1.2.23 – Matgeo Assignment

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Question

Represent graphically a displacement of $40\,\text{km}$, 30° west of south.

Coordinate Convention

We choose the coordinate axes as:

$$\text{East} \equiv +x, \quad \text{West} \equiv -x, \quad \text{North} \equiv +y, \quad \text{South} \equiv -y.$$

The unit column for South is

$$\mathbf{s} = \begin{bmatrix} 0 \\ -1 \end{bmatrix}.$$

Rotation Matrix

For rotation by angle θ anti clockwise,

$$R(\theta) = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}.$$

Since "30° west of south" means clockwise rotation of 30° or anti-clockwise roation of 330°,we apply

$$\mathbf{u} = R(330^\circ)\mathbf{s}.$$

Direction Column

$$\mathbf{u} = \begin{bmatrix} \cos 330^\circ & -\sin 330^\circ \\ \sin 330^\circ & \cos 330^\circ \end{bmatrix} \begin{bmatrix} 0 \\ -1 \end{bmatrix} = \begin{bmatrix} -\frac{1}{2} \\ -\frac{\sqrt{3}}{2} \end{bmatrix}.$$

Displacement Column

With magnitude 40 km:

$$\mathbf{d} = 40\mathbf{u} = 40\begin{bmatrix} -\frac{1}{2} \\ -\frac{\sqrt{3}}{2} \end{bmatrix} = \begin{bmatrix} -20 \\ -20\sqrt{3} \end{bmatrix} \text{ km.}$$

Endpoint:

$$(x, y) = (-20,\ -20\sqrt{3}) \text{ km.}$$

Graphical Representation

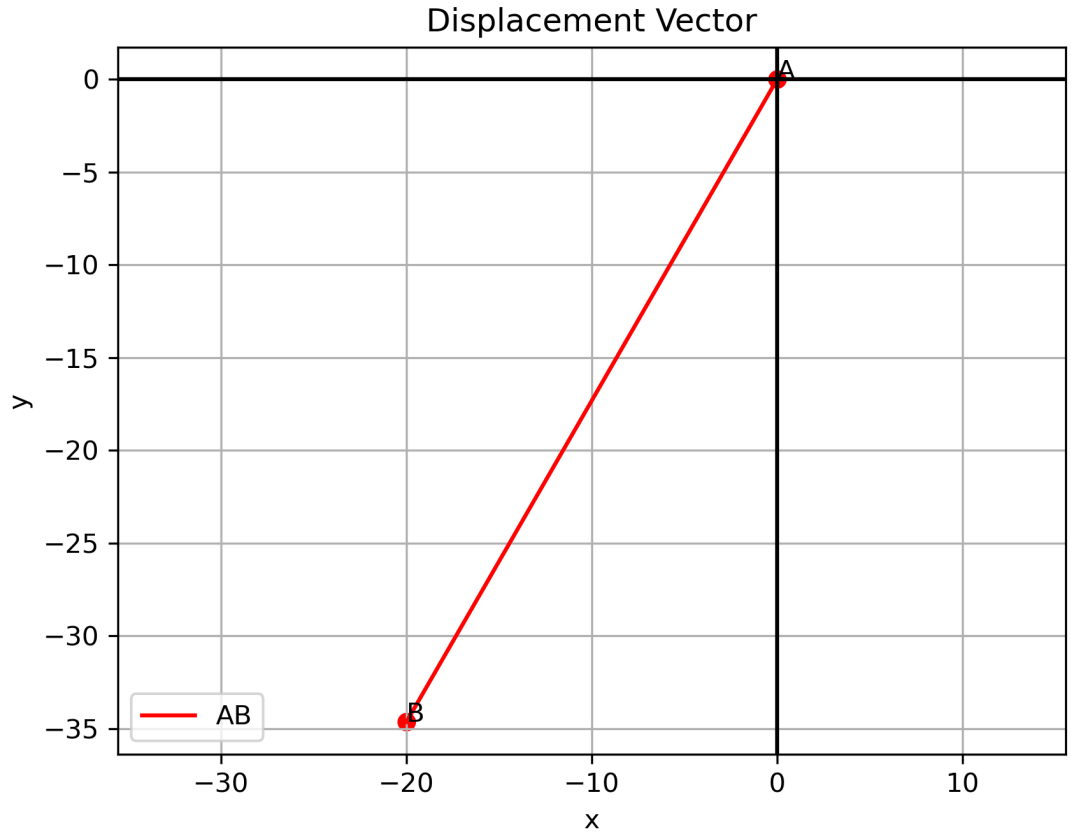

Figure: Displacement vector: 40 km, 30° west of south

C Code

```c
#include <stdio.h>
#include <stdlib.h>
#include <math.h>
#include "libs/matfun.h"

int main() {

    /* This code calculates 30 degrees west of south */

    // Create 2x2 rotation matrix
    double **R = rotMat(-M_PI/6);
    // Create 2x1 south vector (column vector)
    double **v = createMat(2, 1);
    v[0][0] = 0;
    v[1][0] = -1;

    // Multiply: (2x2) * (2x1) = (2x1)
    double **rotated = Matmul(R, v, 2, 2, 1);

    // Print result
    printf("Rotated vector: (%.4f, %.4f)\n", rotated[0][0], rotated
        [1][0]);
```

C Code

```
    FILE *fp = fopen("var.dat", "w");
    if (fp != NULL) {
        fprintf(fp, "%.4f\n%.4f\n", rotated[0][0], rotated[1][0]);
        fclose(fp);
    } else {
        printf("Error opening file for writing.\n");
    }

    return 0;
}
```

Python Code

```
import matplotlib.pyplot as plt
import numpy as np
# Code by M SAI RITHIK
# 1.2.23 Represent graphically a displacement
# of 40 km, 30    west of south.
# ( 20 ,  20    3 )

coords = np.loadtxt('var.dat', delimiter=' ')
point = np.array(coords) * 40


origin = np.array([0,0])

vec = np.array([origin,point])


plt.plot(vec[:,0], vec[:,1], color="red",label="AB")
plt.scatter(vec[:,0], vec[:,1],color = "red")
plt.title("Displacement Vector")

plt.text(vec[0,0],vec[0,1],"A")
plt.text(vec[1,0],vec[1,1],"B")
```

Python Code

```
plt.axhline(0, color='black')    # x-axis
plt.axvline(0, color='black')    # y-axis
plt.xlabel("x")
plt.ylabel("y")
plt.grid(True)
plt.axis("equal")
plt.legend(loc="best")
plt.show()
plt.savefig('../figs/fig.png', dpi=300)
```