) + \vec{C}$ has the same magnitude and direction as $\vec{A} + (\vec{B} + \vec{C})$, though constructed in a different order.

Exercises 5–7: Draw and label the vector difference $\vec{A} - \vec{B}$.

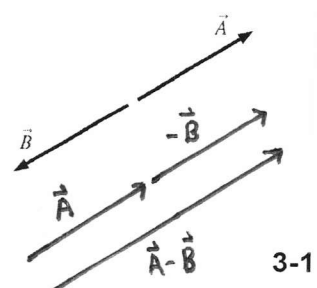
5.



6.



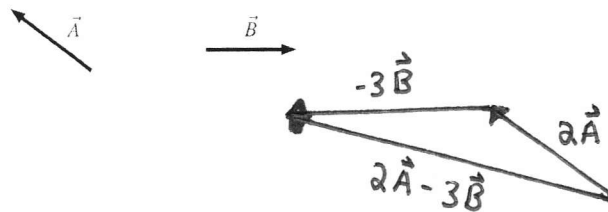
7.



8. Draw and label the vector $2\vec{A}$ and the vector $\frac{1}{2}\vec{A}$.

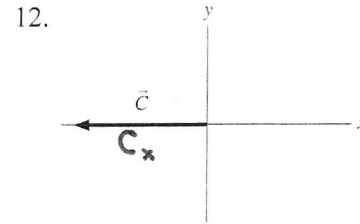
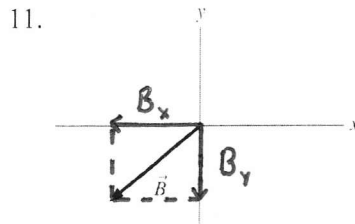
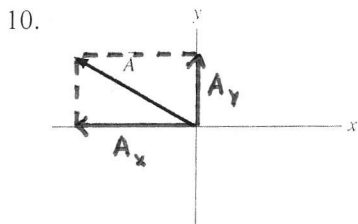


9. Given vectors \vec{A} and \vec{B} below, find the vector $\vec{C} = 2\vec{A} - 3\vec{B}$.

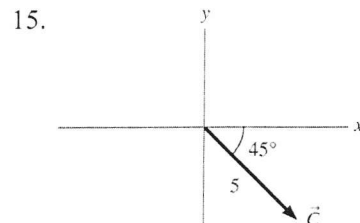
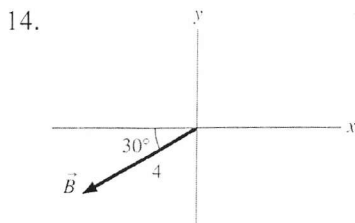
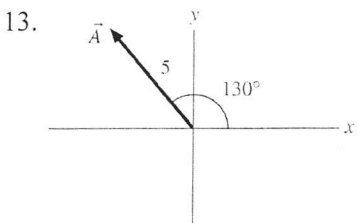


3.3 Coordinate Systems and Vector Components

Exercises 10–12: Draw and label the x - and y -component vectors of the vector shown.



Exercises 13–15: Determine the numerical values of the x - and y -components of each vector.



$$A_x = 5 \cos(130^\circ) = -3.21$$

$$A_y = 5 \sin(130^\circ) = 3.83$$

$$B_x = -4 \cos(30^\circ) = -3.46$$

$$B_y = -4 \sin(30^\circ) = -2.00$$

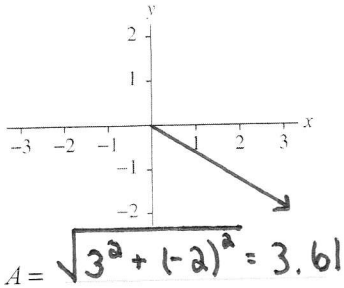
$$C_x = 5 \cos(45^\circ) = 3.54$$

$$C_y = -5 \sin(45^\circ) = -3.54$$

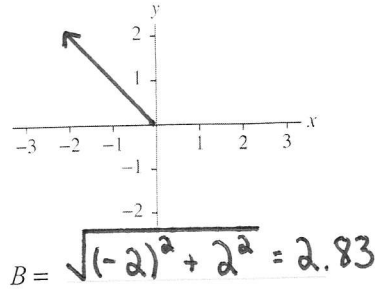
To 3 significant figures

Exercises 16–18: Draw and label the vector with these components. Then determine the magnitude of the vector.

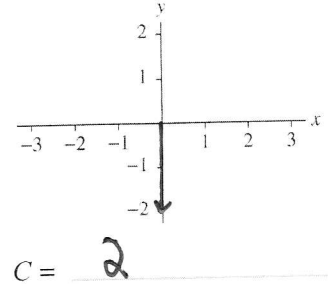
16. $A_x = 3, A_y = -2$



17. $B_x = -2, B_y = 2$



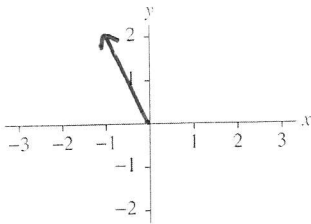
18. $C_x = 0, C_y = -2$



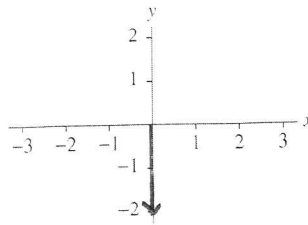
3.4 Vector Algebra

Exercises 19–21: Draw and label the vectors on the axes.

