1.9.3

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Question

$AOBC$ is a rectangle whose three vertices are $(0, -3)$ $(0, 0)$ $(4, 0)$.The length of its diagonal is__________

Theoretical Solution

Given the points $\mathbf{A}, \mathbf{O}$ and $\mathbf{B}$:

Point	**vector**
Point A	$\begin{pmatrix} 4 \\ 0 \end{pmatrix}$
Point O	$\begin{pmatrix} 0 \\ 0 \end{pmatrix}$
Point B	$\begin{pmatrix} 0 \\ -3 \end{pmatrix}$

Table: Position Vectors of the points on rectangle.

Theoretical Solution

Determining the Coordinates of Point C:

$$\mathbf{A} = \begin{pmatrix} 4 \\ 0 \end{pmatrix} \mathbf{B} = \begin{pmatrix} 0 \\ -3 \end{pmatrix} \tag{1}$$

Since $\mathbf{C}$ is opposite to $\mathbf{O}$ in the rectangle,

Formulae

$$\mathbf{C} = \mathbf{A} + \mathbf{B} \tag{2}$$

$$\implies \begin{pmatrix} 4 \\ 0 \end{pmatrix} + \begin{pmatrix} 0 \\ -3 \end{pmatrix} = \begin{pmatrix} 4 \\ -3 \end{pmatrix} \tag{3}$$

$$\therefore \mathbf{C} = \begin{pmatrix} 4 \\ -3 \end{pmatrix} \tag{4}$$

Theoretical solution

We know that the length of the diagonal vector is magnitude of the vector $\mathbf{C}$.

$$\mathbf{C} = \begin{pmatrix} 4 \\ -3 \end{pmatrix} \tag{5}$$

$$|\mathbf{C}| = \sqrt{\mathbf{C}^T \cdot \mathbf{C}} \tag{6}$$

Theoretical Solution

$$\mathbf{C}^T \cdot \mathbf{C} = \begin{pmatrix} 4 & -3 \end{pmatrix} \begin{pmatrix} 4 \\ -3 \end{pmatrix} = 4^2 + (-3)^2 = 16 + 9 = 25 \tag{7}$$

$$|\mathbf{C}| = \sqrt{25} = 5 \tag{8}$$

Therefore the lenght of the diagonal is 5.

C Code

```
    #include <stdio.h>
#include <math.h>

int main() {
    // Coordinates of points
    int x1 = 0, y1 = -3; // A
    int x2 = 4, y2 = 0; // B

    // Calculate diagonal length using distance formula
    double diagonal = sqrt(pow(x2 - x1, 2) + pow(y2 - y1, 2));

    printf(The length of the diagonal of rectangle AOBC is: %.2f\n, diagonal);

    return 0;
}
```

Python Code

```
import numpy as np
import matplotlib.pyplot as plt
import ctypes

# Function to compute the distance between two points using the
    distance formula
def distance(point1, point2):
    return np.sqrt((point2[0] - point1[0])**2 + (point2[1] -
        point1[1])**2)

# Define the coordinates of points A, B, and O
A = np.array([0.0, -3.0])
O = np.array([0.0, 0.0])
B = np.array([4.0, 0.0])
```

Python Code

```
# Calculate the coordinates of C (since AOBC is a rectangle)
C = np.array([4.0, -3.0])

# Calculate the length of the diagonal AC
diagonal_length = distance(A, C)

# Print the length of the diagonal
print(fThe length of the diagonal AC is {diagonal_length:.2f}
    units.)
```

Python Code

```
# Now, plot the rectangle and the diagonal
# Generate the rectangle's lines for plotting
rectangle_x = [A[0], O[0], B[0], C[0], A[0]]
rectangle_y = [A[1], O[1], B[1], C[1], A[1]]

plt.figure(figsize=(6, 6))
plt.plot(rectangle_x, rectangle_y, label='Rectangle AOBC', color=
    'blue')

# Plot points A, B, O, and C
points = np.array([A, O, B, C])
plt.scatter(points[:, 0], points[:, 1], color='red')
```

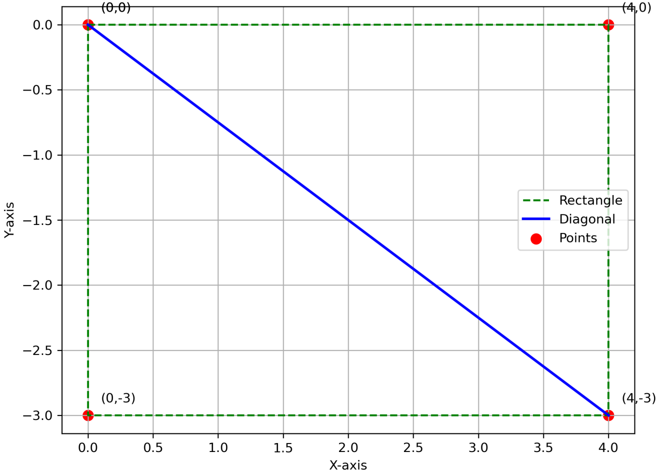
```
# Annotate points A, B, O, and C
point_labels = [f'A {tuple(A)}', f'O {tuple(O)}', f'B {tuple(B)}'
    , f'C {tuple(C)}']
for i, txt in enumerate(point_labels):
    plt.annotate(txt,
                 (points[i, 0], points[i, 1]),
                 textcoords=offset points,
                 xytext=(10, 5),
                 ha='center')
```

Python Code

```
# Set plot details
plt.xlabel('$x$')
plt.ylabel('$y$')
plt.title(f'Rectangle AOBC with diagonal AC = {diagonal_length:.2
    f}')
plt.grid(True)
plt.axis('equal')
plt.legend(loc='best')

# Save and show the plot
plt.savefig('../Figs/fig2.png')
plt.show()
```

Plot



(0,0)
(4,0)
(0,-3)
(4,-3)
Rectangle
Diagonal
Points
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
Y-axis
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
X-axis