2.6.27

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Question

If A (-5,7),B(-4,-5),C(-1,-6) and D(4,5) are the vertices of a quadrilateral, find the area of quadrilateral ABCD.

Theoretical Solution

Solution:

Area of quadrilateral ABCD = The area of triangle ABC + The area of triangle ACD

Let $\mathbf{A}\begin{pmatrix}-5\\7\end{pmatrix}$, $\mathbf{B}\begin{pmatrix}-4\\-5\end{pmatrix}$, $\mathbf{C}\begin{pmatrix}-1\\-6\end{pmatrix}$, $\mathbf{D}\begin{pmatrix}4\\5\end{pmatrix}$ be vectors

$$\overrightarrow{AB} = \mathbf{B} - \mathbf{A} = \begin{pmatrix}1\\-12\end{pmatrix} \tag{1}$$

$$\overrightarrow{AC} = \mathbf{C} - \mathbf{A} = \begin{pmatrix}4\\-13\end{pmatrix} \tag{2}$$

$$\overrightarrow{AD} = \mathbf{D} - \mathbf{A} = \begin{pmatrix}9\\-2\end{pmatrix} \tag{3}$$

Theoretical Solution

$$ar(ABC) = \frac{1}{2} \|(\mathbf{B} - \mathbf{A}) \times (\mathbf{C} - \mathbf{A})\| = 17.5 \tag{4}$$

$$ar(ACD) = \frac{1}{2} \|(\mathbf{C} - \mathbf{A}) \times (\mathbf{D} - \mathbf{A})\| = 54.5 \tag{5}$$

Therefore area of quadrilateral ABCD = 17.5+54.5 = 72 sq. units

OR

Theoretical Solution

Area of quadrilateral ABCD $= \frac{1}{2}|d_1 \times d_2|$
where $d_1 = \overrightarrow{AC}$ and $d_2 = \overrightarrow{BD}$

$$\overrightarrow{AC} = \mathbf{C} - \mathbf{A} = \begin{pmatrix} 4 \\ -13 \end{pmatrix} \tag{6}$$

$$\overrightarrow{BD} = \mathbf{D} - \mathbf{B} = \begin{pmatrix} 8 \\ 10 \end{pmatrix} \tag{7}$$

$$ar(ABCD) = \frac{1}{2} \|(\mathbf{D} - \mathbf{B}) \times (\mathbf{C} - \mathbf{A})\| = 72 sq.units \tag{8}$$

C Code

```c
#include <stdio.h>
#include <stdlib.h>

struct Point {
    int x, y;
};

// Function to calculate the cross product (magnitude) of vectors
    u and v
int crossProduct(int ux, int uy, int vx, int vy) {
    return ux * vy - uy * vx;
}

// Function to calculate area of triangle given vertices p1, p2,
    p3 using vectors
double triangleArea(struct Point p1, struct Point p2, struct
    Point p3) {
```

C Code

```
    int ux = p2.x - p1.x;
    int uy = p2.y - p1.y;
    int vx = p3.x - p1.x;
    int vy = p3.y - p1.y;

    int cross = crossProduct(ux, uy, vx, vy);
    return abs(cross) / 2.0;
}

int main() {
    struct Point A = {-5, 7};
    struct Point B = {-4, -5};
    struct Point C = {-1, -6};
    struct Point D = {4, 5};
```

C Code

```
    // Calculate areas of triangles ABC and ACD
    double areaABC = triangleArea(A, B, C);
    double areaACD = triangleArea(A, C, D);

    // Total area of quadrilateral ABCD
    double areaABCD = areaABC + areaACD;

    printf("Area of quadrilateral ABCD = %.2f\n", areaABCD);

    return 0;
}
```

