1.3.5

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August 22,2025

Question

If $(3,3),(6,y),(x,7)$ and $(5,6)$ are the vertices of a parallelogram taken in order, find the values of x and y.

Theoretical Solution

Solution:

In a parallelogram, the diagonals bisect each other. Therefore, the midpoint of diagonal joining $(3, 3)$ and $(x, 7)$ is equal to the midpoint of diagonal joining $(6, y)$ and $(5, 6)$.

$$\mathbf{A} = \begin{pmatrix} 3 \\ 3 \end{pmatrix} \quad \mathbf{B} = \begin{pmatrix} 6 \\ y \end{pmatrix} \quad \mathbf{C} = \begin{pmatrix} x \\ 7 \end{pmatrix} \quad \mathbf{D} = \begin{pmatrix} 5 \\ 6 \end{pmatrix} \tag{1}$$

condition for the given points to form a parallelogram.

$$\mathbf{B} - \mathbf{A} = \mathbf{C} - \mathbf{D} \tag{2}$$

$$\mathbf{B} - \mathbf{A} = \begin{pmatrix} 3 \\ y - 3 \end{pmatrix} \quad \mathbf{C} - \mathbf{D} = \begin{pmatrix} x - 5 \\ 1 \end{pmatrix} \tag{3}$$

$\therefore x = 8, \; y = 4$

C Code

```c
#include <stdio.h>

int main() {
    int x, y;

    // Using midpoint property of diagonals of
       parallelogram
    x = 11 - 3;    // From (x+3)/2 = 11/2
    y = 10 - 6;    // From (y+6)/2 = 5

    printf( The values are: x = %d, y = %d\n , x, y);

    return 0;
}
```

Python Code

```
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D

# Given and solved coordinates
A = (3, 3, 0)
B = (6, 4, 0)    # y = 4
C = (8, 7, 0)    # x = 8
D = (5, 6, 0)

# Vertices in order, and close the parallelogram by
    repeating the first point
vertices = [A, B, C, D, A]

# Unpack coordinates
xs, ys, zs = zip(*vertices)

# Plotting
fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')
```

Python Code

```
# Plot the edges
ax.plot(xs, ys, zs, label='Parallelogram', color='blue
    ')

# Plot the points
ax.scatter(xs, ys, zs, color='red', s=50)

# Annotate each point
labels = ['A(3,3)', 'B(6,4)', 'C(8,7)', 'D(5,6)', 'A']
for i, (x, y, z) in enumerate(vertices):
    ax.text(x, y, z + 0.1, labels[i], fontsize=10)

# Setting labels
ax.set_xlabel('X')
ax.set_ylabel('Y')
ax.set_zlabel('Z')
ax.set_title('Parallelogram in 3D (Z=0)')
```

Python Code

```
    # Set the view angle for better 3D effect
ax.view_init(elev=20, azim=30)

# Save as PNG
plt.savefig('parallelogram_3d.png', dpi=300)
plt.show()
```

Plot