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:

P	$\begin{pmatrix} 5 \\ -3 \end{pmatrix}$
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 $\mathbf{R}$

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

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

$$||\mathbf{Q}||^2 - 2\mathbf{Q}^\top\mathbf{P} + ||\mathbf{P}||^2 = ||\mathbf{Q}||^2 - 2\mathbf{Q}^\top\mathbf{R} + ||\mathbf{R}||^2 \tag{3}$$

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

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

```c
#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 = dQP2
    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
Q = (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)
    ')
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--')
plt.plot([Q[0], R2[0]], [Q[1], R2[1]], 'm--')
```

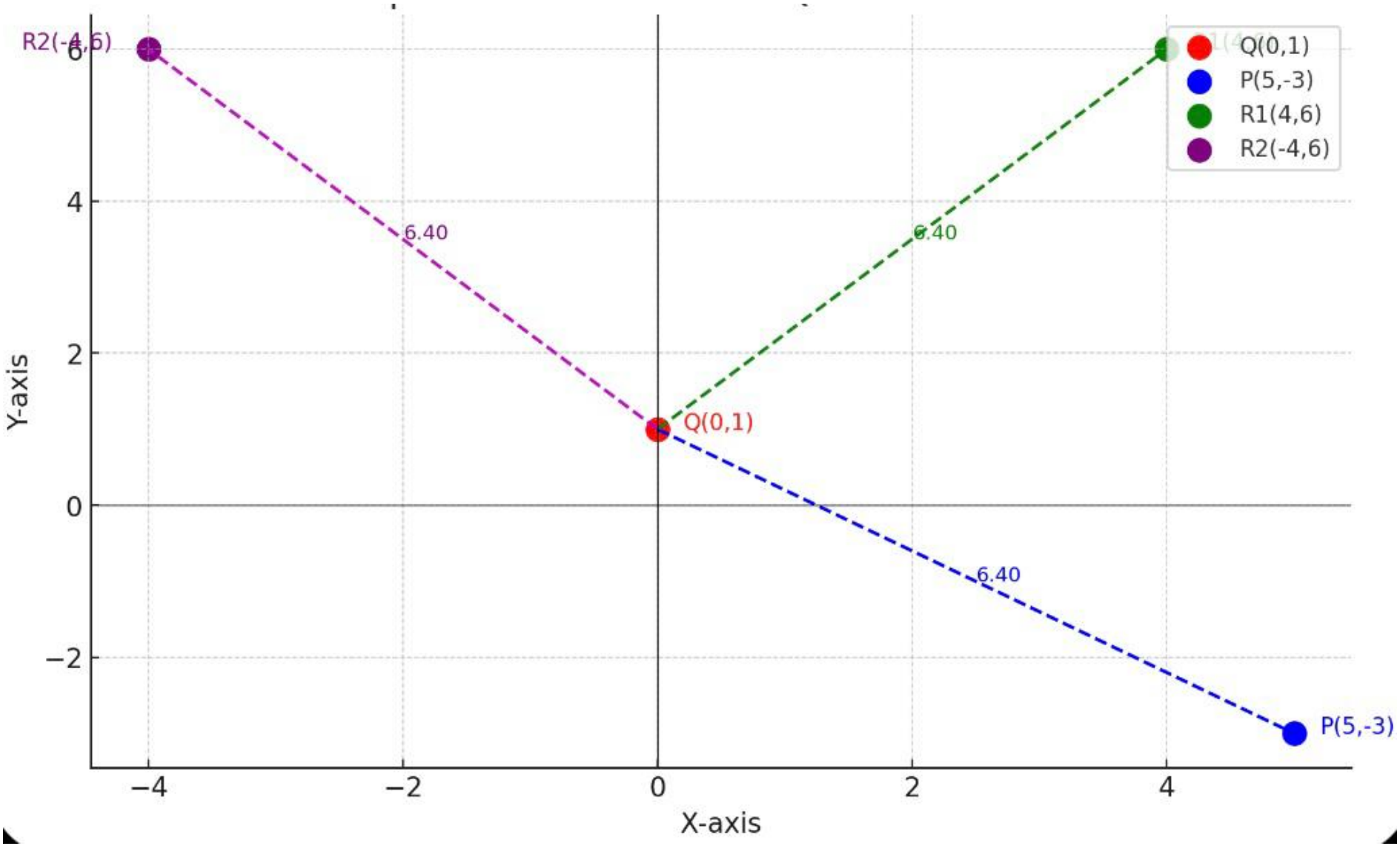
Plot.py

```
# 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 **Q** with Distances