Python Code

```
import matplotlib.pyplot as plt

# Coordinates of the vertices
A = (-5, 7)
B = (-4, -5)
C = (-1, -6)
D = (4, 5)

# Extract x and y coordinates for plotting, closing the shape by
    returning to A
x = [A[0], B[0], C[0], D[0], A[0]]
y = [A[1], B[1], C[1], D[1], A[1]]

plt.figure(figsize=(8, 8))
plt.plot(x, y, 'b-o', label='Quadrilateral ABCD')

# Fill the quadrilateral for visualization
plt.fill(x, y, 'skyblue', alpha=0.4)
```

Python Code

```
# Label the vertices
for point, label in zip([A, B, C, D], ['A', 'B', 'C', 'D']):
    plt.text(point[0], point[1], label, fontsize=12, fontweight='
        bold',
            ha='right', color='darkblue')

plt.title('Quadrilateral ABCD')
plt.xlabel('X')
plt.ylabel('Y')
plt.grid(True)
plt.axis('equal')
plt.tight_layout()

# Save the plot as PNG file
plt.savefig('quadrilateral_ABCD.png', dpi=200)
plt.close()

print('Plot saved as quadrilateral_ABCD.png')
```

Plot

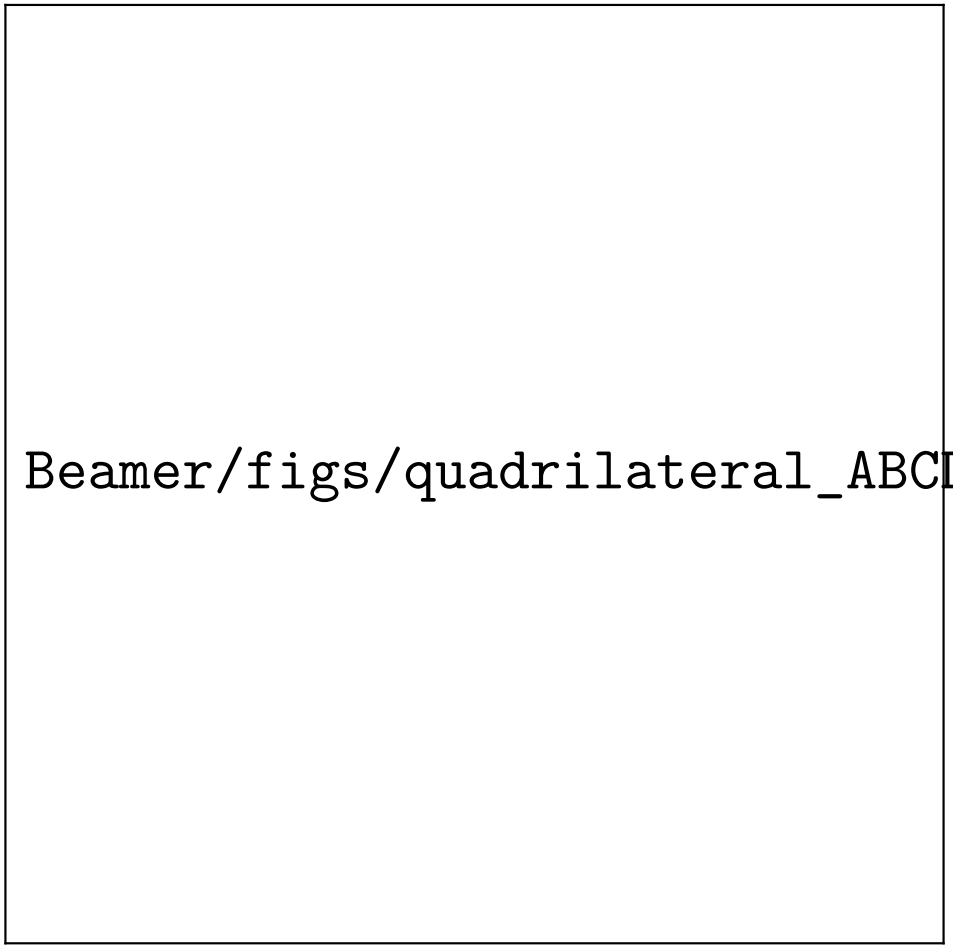

Figure: