

2.7.9

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Question

Find the area of the triangle whose vertices are $P(1, 0)$, $Q(2, 2)$ and $R(3, 1)$.

Theoretical Solution

Let us solve the given equation theoretically and then verify the solution computationally

According to the question,

Given three points

$$\mathbf{P} = \begin{pmatrix} 1 \\ 0 \end{pmatrix} \quad \mathbf{Q} = \begin{pmatrix} 2 \\ 2 \end{pmatrix} \quad \mathbf{R} = \begin{pmatrix} 3 \\ 1 \end{pmatrix} \quad (1)$$

$$\mathbf{Q} - \mathbf{P} = \begin{pmatrix} 1 \\ 2 \end{pmatrix} \quad (2)$$

$$\mathbf{R} - \mathbf{P} = \begin{pmatrix} 2 \\ 1 \end{pmatrix} \quad (3)$$

$$ar(PQR) = \frac{1}{2} \|(\mathbf{Q} - \mathbf{P}) \times (\mathbf{R} - \mathbf{P})\| \quad (4)$$

$$ar(PQR) = \frac{1}{2} \|(\mathbf{Q} - \mathbf{P}) \times (\mathbf{R} - \mathbf{P})\| = \frac{3}{2} \quad (5)$$

C Code

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

int main() {
    // Coordinates of the triangle
    int x1 = 1, y1 = 0;
    int x2 = 2, y2 = 2;
    int x3 = 3, y3 = 1;

    // Applying formula
    int determinant = x1*(y2 - y3) + x2*(y3 - y1) + x3*(y1 - y2);
    float area = 0.5 * abs(determinant);

    printf("Area of the triangle = %.2f\n", area);

    return 0;
}
```

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

# Vertices
P = np.array([1, 0])
Q = np.array([2, 2])
R = np.array([3, 1])

# Function to compute area using determinant formula
def triangle_area(A, B, C):
    return 0.5 * abs(A[0]*(B[1]-C[1]) + B[0]*(C[1]-A[1]) + C[0]*(
        A[1]-B[1]))

# Compute area
area = triangle_area(P, Q, R)
print("Area of triangle:", area)
```

```
# Plotting
x = [P[0], Q[0], R[0], P[0]] # closing the triangle
y = [P[1], Q[1], R[1], P[1]]

plt.figure(figsize=(6,6))
plt.plot(x, y, 'b-o', linewidth=2) # triangle edges
plt.fill(x, y, 'skyblue', alpha=0.5) # fill triangle

# Mark vertices
plt.text(P[0], P[1]-0.2, "P(1,0)", fontsize=12, ha="center")
plt.text(Q[0], Q[1]+0.2, "Q(2,2)", fontsize=12, ha="center")
plt.text(R[0], R[1]-0.2, "R(3,1)", fontsize=12, ha="center")
```

```
# Display area on plot
plt.title(f"Triangle PQR, Area = {area}")
plt.axis("equal")
plt.grid(True)

# Save figure
plt.savefig("triangle_area.png", dpi=300)
plt.show()
```


`figs/triangle_area.png`