# 2.8.15

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# Question

Find the position vector of a point **A** in space such that **OA** is inclined at 60° with **OX** and 45° to **OY** and $\left|\mathbf{OA}\right| = 10$units.

# Theoretical Solution

Given,

$$\|\mathbf{OA}\| = 10 \text{ , Angle with } x\text{-axis} = 60^\circ \text{ and } y\text{-axis } = 45^\circ \tag{1}$$

# Theory

If $l$ , $m$ and $n$ are the direction cosines of a given vector then ,

$$l^2 + m^2 + n^2 = 1 \tag{2}$$

# Theoretical Solution

$$\mathbf{OA} = \|\mathbf{OA}\| \begin{pmatrix} l \\ m \\ n \end{pmatrix} \tag{3}$$

$$l = \cos 60^\circ = \frac{1}{2}, m = \cos 45^\circ = \frac{1}{\sqrt{2}} \tag{4}$$

# Theoretical Solution

$$l^2 + m^2 + n^2 = 1 \tag{5}$$

$$\implies \frac{1}{4} + \frac{1}{2} + n^2 = 1 \tag{6}$$

$$\implies n = \pm\frac{1}{2} \tag{7}$$

$$\mathbf{OA} = 10 \begin{pmatrix} \frac{1}{2} \\ \frac{1}{\sqrt{2}} \\ \pm\frac{1}{2} \end{pmatrix} \tag{8}$$

$$\mathbf{OA} = \begin{pmatrix} 5 \\ 5\sqrt{2} \\ +5 \end{pmatrix} \text{ or } \mathbf{OA} = \begin{pmatrix} 5 \\ 5\sqrt{2} \\ -5 \end{pmatrix} \tag{9}$$

# C Code (1)

```c

#include <math.h>
double calc(double l , double m)
{
    double n = sqrt(1 - pow(l,2) - pow(m,2));
    return n ;
}
```

# C Code (2)

```c
void linegen(double *X, double *Y , double *Z , double *A ,
    double *B , int n , int m )
{
    double temp[m] ;
    for (int i = 0 ; i < m ; i++)
    {
        temp [ i ] = (B[i]- A[i]) /(double) n ;
    }
    for (int i = 0 ; i <= n ; i++ )
    {
        X[i] = A[0] + temp[0] * i ;
        Y[i] = A[1] + temp[1] * i ;
        Z[i] = A[2] + temp[2] * i ;
    }
}
```

# Python Code - Using Shared Object

```python
import ctypes
import numpy as np
import matplotlib.pyplot as plt
handc1 = ctypes.CDLL("./func.so")

handc1.calc.argtypes=[
    ctypes.c_double,
    ctypes.c_double
]
l = np.cos(np.deg2rad(60))
m = np.cos(np.deg2rad(45))

handc1.calc.restype = ctypes.c_double

n = handc1.calc(l , m)
```

# Python Code - Using Shared Object

```python
def line_cre(P: np.ndarray , Q: np.ndarray, str):
    handc2 = ctypes.CDLL("./line_gen.so")

    handc2.linegen.argtypes = [
        ctypes.POINTER(ctypes.c_double),
        ctypes.POINTER(ctypes.c_double),
        ctypes.POINTER(ctypes.c_double),
        ctypes.POINTER(ctypes.c_double),
        ctypes.POINTER(ctypes.c_double),
        ctypes.c_int , ctypes.c_int
    ]

    handc2.linegen.restype = None
```

# Python Code - Using Shared Object

```
n = 200
X_l = np.zeros(n,dtype=np.float64)
Y_l = np.zeros(n,dtype=np.float64)
Z_l = np.zeros(n,dtype=np.float64)
handc2.linegen (
    X_l.ctypes.data_as(ctypes.POINTER(ctypes.c_double)),
    Y_l.ctypes.data_as(ctypes.POINTER(ctypes.c_double)),
    Z_l.ctypes.data_as(ctypes.POINTER(ctypes.c_double)),
    P.ctypes.data_as(ctypes.POINTER(ctypes.c_double)),
    Q.ctypes.data_as(ctypes.POINTER(ctypes.c_double)),
    n,2
)
ax.plot([X_l[0],X_l[-1]],[Y_l[0],Y_l[-1]],[Z_l[0],Z_l[-1]],
    str)
```

# Python Code - Using Shared Object

```

A1 = 10 * np.array([[l],[m],[n]],dtype=np.float64).reshape(-1,1)
A2 = 10 * np.array([[l],[m],[-n]], dtype= np.float64).reshape
    (-1,1)
B = np.array([[0],[0],[0]]).reshape(-1,1)
fig = plt.figure()
ax = fig.add_subplot(111,projection="3d")

line_cre(A1,B,"g-")
line_cre(A2,B,"r-")

coords = np.block([[A1,A2,B]])
ax.scatter(coords[0,:],coords[1,:],coords[2,:])
vert_labels = [r'$A_1$',r'$A_2$','O']
```

