

2.10.33

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# Question

Let  $\alpha, \beta, \gamma$  be distinct real numbers. The points with position vectors  $\alpha\hat{i} + \beta\hat{j} + \gamma\hat{k}$ ,  $\beta\hat{i} + \gamma\hat{j} + \alpha\hat{k}$ ,  $\gamma\hat{i} + \alpha\hat{j} + \beta\hat{k}$ :

- ① are collinear
- ② form an equilateral triangle
- ③ form a scalene triangle
- ④ form a right angled triangle

# Solution

To answer this question, we need to find the distance between each of these points.

Let **A** be  $\begin{pmatrix} \alpha \\ \beta \\ \gamma \end{pmatrix}$ , **B** be  $\begin{pmatrix} \beta \\ \gamma \\ \alpha \end{pmatrix}$ , and **C** be  $\begin{pmatrix} \gamma \\ \alpha \\ \beta \end{pmatrix}$ .

$$\mathbf{A} - \mathbf{B} \text{ is } \begin{pmatrix} \alpha - \beta \\ \beta - \gamma \\ \gamma - \alpha \end{pmatrix} \quad (1)$$

$$\mathbf{B} - \mathbf{C} \text{ is } \begin{pmatrix} \beta - \gamma \\ \gamma - \alpha \\ \alpha - \beta \end{pmatrix} \quad (2)$$

$$\mathbf{C} - \mathbf{A} \text{ is } \begin{pmatrix} \gamma - \alpha \\ \alpha - \beta \\ \beta - \gamma \end{pmatrix} \quad (3)$$

# Solution

Then  $\|\mathbf{A} - \mathbf{B}\|$ ,  $\|\mathbf{B} - \mathbf{C}\|$ ,  $\|\mathbf{C} - \mathbf{A}\|$  are all equal, and equal to

$$\sqrt{(\alpha - \beta)^2 + (\beta - \gamma)^2 + (\gamma - \alpha)^2}$$

The three points therefore form an equilateral triangle, so option (2) is correct.

# Python Code

```
import numpy as np

vector = np.zeros(3)
vector[0] = input()
vector[1] = input()
vector[2] = input()

print(np.linalg.norm(vector))
```

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

float norm(float a, float b, float c){

float answer;
answer = pow(a,2) + pow(b,2) + pow(c,2);
answer = sqrt(answer);

return answer;

}
```

# Python and C Code

```
import numpy as np
import ctypes
c_lib=ctypes.CDLL('./5c.so')

c_lib.norm.argtypes = [ctypes.c_float, ctypes.c_float, ctypes.c_float]
c_lib.norm.restype = ctypes.c_float

vector = np.zeros(3)
vector[0] = input()
vector[1] = input()
vector[2] = input()

answer = c_lib.norm(
    ctypes.c_float(vector[0]),
    ctypes.c_float(vector[1]),
    ctypes.c_float(vector[2]))
print(answer)
```