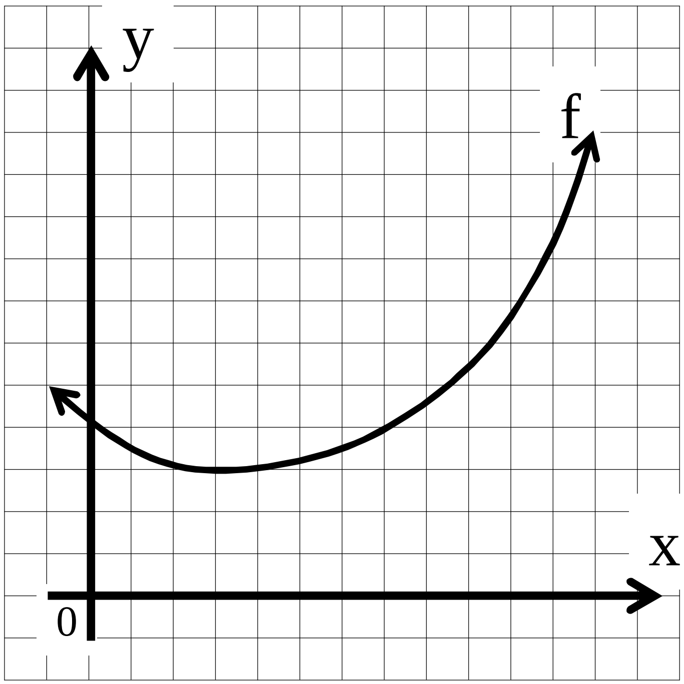
Calculus   Lesson #1
The Derivative Function
The Four Step Method
Class Worksheet #1

Consider the function f whose graph is shown here.



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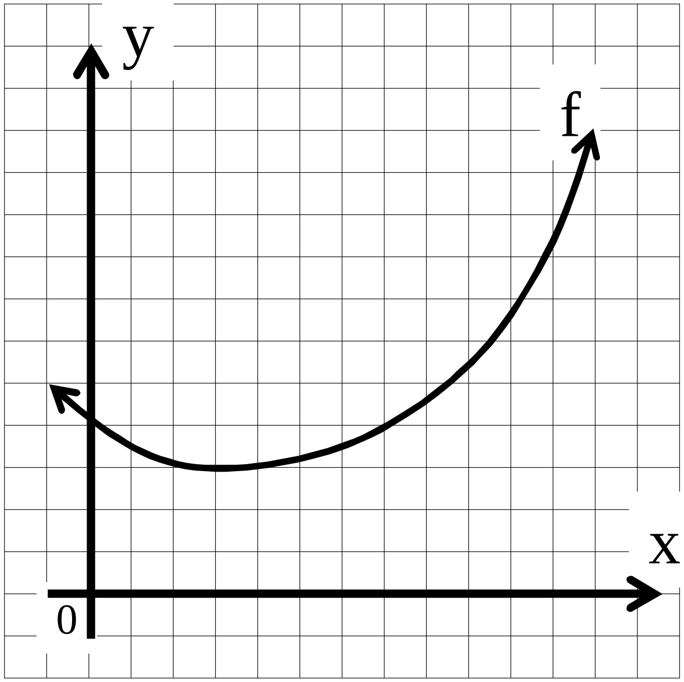

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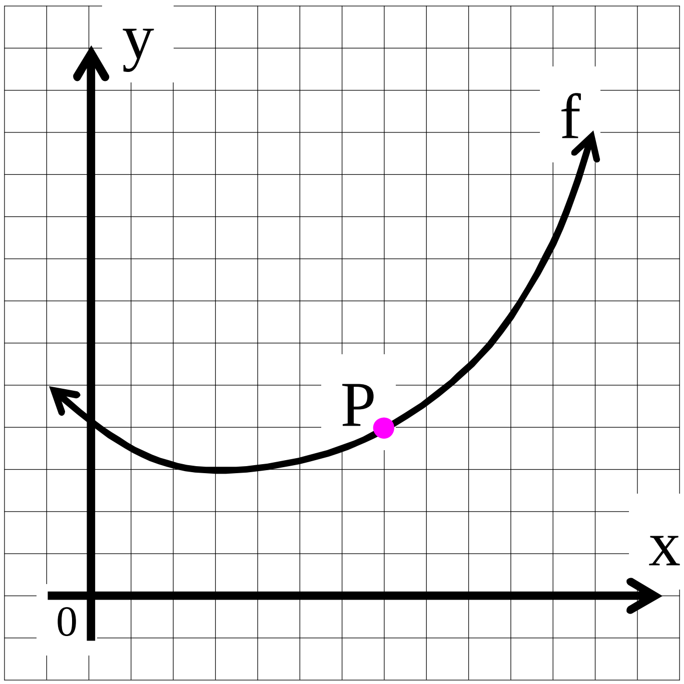

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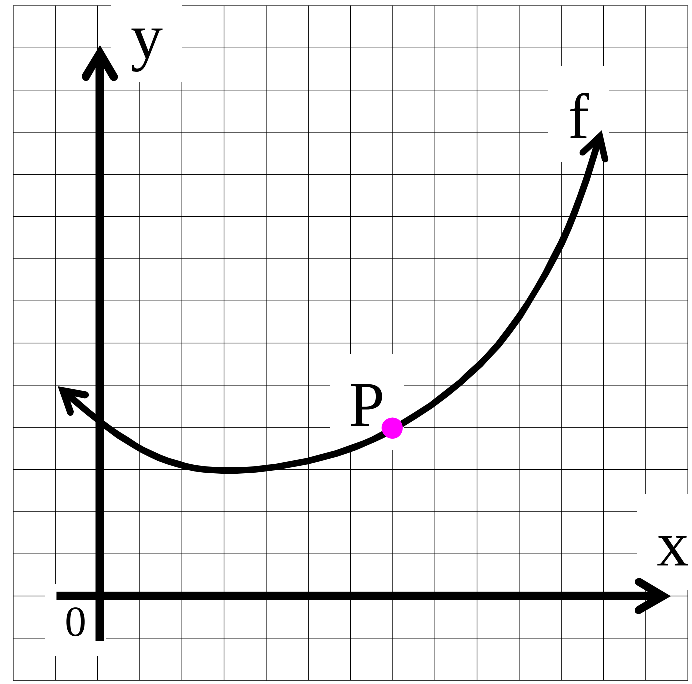
Let **t** be the line that is tangent to the graph of f at P.



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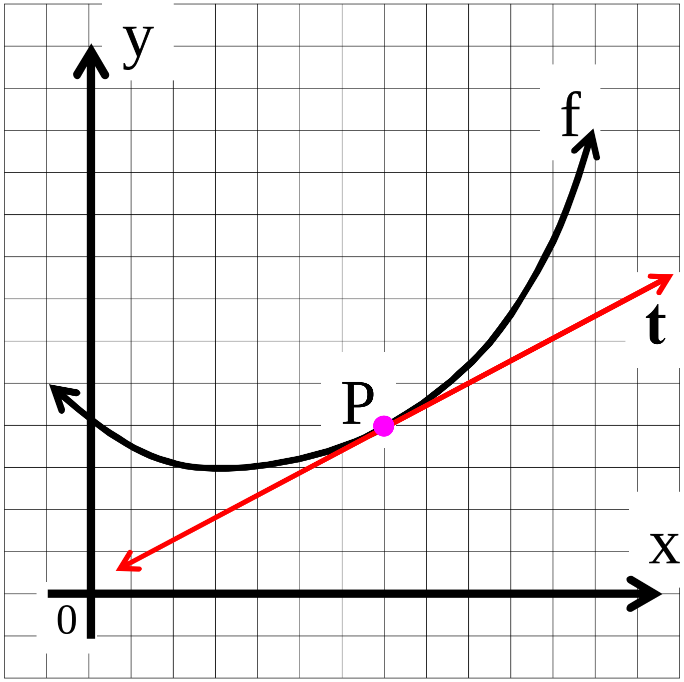

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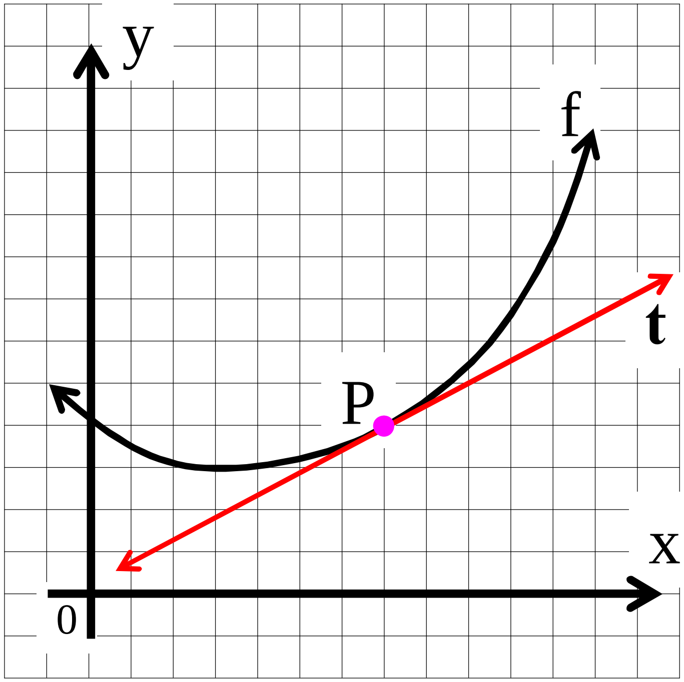

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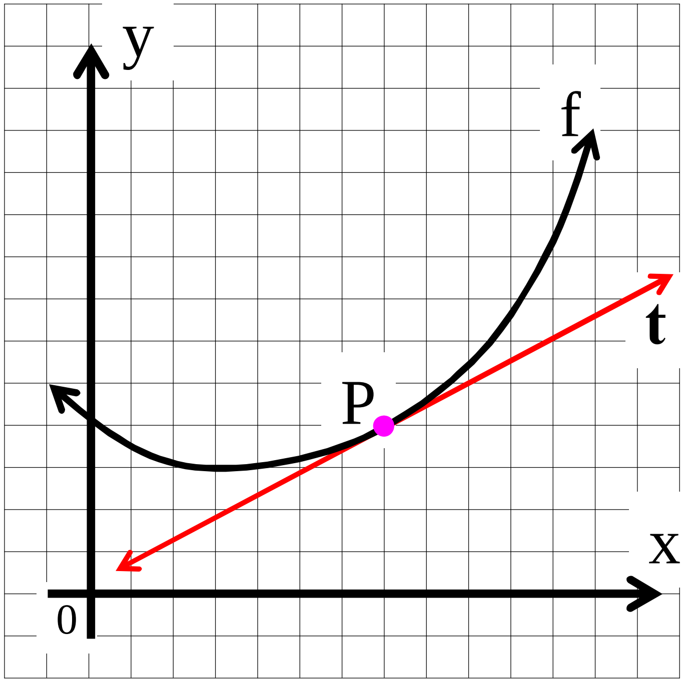

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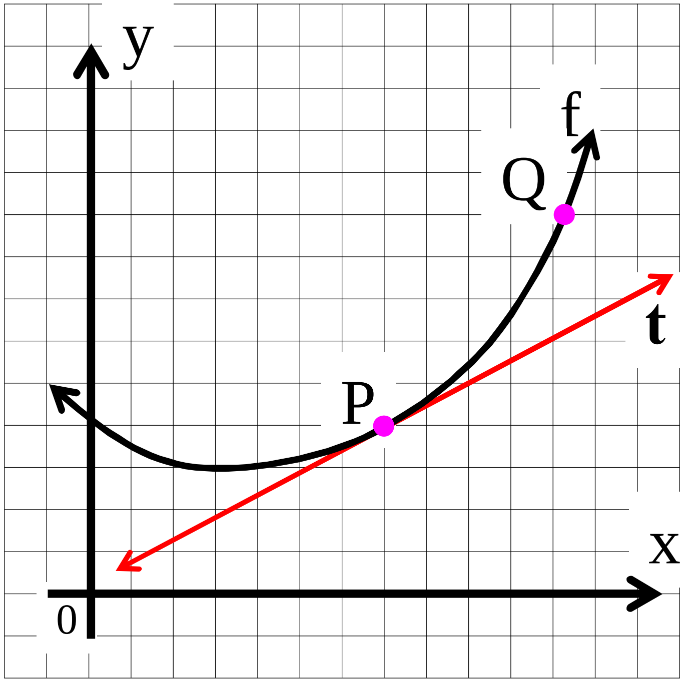

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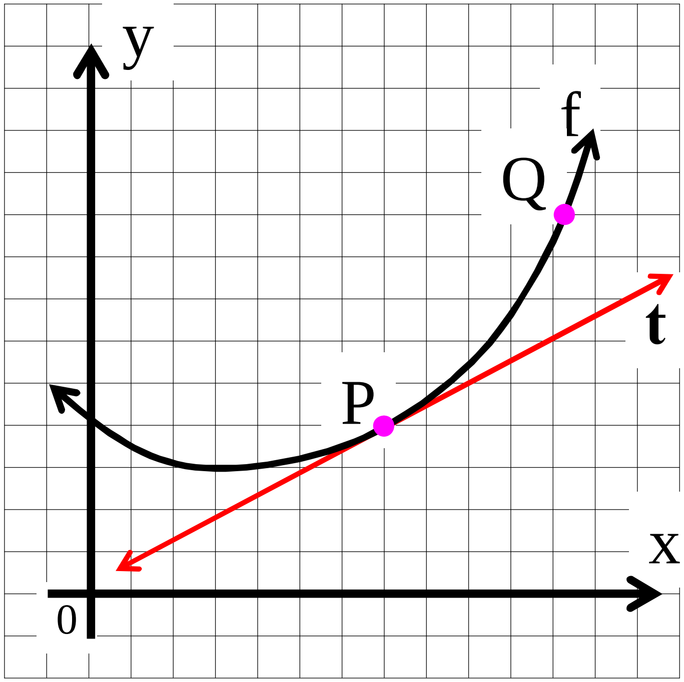

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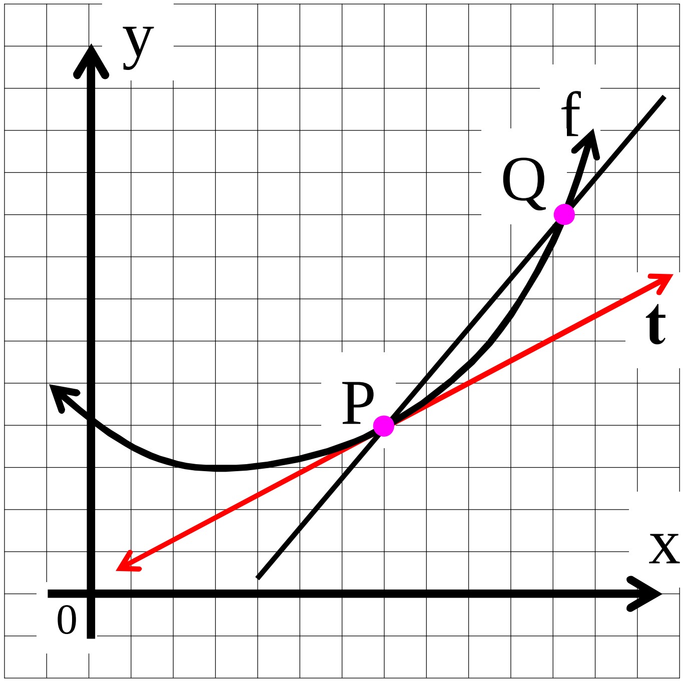

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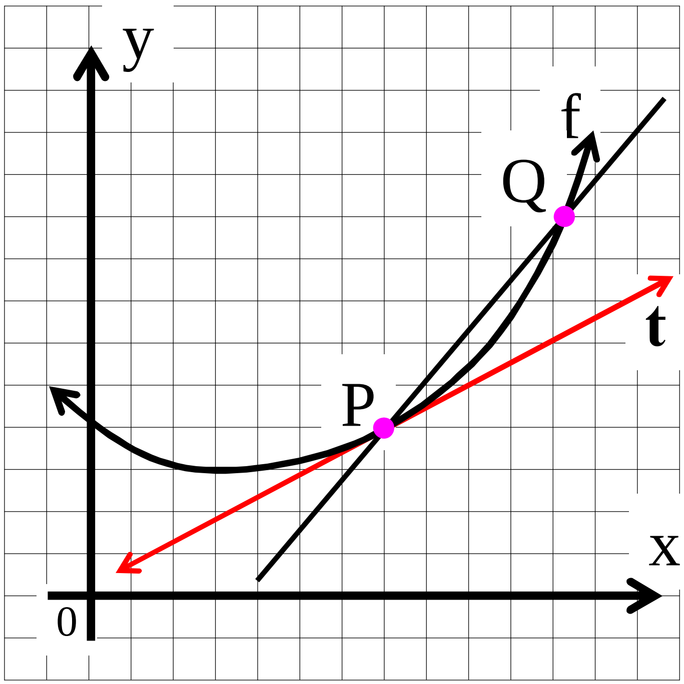

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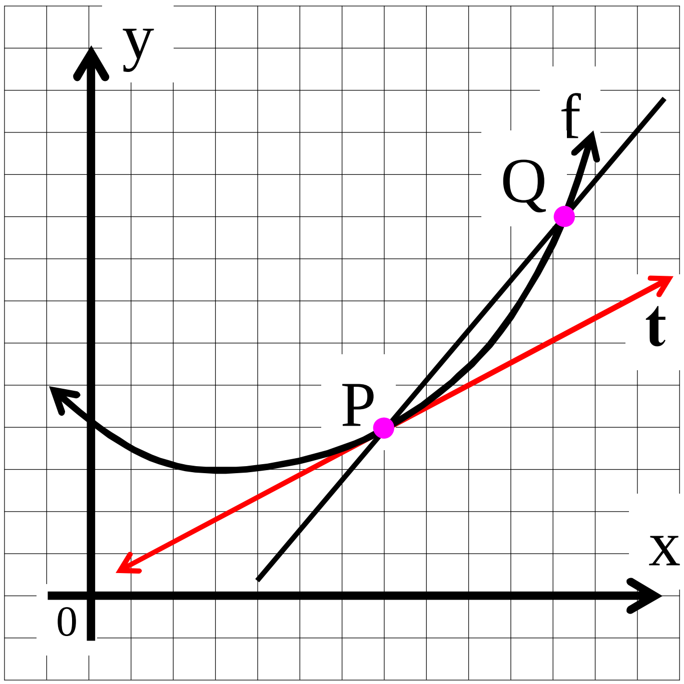

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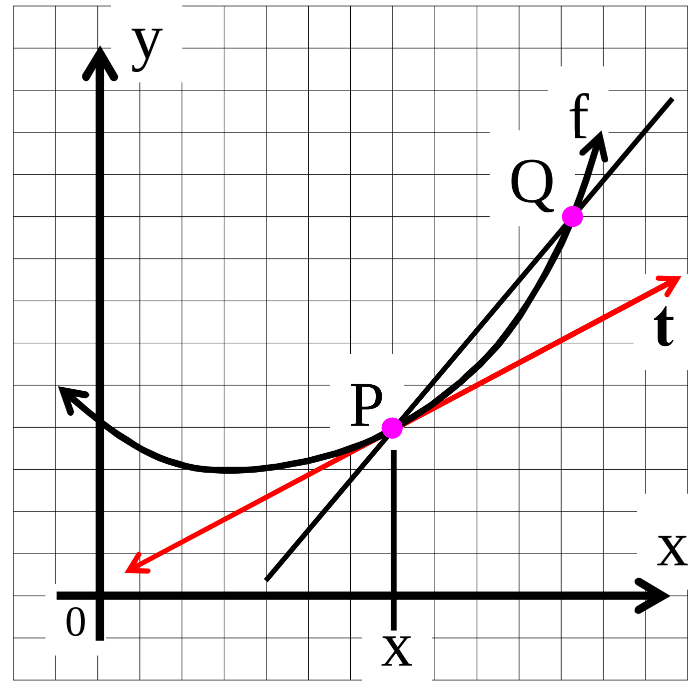

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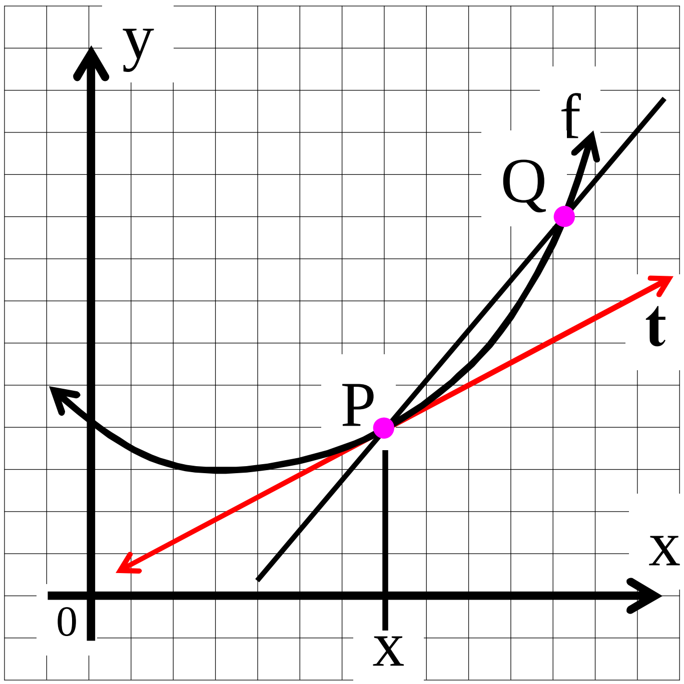

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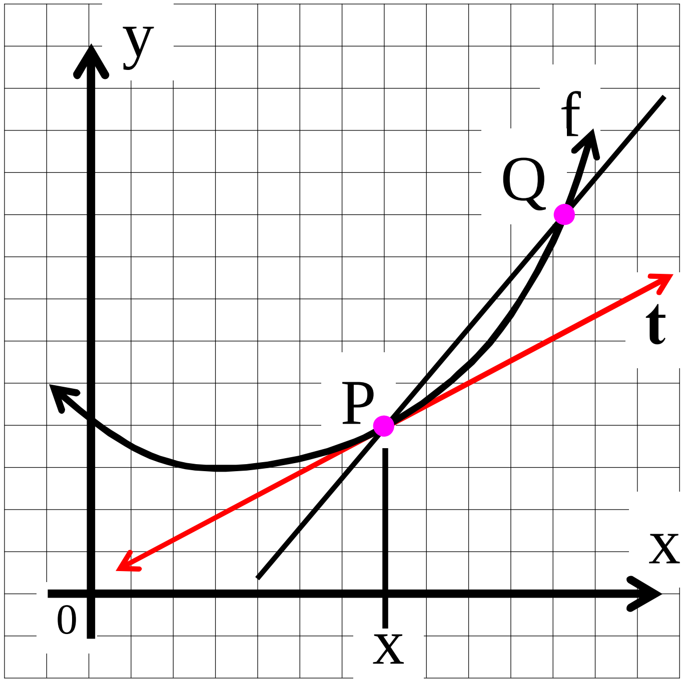

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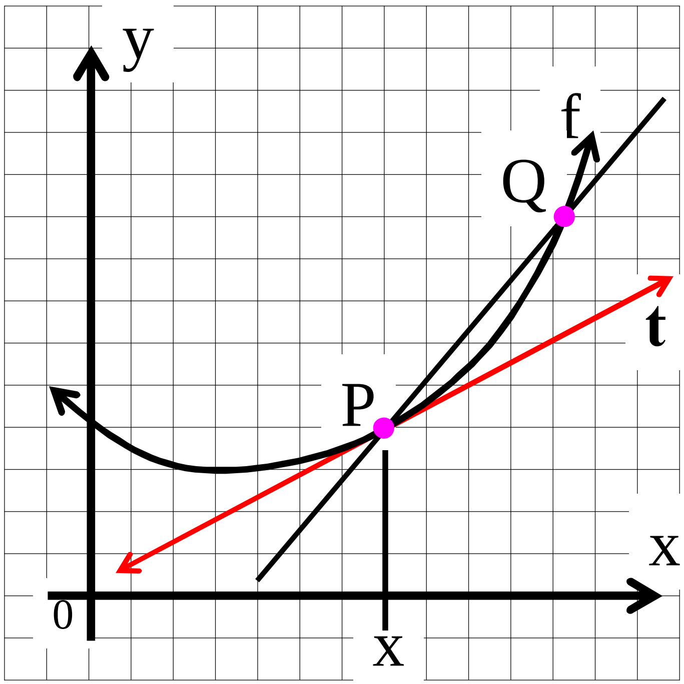

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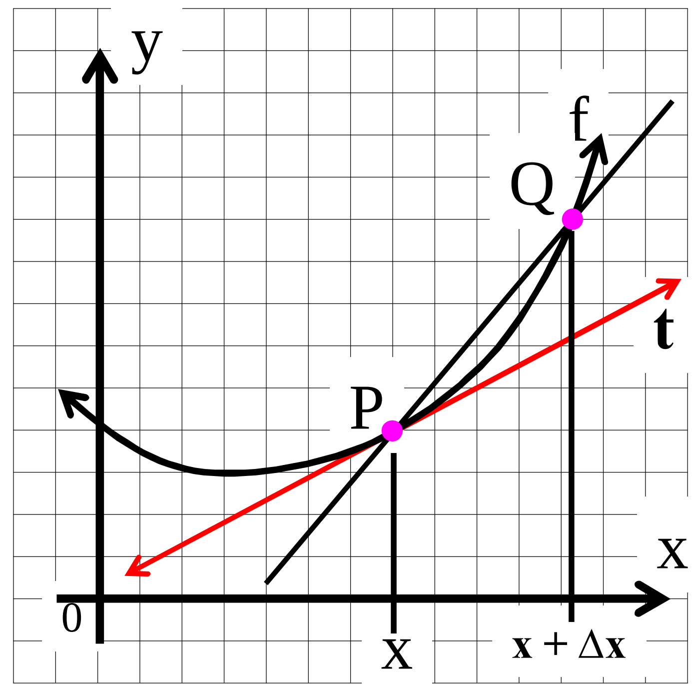

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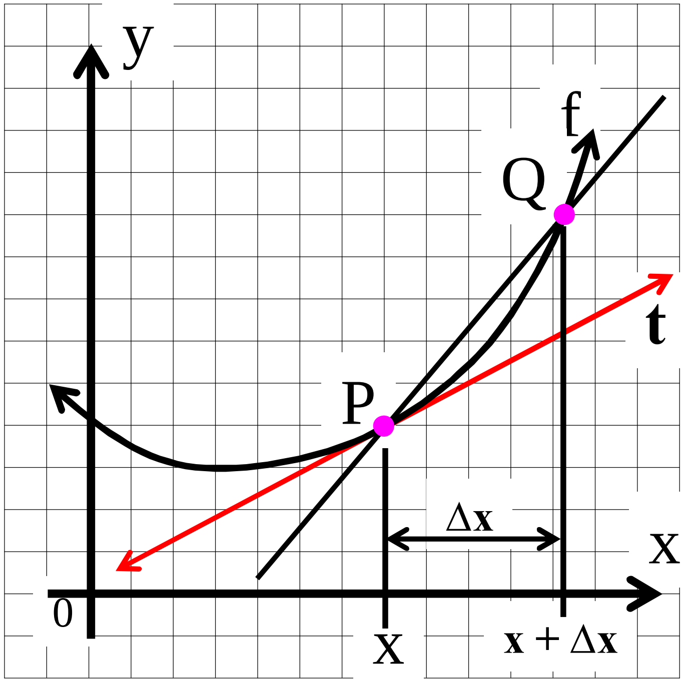

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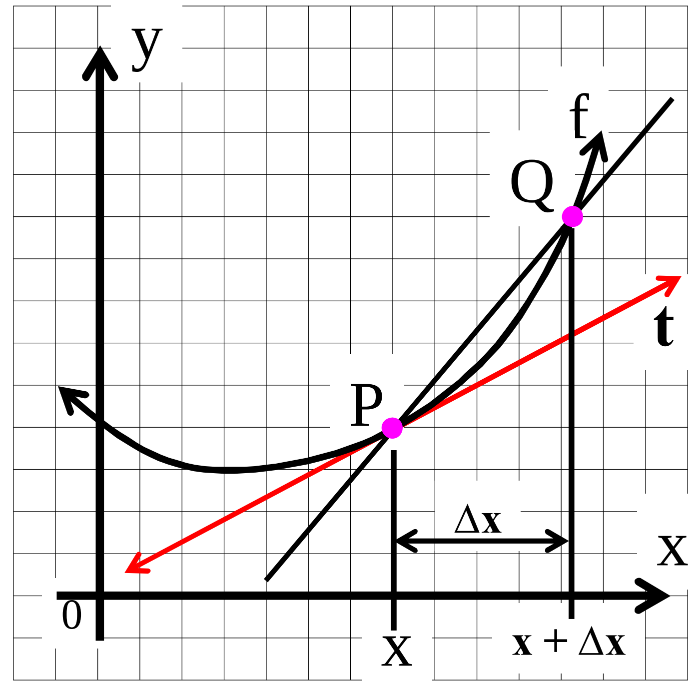

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Note that if Δx was negative, then point Q would be to the left of point P on the graph of f.

