

## 2.7.27

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# Question

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

# The vertices of a triangle

Point	Vector
<b>A</b>	$\begin{bmatrix} 2 \\ 5 \\ 0 \end{bmatrix}$
<b>B</b>	$\begin{bmatrix} 4 \\ 7 \\ 0 \end{bmatrix}$
<b>C</b>	$\begin{bmatrix} 6 \\ 2 \\ 0 \end{bmatrix}$

Table: Vectors

# The sides of the triangle

$$(\mathbf{A} - \mathbf{B}) = \begin{bmatrix} 2 \\ 5 \\ 0 \end{bmatrix} - \begin{bmatrix} 4 \\ 7 \\ 0 \end{bmatrix} = \begin{bmatrix} -2 \\ -2 \\ 0 \end{bmatrix}, \quad (1)$$

$$(\mathbf{A} - \mathbf{C}) = \begin{bmatrix} 2 \\ 5 \\ 0 \end{bmatrix} - \begin{bmatrix} 6 \\ 2 \\ 0 \end{bmatrix} = \begin{bmatrix} -4 \\ 3 \\ 0 \end{bmatrix}. \quad (2)$$

# Cross product

Using (1) and (2) The magnitude of the cross product is

$$\|(\mathbf{A} - \mathbf{B}) \times (\mathbf{A} - \mathbf{C})\| = \sqrt{0^2 + 0^2 + (-14)^2} = 14. \quad (3)$$

Therefore the area of triangle  $ABC$  is

$$\text{ar}(\triangle ABC) = \frac{1}{2} \|(\mathbf{A} - \mathbf{B}) \times (\mathbf{A} - \mathbf{C})\| = \frac{1}{2} \times 14 = 7. \quad (4)$$

# C Code - A function to find if triangle is right angled

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

// Function to compute area of triangle using cross product
float triangle_area(float Ax, float Ay, float Az,
                   float Bx, float By, float Bz,
                   float Cx, float Cy, float Cz) {
    // Vectors AB and AC
    float ABx = Bx - Ax;
    float ABy = By - Ay;
    float ABz = Bz - Az;

    float ACx = Cx - Ax;
    float ACy = Cy - Ay;
    float ACz = Cz - Az;
```

## C Code - A function to find if triangle is right angled

```
// Cross product AB AC
float cross_x = ABy*ACz - ABz*ACy;
float cross_y = ABz*ACx - ABx*ACz;
float cross_z = ABx*ACy - ABy*ACx;

// Area = 0.5 * |cross product|
float area = 0.5 * sqrt(cross_x*cross_x + cross_y*cross_y +
    cross_z*cross_z);

printf("Area of triangle ABC = %.2f\n", area);
return area;
}
```



# Python Code

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

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

# Define argument and return types
c_lib.triangle_area.argtypes = [ctypes.c_float, ctypes.c_float,  
                                ctypes.c_float,  
                                ctypes.c_float, ctypes.c_float,  
                                ctypes.c_float, ctypes.c_float,  
                                ctypes.c_float, ctypes.c_float,
```

# Python Code

```
# --- Given points (2D extended to 3D with z=0) ---
A = np.array([2, 5, 0], dtype=np.float32)
B = np.array([4, 7, 0], dtype=np.float32)
C = np.array([6, 2, 0], dtype=np.float32)

# --- Call C function ---
area = c_lib.triangle_area(A[0], A[1], A[2],
                           B[0], B[1], B[2],
                           C[0], C[1], C[2])
print(f" Area of triangle = {area:.2f}")

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

# Python Code

```
# Plot triangle edges
ax.plot([A[0], B[0]], [A[1], B[1]], color="black")
ax.plot([B[0], C[0]], [B[1], C[1]], color="black")
ax.plot([C[0], A[0]], [C[1], A[1]], color="black")

# Fill triangle
ax.fill([A[0], B[0], C[0]], [A[1], B[1], C[1]], color="cyan",
        alpha=0.3)

# Points
ax.scatter(A[0], A[1], color="red", s=60)
ax.scatter(B[0], B[1], color="blue", s=60)
ax.scatter(C[0], C[1], color="green", s=60)

# Labels
ax.text(A[0]+0.1, A[1], "A(2,5)", color="red")
ax.text(B[0]+0.1, B[1], "B(4,7)", color="blue")
ax.text(C[0]+0.1, C[1], "C(6,2)", color="green")
```

```
# Area annotation
ax.text(3.5, 4.5, f"Area = {area:.2f}", color="purple", fontsize
       =12)

# Formatting
ax.set_xlabel("X-axis")
ax.set_ylabel("Y-axis")
ax.set_title("Triangle ABC in 2D plane")
ax.grid(True)
ax.set_aspect("equal")

plt.show()
```

# Plot

