2.2.26

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Find the area of the triangle formed by the points $P(-1.5, 3)$, $Q(6, -2)$ and $R(-3, 4)$.

Theoretical Solution

Given three points

$$\mathbf{P} = \begin{pmatrix} -1.5 \\ 3 \end{pmatrix} \ \mathbf{Q} = \begin{pmatrix} 6 \\ -2 \end{pmatrix} \ \mathbf{R} = \begin{pmatrix} -3 \\ 4 \end{pmatrix} \tag{1}$$

$$\mathbf{Q} - \mathbf{P} = \begin{pmatrix} 7.5 \\ -5 \end{pmatrix} \tag{2}$$

$$\mathbf{R} - \mathbf{P} = \begin{pmatrix} -1.5 \\ 1 \end{pmatrix} \tag{3}$$

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

$$ar(PQR) = \frac{1}{2} \left\| (\mathbf{Q} - \mathbf{P}) \times (\mathbf{R} - \mathbf{P}) \right\| = 0 \tag{5}$$

points are collinear

C Code

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

// Function to calculate area of triangle using cross product
double triangle_area(double P[2], double Q[2], double R[2]) {
    double x1 = Q[0] - P[0];
    double y1 = Q[1] - P[1];
    double x2 = R[0] - P[0];
    double y2 = R[1] - P[1];

    // Cross product magnitude in 2D
    double cross = fabs(x1 * y2 - y1 * x2);

    return 0.5 * cross;
}
```

```
int main() {
  double P[2] = {-1.5, 3};
  double Q[2] = {6, -2};
  double R[2] = {-3, 4};

  double area = triangle_area(P, Q, R);

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

  return 0;
}
```

Python Code

```python
import matplotlib.pyplot as plt #  Import first

# Coordinates of the points
P = (-1.5, 3)
Q = (6, -2)
R = (-3, 4)

# Function to calculate area of triangle
def triangle_area(p, q, r):
    x1, y1 = p
    x2, y2 = q
    x3, y3 = r
    return 0.5 * abs(x1*(y2-y3) + x2*(y3-y1) + x3*(y1-y2))

# Calculate area
area = triangle_area(P, Q, R)
print(fArea of triangle PQR = {area})
```

```python
# Plotting
plt.figure(figsize=(6,6))
x_vals = [P[0], Q[0], R[0], P[0]]
y_vals = [P[1], Q[1], R[1], P[1]]

plt.plot(x_vals, y_vals, 'b-o', label=fTriangle PQR (Area = {area
    }))
plt.scatter([P[0], Q[0], R[0]], [P[1], Q[1], R[1]], color='red')

# Annotate points
plt.text(P[0]+0.2, P[1], fP{P})
plt.text(Q[0]+0.2, Q[1], fQ{Q})
plt.text(R[0]+0.2, R[1], fR{R})
```

Python Code

```
plt.title(Triangle formed by P, Q, R)
plt.axhline(0, color='black', linewidth=0.5)
plt.axvline(0, color='black', linewidth=0.5)
plt.grid(True)
plt.legend()
plt.axis(equal)

# Save as picture
plt.savefig(triangle_pqr.png) # Saves in current folder
plt.show()
```

Plot

Area of Triangle PQR = 0.00