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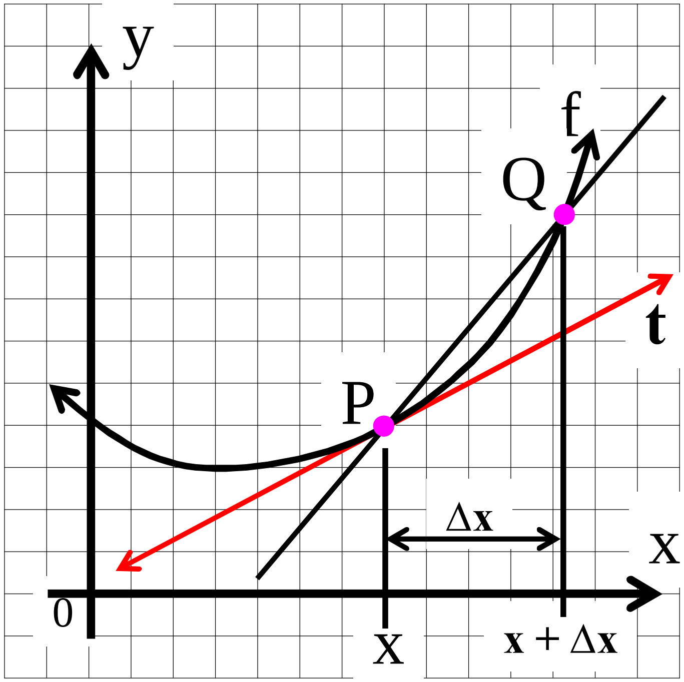

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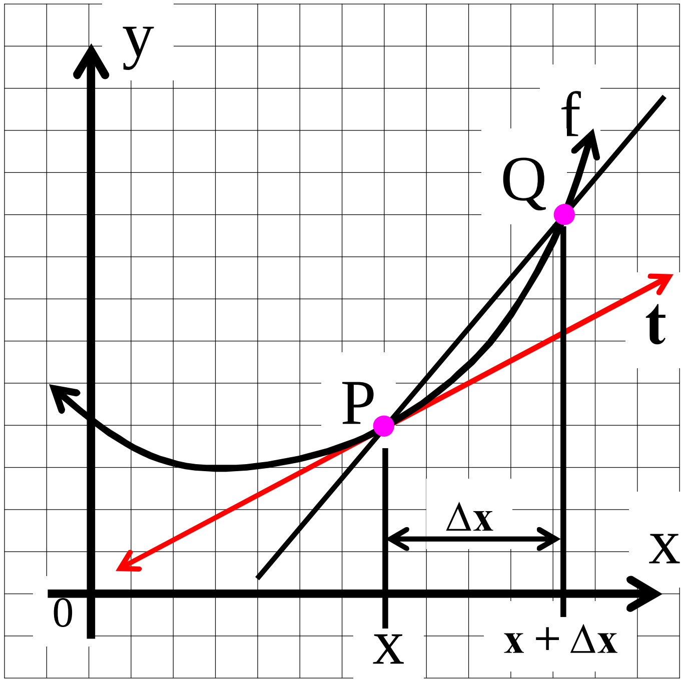

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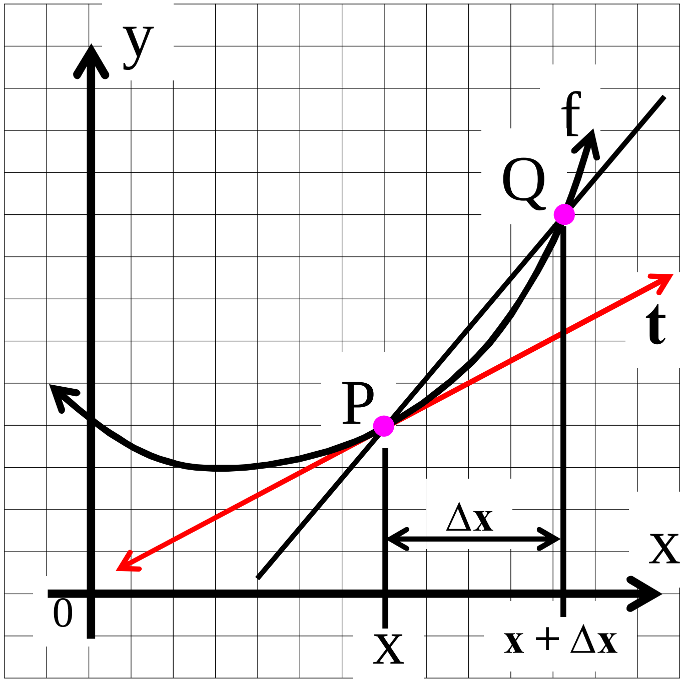

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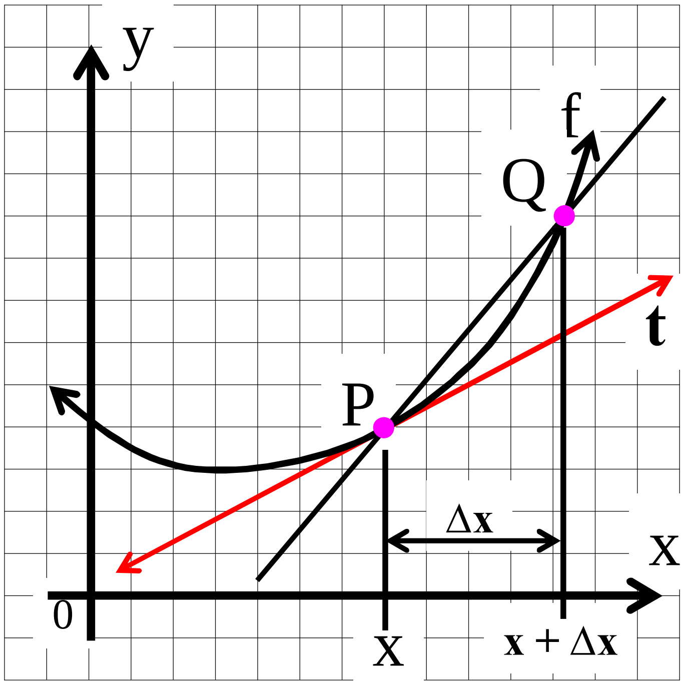

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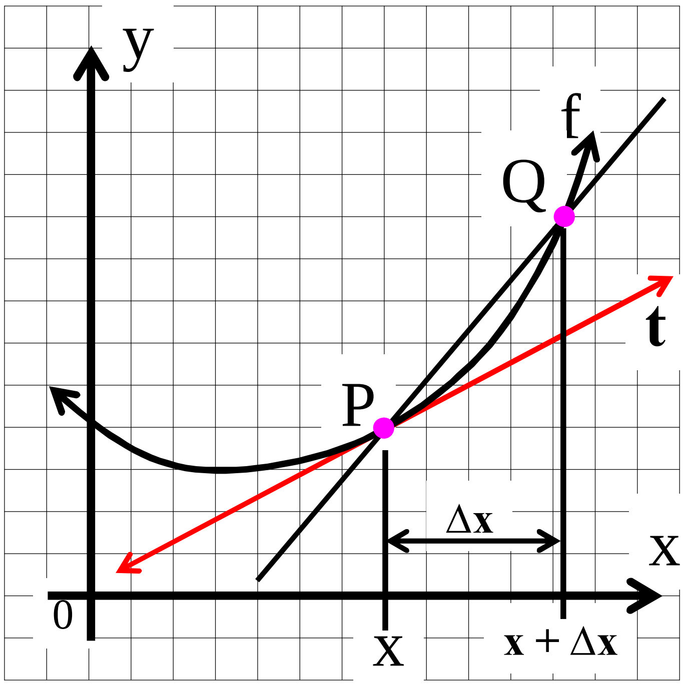

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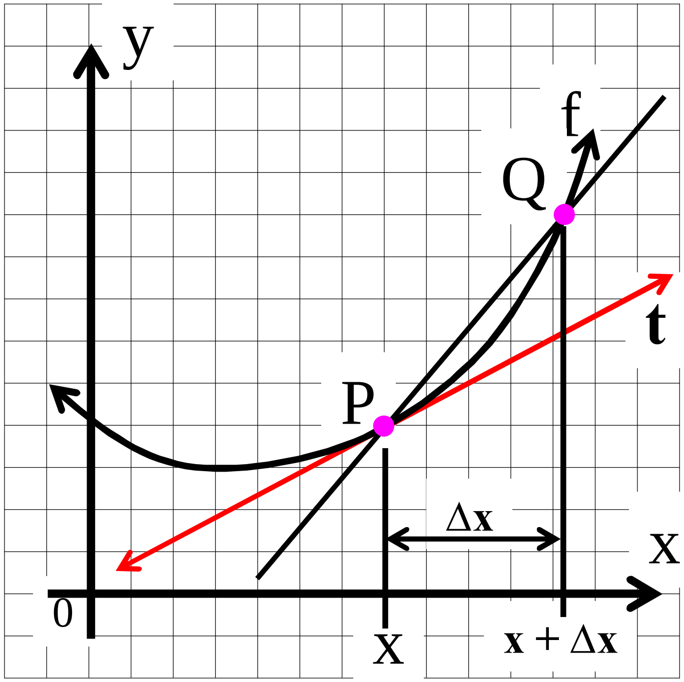

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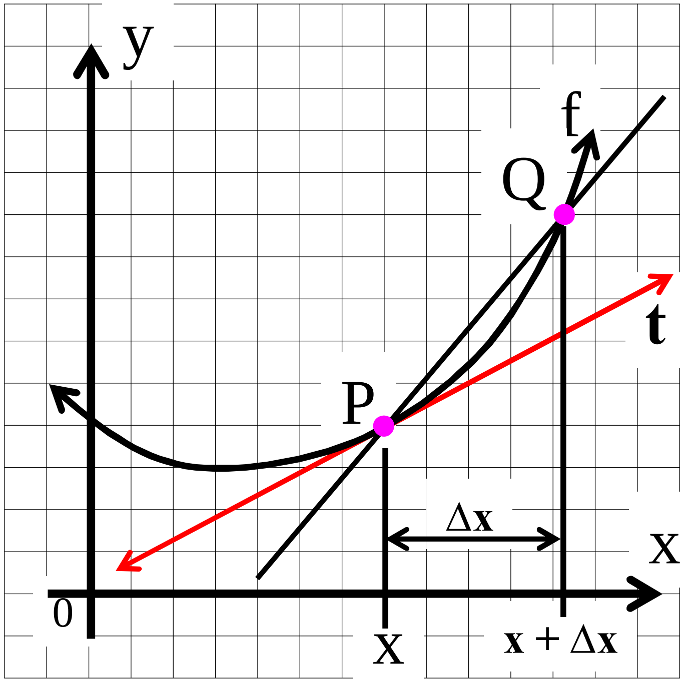

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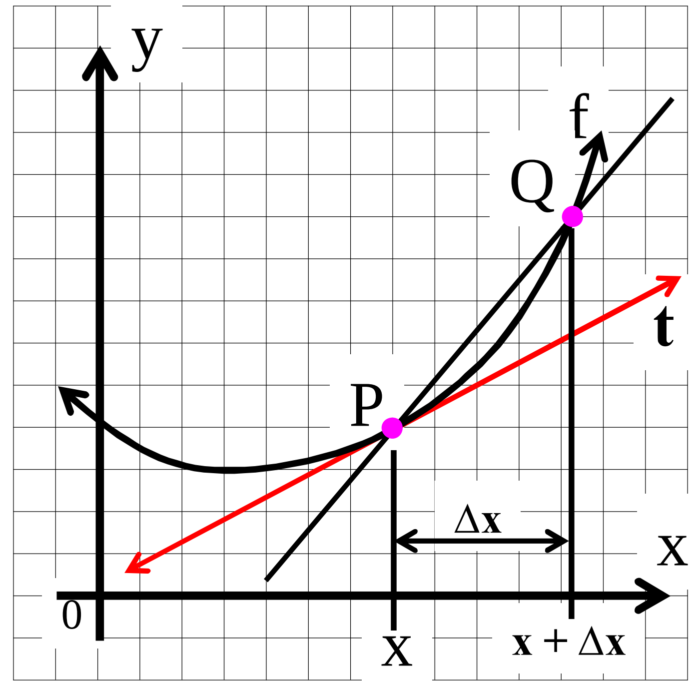

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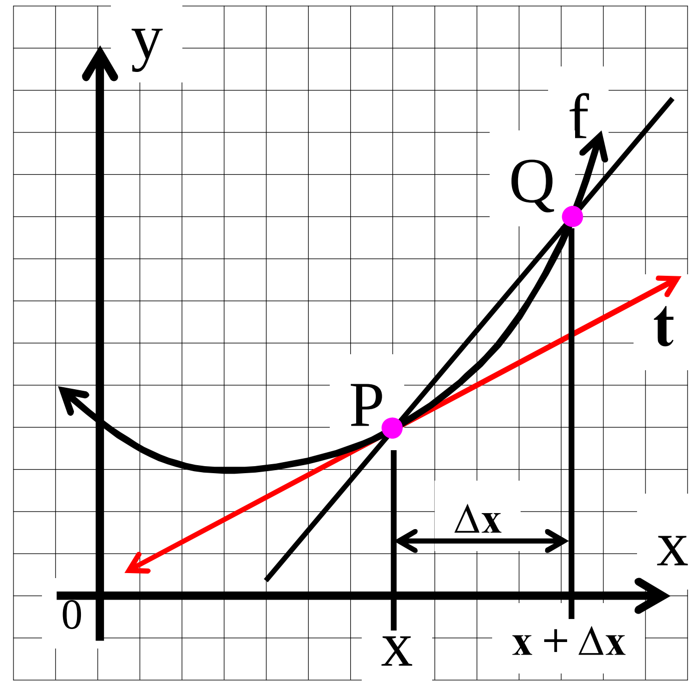

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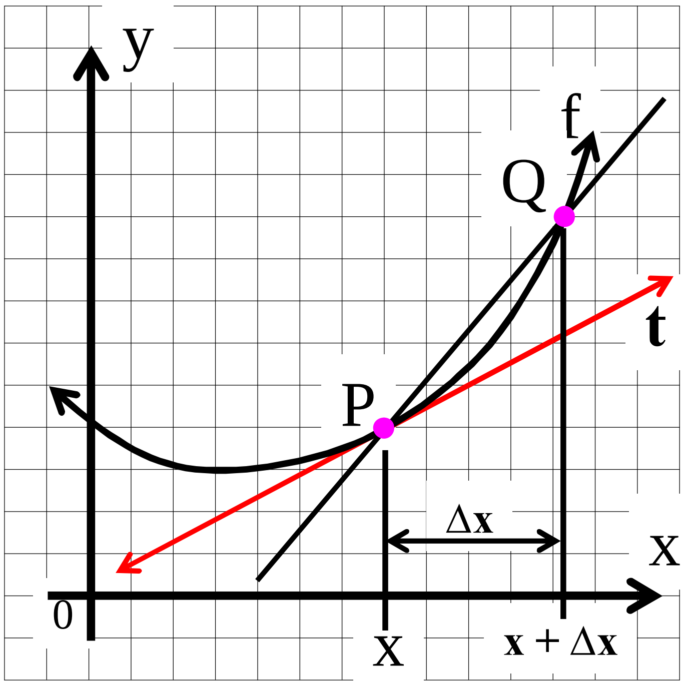

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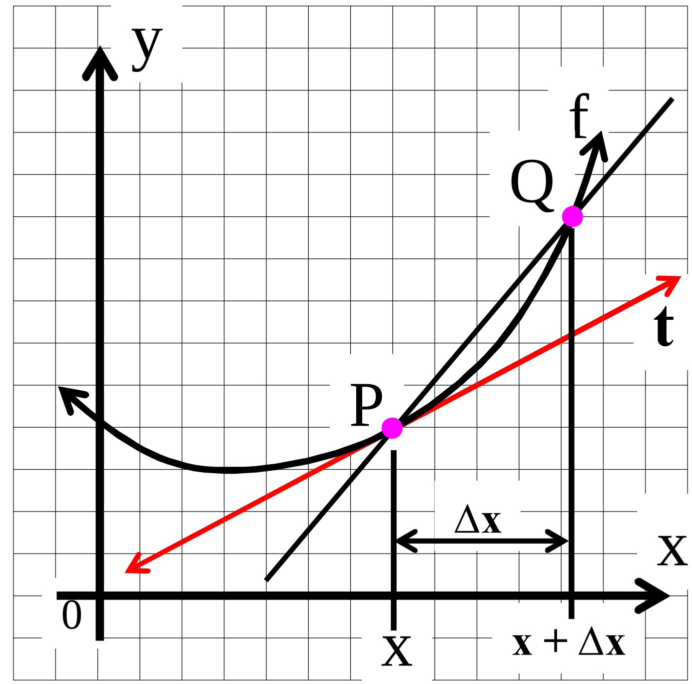

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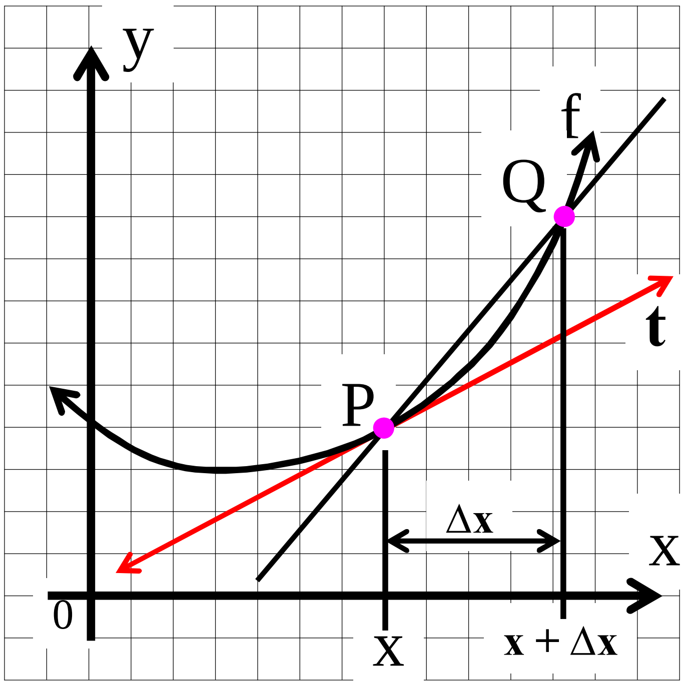

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The slope of line PQ = $\dfrac{f(x + \Delta x) \text{ ï } f(x)}{(x + \Delta x) \text{ ï } x} = \dfrac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}}$

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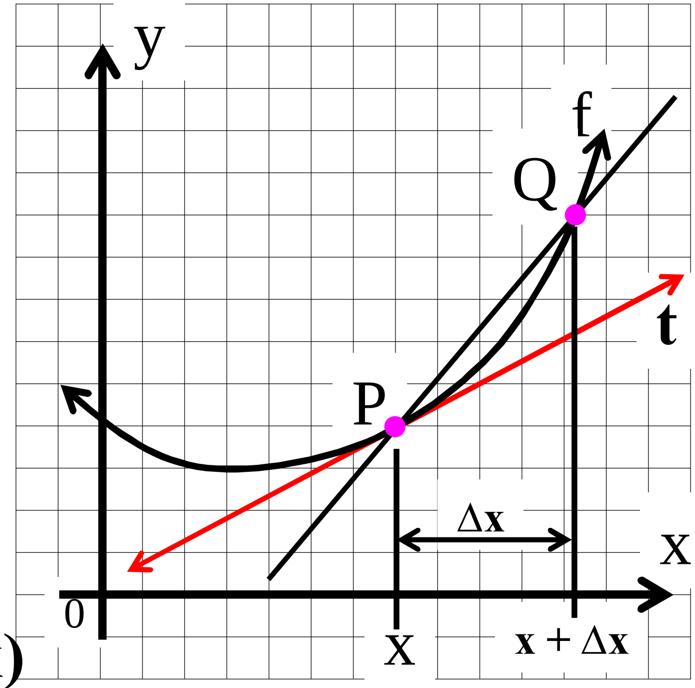

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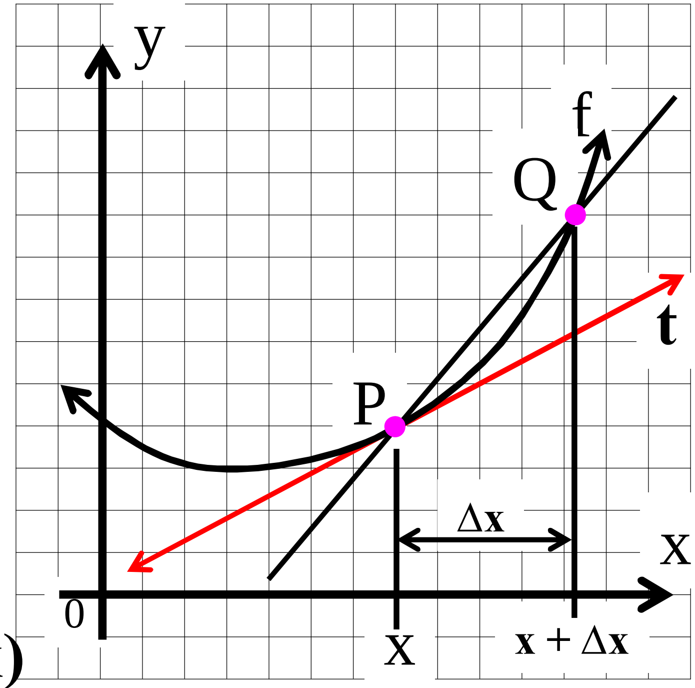

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$$\textbf{The slope of line PQ} = \frac{f(x + \Delta x) - f(x)}{\Delta x}$$

Now imagine moving point Q closer to point P along the curve.

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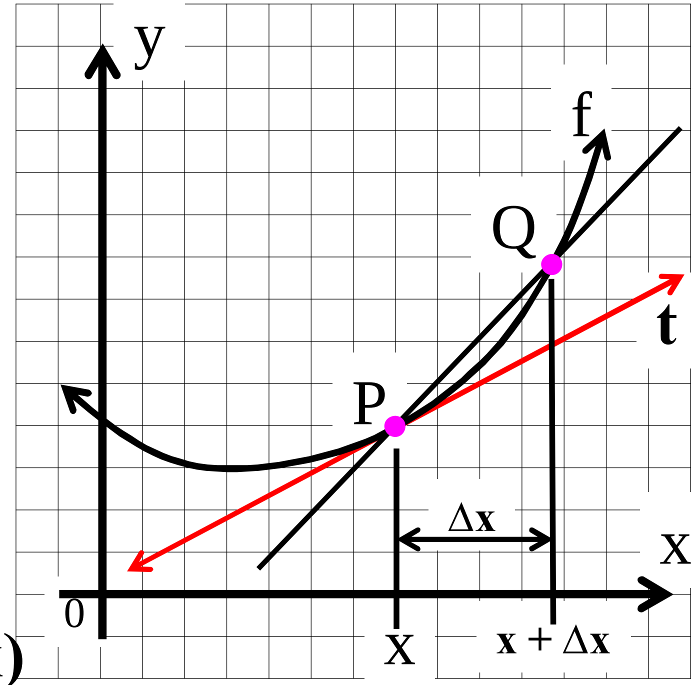

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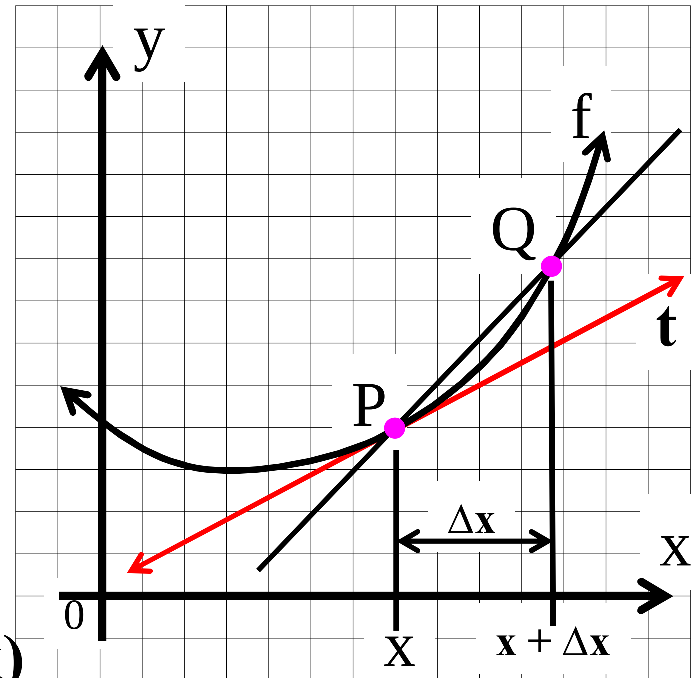

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Now imagine moving point Q closer to point P along the curve.

Clearly, as point Q moves,

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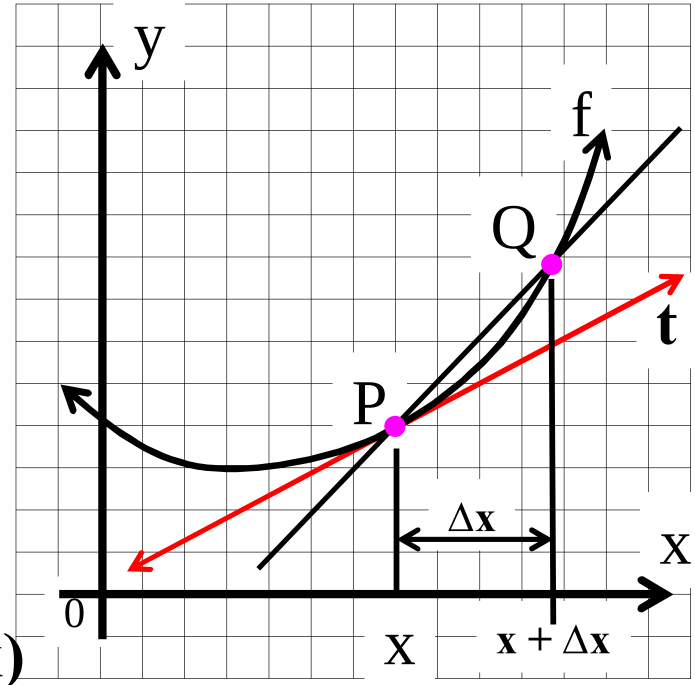

The slope of line PQ = $\dfrac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}}$

Now imagine moving point Q closer to point P along the curve.