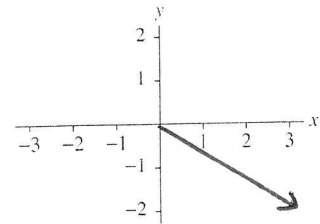
19. $\vec{A} = -\hat{i} + 2\hat{j}$



20. $\vec{B} = -2\hat{j}$

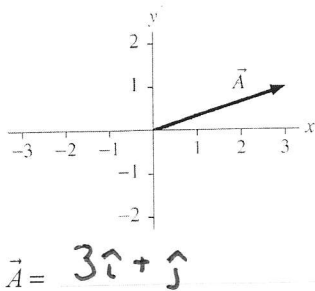


21. $\vec{C} = 3\hat{i} - 2\hat{j}$

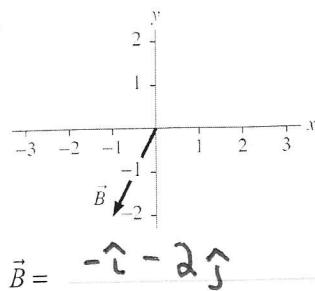


Exercises 22–24: Write the vector in component form (e.g., $3\hat{i} + 2\hat{j}$).

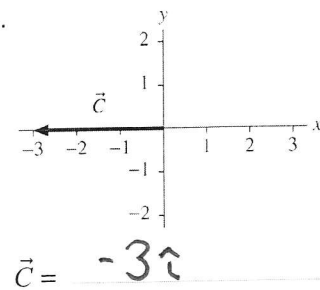
22.



23.



24.



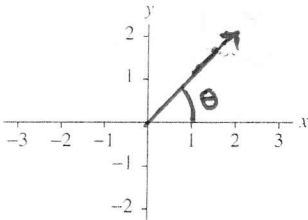
25. What is the vector sum $\vec{D} = \vec{A} + \vec{B} + \vec{C}$ of the three vectors defined in Exercises 22–24? Write your answer in *component* form.

$$\vec{D} = (3 - 1 - 3)\hat{i} + (1 - 2 + 0)\hat{j} = -\hat{i} - \hat{j}$$

Exercises 26–28: For each vector:

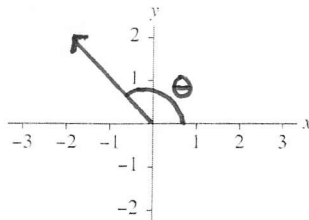
- Draw the vector on the axes provided.
- Draw and label an angle θ to describe the direction of the vector.
- Find the magnitude and the angle of the vector.

26. $\vec{A} = 2\hat{i} + 2\hat{j}$



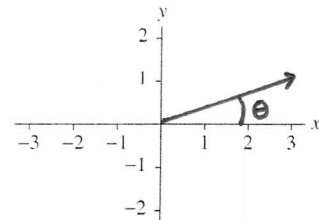
$A = 2.83 \quad (2\sqrt{2})$
 $\theta = 45^\circ$

27. $\vec{B} = -2\hat{i} + 2\hat{j}$



$B = 2.83 \quad (2\sqrt{2})$
 $\theta = 135^\circ$

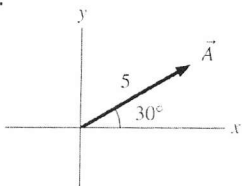
28. $\vec{C} = 3\hat{i} + \hat{j}$



$C = 3.16 \quad (\sqrt{10})$
 $\theta = 18.4^\circ$

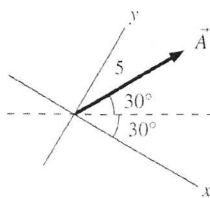
Exercises 29–31: Define vector $\vec{A} = (5, 30^\circ \text{ above the horizontal})$. Determine the components A_x and A_y in the three coordinate systems shown below. Show your work below the figure.

29.



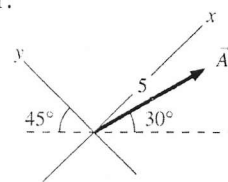
$A_x = 4.33$
 $A_y = 2.50$
 $A_x = 5 \cos(30^\circ)$
 $A_y = 5 \sin(30^\circ)$

30.



$A_x = 2.50$
 $A_y = 4.33$
 $A_x = 5 \cos(30^\circ + 30^\circ)$
 $A_y = 5 \sin(30^\circ + 30^\circ)$

31.



$A_x = 4.80$
 $A_y = -1.29$
 $A_x = 5 \cos(45^\circ - 30^\circ)$
 $A_y = -5 \sin(45^\circ - 30^\circ)$