# 1.7.12

Rathlavath Jeevan-AI25BTECH11026

August 27,2025

# Question

Find the value of $k$, if the points $P(5, 4)$, $Q(7, k)$ and $R(9, -2)$ are collinear.

*Hint:* Three points $P(x_1, y_1)$, $Q(x_2, y_2)$, $R(x_3, y_3)$ are collinear if the area of the triangle formed by them is zero.

# Theoretical Solution

**Solution:**

$$\mathbf{A} = \begin{pmatrix} -3 \\ -14 \end{pmatrix}, \quad \mathbf{B} = \begin{pmatrix} a \\ -5 \end{pmatrix} \tag{1}$$

$$\|\mathbf{A} - \mathbf{B}\| = 9 \tag{2}$$

$$\implies \left\| \begin{pmatrix} -3 \\ -14 \end{pmatrix} - \begin{pmatrix} a \\ -5 \end{pmatrix} \right\| = 9 \tag{3}$$

$$\implies \left\| \begin{pmatrix} -3-a \\ -9 \end{pmatrix} \right\| = 9 \tag{4}$$

$$\implies (-3-a)^2 + (-9)^2 = 9^2 \tag{5}$$

$$(a+3)^2 + 81 = 81 \tag{6}$$

$$(a+3)^2 = 0 \tag{7}$$

# C Code

```c
#include <stdio.h>

int main() {
    int x1 = 5, y1 = 4;
    int x2 = 7, y2; // y2 = k
    int x3 = 9, y3 = -2;
    int k;

    // Equation: x1(y2 - y3) + x2(y3 - y1) + x3(y1 - y2) = 0
    // Substituting values
    // 5(k - (-2)) + 7((-2) - 4) + 9(4 - k) = 0
    // Solve manually inside program:

    // Simplified form: -4k + 4 = 0 => k = 1
    k = 1;
```

# C Code

```
    printf(The value of k is: %d\n, k);

    return 0;
}
```

# Python Code

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

# Points
x1, y1 = 5, 4
x2, y2 = 7, 1 # k = 1 (solution)
x3, y3 = 9, -2

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

# Python Code

```
# Plot the points in 3D (z = 0 for 2D points)
ax.scatter([x1, x2, x3], [y1, y2, y3], [0, 0, 0], c='r', s=100,
    label='Points')

# Draw line through the points
xs = np.array([x1, x2, x3])
ys = np.array([y1, y2, y3])
zs = np.array([0, 0, 0])
ax.plot(xs, ys, zs, label='Collinear Line')

# Labels and title
ax.set_xlabel('X axis')
ax.set_ylabel('Y axis')
ax.set_zlabel('Z axis')
ax.set_title('3D Visualization of Collinear Points')
ax.legend()
```

# Python Code

```
# Save plot as picture
plt.savefig(collinear_points.png, dpi=300)

# Show the plot
plt.show()

print(Graph saved as collinear_points.png)
```

# Plot