Clearly, as point Q moves, the value of **Δx gets closer to 0**

Consider the function f whose graph is shown here.

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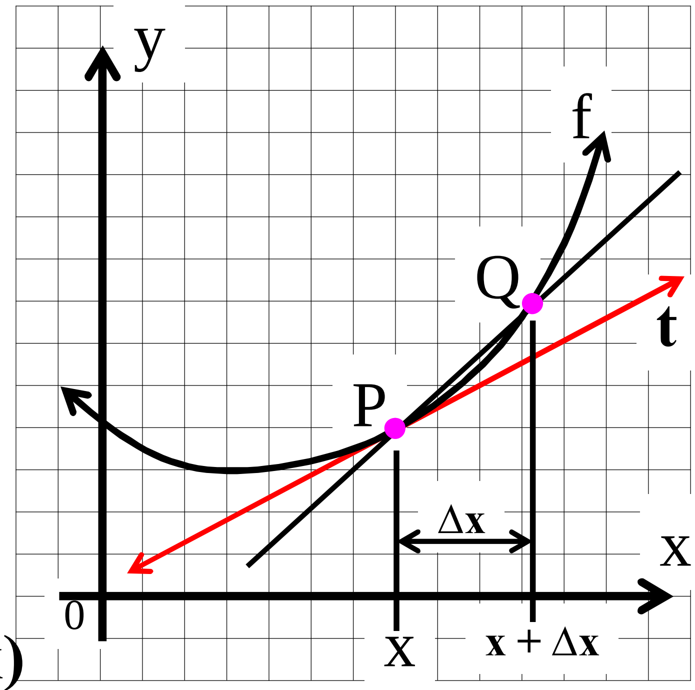

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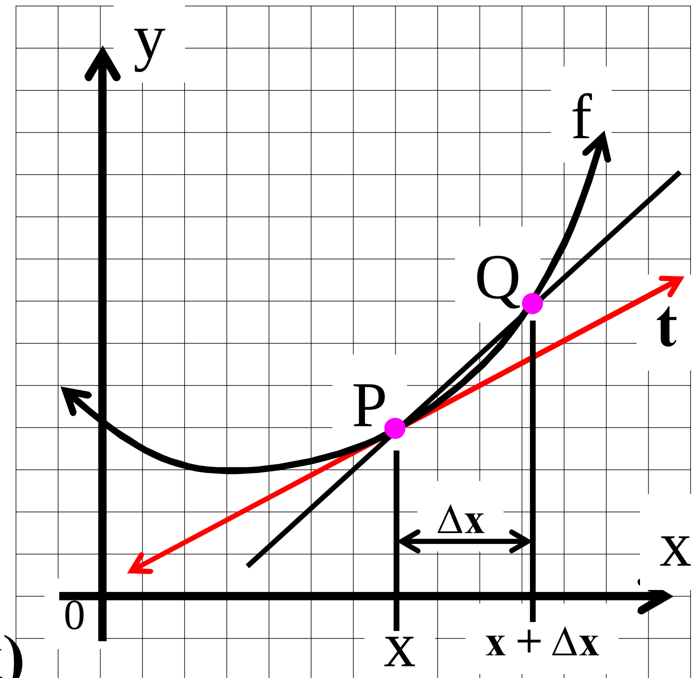

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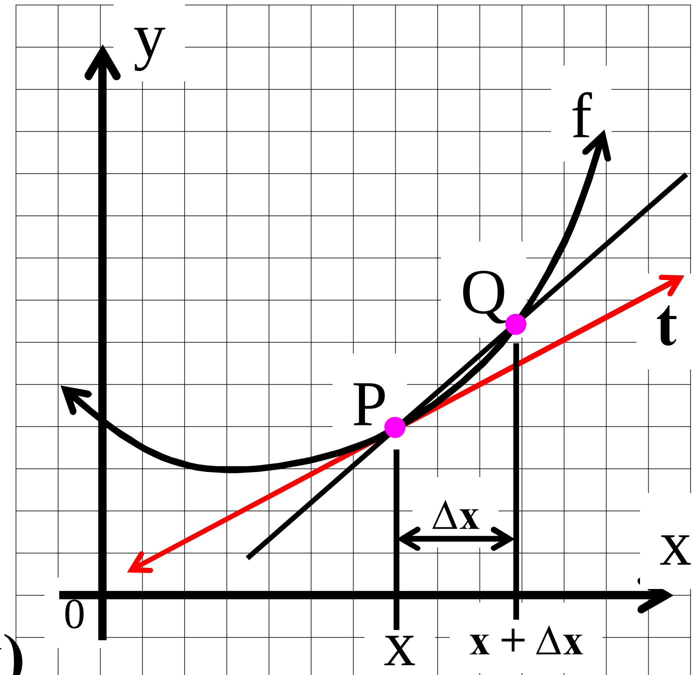

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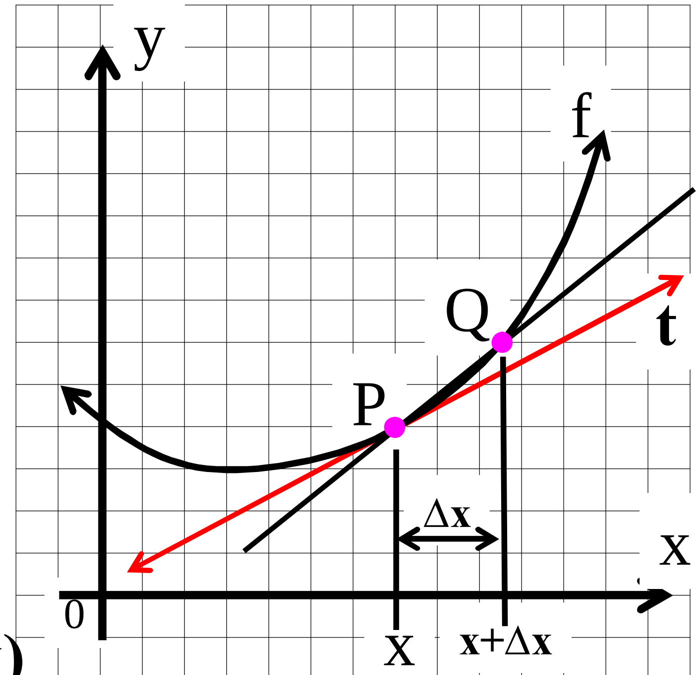

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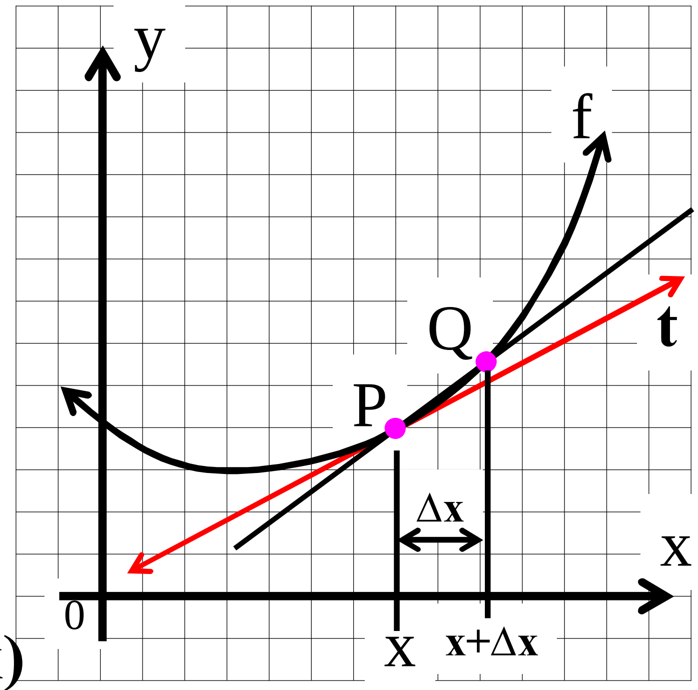

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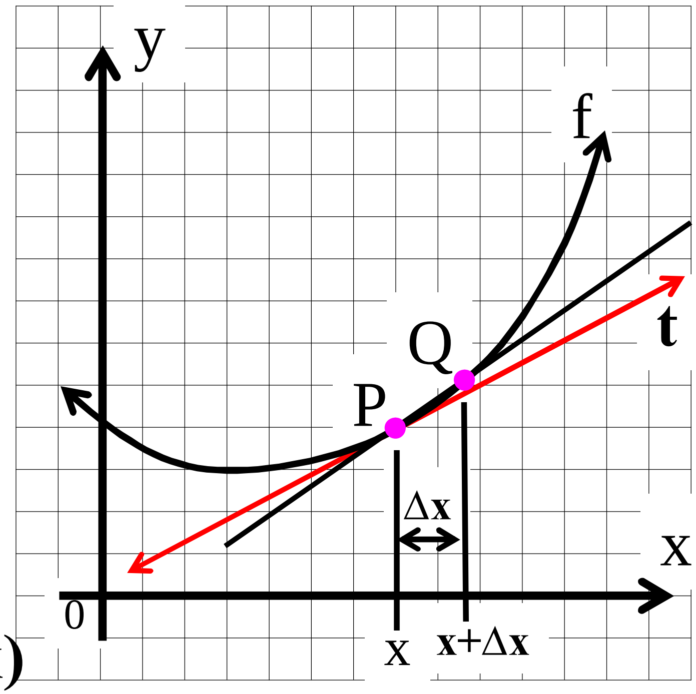

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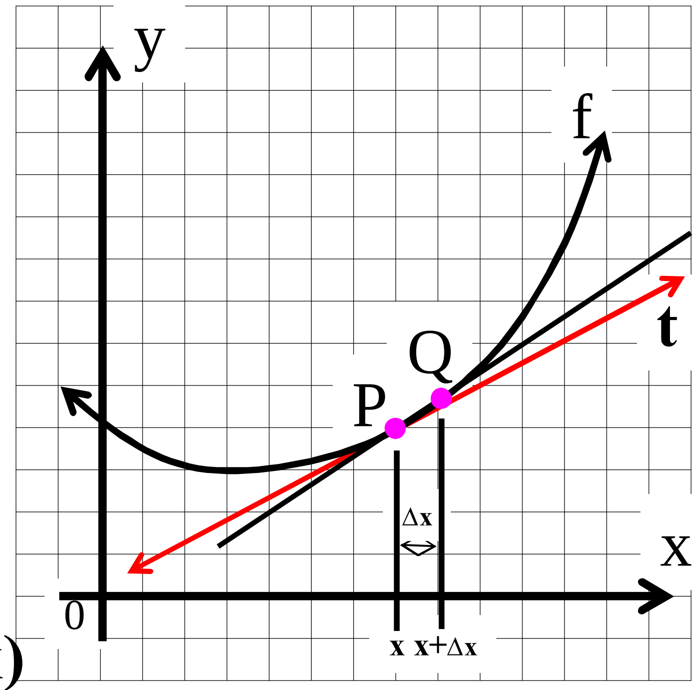

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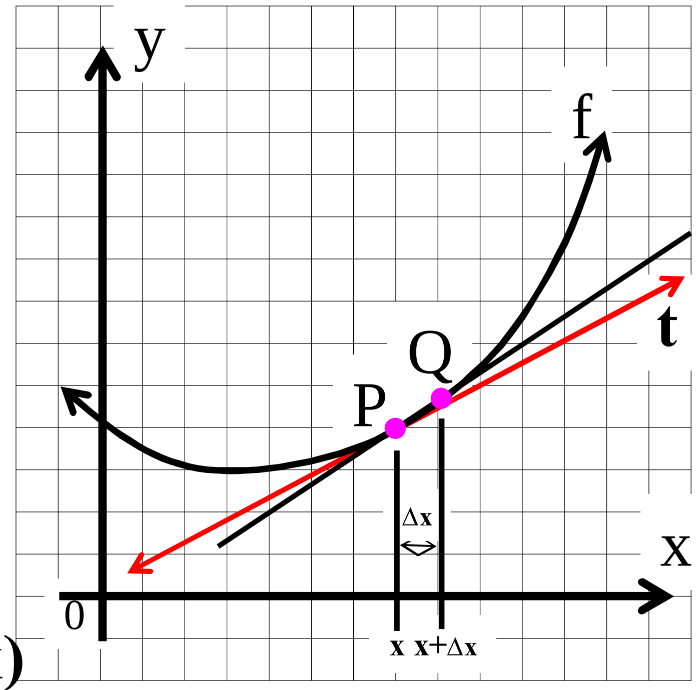

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Now imagine moving point Q closer to point P along the curve. Clearly, as point Q moves, the value of Δ**x gets closer to 0** and the **slope of line PQ gets closer to the slope of line t.**

We say that the slope of line t is the **limiting value** of the slope of line PQ as Δx approaches 0.

Consider the function f whose graph is shown here.

Let P represent any point on the graph of f.

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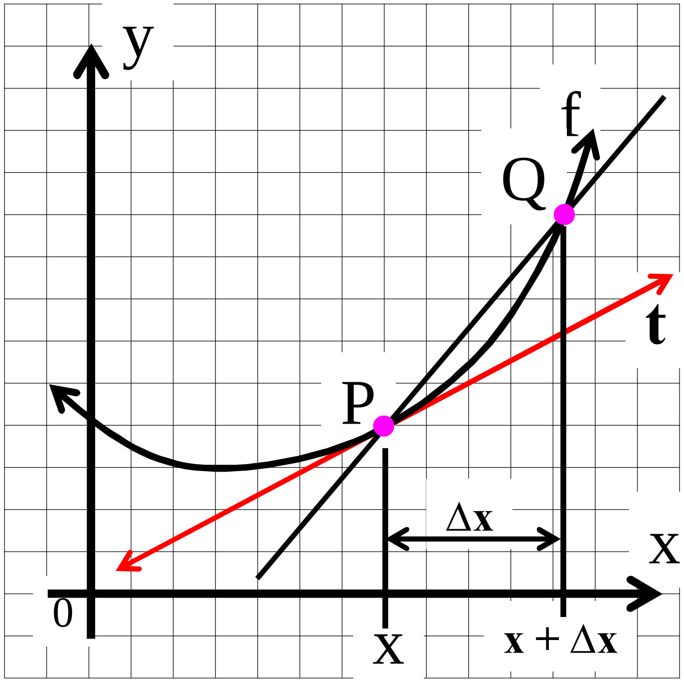
Our goal is to find an expression for the slope of line **t**.



$$\textbf{Slope of line t} = \lim_{\Delta x \to 0} \left[\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}} \right]$$

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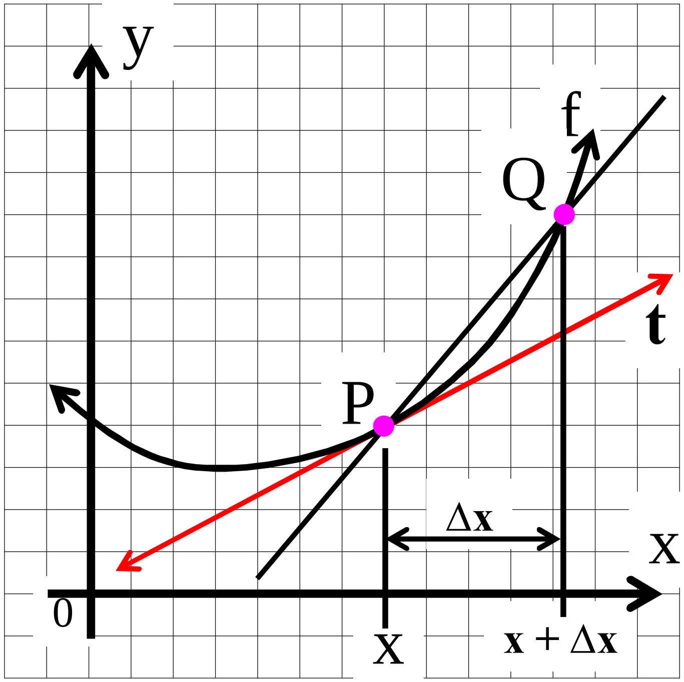

Clearly, the slope of the tangent line depends on the value of x.

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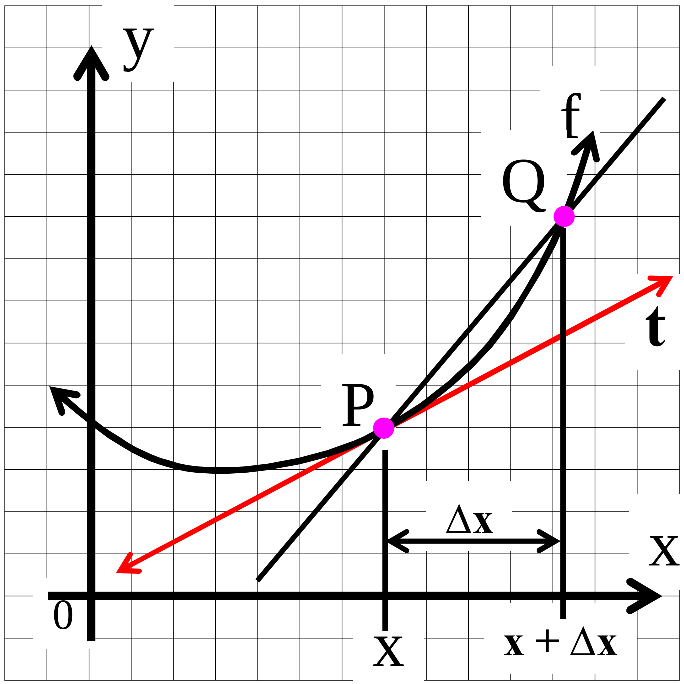

Our goal is to find an expression for the slope of line **t**.

$$\textbf{Slope of line t} = \lim_{\Delta x \to 0}\left[\frac{f(x+\Delta x) - f(x)}{\Delta x}\right]$$

Clearly, the slope of the tangent line **is a function of x**.

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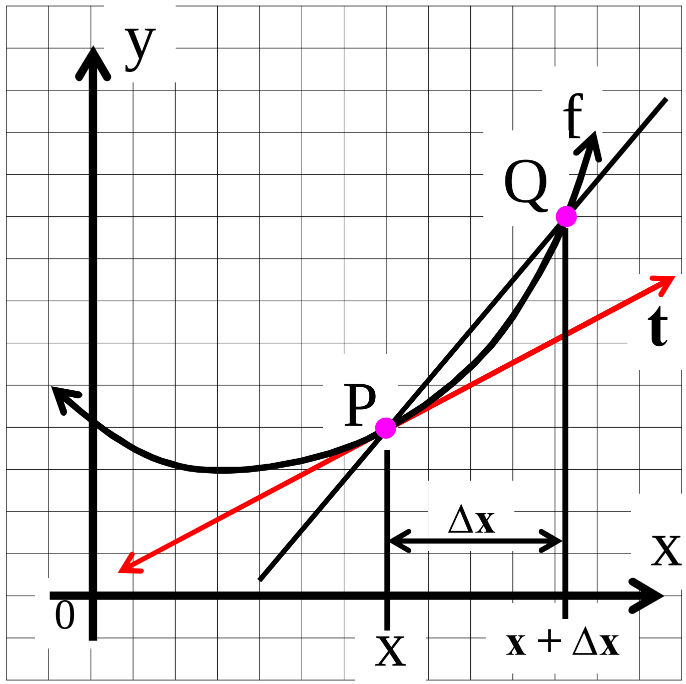

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Clearly, the slope of the tangent line **is a function of x**.

This function is called **the derivative function**.

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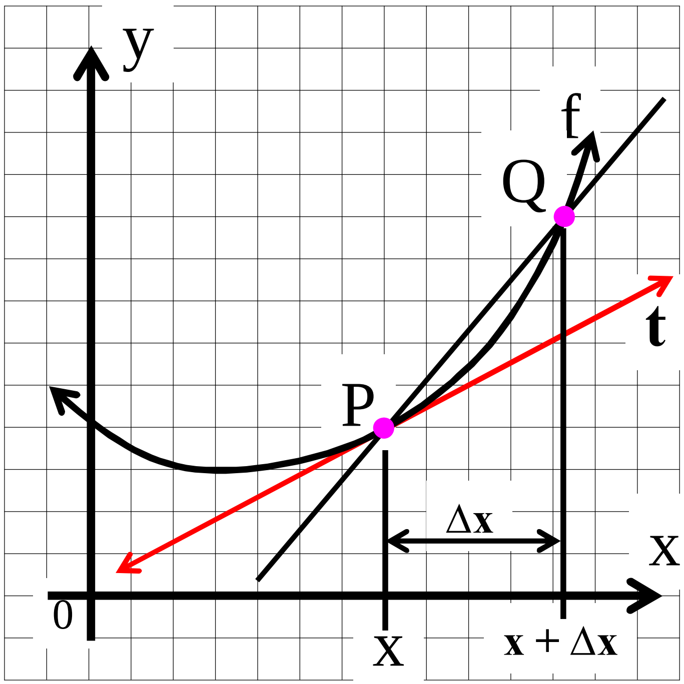

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The derivative of function f is commonly named f′.

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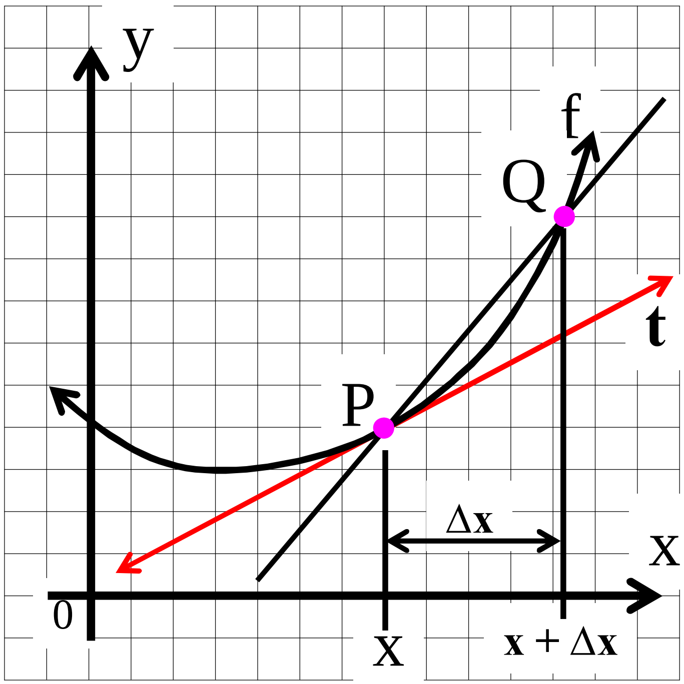

Clearly, the slope of the tangent line **is a function of x**.

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The derivative of function f is commonly named f ′.

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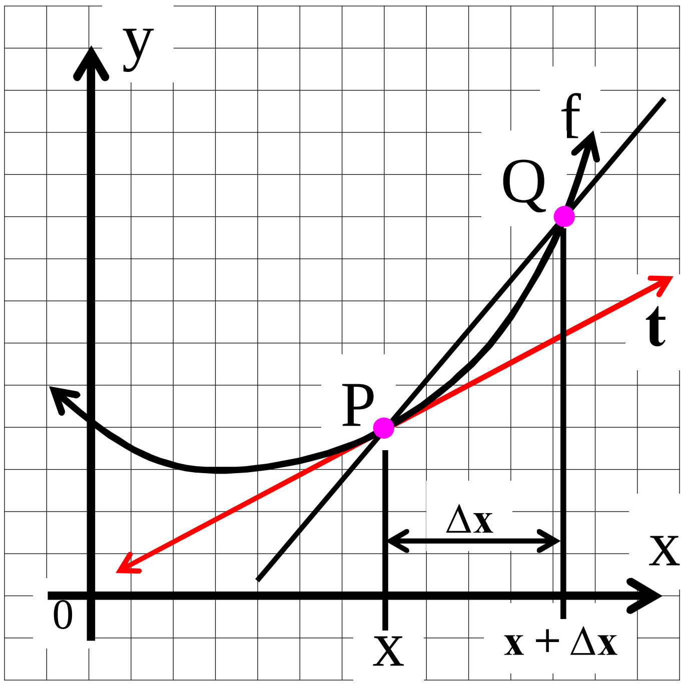
$$\mathbf{f'(x)} = \lim_{\Delta x \to 0}\left[\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}}\right]$$



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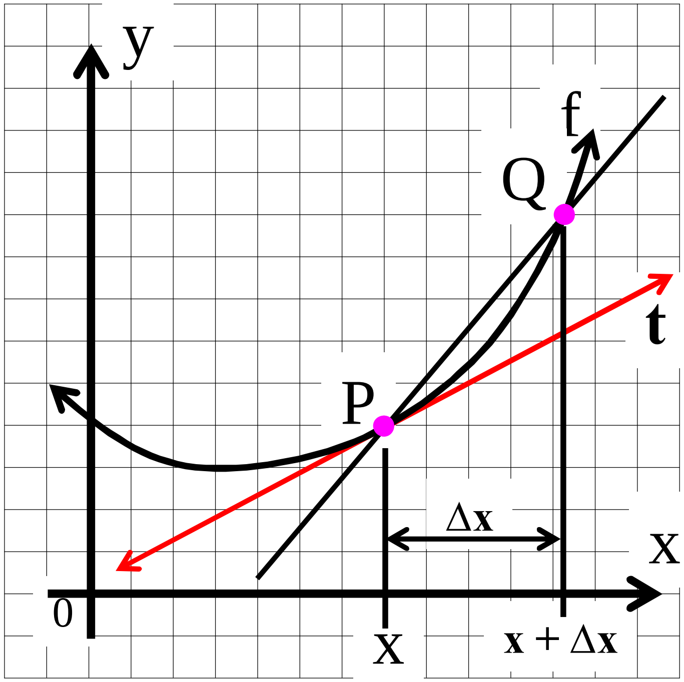
$$\mathbf{f'(x) = \lim_{\Delta x \to 0}\left[\frac{f(x + \Delta x) - f(x)}{\Delta x}\right]}$$



The process of finding the derivative function is called **differentiation**.

Consider the function f whose graph is shown here.

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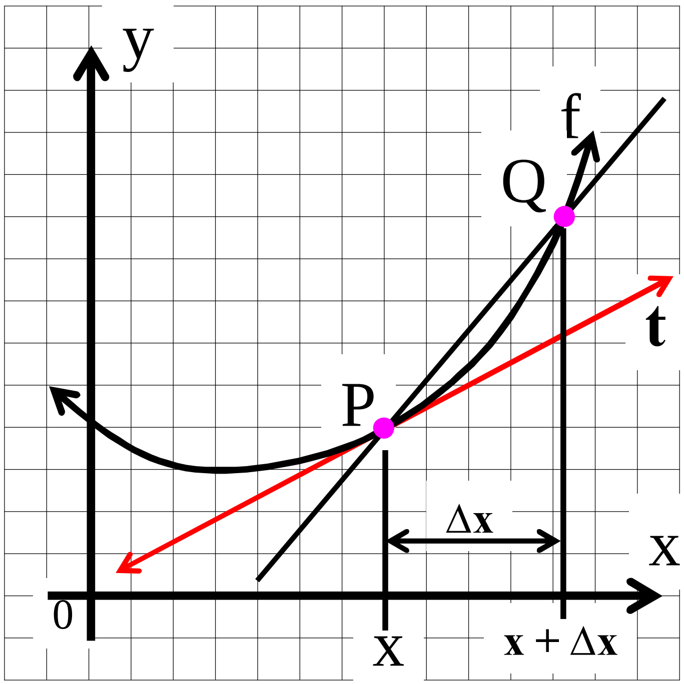

The process of finding the derivative function is called **differentiation**.

