1.10.11

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Question

Find a vector of magnitude 5 units, and parallel to the resultant of the vectors $\mathbf{a} = 2\hat{i} + 3\hat{j} - \hat{k}$ and $\mathbf{b} = \hat{i} - 2\hat{j} + \hat{k}$.

Variables used

Vector	Matrix
$\begin{pmatrix} 2 \\ 3 \\ -1 \end{pmatrix}$	a
$\begin{pmatrix} 1 \\ -2 \\ 1 \end{pmatrix}$	b

Table: Variables Used

Solution

$$\mathbf{a} = \begin{bmatrix} 2 \\ 3 \\ -1 \end{bmatrix}, \quad \mathbf{b} = \begin{bmatrix} 1 \\ -2 \\ 1 \end{bmatrix}$$

Resultant Vector is,

$$\mathbf{R} = \mathbf{a} + \mathbf{b} = \begin{bmatrix} 2 \\ 3 \\ -1 \end{bmatrix} + \begin{bmatrix} 1 \\ -2 \\ 1 \end{bmatrix} = \begin{bmatrix} 3 \\ 1 \\ 0 \end{bmatrix} \tag{1}$$

Magnitude of Resultant vector is,

$$|R| = \sqrt{3^2 + 1^2 + 0^2} = \sqrt{9 + 1} = \sqrt{10} \tag{2}$$

Solution

Unit Vector Parallel to Resultant is,

$$\hat{R} = \frac{1}{\sqrt{10}} \begin{bmatrix} 3 \\ 1 \\ 0 \end{bmatrix} \tag{3}$$

Scale to Magnitude 5,

$$\mathbf{v} = 5 \cdot \hat{R} = 5 \cdot \frac{1}{\sqrt{10}} \begin{bmatrix} 3 \\ 1 \\ 0 \end{bmatrix} = \begin{bmatrix} \frac{15}{\sqrt{10}} \\ \frac{5}{\sqrt{10}} \\ 0 \end{bmatrix} \tag{4}$$

Therefore,

$$\mathbf{v} = \begin{bmatrix} \frac{15}{\sqrt{10}} \\ \frac{5}{\sqrt{10}} \\ 0 \end{bmatrix} \tag{5}$$

is a matrix with magnitude 5 parallel to the resultant vector.

Python

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

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

# Resultant vector: a + b
r = a + b

# Magnitude of resultant
mag_r = np.linalg.norm(r)

# Unit vector in direction of resultant
unit_r = r / mag_r
```

Python

```
# Vector of magnitude 5, parallel to r
res = 5 * unit_r

fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')
# Origin
origin = np.array([0, 0, 0])

# Plot vectors
ax.quiver(*origin, *a, color='r', label='a', linewidth=2)
ax.quiver(*origin, *b, color='g', label='b', linewidth=2)
ax.quiver(*origin, *res, color='b', label='Resultant (Mag 5)',
    linewidth=2)
```

Python

```
# Axes labels
ax.set_xlim([0, 5])
ax.set_ylim([0, 5])
ax.set_zlim([-2, 2])
ax.set_xlabel('X')
ax.set_ylabel('Y')
ax.set_zlabel('Z')

# Add legend
ax.legend()

plt.title('graph')
plt.savefig(graph.png)
plt.show()
```

C Code

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

int main() {
    // Given vectors
    double a[3] = {2, 3, -1};
    double b[3] = {1, -2, 1};
    double r[3], mag_r, unit_r[3], result[3];
    int i;

    // Calculate resultant r = a + b
    for(i = 0; i < 3; i++)
        r[i] = a[i] + b[i];
```

C Code

```
// Magnitude of r
mag_r = sqrt(r[0]*r[0] + r[1]*r[1] + r[2]*r[2]);

// Unit vector in direction of r
for(i = 0; i < 3; i++)
    unit_r[i] = r[i] / mag_r;

// Vector of magnitude 5, parallel to r
for(i = 0; i < 3; i++)
    result[i] = 5 * unit_r[i];

// Print result
printf(Vector of magnitude 5, parallel to resultant: );
printf((%.4lf) i + (%.4lf) j + (%.4lf) k\n, result[0], result
    [1], result[2]);

return 0;
 }
```

Python and C Code

```
 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)
print(result.stdout)
```

Graph

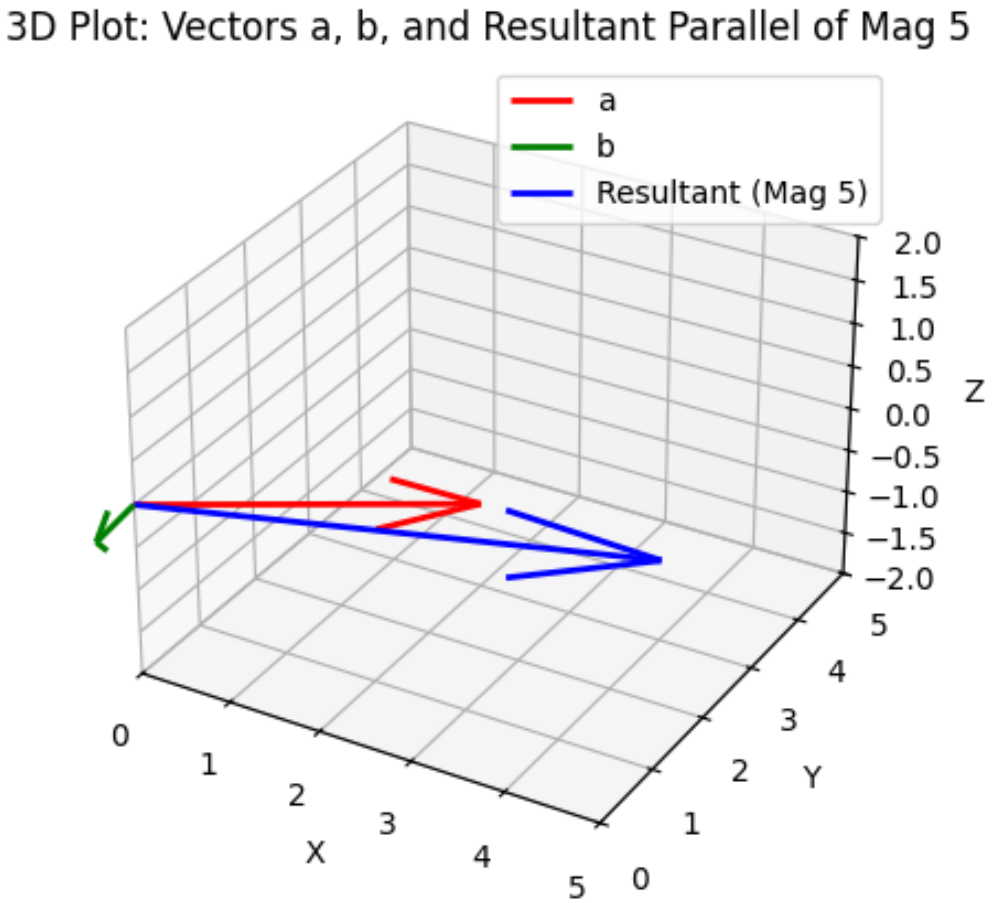

Figure: