Matrices in Geometry - 10.5.5

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Problem Statement

Construct a tangent to a circle of radius $4cm$ from a point on the concentric circle of radius $6cm$ and measure its length. Also verify the measurement by actual calculation.

Solution

Consider two concentric circles of radii $4cm$ and $6cm$, respectively. Let the center be $\mathbf{O}$.

$$\mathbf{C_1}: \ \|\mathbf{x} - \mathbf{O}\| = 4 \tag{1}$$
$$\mathbf{C_2}: \ \|\mathbf{x} - \mathbf{O}\| = 6 \tag{2}$$

Let $\mathbf{P}$ be a point on the $\mathbf{C_2}$. From point $\mathbf{P}$ a tangent is drawn to the $\mathbf{C_1}$ that intersects $\mathbf{C_1}$ at $\mathbf{T}$

$$(\mathbf{P} - \mathbf{T})^\top (\mathbf{T} - \mathbf{O}) = 0 \quad (\because \mathbf{P} - \mathbf{T} \text{ is a tangent to } C_1) \tag{3}$$

Solution

Thus, $\triangle\mathbf{PTO}$ is a right-angled triangle. Using Pythagorean theorem,

$$\|\mathbf{P}-\mathbf{T}\|^2+\|\mathbf{T}-\mathbf{O}\|^2=\|\mathbf{P}-\mathbf{O}\|^2 \tag{4}$$

$$\|\mathbf{T}-\mathbf{O}\|=4\ ,\ \|\mathbf{P}-\mathbf{O}\|=6 \tag{5}$$

$$\|\mathbf{P}-\mathbf{T}\|^2=36-16=20\implies\|\mathbf{P}-\mathbf{T}\|=2\sqrt{5} \tag{6}$$

Thus, the length of the tangent is $2\sqrt{5}\ cm$

Solution

Let us show this in graph using center $\mathbf{O} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$

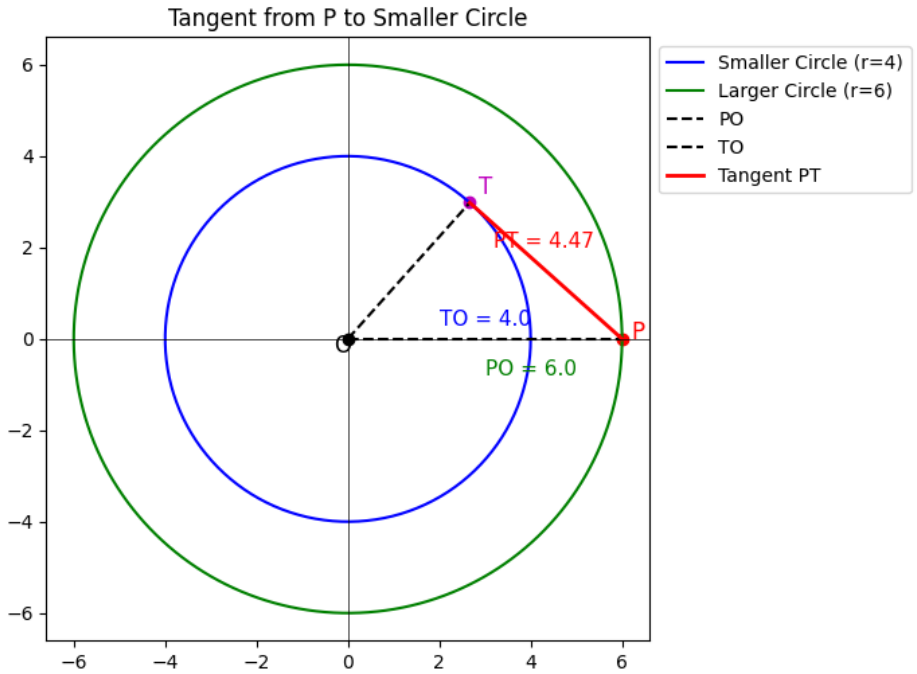

Figure: Graph for 10.5.5