

5.8.13

Bhoomika V - EE25BTECH11015

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Question

Find the area of the triangle ABC whose vertices are $A(2, 5)$, $B(4, 7)$, $C(6, 2)$

Let the two numbers be x and y ($x > y$).
Define equations From the problem:

$$x - y = 26$$

$$x = 3y$$

Rewriting in standard form $Ax = b$:

$$\begin{cases} x - y = 26 \\ x - 3y = 0 \end{cases}$$

Matrices A and b

$$A = \begin{bmatrix} 1 & -1 \\ 1 & -3 \end{bmatrix}, \quad b = \begin{bmatrix} 26 \\ 0 \end{bmatrix}, \quad \mathbf{x} = \begin{bmatrix} x \\ y \end{bmatrix}$$

using RREF

So the system is:

$$A\mathbf{x} = b$$

Reduce A to RREF (only A)

Start with:

$$A = \begin{bmatrix} 1 & -1 \\ 1 & -3 \end{bmatrix}$$

Eliminate first column in row 2

$$R_2 \rightarrow R_2 - R_1 \implies \begin{bmatrix} 1 & -1 \\ 0 & -2 \end{bmatrix}$$

$$R_2 \rightarrow -\frac{1}{2}R_2 \implies \begin{bmatrix} 1 & -1 \\ 0 & 1 \end{bmatrix}$$

$$R_1 \rightarrow R_1 + R_2 \implies \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

So the RREF of A is the identity matrix:

$$\text{RREF}(A) = I_2 = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

Solve $A\mathbf{x} = \mathbf{b}$

Using the original \mathbf{b} :

$$\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 39 \\ 13 \end{bmatrix}$$

Thus:

$$x = 39, \quad y = 13$$

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```
#include <stdio.h>

// Function to solve the 2x2 system:
//  $x - y = 26$ 
//  $x - 3y = 0$ 
void solve_system(double* x, double* y) {
    double a1 = 1, b1 = -1, c1 = 26;
    double a2 = 1, b2 = -3, c2 = 0;

    double det = a1*b2 - a2*b1;
    if(det != 0) {
        *x = (c1*b2 - c2*b1)/det;
        *y = (a1*c2 - a2*c1)/det;
    } else {
        *x = 0;
        *y = 0;
    }
}
```


Python Code

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

# --- Load the C library ---
try:
    c_lib = ctypes.CDLL('./solve_system.so')
except OSError:
    print("Error: 'solve_system.so' not found. Compile using: gcc  
-shared -o solve_system.so -fPIC solve_system.c")
    exit()

# Define argument and return types
c_lib.solve_system.argtypes = [ctypes.POINTER(ctypes.c_double),
                                ctypes.POINTER(ctypes.c_double)]
c_lib.solve_system.restype = None
```

```
# Prepare variables for result
x = ctypes.c_double()
y = ctypes.c_double()

# --- Call C function ---
c_lib.solve_system(ctypes.byref(x), ctypes.byref(y))
x_val = x.value
y_val = y.value

print(f"Solution: x = {x_val}, y = {y_val}")

# --- Plotting in 2D ---
fig, ax = plt.subplots(figsize=(6,6))

# Define range for plotting
X = np.linspace(0, 50, 400)
```

Python Code

```
# Equations:  $y = x - 26$  and  $y = x / 3$ 
Y1 = X - 26
Y2 = X / 3

# Plot the lines
ax.plot(X, Y1, label=r'$x - y = 26$', color="blue")
ax.plot(X, Y2, label=r'$x - 3y = 0$', color="green")

# Plot the intersection point
ax.scatter(x_val, y_val, color="red", s=60, label=f'Solution ({
    x_val:.0f}, {y_val:.0f})')

# Labels for intersection
ax.text(x_val+0.5, y_val, f'({x_val:.0f}, {y_val:.0f})', color="
    red")
```

```
# Formatting
ax.set_xlabel("x-axis")
ax.set_ylabel("y-axis")
ax.set_title("Graphical Solution of 2x2 System")
ax.grid(True)
ax.legend()
ax.set_xlim(0, 50)
ax.set_ylim(0, 50)
ax.set_aspect("equal")

plt.show()
```