The specific procedure of differentiation using the definition is called the **four-step method**.

Consider the function f whose graph is shown here.

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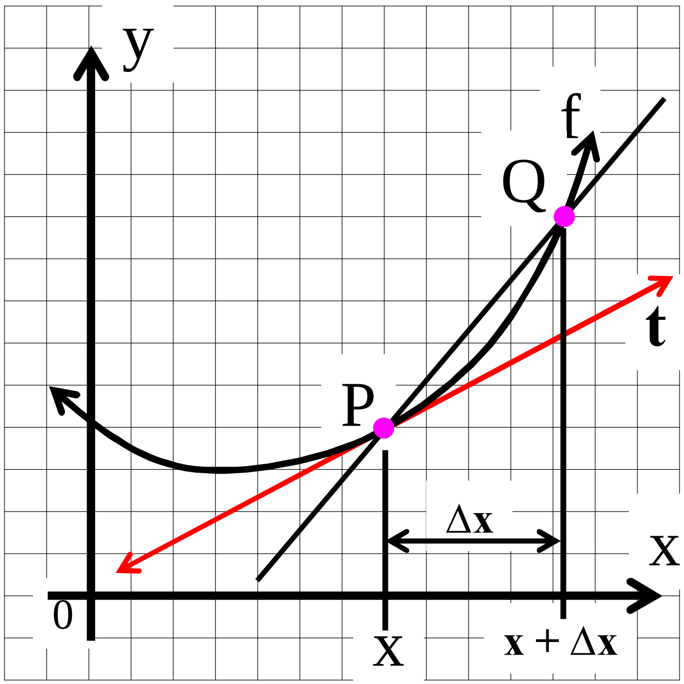

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The four-step method

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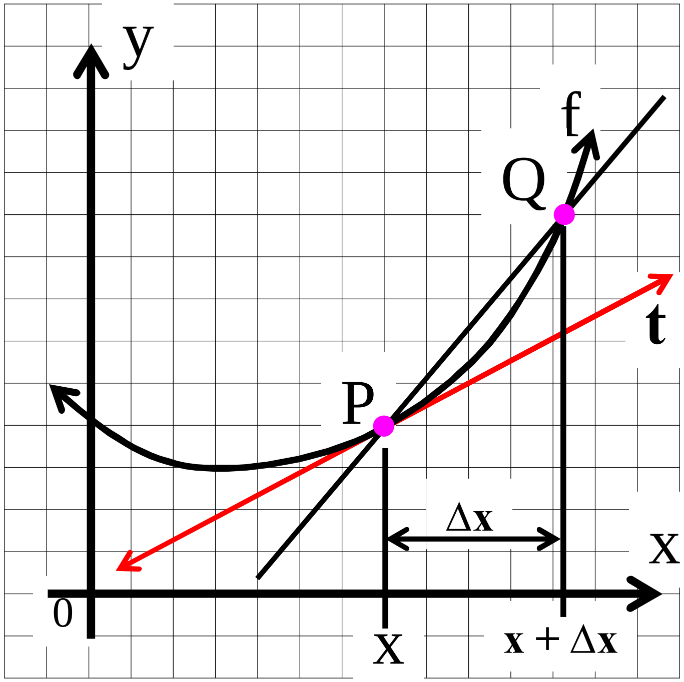

$$\mathbf{f'(x)} = \lim_{\Delta x \to 0}\left[\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}}\right]$$

The four-step method

Step 1: Find f(x + Δx).

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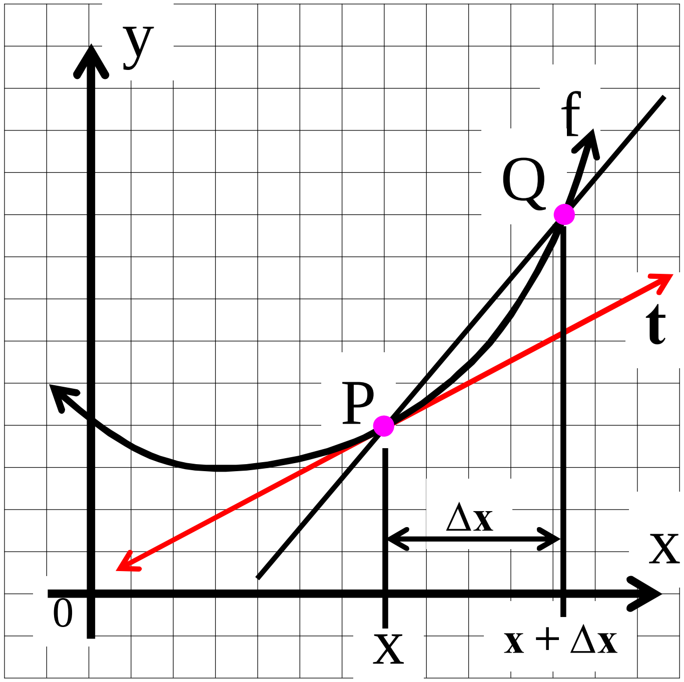
Our goal is to find an expression for the slope of line **t**.



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Step 1: Find f(x + Δx).

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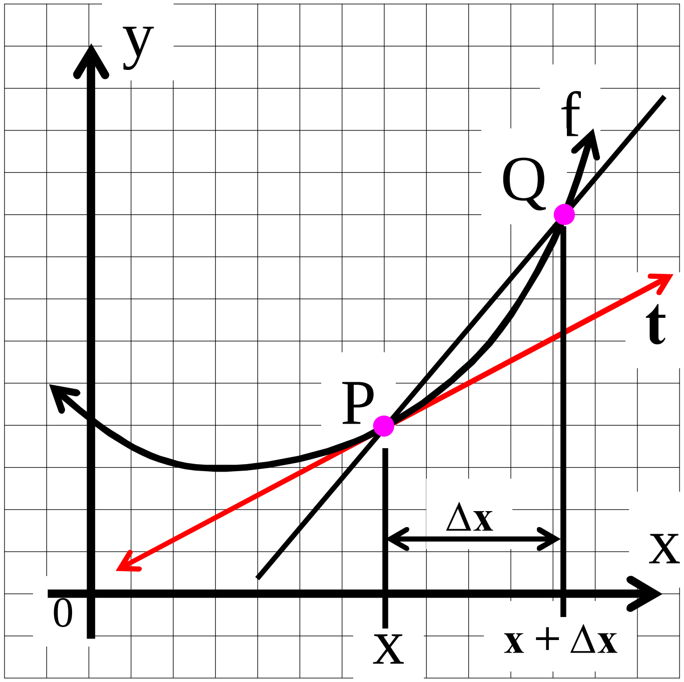

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Step 1: Find f(x + Δx).

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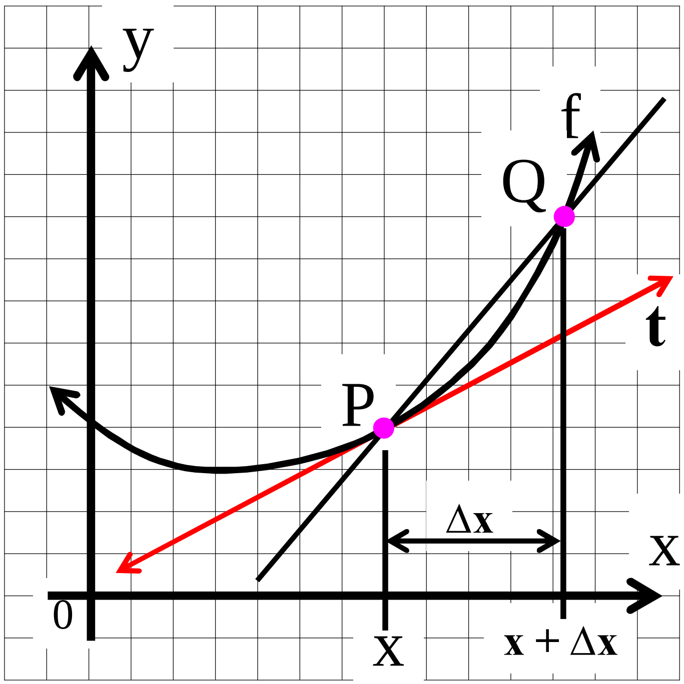

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Step 4: Evaluate the limit as Δx approaches 0.

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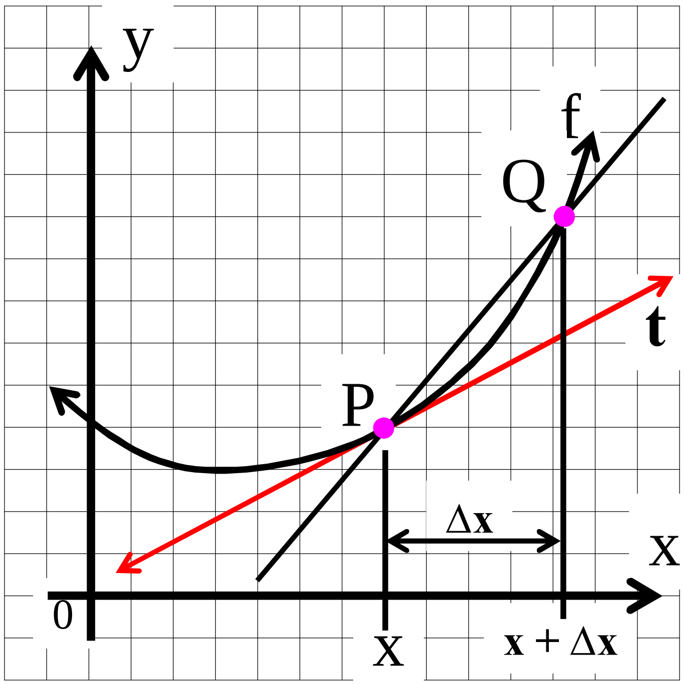

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Letôs do some sample problems.

Given any function f. The function f ′ , the derivative of f, is defined by

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Sample problem #1: Given $\mathbf{f(x) = x^2}$. Find f ′(x).

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These problems are on class worksheet #1.

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Step 1: $\mathbf{f(x + \Delta x)} = (x + \Delta x)^2$

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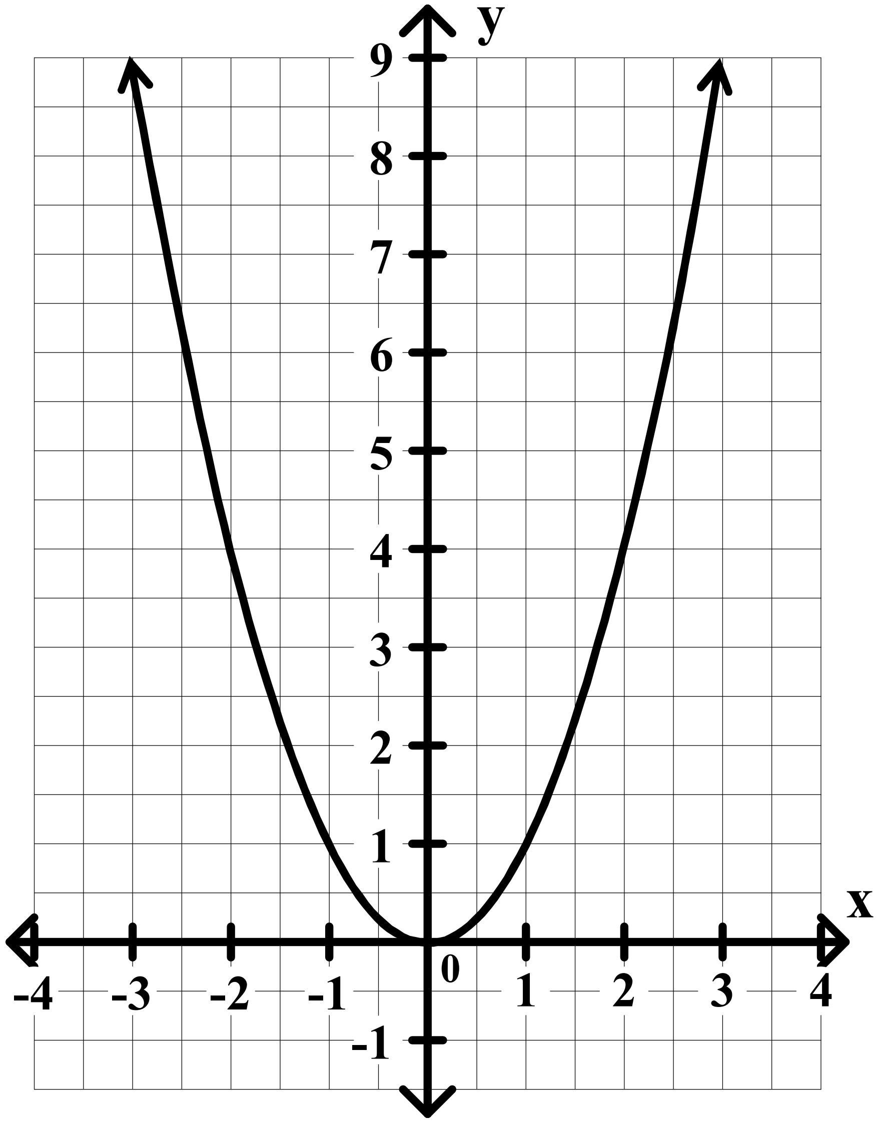

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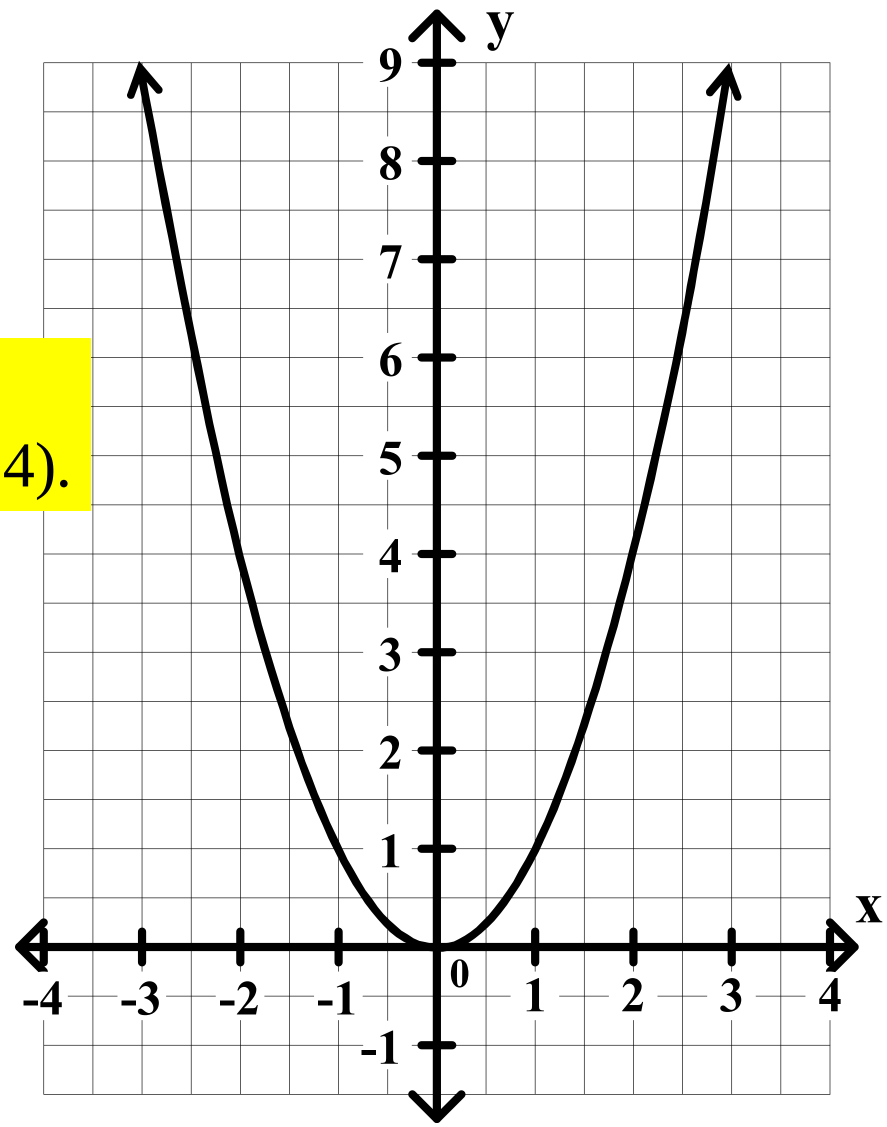

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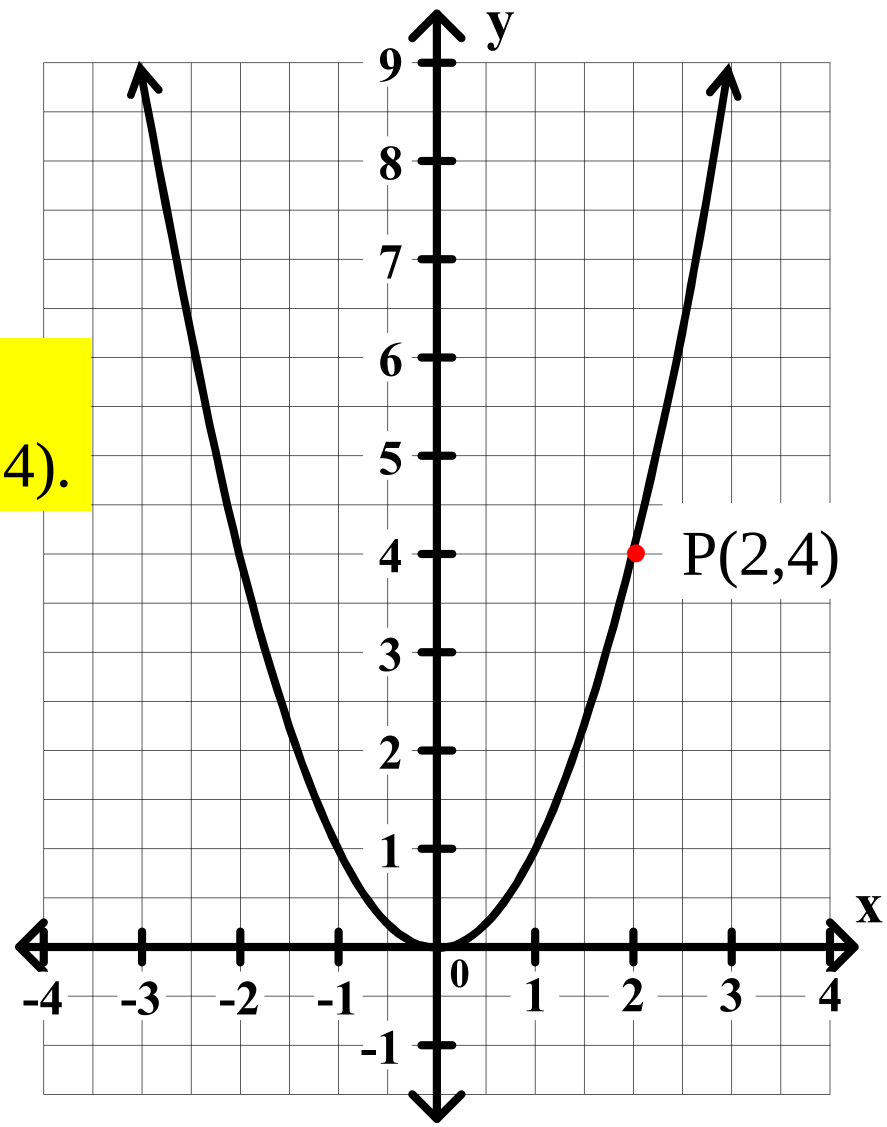

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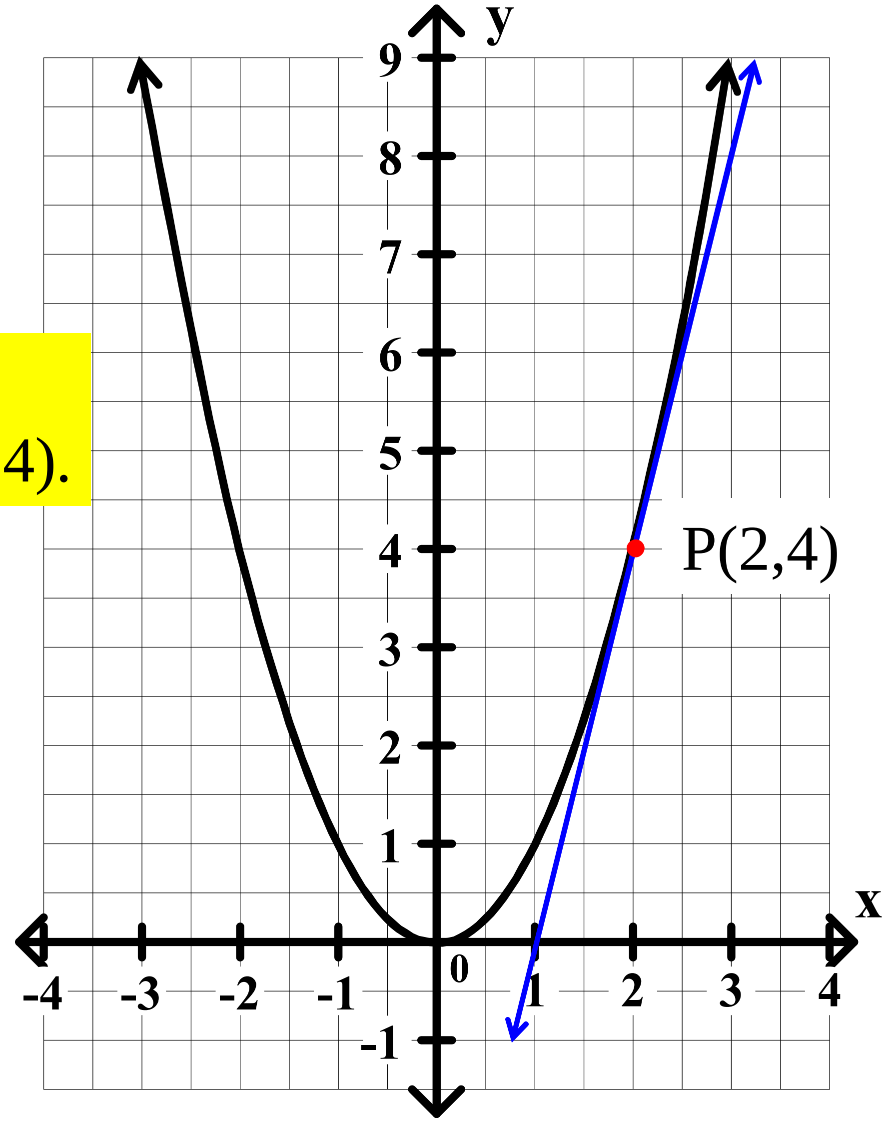

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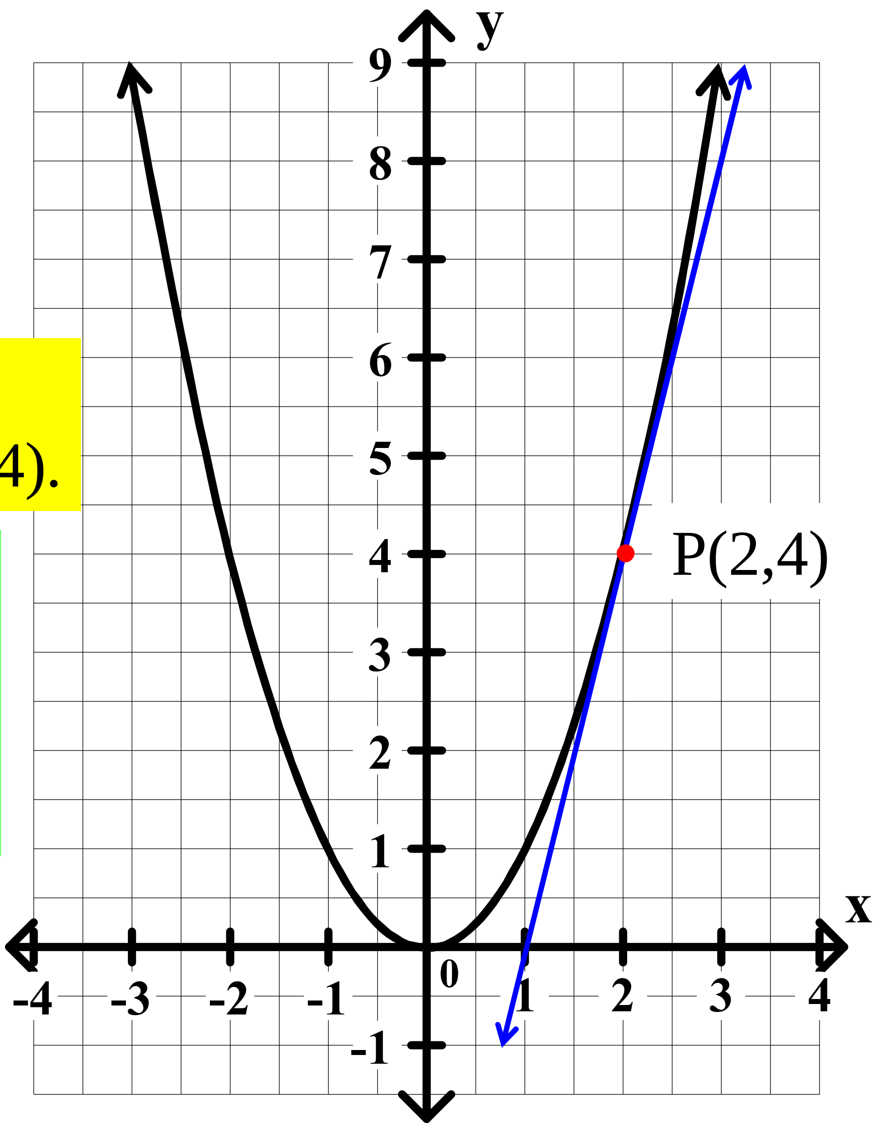

