

## Tangent Lines and Normal Lines

tangent is  $\parallel$  to curve

normal is  $\perp$  to curve

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Let's try it... Find the equation of the tangent line and the normal line to the curve  $f(x) = x^2$  when  $x=3$ .

<p>tangent: <u>Slope</u></p> <p><math>f(x) = x^2</math></p> <p><math>f'(x) = 2x</math></p> <p><math>f'(3) = 2(3)</math></p> <p><u><math>m = 6</math></u></p>	<p>point</p> <p><math>(3, ?)</math></p> <p><math>f(3) = 3^2</math></p> <p><math>= 9</math></p> <p><u><math>(3, 9)</math></u></p>
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$y - y_1 = m(x - x_1)$

\*  $y - 9 = 6(x - 3)$

normal:

$y - 9 = -\frac{1}{6}(x - 3)$

$y - 9 = 6x - 18$

$\begin{array}{r} +9 \\ +9 \\ \hline \end{array}$

$y = 6x - 9$

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tangent line:

Slope | point  
 $y = x^3 - 3x^2 + 2$  |  $(3, 2)$

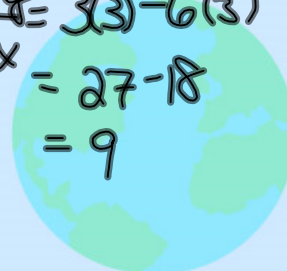
$$\frac{dy}{dx} = 3x^2 - 6x$$

$$x = 3$$

$$\frac{dy}{dx} = 3(3)^2 - 6(3)$$

$$= 27 - 18$$

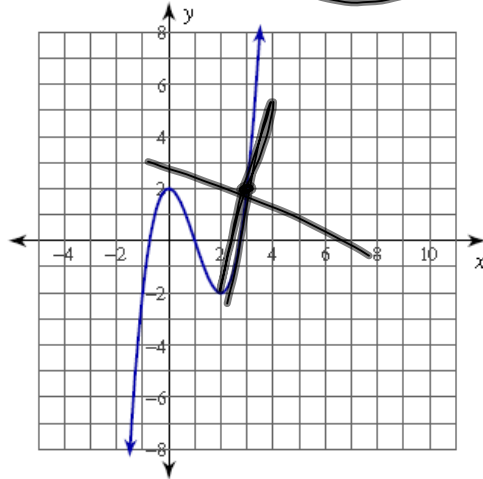
$$= 9$$



tangent:  $y - 2 = 9(x - 3)$

normal:  $y - 2 = -\frac{1}{9}(x - 3)$

1)  $y = x^3 - 3x^2 + 2$  at  $(3, 2)$



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3)  $y = x^3 - 2x^2 + 2$  at  $(2, 2)$

tangent:

slope

$$y = x^3 - 2x^2 + 2$$

$$y' = 3x^2 - 4x$$

$$x = 2$$

$$y' = 3(2)^2 - 2(2)^2$$

$$y' = 12 - 8$$

$$y' = 4$$

point

$(2, 2)$

tangent:  $y - 2 = 4(x - 2)$

normal:  $y - 2 = -\frac{1}{4}(x - 2)$

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**Exercise 7G**

- 1 Find the equations of the tangent and normal lines to the graph of  $f(x) = x^2 - 4x$  at the point  $(3, -3)$ . Graph the function and the lines by hand.



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**Homework: p207**

- 2 Find the equation for the tangent line to the curve at the given point.

**a**  $f(x) = x^2 + 2x + 1$  at  $(-3, 4)$

**b**  $f(x) = 2\sqrt{x} + 4$  at  $x = 1$

**c**  $f(x) = \frac{x^2 + 6}{x}$  at  $(3, 5)$

**d**  $f(x) = \sqrt[4]{x} + \frac{8}{\sqrt{x}}$  at  $x = 1$

- 3 Find the equation for the normal line to the curve at the given point.

**a**  $f(x) = 2x^2 - x - 3$  at  $(2, 3)$

**b**  $f(x) = \frac{4}{x} - \frac{1}{x^2}$  at  $x = -1$

**c**  $f(x) = (2x + 1)^2$  at  $(2, 25)$

**d**  $f(x) = 2\sqrt[3]{x} - \frac{4}{x^2}$  at  $x = 1$



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