### 1.9.33

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### Question

If  $\mathbf{Q}(0,1)$  is equidistant from  $\mathbf{P}(5,-3)$  and  $\mathbf{R}(x,6)$ . Find the value of x.

#### Variables taken:

Р	$\begin{pmatrix} 5 \\ -3 \end{pmatrix}$
Q	$\begin{pmatrix} 0 \\ 1 \end{pmatrix}$
R	$\begin{pmatrix} x \\ 6 \end{pmatrix}$

### Theoretical Solution

Since  $\mathbf{Q}$  is equidistant from  $\mathbf{p}$  and  $\mathbf{R}$ 

$$\left\| \left( \mathbf{Q} - \mathbf{P} \right) \right\| = \left\| \left( \mathbf{Q} - \mathbf{R} \right) \right\| \tag{1}$$

$$\left\| \left( \mathbf{Q} - \mathbf{P} \right) \right\|^2 = \left\| \left( \mathbf{Q} - \mathbf{R} \right) \right\|^2 \tag{2}$$

$$||\mathbf{Q}||^2 - 2\mathbf{Q}^{\mathsf{T}}\mathbf{P} + ||\mathbf{P}||^2 = ||\mathbf{Q}||^2 - 2\mathbf{Q}^{\mathsf{T}}\mathbf{R} + ||\mathbf{R}||^2$$
 (3)

$$(\mathbf{P} - \mathbf{R})^{\top} \mathbf{Q} = \frac{||\mathbf{P}||^2 - ||\mathbf{R}||^2}{2}$$
 (4)

After substituting the values,

$$\begin{pmatrix} 5 - x \\ -9 \end{pmatrix}^{\top} \begin{pmatrix} 0 \\ 1 \end{pmatrix} = \frac{34 - x^2 - 36}{2} \tag{5}$$

$$-18 = -2 - x^2 \tag{6}$$

Therefore,

$$x = \pm 4 \tag{7}$$

#### C code

```
#include <stdio.h>
#include <math.h>
int main() {
    int qx = 0, qy = 1;
    int px = 5, py = -3;
    int ry = 6;
   // Distance QP^2
    int dQP2 = (qx - px) * (qx - px) + (qy - py) * (qy - py);
   // Equation: (qx - x)^2 + (qy - ry)^2 = dQP^2
   // => (0 - x)^2 + (1 - 6)^2 = dQP2
   // => x^2 + 25 = dOP2
    int rhs = dQP2 - 25;
    int x1 = (int)sqrt(rhs);
    int x2 = -x1:
    printf("The value of x can be %d or %d\n", x1, x2);
    return 0;
```

# Call C.py

```
import subprocess
# Compile the C program (only once)
subprocess.run(["gcc", "equidistant.c", "-o", "equidistant", "-lm
    "])
# Run the compiled program and capture output
result = subprocess.run(["./equidistant"], capture_output=True,
    text=True)
print("Output from C program:")
print(result.stdout)
```

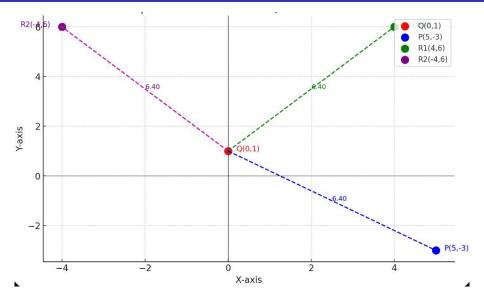
### Plot.py

```
import matplotlib.pyplot as plt
 # Points
0 = (0, 1)
P = (5, -3)
R1 = (4, 6)
R2 = (-4, 6)
 # Plot points with markers
plt.scatter(*Q, color='red', s=100, marker='o', label='Q(0,1)')
| plt.scatter(*P, color='blue', s=100, marker='o', label='P(5,-3)')
 plt.scatter(*R1, color='green', s=100, marker='o', label='R1(4,6)
s |plt.scatter(*R2, color='purple', s=100, marker='o', label='R2
     (-4.6)'
# Draw lines QP, QR1, QR2
plt.plot([Q[0], P[0]], [Q[1], P[1]], 'b--')
plt.plot([Q[0], R1[0]], [Q[1], R1[1]], 'g--')
```

### Plot.py

```
# Annotate points
 plt.text(Q[0]+0.2, Q[1], "Q(0,1)", fontsize=10, color='red')
 plt.text(P[0]+0.2, P[1], "P(5,-3)", fontsize=10, color='blue')
 |plt.text(R1[0]+0.2, R1[1], "R1(4,6)", fontsize=10, color='green')
 plt.text(R2[0]-1, R2[1], "R2(-4,6)", fontsize=10, color='purple')
 # Labels and grid
 plt.xlabel('X-axis')
 plt.ylabel('Y-axis')
 plt.title('Equidistant Points from Q')
 plt.legend()
plt.grid(True)
 plt.axhline(0, color='black', linewidth=0.5)
 plt.axvline(0, color='black', linewidth=0.5)
 plt.show()
```

## Plot



Equidistant Points from  ${\bf Q}$  with Distances