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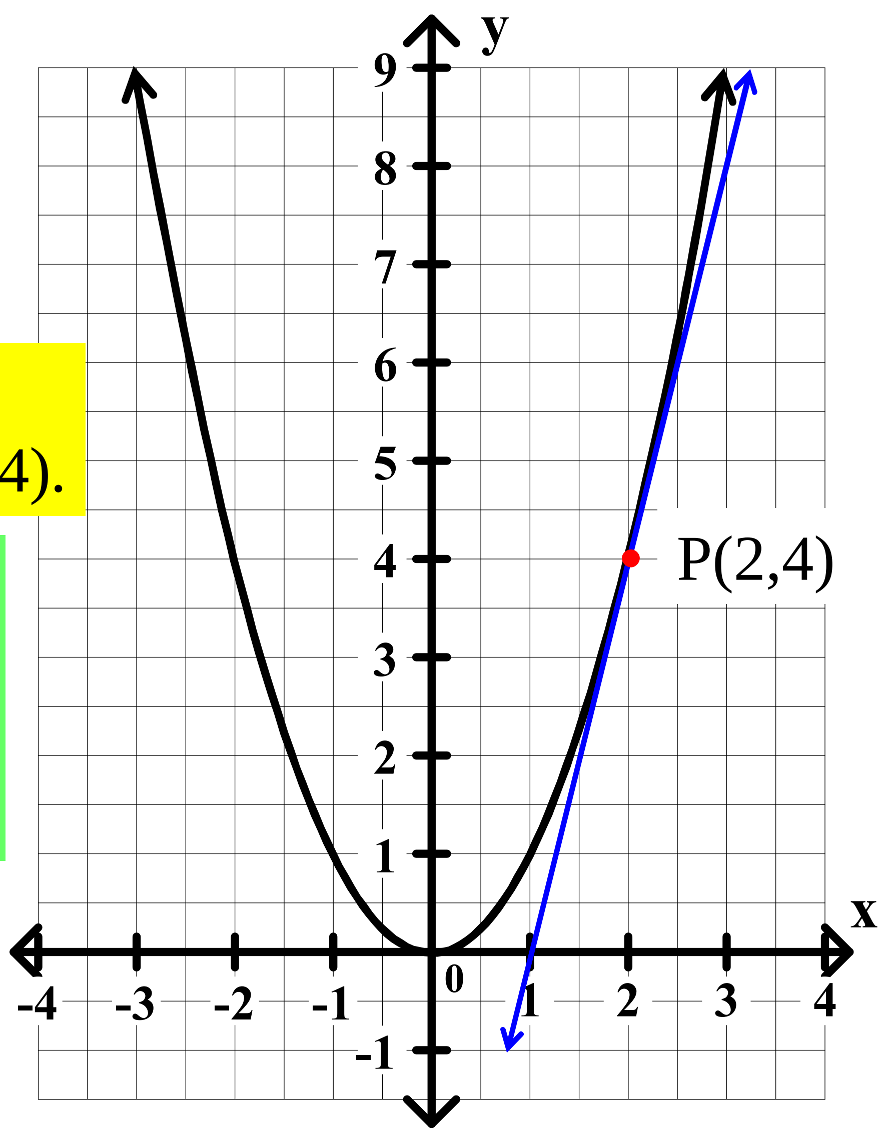

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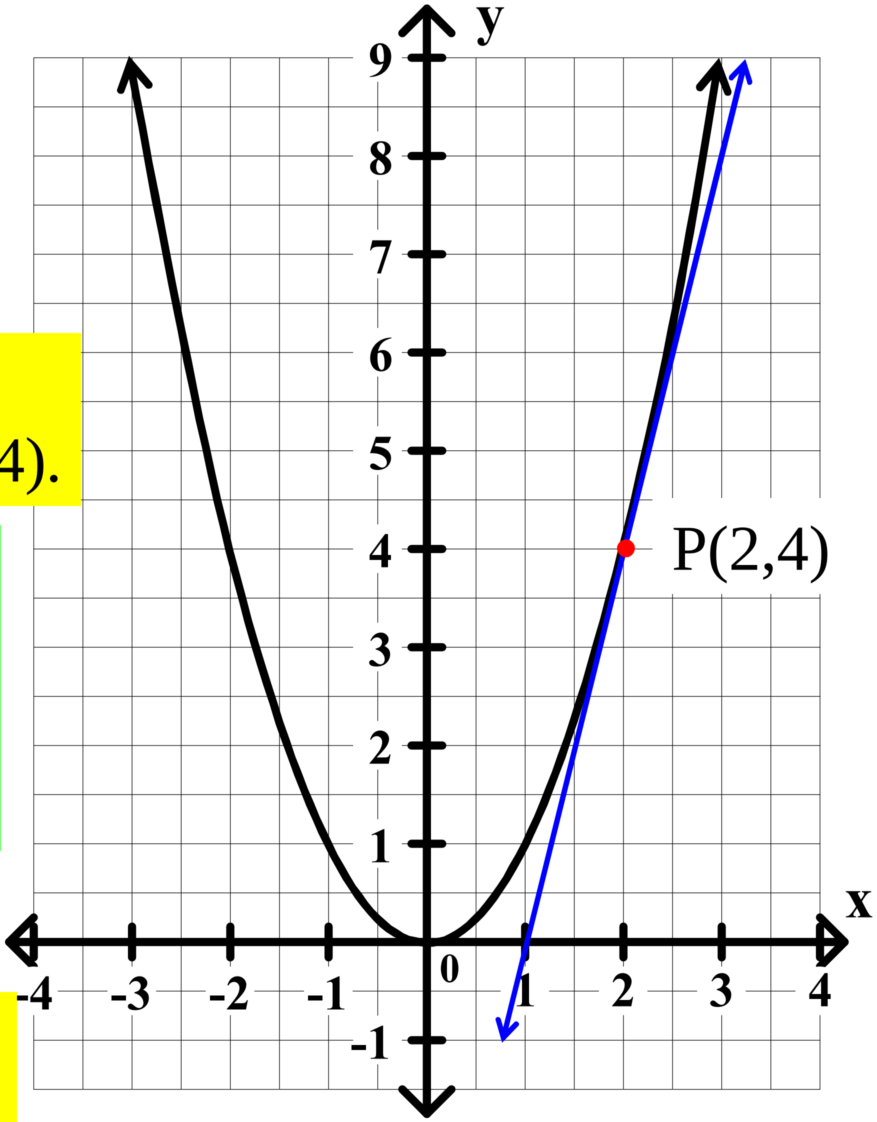

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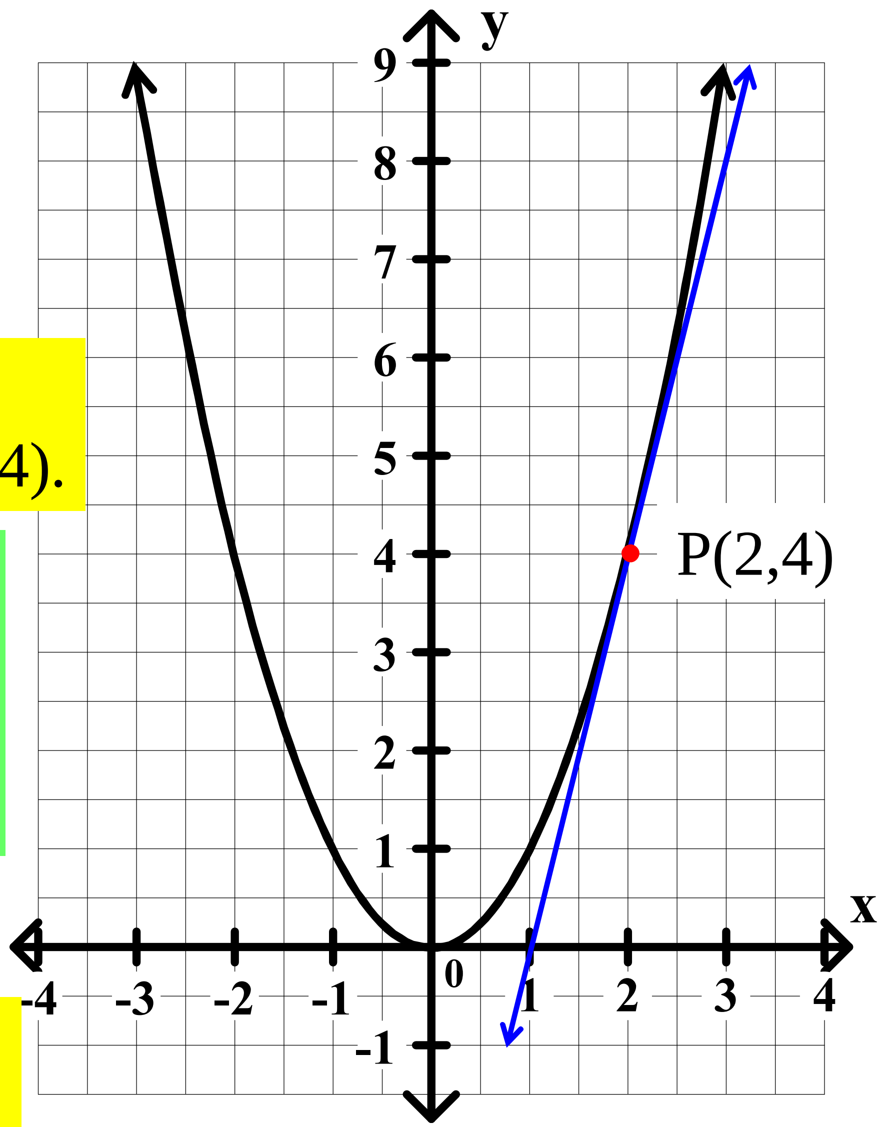

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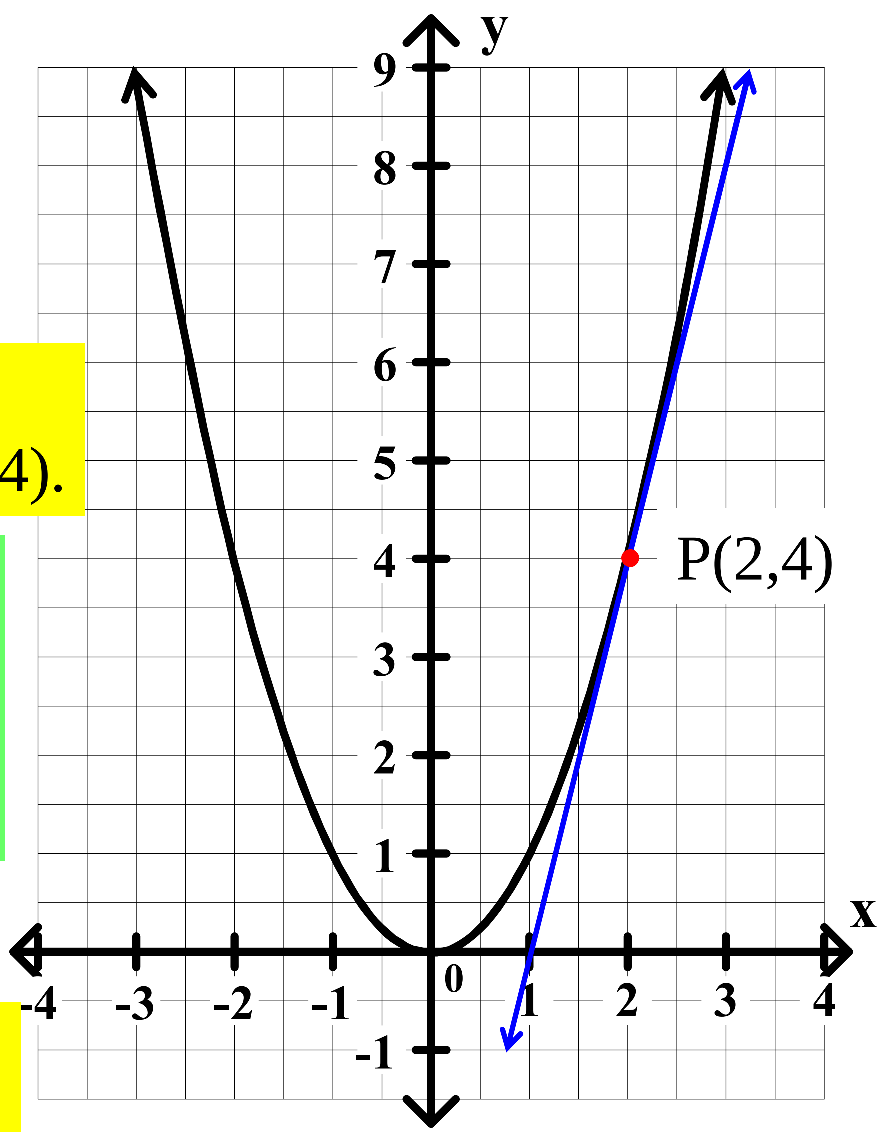

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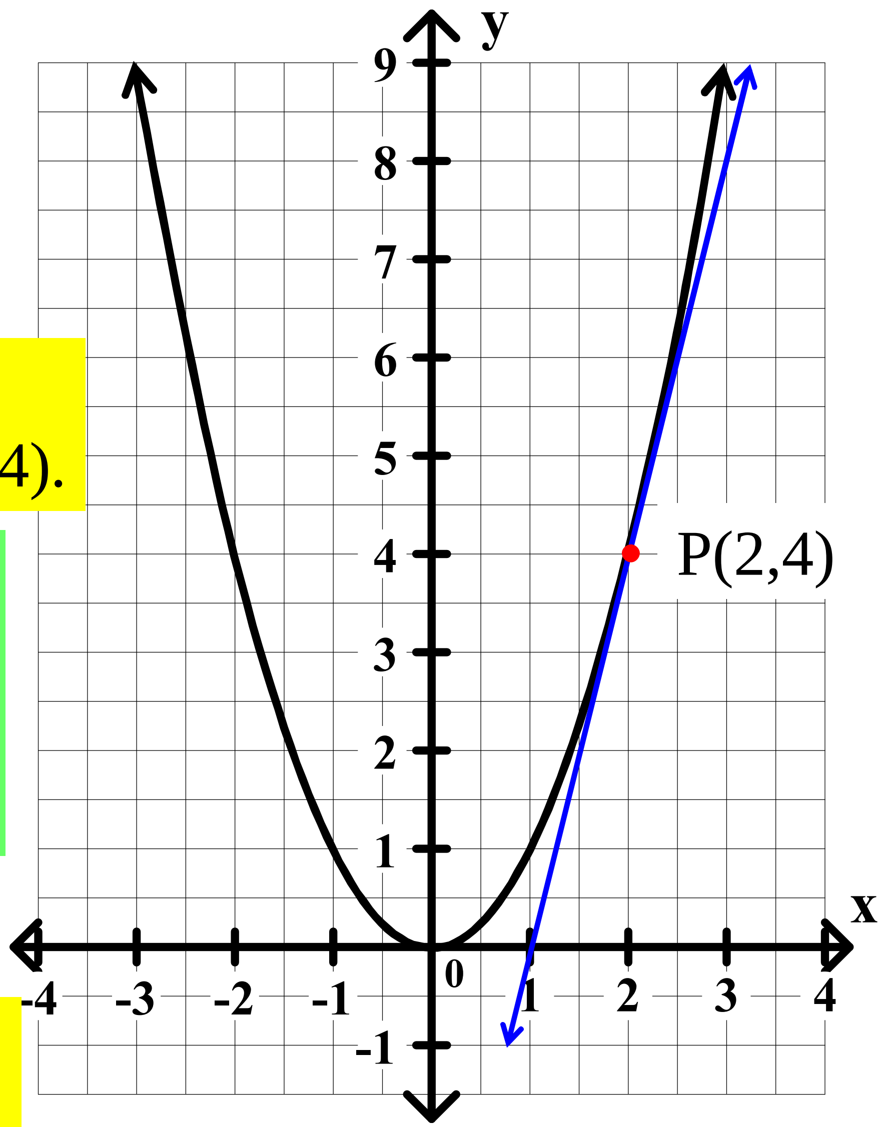

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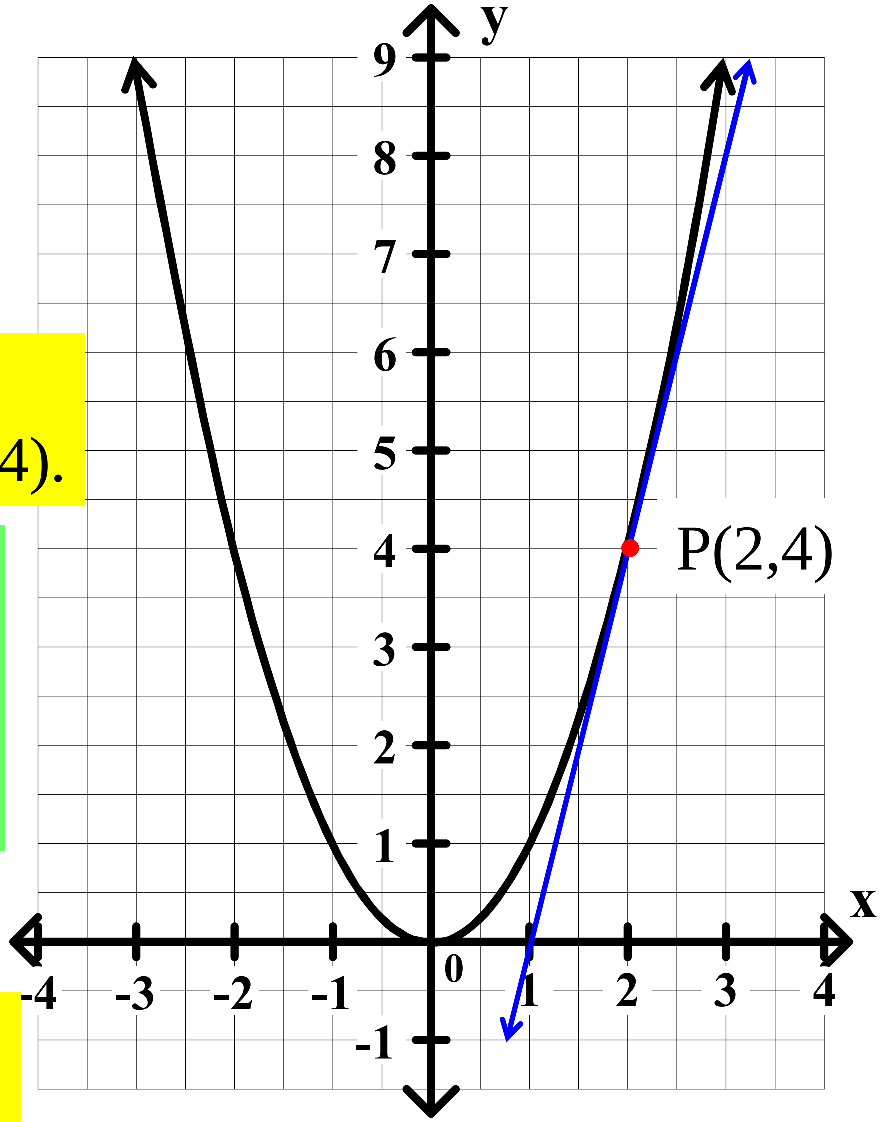

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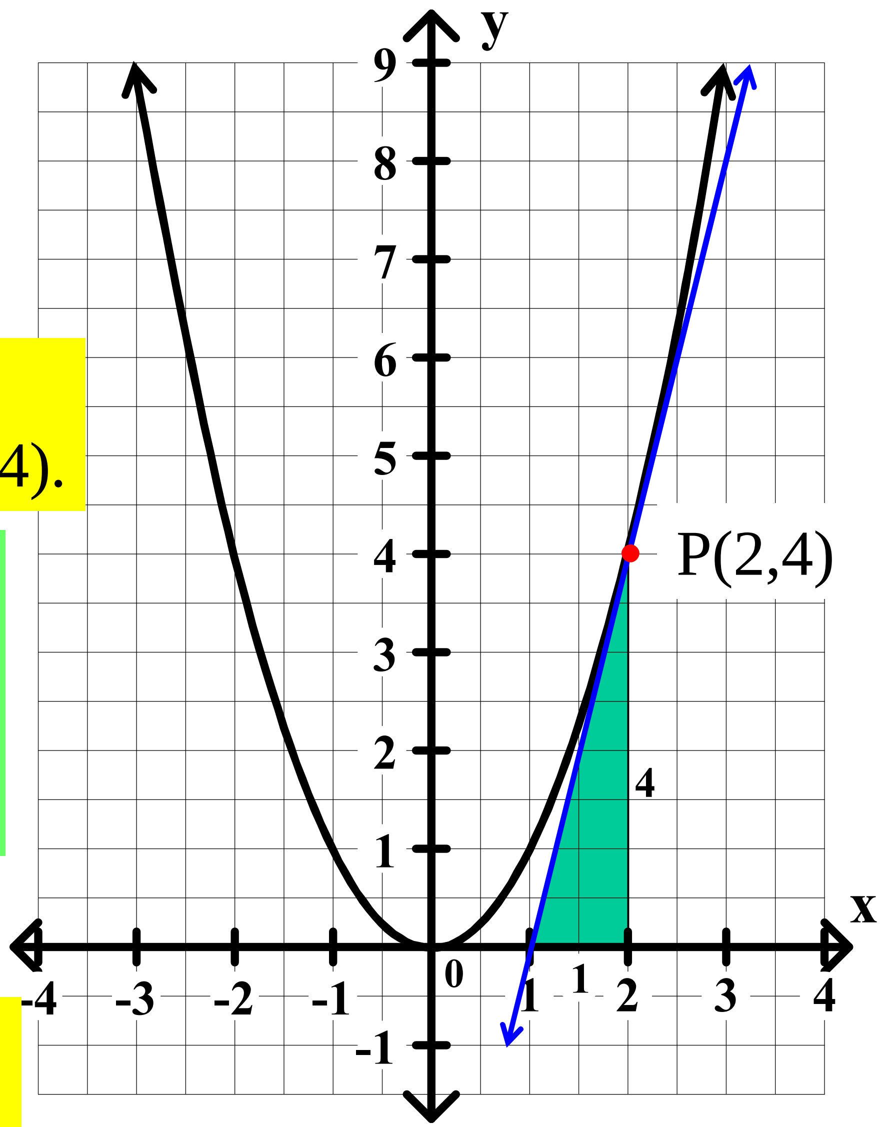

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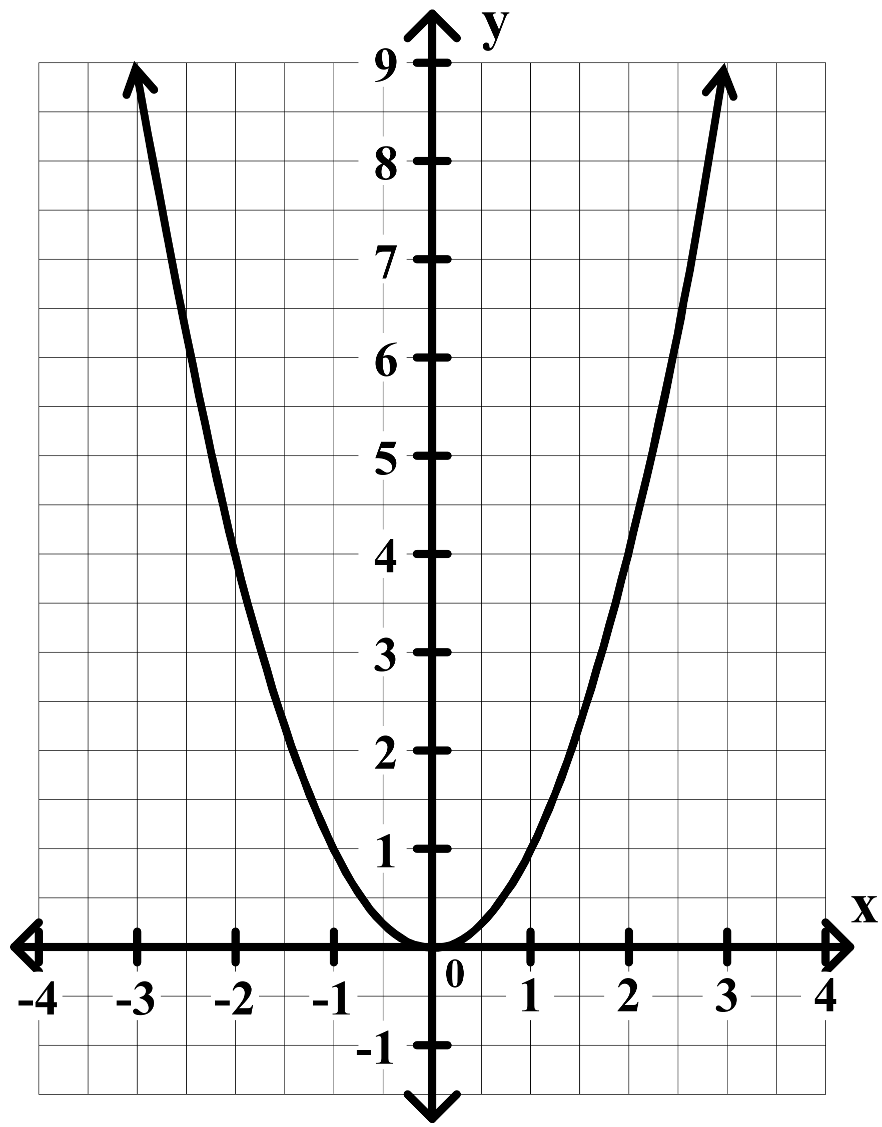

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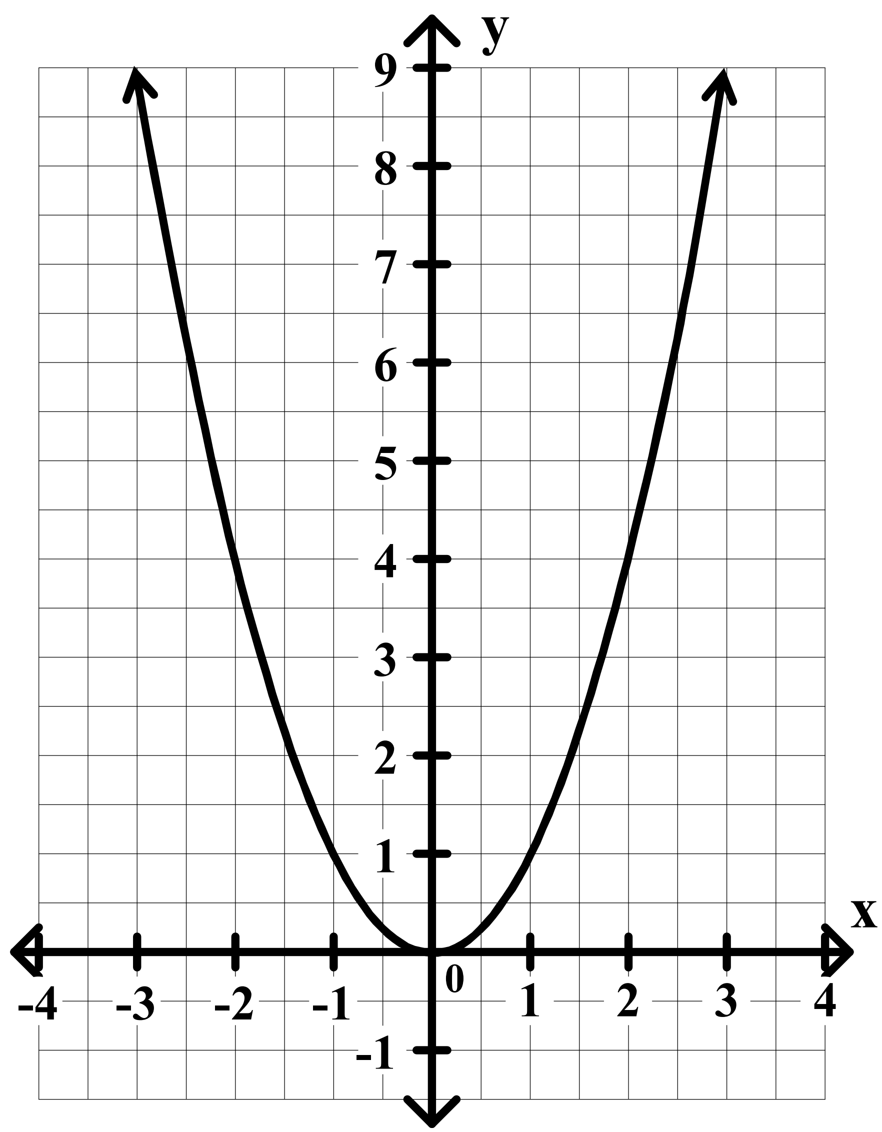

