

## 1.4.19

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# Question

Show that the points **A**(1, −2, −8), **B**(5, 0, −2) and **C**(11, 3, 7) are collinear and find the ratio in which B divides AC.

given data

Point	x	y	z
<i>A</i>	1	-2	-8
<i>B</i>	5	0	-2
<i>C</i>	11	3	7

collinearity matrix can be expressed as

$$(B - A \quad C - A) = \begin{pmatrix} 4 & 10 \\ 2 & 5 \\ 6 & 15 \end{pmatrix}$$

# Row reduction

$$\begin{pmatrix} 4 & 10 \\ 2 & 5 \\ 6 & 15 \end{pmatrix} R_3 \leftarrow R_3 - (R_1 + R_2) \Rightarrow \begin{pmatrix} 4 & 10 \\ 2 & 5 \\ 0 & 0 \end{pmatrix}$$

$$\begin{pmatrix} 4 & 10 \\ 2 & 5 \\ 0 & 0 \end{pmatrix} R_2 \leftarrow R_2 - (R_1/2) \Rightarrow \begin{pmatrix} 4 & 10 \\ 0 & 0 \\ 0 & 0 \end{pmatrix}$$

$$\begin{pmatrix} 4 & 10 \\ 0 & 0 \\ 0 & 0 \end{pmatrix} R_1 \leftarrow R_1/4 \Rightarrow \begin{pmatrix} 1 & 2.5 \\ 0 & 0 \\ 0 & 0 \end{pmatrix}$$

Which is a Rank 1 matrix , Hence **A**(1, -2, -8), **B**(5, 0, -2) and **C**(11, 3, 7) are collinear.

# finding ratio

Section formula for a vector **B** which divides the line formed by vectors **A** and **C** in the ratio  $k:1$  is given by

$$\mathbf{B} = \frac{k\mathbf{C} + \mathbf{A}}{k + 1} \quad (1)$$

$$\begin{pmatrix} 5 \\ 0 \\ -2 \end{pmatrix} = \frac{\begin{pmatrix} 1 \\ -2 \\ -8 \end{pmatrix} + k \begin{pmatrix} 11 \\ 3 \\ 7 \end{pmatrix}}{1 + k} \quad (2)$$

$$\Rightarrow \begin{pmatrix} 5 \\ 0 \\ -2 \end{pmatrix} + k \begin{pmatrix} 5 \\ 0 \\ -2 \end{pmatrix} = \begin{pmatrix} 1 \\ -2 \\ -8 \end{pmatrix} + k \begin{pmatrix} 11 \\ 3 \\ 7 \end{pmatrix} \quad (3)$$

$$\Rightarrow \begin{pmatrix} 4 \\ 2 \\ 6 \end{pmatrix} = k \begin{pmatrix} 6 \\ 3 \\ 9 \end{pmatrix} \quad (4)$$

$$k = \frac{2}{3}$$

**B** which divides **AC** in the ratio 2:3

```
# Plotting points A(1, -2, -8), B(5, 0, -2), and C(11, 3, 7)

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

# Define the points as numpy arrays
A = np.array([1, -2, -8])
B = np.array([5, 0, -2])
C = np.array([11, 3, 7])
```



```
# Create a 3D plot
fig = plt.figure(figsize=(8, 6))
ax = fig.add_subplot(111, projection='3d')

# Plot the points
ax.scatter(*A, color='red', s=100, label='A(1, -2, -8)')
ax.scatter(*B, color='green', s=100, label='B(5, 0, -2)')
ax.scatter(*C, color='blue', s=100, label='C(11, 3, 7)')
```

```
# Plot line AC
ax.plot([A[0], C[0]], [A[1], C[1]], [A[2], C[2]], color='purple',
        label='Line AC')

# Annotate points
ax.text(*A, ' A', color='red', fontsize=10)
ax.text(*B, ' B', color='green', fontsize=10)
ax.text(*C, ' C', color='blue', fontsize=10)
```

```
# Set axes labels
ax.set_xlabel('X-axis')
ax.set_ylabel('Y-axis')
ax.set_zlabel('Z-axis')
ax.set_title('3D Plot of Points A, B, C and Line AC')
ax.legend()
ax.grid(True)

# Show the plot
plt.show()
```

```
#include <stdio.h>

int main(){
    double Ax = 1, Ay = -2, Az = -8;
    double Bx = 5, By = 0, Bz = -2;
    double Cx = 11, Cy = 3, Cz = 7;

    double kx = (Bx - Ax) / (Cx - Bx);
    double ky = (By - Ay) / (Cy - By);
    double kz = (Bz - Az) / (Cz - Bz);

    printf("%lf",kx);

    return 0;
}
```

```
import subprocess

# Compile the C program
subprocess.run(["gcc", "points.c", "-o", "points"])

# Run the compiled C program
result = subprocess.run(["./points"], capture_output=True, text=
    True)

# Print the output from the C program (solution steps for k=2/3)
print(result.stdout)
```

3D Plot of Points A, B, C and Line AC

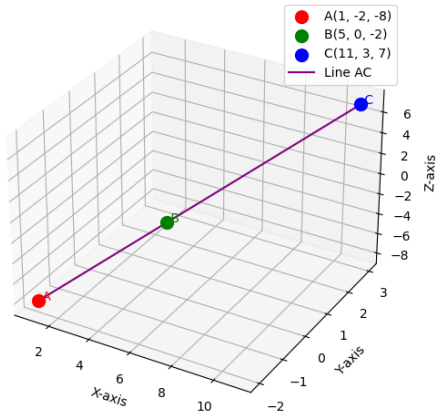


Figure: Plot