Guide to:
Circles and tangents

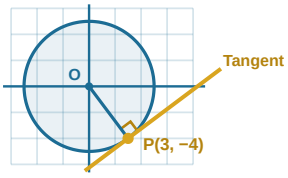
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Explanation:

At GCSE, a circle with centre **(0, 0)** and radius **r** has equation $\mathbf{x^2 + y^2 = r^2}$. Because a **tangent to a circle is always perpendicular to the radius** at the point of contact P(x_1, y_1), their gradients multiply to give −1.

Follow these 3 steps to find the equation of the tangent at P(x_1, y_1): (1) find the gradient of the radius OP using $\mathbf{m_r = \frac{y_1}{x_1}}$; (2) find the perpendicular tangent gradient $\mathbf{m_t = -\frac{1}{m_r}}$; (3) substitute m_t and (x_1, y_1) into $\mathbf{y - y_1 = m_t(x - x_1)}$.

Example 1: Find the equation of the tangent to $x^2 + y^2 = 25$ at the point P(3, −4).



Solution:

Gradient of radius OP: $m_r = \frac{-4 - 0}{3 - 0} = \mathbf{-\frac{4}{3}}$

Gradient of tangent (perpendicular): $m_t = \mathbf{+\frac{3}{4}}$

Equation: $y - (-4) = \frac{3}{4}(x - 3) \Rightarrow 4y + 16 = 3x - 9$

Answer: $y = \frac{3}{4}x - \frac{25}{4}$ (or $3x - 4y = 25$)

Example 2: The tangent to $x^2 + y^2 = 20$ at A(2, 4) crosses the x-axis at B. Find the coordinates of B.

Solution:

Gradient of radius OA: $m_r = \frac{4}{2} = 2 \Rightarrow m_t = \mathbf{-\frac{1}{2}}$

Tangent: $y - 4 = -\frac{1}{2}(x - 2) \Rightarrow y = -\frac{1}{2}x + 5$

On the x-axis, $y = 0$: $-\frac{1}{2}x + 5 = 0 \Rightarrow x = 10$

Answer: B(10, 0)

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