MatGeo Assignment 1.2.13

AI25BTECH11007

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Question

Construct a triangle ABC in which

$$BC = 5\,\text{cm}, \quad \angle B = 45^\circ, \quad \text{and} \quad AC + AB = 7.5\,\text{cm}.$$

Solution

Using the cosine formula in $\triangle ABC$,

$$b^2 = a^2 + c^2 - 2ac\cos B \tag{1}$$

$$\Rightarrow (7.5 - c)^2 = 5^2 + c^2 - 2\cdot 5c\cos 60^\circ \tag{2}$$

$$\Rightarrow c = \frac{7.5^2 - 5^2}{2(7.5 - 5\cos 60^\circ)} \tag{3}$$

$$c = 3.125, \qquad b = 7.5 - 3.125 = 4.375.$$

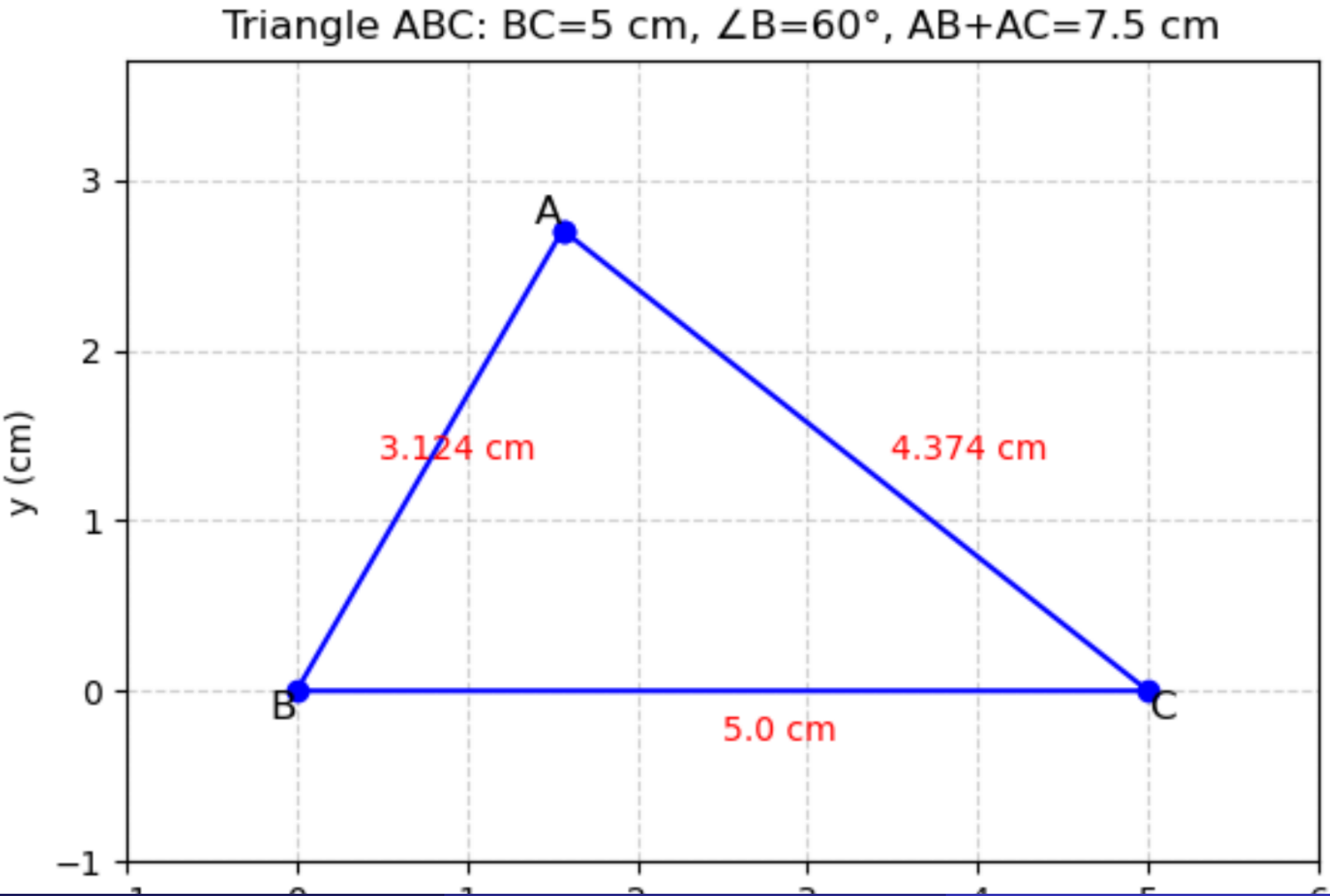
$$A = \begin{pmatrix} \frac{3.125\cos 60^\circ}{\sin 60^\circ} \\ \frac{3.125}{\sin 60^\circ} \end{pmatrix}, \quad B = \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \quad C = \begin{pmatrix} 5 \\ 0 \end{pmatrix}.$$

