2.6.37

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Question

The vector from origin to the points A and B are

$$\mathbf{a} = 2\hat{i} - 3\hat{j} + 2\hat{k} \quad \text{and} \quad \mathbf{b} = 2\hat{i} + 3\hat{j} + \hat{k}, \tag{1}$$

respectively, then the area of $\triangle OAB$ is _____.

Theoretical Solution

Solution:
Given

$$\mathbf{a} = \begin{pmatrix} 2 \\ -3 \\ 2 \end{pmatrix}, \quad \mathbf{b} = \begin{pmatrix} 2 \\ 3 \\ 1 \end{pmatrix}, \quad \mathbf{B} - \mathbf{A} = \mathbf{b} - \mathbf{a}. \tag{2}$$

$$\text{Area}(\triangle OAB) = \frac{1}{2}\|\mathbf{a} \times \mathbf{b}\| \tag{3}$$

$$= \frac{1}{2}\left\|-9\,\hat{i} + 2\,\hat{j} + 12\,\hat{k}\right\| = \frac{1}{2}\sqrt{(-9)^2 + 2^2 + 12^2} = \frac{\sqrt{229}}{2} \tag{4}$$

C Code

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

int main() {
    // Vectors a and b
    double ax = 2, ay = -3, az = 2;
    double bx = 2, by = 3, bz = 1;

    // Cross product a * b
    double cx = ay*bz - az*by;
    double cy = az*bx - ax*bz;
    double cz = ax*by - ay*bx;

    // Magnitude of cross product
    double magnitude = sqrt(cx*cx + cy*cy + cz*cz);
```

C Code

```c
// Area of triangle OAB
    double area = 0.5 * magnitude;

    printf(The area of triangle OAB is: %.2f\n, area);

    return 0;
}
```

Python Code

```
import numpy as np
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d.art3d import Poly3DCollection

# Vectors
a = np.array([2, -3, 2])
b = np.array([2, 3, 1])

# Cross product and area
cross = np.cross(a, b)
area = 0.5 * np.linalg.norm(cross)
print(Area of triangle OAB:, area)

# Points
origin = np.array([0, 0, 0])
A = a
B = b
```

Python Code

```
    # Create 3D plot
fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')
# Plot vectors a and b
ax.quiver(0, 0, 0, a[0], a[1], a[2], color='r', label='a =
    (2,-3,2)')
ax.quiver(0, 0, 0, b[0], b[1], b[2], color='b', label='b =
    (2,3,1)')

# Draw triangle OAB
verts = [[origin, A, B]]
ax.add_collection3d(Poly3DCollection(verts, alpha=0.3, facecolor=
    'cyan'))

# Labels and legend
ax.set_xlabel('X')
ax.set_ylabel('Y')
ax.set_zlabel('Z')
```

Python Code

```
    ax.legend()
# Set equal aspect ratio
ax.set_box_aspect([1,1,1])

# Save figure as image
plt.savefig(triangle_OAB.png, dpi=300)
plt.show()
```

Plot