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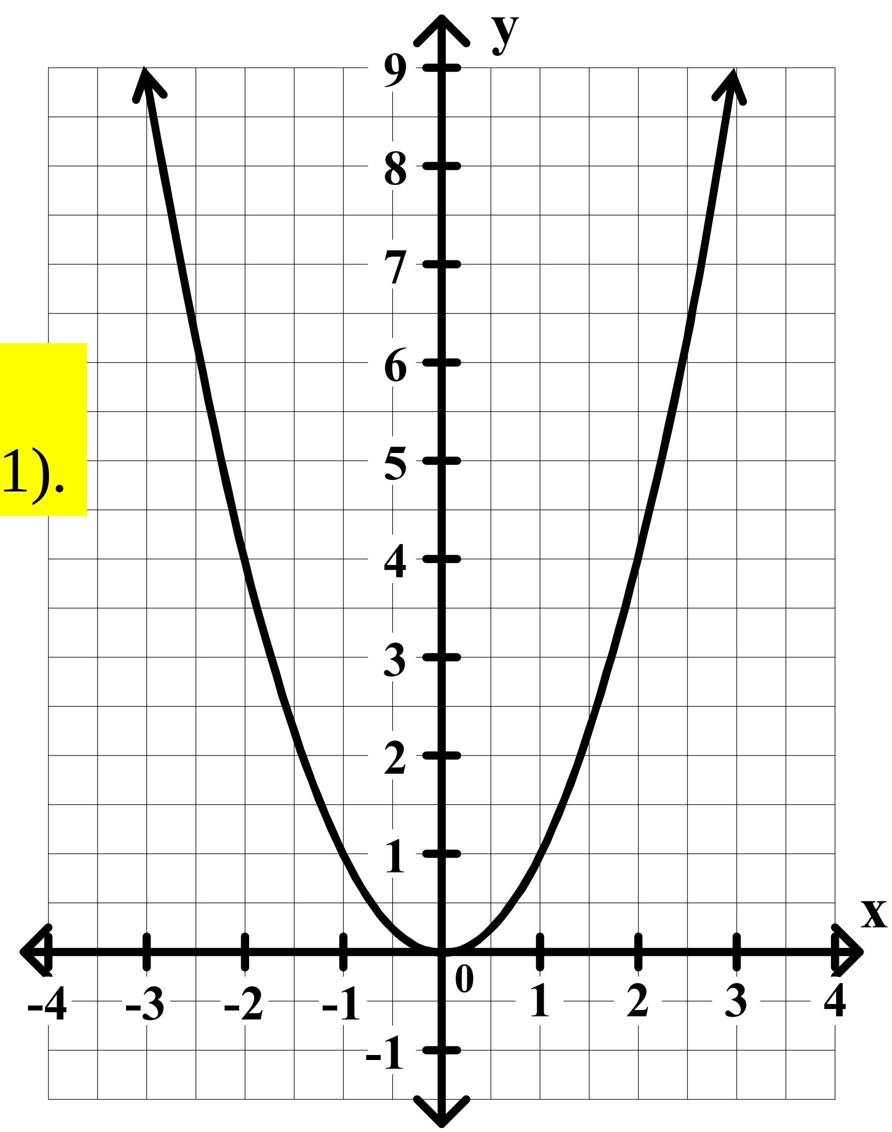

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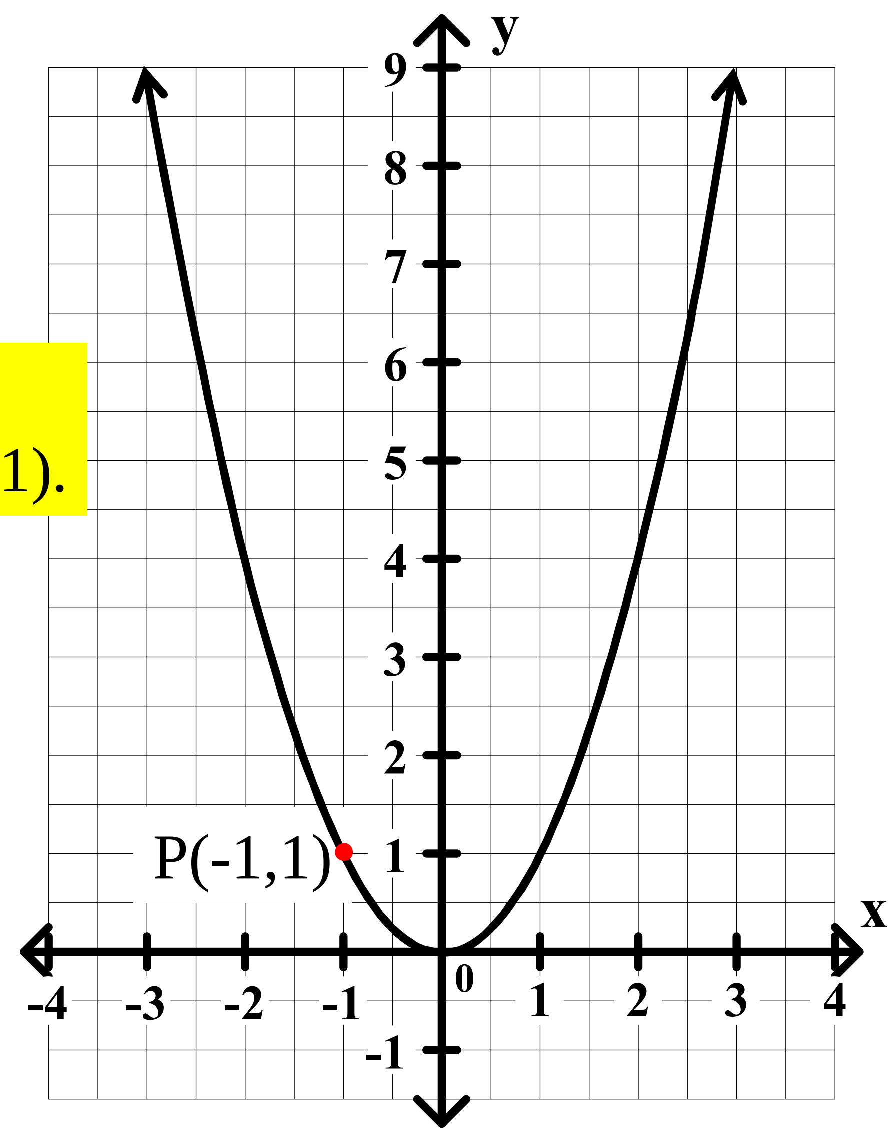

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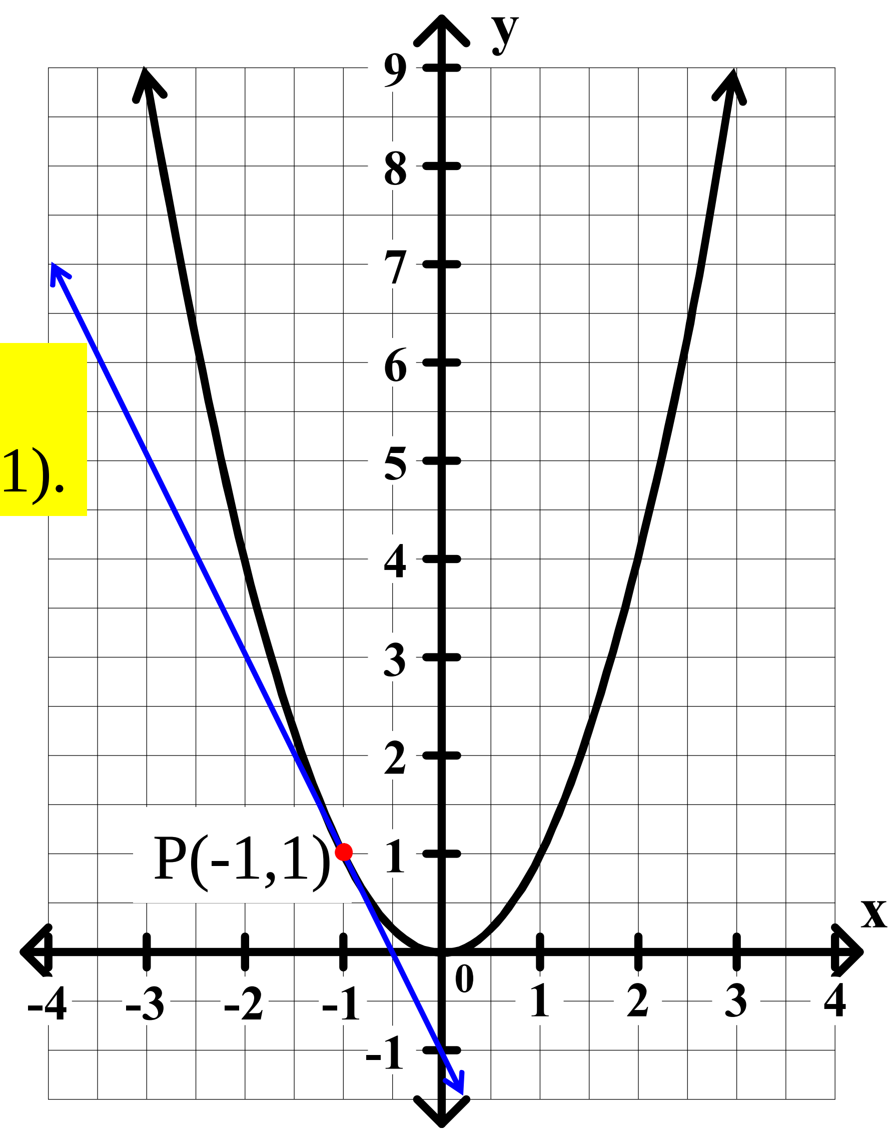

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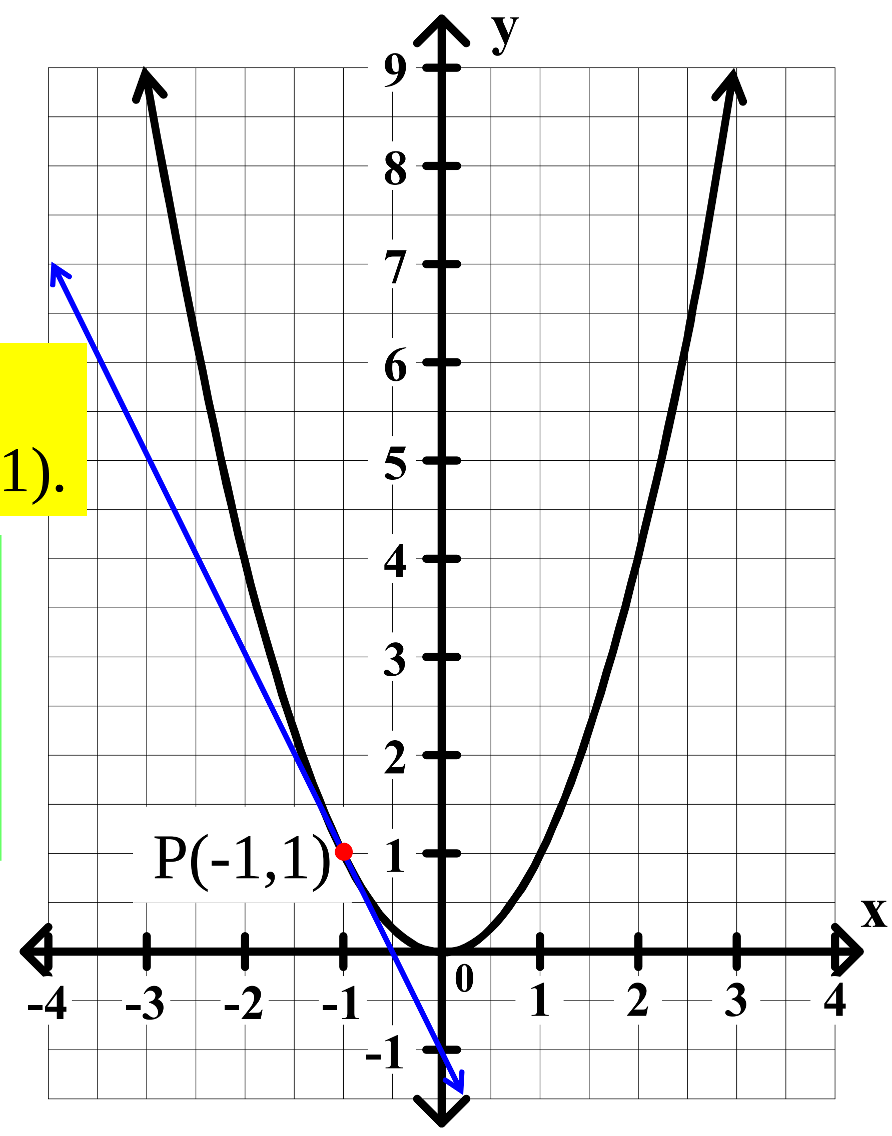

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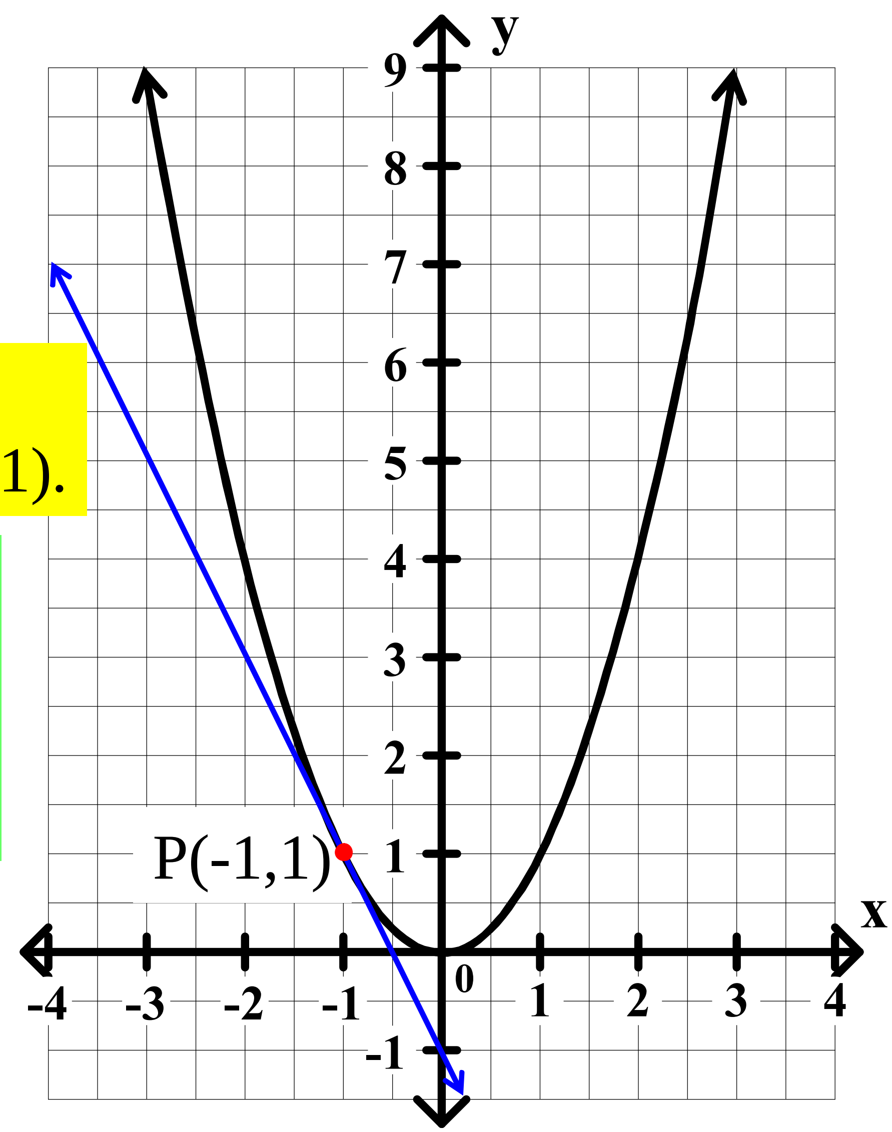

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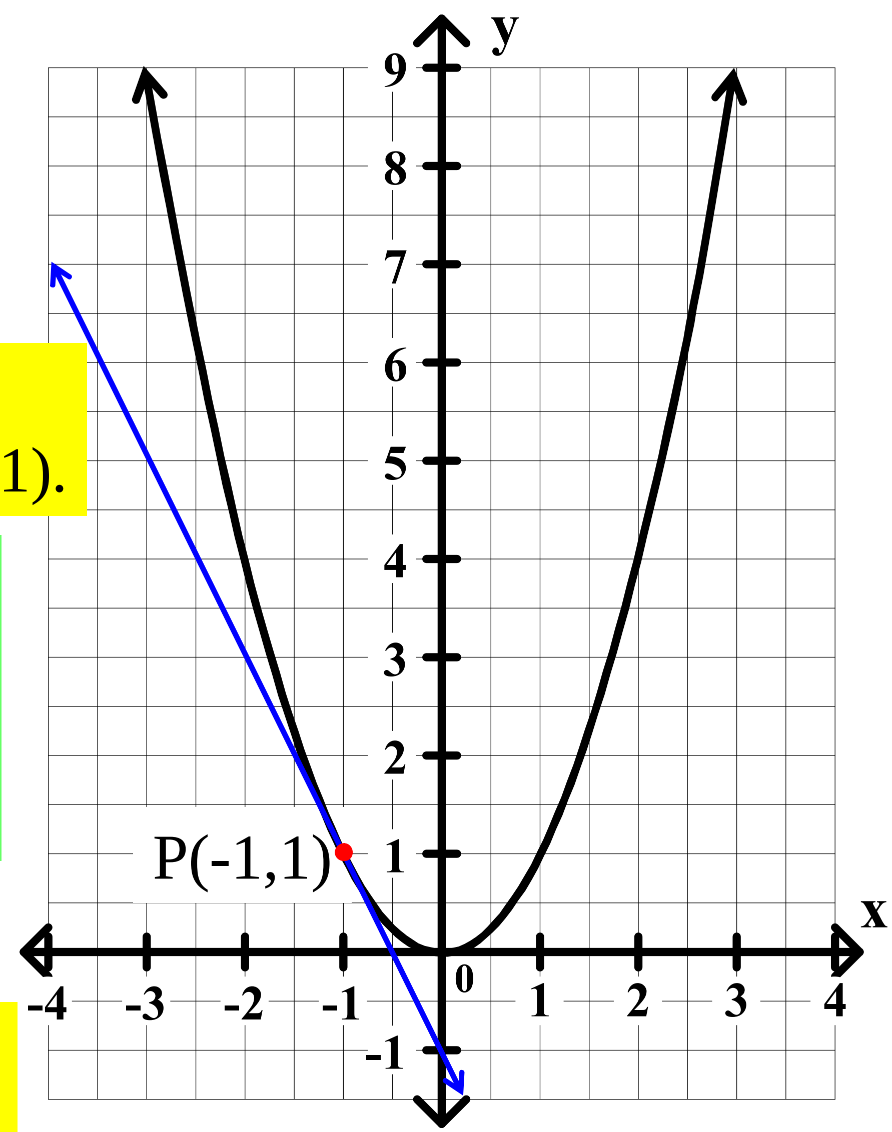

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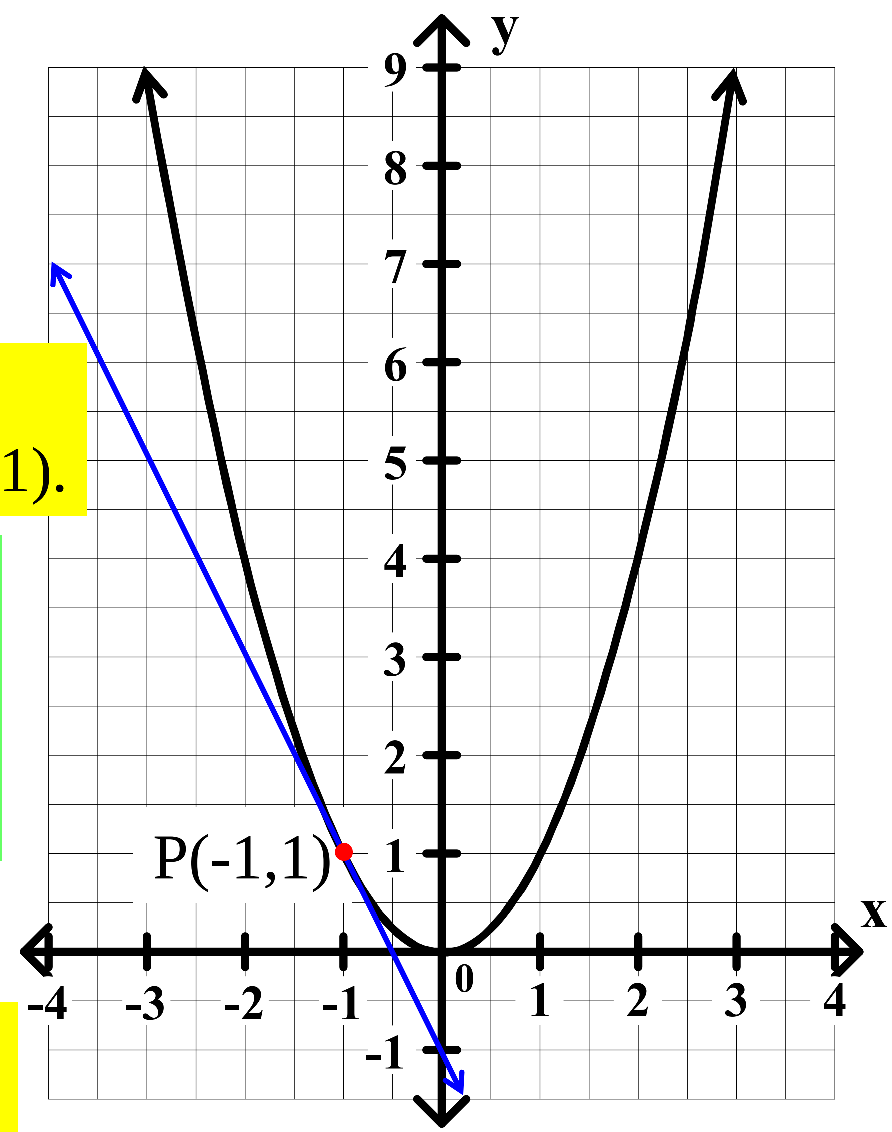

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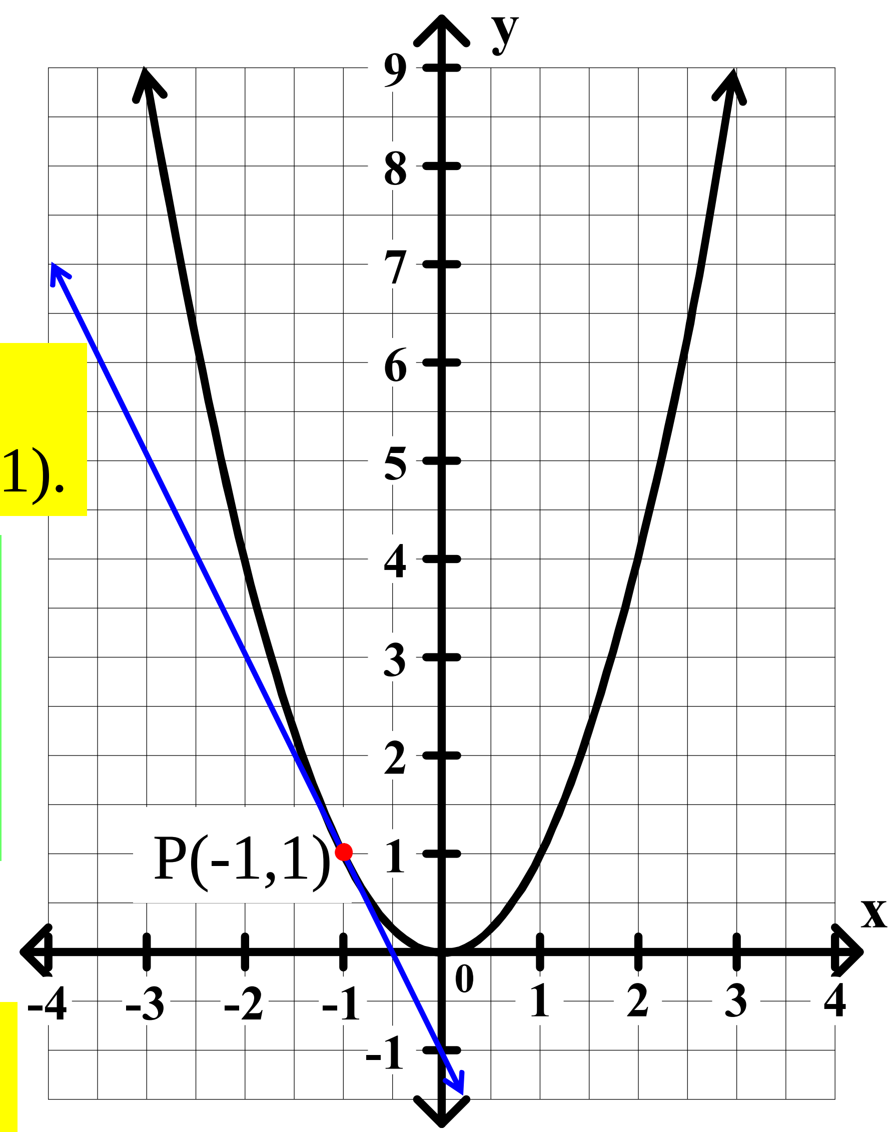

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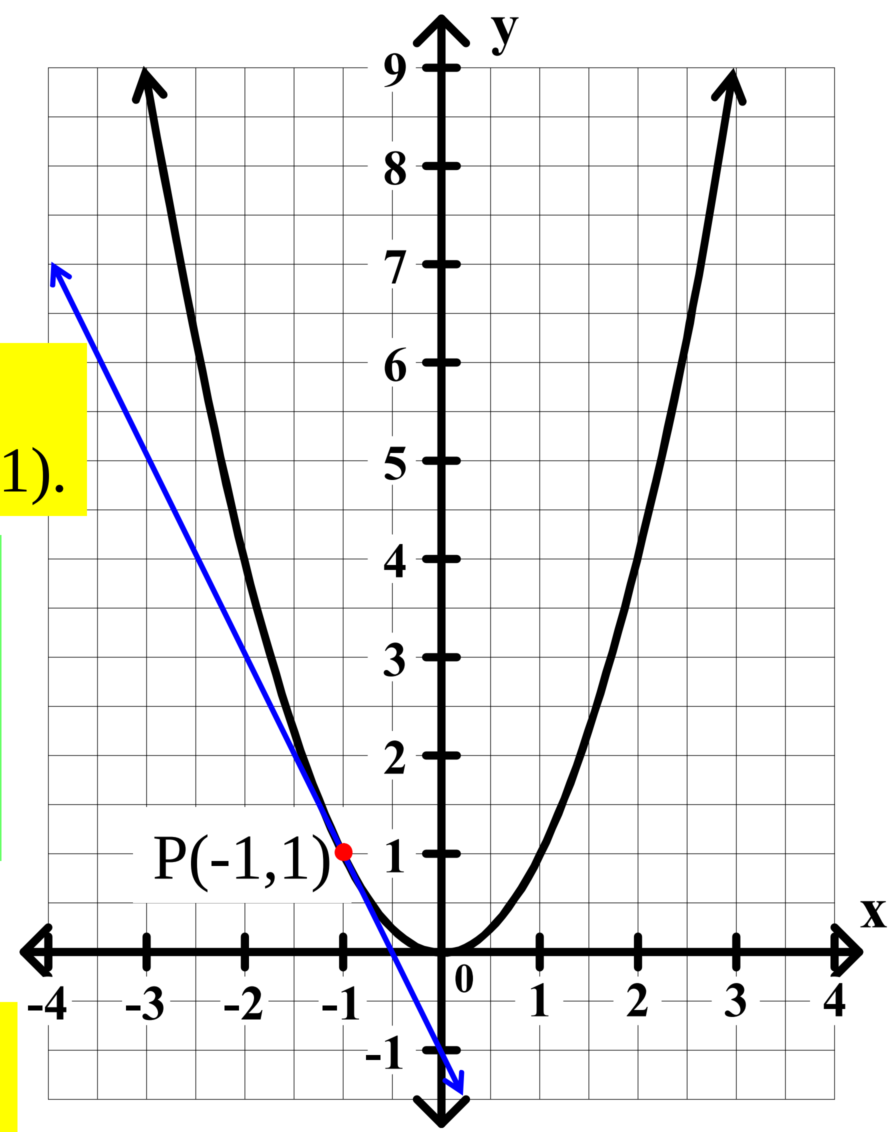