Solution

The coordinates of $\triangle ABC$ are

$$A = \begin{pmatrix} \frac{3.125}{\sqrt{3}} \\ \frac{6.25}{\sqrt{3}} \end{pmatrix} \approx \begin{pmatrix} 1.804 \\ 3.608 \end{pmatrix}, \quad B = \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \quad C = \begin{pmatrix} 5 \\ 0 \end{pmatrix}.$$

Construction Plot



C Code: Dot Product and Magnitude

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

int main(void) {
    /* Given data */
    double a = 5.0; /* BC */
    double K = 7.5; /* AC + AB = b + c */
    double cosB = 0.5; /* cos 60Âř */
    double sinB = sqrt(3.0) / 2.0; /* sin 60Âř */

    /* Formula from your solution */
    double c = (K*K - a*a) / (2.0 * (K - a * cosB));
    double b = K - c;

    /* Coordinates with B=(0,0), C=(a,0) */
    double Ax = (c * cosB) / sinB;
    double Ay = c / sinB;
```

C Code: Angle Calculation and Main

```c
printf("Computed values:\n");
    printf("c (AC) = %.6f\n", c);
    printf("b (AB) = %.6f\n", b);
    printf("A = (%.6f, %.6f)\n", Ax, Ay);
    printf("B = (0.000000, 0.000000)\n");
    printf("C = (%.6f, 0.000000)\n", a);

    return 0;
}
```

Python Code: Setup and Points

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

# Coordinates of vertices
A = np.array([1.5625, 2.705]) # Computed intersection
B = np.array([0, 0]) # Origin
C = np.array([5, 0]) # On x-axis
```

Python Code: Plot Triangle

```
fig, ax = plt.subplots()

# Plot the triangle edges
triangle_points = np.array([A, B, C, A])
ax.plot(triangle_points[:, 0], triangle_points[:, 1], 'b-',
    marker='o')

# Annotate vertices
ax.text(A[0], A[1], 'A', fontsize=12, ha='right', va='bottom')
ax.text(B[0], B[1], 'B', fontsize=12, ha='right', va='top')
ax.text(C[0], C[1], 'C', fontsize=12, ha='left', va='top')
```

Python Code: Final Touches and Save

```
# Formatting and labels
ax.set_aspect('equal', 'box')
ax.grid(True, linestyle='--', alpha=0.6)
ax.set_xlabel('x (cm)')
ax.set_ylabel('y (cm)')
ax.set_title('Triangle ABC: BC=5 cm, âĹăB=60Âř, AB+AC=7.5 cm')

# Axis limits with padding
padding = 1
min_x, max_x = min(A[0], B[0], C[0]) - padding, max(A[0], B[0], C
    [0]) + padding
min_y, max_y = min(A[1], B[1], C[1]) - padding, max(A[1], B[1], C
    [1]) + padding
ax.set_xlim(min_x, max_x)
ax.set_ylim(min_y, max_y)

# Save and display
plt.savefig('triangle_plot.png', dpi=300)
plt.show()
```