# Python Code - Using Shared Object

```python
for i, txt in enumerate(vert_labels):
    if (coords[0,i] == 0 ) :
        ax.text(coords[0,i], coords[1,i] , coords[2,i],txt , ha='center', va = 'bottom')
    else :
        ax.text(coords[0,i], coords[1,i] , coords[2,i],f'{txt}\n({coords[0,i]:.1f}, {coords[1,i]:.1f}, {coords[2,i]:.1f})',ha='center', va = 'bottom')
ax.scatter(coords[0,2], coords[1,2], coords[2,2], color="b", label="O : ORIGIN")
ax.legend(loc = "best")
ax.set_xlabel('$x$')
ax.set_ylabel('$y$')
ax.set_zlabel('$z$')
```

# Python Code - Using Shared Object

```python
ax.grid()
ax.set_xlim([-2, 7])
ax.set_ylim([-2,8])
ax.set_zlim([-6,6])
plt.title("Fig:2.8.15")
#ax.set_box_aspect([1,1,1])

fig.savefig("../figs/vector1.png")
fig.show()

#plt.savefig('figs/triangle/ang-bisect.pdf')
#subprocess.run(shlex.split("termux-open figs/triangle/ang-bisect.pdf"))
```

# Python Code

```python
import math
import sys
sys.path.insert(0, '/home/kartik-lahoti/matgeo/codes/CoordGeo')
import numpy as np
import numpy.linalg as LA
import matplotlib.pyplot as plt
import matplotlib.image as mpimg

from line.funcs import *
#from triangle.funcs import *
#from conics.funcs import circ_gen


#if using termux
#import subprocess
#import shlex
```

# Python Code

```

l = np.cos(np.deg2rad(60))
m = np.cos(np.deg2rad(45))
n = np.sqrt(1 - l**2 - m**2)

A1 = 10 * np.array([l,m,n]).reshape(-1,1)
A2 = 10 * np.array([l,m,-n]).reshape(-1,1)
O = np.array([0,0,0]).reshape(-1,1)

def plot_it(P,Q,str):
    x_l = line_gen_num(P,Q,20)
    ax.plot(x_l[0,:],x_l[1,:],x_l[2,:] , str )

fig = plt.figure()
ax = fig.add_subplot(111,projection = "3d")

plot_it(A1,O,"g-")
plot_it(A2,O,"r-")
```

# Python Code

```
coords = np.block([[A1,A2,O]])
plt.scatter(coords[0,:],coords[1,:],coords[2,:])
vert_labels = [r'$A_1$',r'$A_2$','O']
for i, txt in enumerate(vert_labels):
    if (coords[0,i] == 0 ) :
        ax.text(coords[0,i], coords[1,i] , coords[2,i],txt , ha='
            center', va = 'bottom')
    else :
        ax.text(coords[0,i], coords[1,i] , coords[2,i],f'{txt}\n
            ({coords[0,i]:.1f}, {coords[1,i]:.1f}, {coords[2,i]:.1
            f})',ha='center', va = 'bottom')

ax.scatter(coords[0,2], coords[1,2], coords[2,2], color="b",
    label="O : ORIGIN")
ax.legend(loc = "best")
```

# Python Code

```python

ax.set_xlabel('$x$')
ax.set_ylabel('$y$')
ax.set_zlabel('$z$')
ax.grid()
ax.set_xlim([-2, 7])
ax.set_ylim([-2,8])
ax.set_zlim([-6,6])
plt.title("Fig:2.8.15")
#ax.set_box_aspect([1,1,1])

fig.savefig("../figs/vector2.png")
fig.show()
#plt.savefig('figs/triangle/ang-bisect.pdf')
#subprocess.run(shlex.split("termux-open figs/triangle/ang-bisect
    .pdf"))
```

# Plot

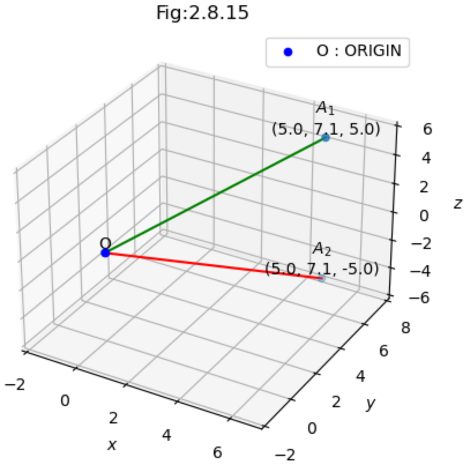
Fig:2.8.15
● O : ORIGIN
$A_1$
(5.0, 7.1, 5.0)
$A_2$
(5.0, 7.1, -5.0)
O
x
y
z
−2
0
2
4
6
−2
0
2
4
6
8
−6
−4
−2
0
2
4
6