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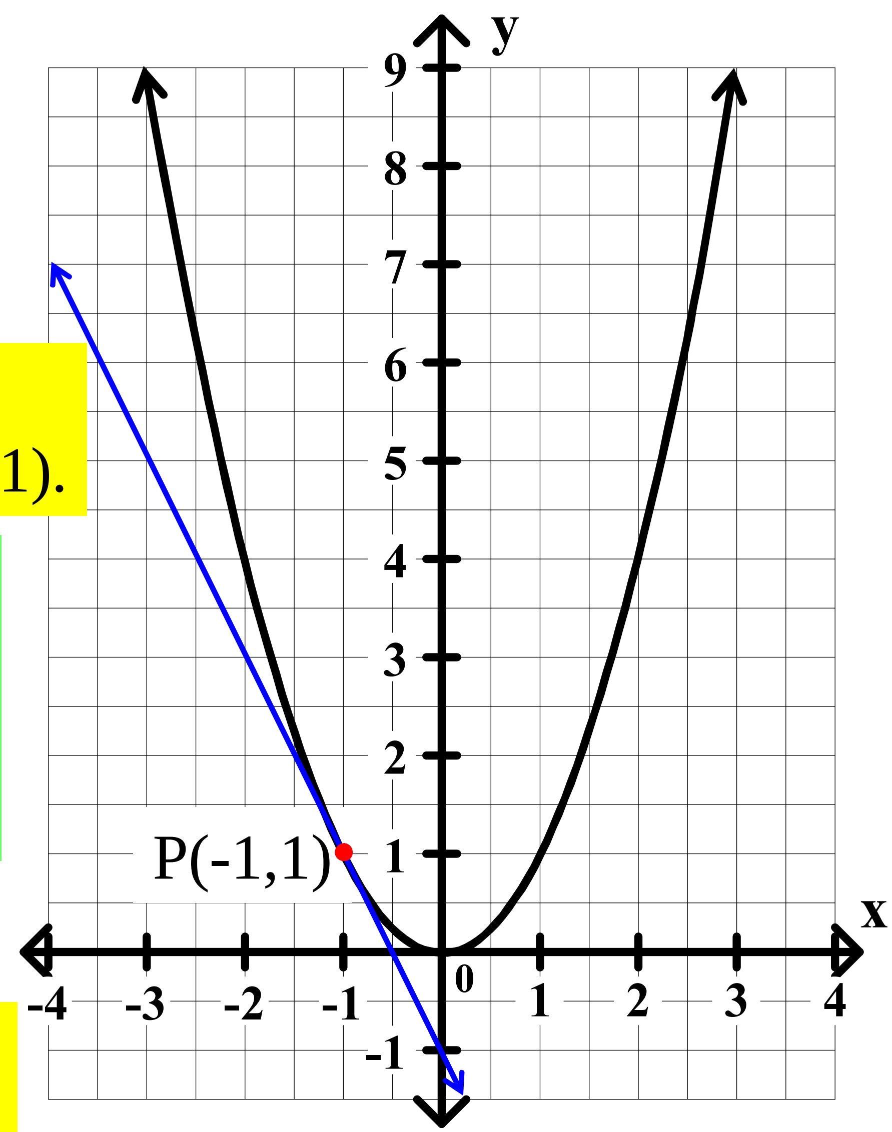

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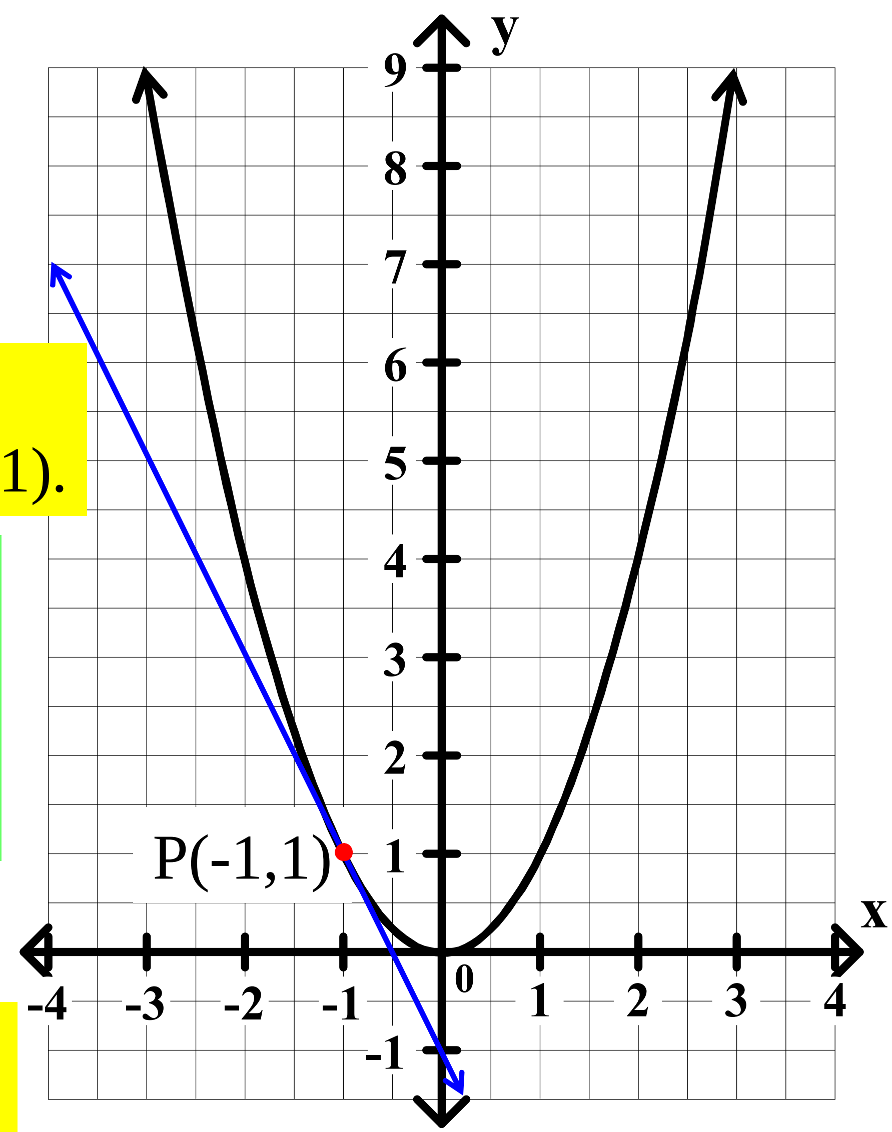

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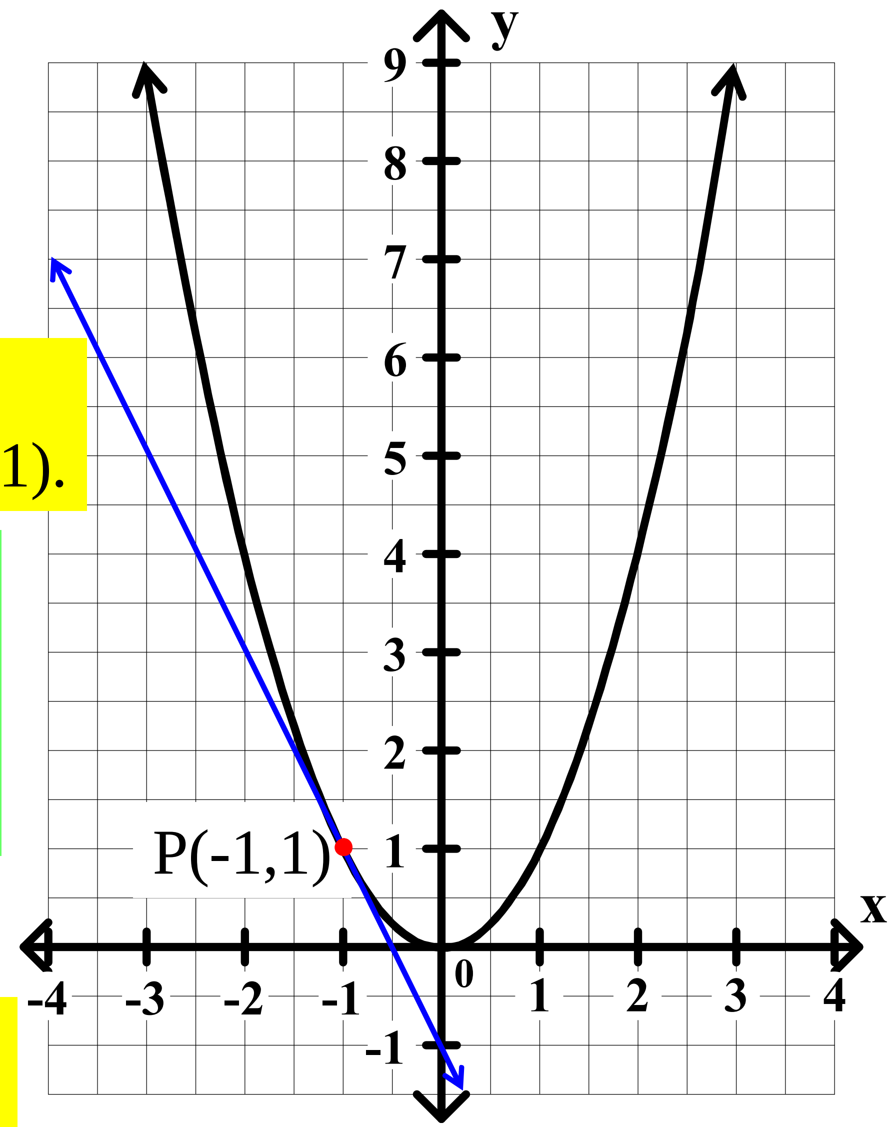

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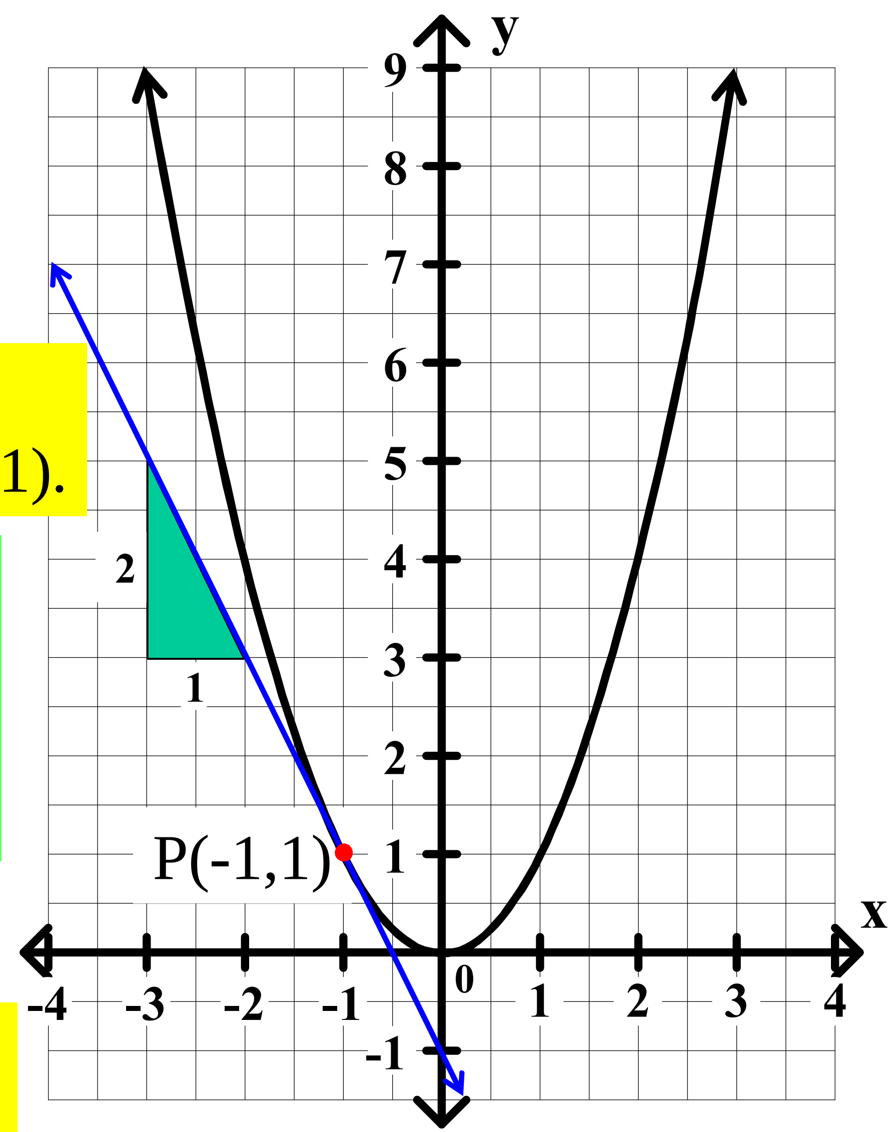

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Sample problem #2: Given **f(x) = 5 + 4x – x²**. Find f ′(x).

Step 1: **f(x + Δx)** = 5 + 4(x + Δx) ï (x + Δx)^2

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$$= 5 + 4x + 4\Delta x$$

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= **5 + 4x + 4Δx – x^2 – 2x Δx – Δx^2**

Step 2: **f(x + Δx) – f(x)** =

= (5 + 4x + 4Δx ï x^2 ï 2x Δx ï Δx^2) ï (5 + 4x ï x^2) =

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Step 2: **f(x + Δx) – f(x)** =

= (5 + 4x + 4Δx ï x^2 ï 2x Δx ï Δx^2) ï (5 + 4x ï x^2) =

= 5 + 4x + 4Δx ï x^2 ï 2xΔx ï Δx^2 ï 5 ï 4x + x^2

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$$= \cancel{5} + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\Delta x \text{ ï } \Delta x^2 \text{ ï } \cancel{5} \text{ ï } 4x + x^2 =$$

$$=$$

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$=$

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= $\mathbf{5 + 4x + 4\Delta x - x^2 - 2x\,\Delta x - \Delta x^2}$

Step 2: $\mathbf{f(x + \Delta x) - f(x)}$ =

= (5 + 4x + 4Δx ï x^2 ï 2x Δx ï Δx^2) ï (5 + 4x ï x^2) =

= ~~5~~ + ~~4x~~ + 4Δx ï x^2 ï 2xΔx ï Δx^2 ï ~~5~~ ï ~~4x~~ + x^2 =

= 4Δx

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$$= 5 + 4x + 4\Delta x\ \text{ï}\ x^2\ \text{ï}\ 2x\Delta x\ \text{ï}\ \Delta x^2\ \text{ï}\ 5\ \text{ï}\ 4x + x^2 =$$

$$= 4\Delta x$$

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= **5 + 4x + 4Δx – x^2 – 2x Δx – Δx^2**

Step 2: **f(x + Δx) – f(x)** =

= (5 + 4x + 4Δx ï x^2 ï 2x Δx ï Δx^2) ï (5 + 4x ï x^2) =

= ~~5~~ + ~~4x~~ + 4Δx ï ~~x^2~~ ï 2xΔx ï Δx^2 ï ~~5~~ ï ~~4x~~ + ~~x^2~~ =

= 4Δx ï 2xΔx

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$= 4\Delta x$ ï $2x\Delta x$ ï Δx^2

Sample problem #2: Given $\mathbf{f(x) = 5 + 4x - x^2}$. Find $f'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 5 + 4(x + \Delta x)$ ï $(x + \Delta x)^2 =$

$= 5 + 4x + 4\Delta x$ ï $(x^2 + 2x\Delta x + \Delta x^2) =$

$= \mathbf{5 + 4x + 4\Delta x - x^2 - 2x\,\Delta x - \Delta x^2}$

Step 2: $\mathbf{f(x + \Delta x) - f(x)} =$

$= (5 + 4x + 4\Delta x$ ï x^2 ï $2x\,\Delta x$ ï $\Delta x^2)$ ï $(5 + 4x$ ï $x^2) =$

$= 5 + 4x + 4\Delta x$ ï x^2 ï $2x\Delta x$ ï Δx^2 ï 5 ï $4x + x^2 =$

$= \mathbf{4\Delta x - 2x\,\Delta x - \Delta x^2}$

Sample problem #2: Given $\mathbf{f(x) = 5 + 4x - x^2}$. Find $f'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 5 + 4(x + \Delta x) \text{ ï } (x + \Delta x)^2 =$

$$= 5 + 4x + 4\Delta x \text{ ï } (x^2 + 2x\Delta x + \Delta x^2) =$$

$$= \mathbf{5 + 4x + 4\Delta x - x^2 - 2x\,\Delta x - \Delta x^2}$$

Step 2: $\mathbf{f(x + \Delta x) - f(x)} =$

$$= (5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\,\Delta x \text{ ï } \Delta x^2) \text{ ï } (5 + 4x \text{ ï } x^2) =$$

$$= 5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\Delta x \text{ ï } \Delta x^2 \text{ ï } 5 \text{ ï } 4x + x^2 =$$

$$= \mathbf{4\Delta x - 2x\,\Delta x - \Delta x^2}$$

Step 3:

Sample problem #2: Given **f(x) = 5 + 4x – x^2**. Find f ′(x).

Step 1: **f(x + Δx)** = 5 + 4(x + Δx) ï (x + Δx)^2 =

= 5 + 4x + 4Δx ï (x^2 + 2xΔx + Δx^2) =

= **5 + 4x + 4Δx – x^2 – 2x Δx – Δx^2**

Step 2: **f(x + Δx) – f(x)** =

= (5 + 4x + 4Δx ï x^2 ï 2x Δx ï Δx^2) ï (5 + 4x ï x^2) =

= 5 + 4x + 4Δx ï x^2 ï 2xΔx ï Δx^2 ï 5 ï 4x + x^2 =

= **4Δx – 2xΔx – Δx^2**

Step 3: $$\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}}$$

Sample problem #2: Given $\mathbf{f(x) = 5 + 4x - x^2}$. Find $f'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 5 + 4(x + \Delta x)$ ï $(x + \Delta x)^2 =$

$= 5 + 4x + 4\Delta x$ ï $(x^2 + 2x\Delta x + \Delta x^2) =$

$= \mathbf{5 + 4x + 4\Delta x - x^2 - 2x\,\Delta x - \Delta x^2}$

Step 2: $\mathbf{f(x + \Delta x) - f(x)} =$

$= (5 + 4x + 4\Delta x$ ï x^2 ï $2x\,\Delta x$ ï $\Delta x^2)$ ï $(5 + 4x$ ï $x^2) =$

$= 5 + 4x + 4\Delta x$ ï x^2 ï $2x\Delta x$ ï Δx^2 ï 5 ï $4x + x^2 =$

$= \mathbf{4\Delta x - 2x\,\Delta x - \Delta x^2}$

Step 3: $\dfrac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}} =$

Sample problem #2: Given $\mathbf{f(x) = 5 + 4x - x^2}$. Find $f\,'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 5 + 4(x + \Delta x)\ \text{ï}\ (x + \Delta x)^2 =$

$$= 5 + 4x + 4\Delta x\ \text{ï}\ (x^2 + 2x\Delta x + \Delta x^2) =$$

$$= \mathbf{5 + 4x + 4\Delta x - x^2 - 2x\,\Delta x - \Delta x^2}$$

Step 2: $\mathbf{f(x + \Delta x) - f(x)} =$

$$= (5 + 4x + 4\Delta x\ \text{ï}\ x^2\ \text{ï}\ 2x\,\Delta x\ \text{ï}\ \Delta x^2)\ \text{ï}\ (5 + 4x\ \text{ï}\ x^2) =$$

$$= 5 + 4x + 4\Delta x\ \text{ï}\ x^2\ \text{ï}\ 2x\Delta x\ \text{ï}\ \Delta x^2\ \text{ï}\ 5\ \text{ï}\ 4x + x^2 =$$

$$= \mathbf{4\Delta x - 2x\,\Delta x - \Delta x^2}$$

Step 3: $$\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}} = \frac{4\Delta x\ \text{ï}\ 2x\Delta x\ \text{ï}\ \Delta x^2}{}$$

Sample problem #2: Given $\mathbf{f(x) = 5 + 4x – x^2}$. Find $f'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 5 + 4(x + \Delta x)\ \text{ï}\ (x + \Delta x)^2 =$

$$= 5 + 4x + 4\Delta x\ \text{ï}\ (x^2 + 2x\Delta x + \Delta x^2) =$$

$$= \mathbf{5 + 4x + 4\Delta x – x^2 – 2x\, \Delta x – \Delta x^2}$$

Step 2: $\mathbf{f(x + \Delta x) – f(x)} =$

$$= (5 + 4x + 4\Delta x\ \text{ï}\ x^2\ \text{ï}\ 2x\ \Delta x\ \text{ï}\ \Delta x^2)\ \text{ï}\ (5 + 4x\ \text{ï}\ x^2) =$$

$$= 5 + 4x + 4\Delta x\ \text{ï}\ x^2\ \text{ï}\ 2x\Delta x\ \text{ï}\ \Delta x^2\ \text{ï}\ 5\ \text{ï}\ 4x + x^2 =$$

$$= \mathbf{4\Delta x – 2x\,\Delta x – \Delta x^2}$$

Step 3: $$\frac{\mathbf{f(x + \Delta x) – f(x)}}{\mathbf{\Delta x}} = \frac{4\Delta x\ \text{ï}\ 2x\Delta x\ \text{ï}\ \Delta x^2}{\Delta x}$$

Sample problem #2: Given $\mathbf{f(x) = 5 + 4x – x^2}$. Find $f\,'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 5 + 4(x + \Delta x) \text{ ï } (x + \Delta x)^2 =$

$$= 5 + 4x + 4\Delta x \text{ ï } (x^2 + 2x\Delta x + \Delta x^2) =$$

$$= \mathbf{5 + 4x + 4\Delta x – x^2 – 2x\,\Delta x – \Delta x^2}$$

Step 2: $\mathbf{f(x + \Delta x) – f(x)} =$

$$= (5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\,\Delta x \text{ ï } \Delta x^2) \text{ ï } (5 + 4x \text{ ï } x^2) =$$

$$= 5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\Delta x \text{ ï } \Delta x^2 \text{ ï } 5 \text{ ï } 4x + x^2 =$$

$$= \mathbf{4\Delta x – 2x\,\Delta x – \Delta x^2}$$

Step 3: $$\frac{\mathbf{f(x + \Delta x) – f(x)}}{\mathbf{\Delta x}} = \frac{4\Delta x \text{ ï } 2x\Delta x \text{ ï } \Delta x^2}{\Delta x} =$$

Sample problem #2: Given $\mathbf{f(x) = 5 + 4x - x^2}$. Find $f'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 5 + 4(x + \Delta x) \text{ ï } (x + \Delta x)^2 =$

$= 5 + 4x + 4\Delta x \text{ ï } (x^2 + 2x\Delta x + \Delta x^2) =$

$= \mathbf{5 + 4x + 4\Delta x - x^2 - 2x\,\Delta x - \Delta x^2}$

Step 2: $\mathbf{f(x + \Delta x) - f(x)} =$

$= (5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\,\Delta x \text{ ï } \Delta x^2) \text{ ï } (5 + 4x \text{ ï } x^2) =$

$= 5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\Delta x \text{ ï } \Delta x^2 \text{ ï } 5 \text{ ï } 4x + x^2 =$

$= \mathbf{4\Delta x - 2x\,\Delta x - \Delta x^2}$

Step 3: $$\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}} = \frac{4\Delta x \text{ ï } 2x\Delta x \text{ ï } \Delta x^2}{\Delta x} = 4$$

Sample problem #2: Given $\mathbf{f(x) = 5 + 4x - x^2}$. Find $f'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 5 + 4(x + \Delta x)$ ï $(x + \Delta x)^2 =$

$= 5 + 4x + 4\Delta x$ ï $(x^2 + 2x\Delta x + \Delta x^2) =$

$= \mathbf{5 + 4x + 4\Delta x - x^2 - 2x\,\Delta x - \Delta x^2}$

Step 2: $\mathbf{f(x + \Delta x) - f(x)} =$

$= (5 + 4x + 4\Delta x$ ï x^2 ï $2x\,\Delta x$ ï $\Delta x^2)$ ï $(5 + 4x$ ï $x^2) =$

$= 5 + 4x + 4\Delta x$ ï x^2 ï $2x\Delta x$ ï Δx^2 ï 5 ï $4x + x^2 =$

$= \mathbf{4\Delta x - 2x\,\Delta x - \Delta x^2}$

Step 3: $\dfrac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}} = \dfrac{4\Delta x \text{ ï } 2x\Delta x \text{ ï } \Delta x^2}{\Delta x} = 4$ ï

Sample problem #2: Given $\mathbf{f(x) = 5 + 4x - x^2}$. Find $f\,'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 5 + 4(x + \Delta x) \text{ ï } (x + \Delta x)^2 =$

$= 5 + 4x + 4\Delta x \text{ ï } (x^2 + 2x\Delta x + \Delta x^2) =$

$= \mathbf{5 + 4x + 4\Delta x - x^2 - 2x\,\Delta x - \Delta x^2}$

Step 2: $\mathbf{f(x + \Delta x) - f(x)} =$

$= (5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\,\Delta x \text{ ï } \Delta x^2) \text{ ï } (5 + 4x \text{ ï } x^2) =$

$= 5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\Delta x \text{ ï } \Delta x^2 \text{ ï } 5 \text{ ï } 4x + x^2 =$

$= \mathbf{4\Delta x - 2x\,\Delta x - \Delta x^2}$

Step 3: $$\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}} = \frac{4\Delta x \text{ ï } 2x\Delta x \text{ ï } \Delta x^2}{\Delta x} = 4 \text{ ï } 2x$$

Sample problem #2: Given $\mathbf{f(x) = 5 + 4x - x^2}$. Find $f'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 5 + 4(x + \Delta x) \text{ ï } (x + \Delta x)^2 =$

$$= 5 + 4x + 4\Delta x \text{ ï } (x^2 + 2x\Delta x + \Delta x^2) =$$

$$= \mathbf{5 + 4x + 4\Delta x - x^2 - 2x\,\Delta x - \Delta x^2}$$

Step 2: $\mathbf{f(x + \Delta x) - f(x)} =$

$$= (5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\,\Delta x \text{ ï } \Delta x^2) \text{ ï } (5 + 4x \text{ ï } x^2) =$$

$$= 5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\Delta x \text{ ï } \Delta x^2 \text{ ï } 5 \text{ ï } 4x + x^2 =$$

$$= \mathbf{4\Delta x - 2x\,\Delta x - \Delta x^2}$$

Step 3: $$\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}} = \frac{4\Delta x \text{ ï } 2x\Delta x \text{ ï } \Delta x^2}{\Delta x} = 4 \text{ ï } 2x \text{ ï }$$

Sample problem #2: Given $\mathbf{f(x) = 5 + 4x - x^2}$. Find $f'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 5 + 4(x + \Delta x) \text{ ï } (x + \Delta x)^2 =$

$$= 5 + 4x + 4\Delta x \text{ ï } (x^2 + 2x\Delta x + \Delta x^2) =$$

$$= \mathbf{5 + 4x + 4\Delta x - x^2 - 2x\,\Delta x - \Delta x^2}$$

Step 2: $\mathbf{f(x + \Delta x) - f(x)} =$

$$= (5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\,\Delta x \text{ ï } \Delta x^2) \text{ ï } (5 + 4x \text{ ï } x^2) =$$

$$= 5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\Delta x \text{ ï } \Delta x^2 \text{ ï } 5 \text{ ï } 4x + x^2 =$$

$$= \mathbf{4\Delta x - 2x\,\Delta x - \Delta x^2}$$

Step 3: $$\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}} = \frac{4\Delta x \text{ ï } 2x\Delta x \text{ ï } \Delta x^2}{\Delta x} = 4 \text{ ï } 2x \text{ ï } \Delta x$$

Sample problem #2: Given $\mathbf{f(x) = 5 + 4x - x^2}$. Find $f'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 5 + 4(x + \Delta x)$ ï $(x + \Delta x)^2 =$

$$= 5 + 4x + 4\Delta x \text{ ï } (x^2 + 2x\Delta x + \Delta x^2) =$$

$$= \mathbf{5 + 4x + 4\Delta x - x^2 - 2x\,\Delta x - \Delta x^2}$$

Step 2: $\mathbf{f(x + \Delta x) - f(x)} =$

$$= (5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\,\Delta x \text{ ï } \Delta x^2) \text{ ï } (5 + 4x \text{ ï } x^2) =$$

$$= 5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\Delta x \text{ ï } \Delta x^2 \text{ ï } 5 \text{ ï } 4x + x^2 =$$

$$= \mathbf{4\Delta x - 2x\,\Delta x - \Delta x^2}$$

Step 3: $$\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}} = \frac{4\Delta x \text{ ï } 2x\Delta x \text{ ï } \Delta x^2}{\Delta x} = \mathbf{4 - 2x - \Delta x}$$

Sample problem #2: Given $\mathbf{f(x) = 5 + 4x - x^2}$. Find $f'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 5 + 4(x + \Delta x) \text{ ï } (x + \Delta x)^2 =$

$$= 5 + 4x + 4\Delta x \text{ ï } (x^2 + 2x\Delta x + \Delta x^2) =$$

$$= \mathbf{5 + 4x + 4\Delta x - x^2 - 2x\,\Delta x - \Delta x^2}$$

Step 2: $\mathbf{f(x + \Delta x) - f(x)} =$

$$= (5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\,\Delta x \text{ ï } \Delta x^2) \text{ ï } (5 + 4x \text{ ï } x^2) =$$

$$= 5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\Delta x \text{ ï } \Delta x^2 \text{ ï } 5 \text{ ï } 4x + x^2 =$$

$$= \mathbf{4\Delta x - 2x\,\Delta x - \Delta x^2}$$

Step 3: $$\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}} = \frac{4\Delta x \text{ ï } 2x\Delta x \text{ ï } \Delta x^2}{\Delta x} = \mathbf{4 - 2x - \Delta x}$$

Step 4:

Sample problem #2: Given **f(x) = 5 + 4x – x²**. Find f ′(x).

Step 1: **f(x + Δx)** = 5 + 4(x + Δx) ï (x + Δx)^2 =

= 5 + 4x + 4Δx ï (x^2 + 2xΔx + Δx^2) =

= **5 + 4x + 4Δx – x^2 – 2x Δx – Δx^2**

Step 2: **f(x + Δx) – f(x)** =

= (5 + 4x + 4Δx ï x^2 ï 2x Δx ï Δx^2) ï (5 + 4x ï x^2) =

= 5 + 4x + 4Δx ï x^2 ï 2xΔx ï Δx^2 ï 5 ï 4x + x^2 =

= **4Δx – 2xΔx – Δx^2**

Step 3: $\dfrac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}}$ = $\dfrac{4\Delta x \text{ ï } 2x\Delta x \text{ ï } \Delta x^2}{\Delta x}$ = **4 – 2x – Δx**

Step 4: **f ′(x) =**

Sample problem #2: Given $\mathbf{f(x) = 5 + 4x - x^2}$. Find $f'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 5 + 4(x + \Delta x)$ ï $(x + \Delta x)^2 =$

$= 5 + 4x + 4\Delta x$ ï $(x^2 + 2x\Delta x + \Delta x^2) =$

$= \mathbf{5 + 4x + 4\Delta x - x^2 - 2x\,\Delta x - \Delta x^2}$

Step 2: $\mathbf{f(x + \Delta x) - f(x)} =$

$= (5 + 4x + 4\Delta x$ ï x^2 ï $2x\,\Delta x$ ï $\Delta x^2)$ ï $(5 + 4x$ ï $x^2) =$

$= 5 + 4x + 4\Delta x$ ï x^2 ï $2x\Delta x$ ï Δx^2 ï 5 ï $4x + x^2 =$

$= \mathbf{4\Delta x - 2x\,\Delta x - \Delta x^2}$

Step 3: $\dfrac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}} = \dfrac{4\Delta x \text{ ï } 2x\Delta x \text{ ï } \Delta x^2}{\Delta x} = \mathbf{4 - 2x - \Delta x}$

Step 4: $$\mathbf{f'(x) =} \lim_{\Delta x \to 0} \left[\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}} \right]$$

Sample problem #2: Given $\mathbf{f(x) = 5 + 4x - x^2}$. Find $f'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 5 + 4(x + \Delta x) \text{ ï } (x + \Delta x)^2 =$

$$= 5 + 4x + 4\Delta x \text{ ï } (x^2 + 2x\Delta x + \Delta x^2) =$$

$$= \mathbf{5 + 4x + 4\Delta x - x^2 - 2x\,\Delta x - \Delta x^2}$$

Step 2: $\mathbf{f(x + \Delta x) - f(x)} =$

$$= (5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\,\Delta x \text{ ï } \Delta x^2) \text{ ï } (5 + 4x \text{ ï } x^2) =$$

$$= 5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\Delta x \text{ ï } \Delta x^2 \text{ ï } 5 \text{ ï } 4x + x^2 =$$

$$= \mathbf{4\Delta x - 2x\,\Delta x - \Delta x^2}$$

Step 3: $$\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}} = \frac{4\Delta x \text{ ï } 2x\Delta x \text{ ï } \Delta x^2}{\Delta x} = \mathbf{4 - 2x - \Delta x}$$

Step 4: $$\mathbf{f'(x) =} \lim_{\Delta x \to 0} \left[\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}} \right] =$$

Sample problem #2: Given $\mathbf{f(x) = 5 + 4x - x^2}$. Find $f'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 5 + 4(x + \Delta x)\ \text{ï}\ (x + \Delta x)^2 =$

$$= 5 + 4x + 4\Delta x\ \text{ï}\ (x^2 + 2x\Delta x + \Delta x^2) =$$

$$= \mathbf{5 + 4x + 4\Delta x - x^2 - 2x\,\Delta x - \Delta x^2}$$

Step 2: $\mathbf{f(x + \Delta x) - f(x)} =$

$$= (5 + 4x + 4\Delta x\ \text{ï}\ x^2\ \text{ï}\ 2x\,\Delta x\ \text{ï}\ \Delta x^2)\ \text{ï}\ (5 + 4x\ \text{ï}\ x^2) =$$

$$= 5 + 4x + 4\Delta x\ \text{ï}\ x^2\ \text{ï}\ 2x\Delta x\ \text{ï}\ \Delta x^2\ \text{ï}\ 5\ \text{ï}\ 4x + x^2 =$$

$$= \mathbf{4\Delta x - 2x\,\Delta x - \Delta x^2}$$

Step 3: $$\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}} = \frac{4\Delta x\ \text{ï}\ 2x\Delta x\ \text{ï}\ \Delta x^2}{\Delta x} = \mathbf{4 - 2x - \Delta x}$$

Step 4: $$\mathbf{f'(x) =} \lim_{\mathbf{\Delta x} \to 0} \left[\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}} \right] = \lim_{\mathbf{\Delta x} \to 0}$$

Sample problem #2: Given $\mathbf{f(x) = 5 + 4x - x^2}$. Find $f'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 5 + 4(x + \Delta x) - (x + \Delta x)^2 =$

$$= 5 + 4x + 4\Delta x - (x^2 + 2x\Delta x + \Delta x^2) =$$

$$= \mathbf{5 + 4x + 4\Delta x - x^2 - 2x\,\Delta x - \Delta x^2}$$

Step 2: $\mathbf{f(x + \Delta x) - f(x)} =$

$$= (5 + 4x + 4\Delta x - x^2 - 2x\,\Delta x - \Delta x^2) - (5 + 4x - x^2) =$$

$$= 5 + 4x + 4\Delta x - x^2 - 2x\Delta x - \Delta x^2 - 5 - 4x + x^2 =$$

$$= \mathbf{4\Delta x - 2x\,\Delta x - \Delta x^2}$$

Step 3: $$\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}} = \frac{4\Delta x - 2x\Delta x - \Delta x^2}{\Delta x} = \mathbf{4 - 2x - \Delta x}$$

Step 4: $$\mathbf{f'(x) =} \lim_{\Delta x \to 0}\left[\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}}\right] = \lim_{\Delta x \to 0}(4 - 2x - \Delta x)$$

Sample problem #2: Given $\mathbf{f(x) = 5 + 4x - x^2}$. Find $f\,'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 5 + 4(x + \Delta x) \text{ ï } (x + \Delta x)^2 =$

$$= 5 + 4x + 4\Delta x \text{ ï } (x^2 + 2x\Delta x + \Delta x^2) =$$

$$= \mathbf{5 + 4x + 4\Delta x - x^2 - 2x\,\Delta x - \Delta x^2}$$

Step 2: $\mathbf{f(x + \Delta x) - f(x)} =$

$$= (5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\,\Delta x \text{ ï } \Delta x^2) \text{ ï } (5 + 4x \text{ ï } x^2) =$$

$$= 5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\Delta x \text{ ï } \Delta x^2 \text{ ï } 5 \text{ ï } 4x + x^2 =$$

$$= \mathbf{4\Delta x - 2x\,\Delta x - \Delta x^2}$$

Step 3: $$\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}} = \frac{4\Delta x \text{ ï } 2x\Delta x \text{ ï } \Delta x^2}{\Delta x} = \mathbf{4 - 2x - \Delta x}$$

Step 4: $$\mathbf{f\,'(x) =} \lim_{\mathbf{\Delta x} \to 0} \left[\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}} \right] = \lim_{\mathbf{\Delta x} \to 0} (4 \text{ ï } 2x \text{ ï } \Delta x) =$$

Sample problem #2: Given $\mathbf{f(x) = 5 + 4x - x^2}$. Find $f\,'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 5 + 4(x + \Delta x)\ \text{ï}\ (x + \Delta x)^2 =$

$$= 5 + 4x + 4\Delta x\ \text{ï}\ (x^2 + 2x\Delta x + \Delta x^2) =$$

$$= \mathbf{5 + 4x + 4\Delta x - x^2 - 2x\,\Delta x - \Delta x^2}$$

Step 2: $\mathbf{f(x + \Delta x) - f(x)} =$

$$= (5 + 4x + 4\Delta x\ \text{ï}\ x^2\ \text{ï}\ 2x\,\Delta x\ \text{ï}\ \Delta x^2)\ \text{ï}\ (5 + 4x\ \text{ï}\ x^2) =$$

$$= 5 + 4x + 4\Delta x\ \text{ï}\ x^2\ \text{ï}\ 2x\Delta x\ \text{ï}\ \Delta x^2\ \text{ï}\ 5\ \text{ï}\ 4x + x^2 =$$

$$= \mathbf{4\Delta x - 2x\,\Delta x - \Delta x^2}$$

Step 3: $$\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}} = \frac{4\Delta x\ \text{ï}\ 2x\Delta x\ \text{ï}\ \Delta x^2}{\Delta x} = \mathbf{4 - 2x - \underset{\downarrow}{\overset{0}{\Delta x}}}$$

Step 4: $$\mathbf{f\,'(x)} = \lim_{\Delta x \to 0}\left[\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}}\right] = \lim_{\Delta x \to 0}(4\ \text{ï}\ 2x\ \text{ï}\ \overset{0}{\Delta x}) =$$

Sample problem #2: Given $\mathbf{f(x) = 5 + 4x - x^2}$. Find $f'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 5 + 4(x + \Delta x)$ ï $(x + \Delta x)^2 =$

$= 5 + 4x + 4\Delta x$ ï $(x^2 + 2x\Delta x + \Delta x^2) =$

$= \mathbf{5 + 4x + 4\Delta x - x^2 - 2x\,\Delta x - \Delta x^2}$

Step 2: $\mathbf{f(x + \Delta x) - f(x)} =$

$= (5 + 4x + 4\Delta x$ ï x^2 ï $2x\,\Delta x$ ï $\Delta x^2)$ ï $(5 + 4x$ ï $x^2) =$

$= 5 + 4x + 4\Delta x$ ï x^2 ï $2x\Delta x$ ï Δx^2 ï 5 ï $4x + x^2 =$

$= \mathbf{4\Delta x - 2x\,\Delta x - \Delta x^2}$

Step 3: $\dfrac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}} = \dfrac{4\Delta x \text{ ï } 2x\Delta x \text{ ï } \Delta x^2}{\Delta x} = \mathbf{4 - 2x - \Delta x}$

0 ↓

Step 4: $\mathbf{f'(x) =} \lim_{\Delta x \to 0} \left[\dfrac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}} \right] = \lim_{\Delta x \to 0} (4 \text{ ï } 2x \text{ ï } \Delta x) = 4 \text{ ï } 2x$

Sample problem #2: Given $\mathbf{f(x) = 5 + 4x - x^2}$. Find $f'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 5 + 4(x + \Delta x) \text{ ï } (x + \Delta x)^2 =$

$$= 5 + 4x + 4\Delta x \text{ ï } (x^2 + 2x\Delta x + \Delta x^2) =$$

$$= \mathbf{5 + 4x + 4\Delta x - x^2 - 2x\,\Delta x - \Delta x^2}$$

Step 2: $\mathbf{f(x + \Delta x) - f(x)} =$

$$= (5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\,\Delta x \text{ ï } \Delta x^2) \text{ ï } (5 + 4x \text{ ï } x^2) =$$

$$= 5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\Delta x \text{ ï } \Delta x^2 \text{ ï } 5 \text{ ï } 4x + x^2 =$$

$$= \mathbf{4\Delta x - 2x\,\Delta x - \Delta x^2}$$

Step 3: $$\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}} = \frac{4\Delta x \text{ ï } 2x\Delta x \text{ ï } \Delta x^2}{\Delta x} = \mathbf{4 - 2x - \Delta x}$$

0

Step 4: $$\mathbf{f'(x)} = \lim_{\Delta x \to 0}\left[\frac{\mathbf{f(x + \Delta x) - f(x)}}{\mathbf{\Delta x}}\right] = \lim_{\Delta x \to 0}(4 \text{ ï } 2x \text{ ï } \Delta x) = \mathbf{4 - 2x}$$

Sample problem #2: Given $\mathbf{f(x) = 5 + 4x – x^2}$. Find $f'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 5 + 4(x + \Delta x) \text{ ï } (x + \Delta x)^2 =$

$$= 5 + 4x + 4\Delta x \text{ ï } (x^2 + 2x\Delta x + \Delta x^2) =$$

$$= \mathbf{5 + 4x + 4\Delta x – x^2 – 2x\,\Delta x – \Delta x^2}$$

Step 2: $\mathbf{f(x + \Delta x) – f(x)} =$

$$= (5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\,\Delta x \text{ ï } \Delta x^2) \text{ ï } (5 + 4x \text{ ï } x^2) =$$

$$= 5 + 4x + 4\Delta x \text{ ï } x^2 \text{ ï } 2x\Delta x \text{ ï } \Delta x^2 \text{ ï } 5 \text{ ï } 4x + x^2 =$$

$$= \mathbf{4\Delta x – 2x\,\Delta x – \Delta x^2}$$

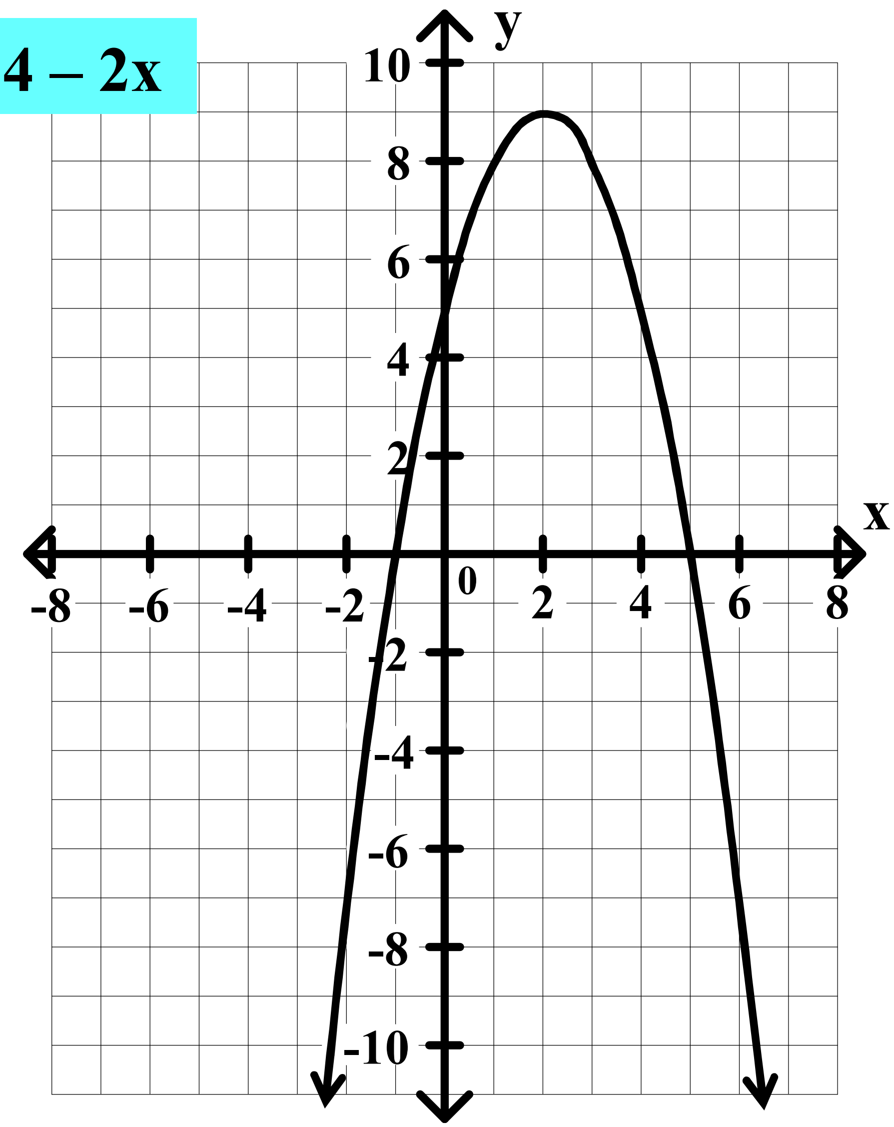
Step 3: $$\frac{\mathbf{f(x + \Delta x) – f(x)}}{\mathbf{\Delta x}} = \frac{4\Delta x \text{ ï } 2x\Delta x \text{ ï } \Delta x^2}{\Delta x} = \mathbf{4 – 2x – \Delta x}$$

0 ↓

Step 4: $$\mathbf{f'(x)} = \lim_{\Delta x \to 0}\left[\frac{\mathbf{f(x + \Delta x) – f(x)}}{\mathbf{\Delta x}}\right] = \lim_{\Delta x \to 0}(4 \text{ ï } 2x \text{ ï } \Delta x) = \mathbf{4 – 2x}$$

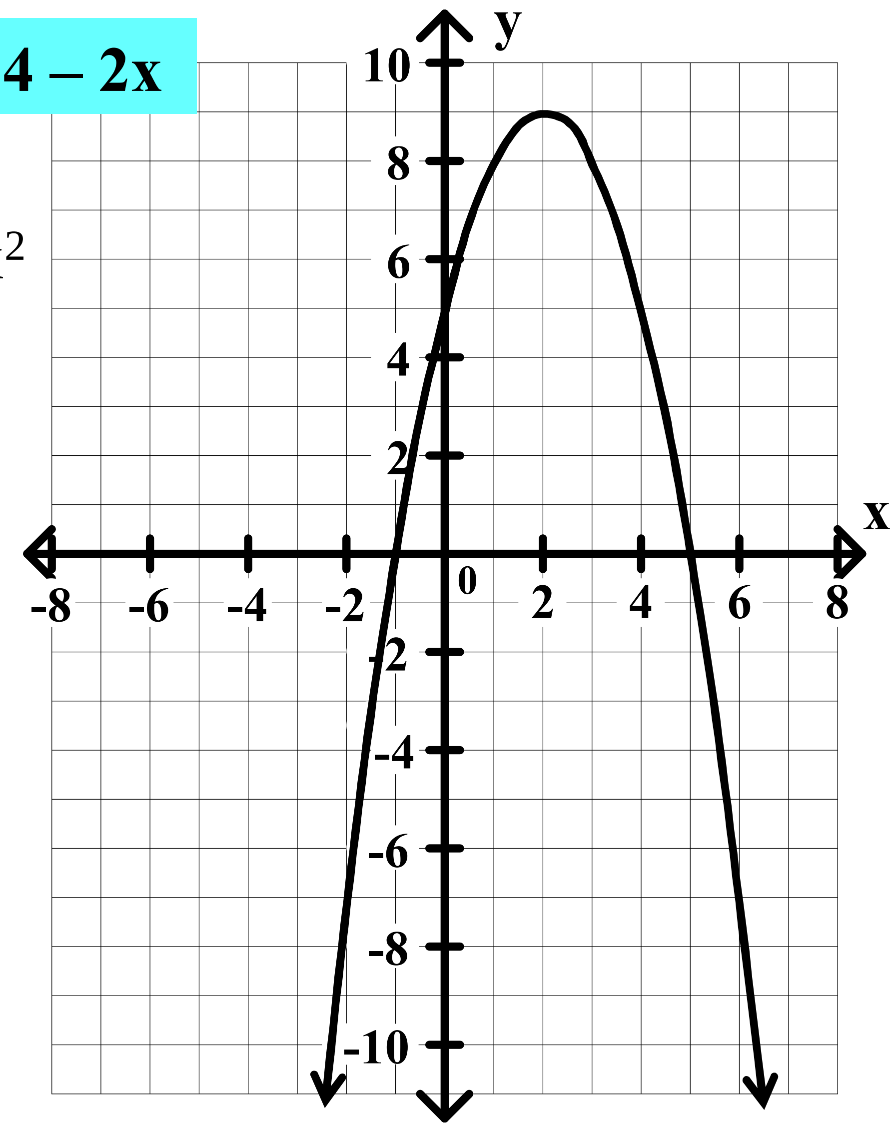
If $f(x) = 5 + 4x – x^2$, then $f'(x) = 4 – 2x$

If $f(x) = 5 + 4x - x^2$, then $f'(x) = 4 - 2x$



If $f(x) = 5 + 4x - x^2$, then $f'(x) = 4 - 2x$

Find the slope of the line tangent to the graph of y = f(x) = 5 + 4x ï x^2 at P(0,5).



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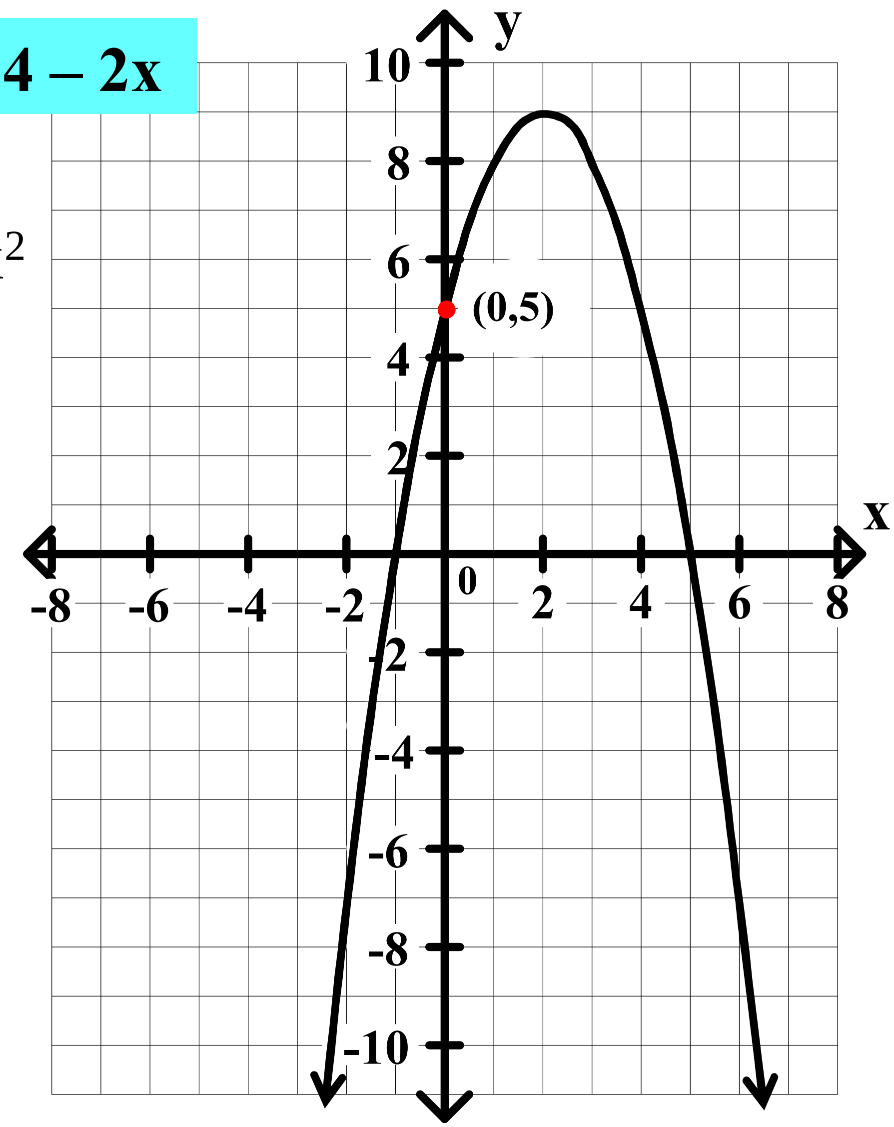

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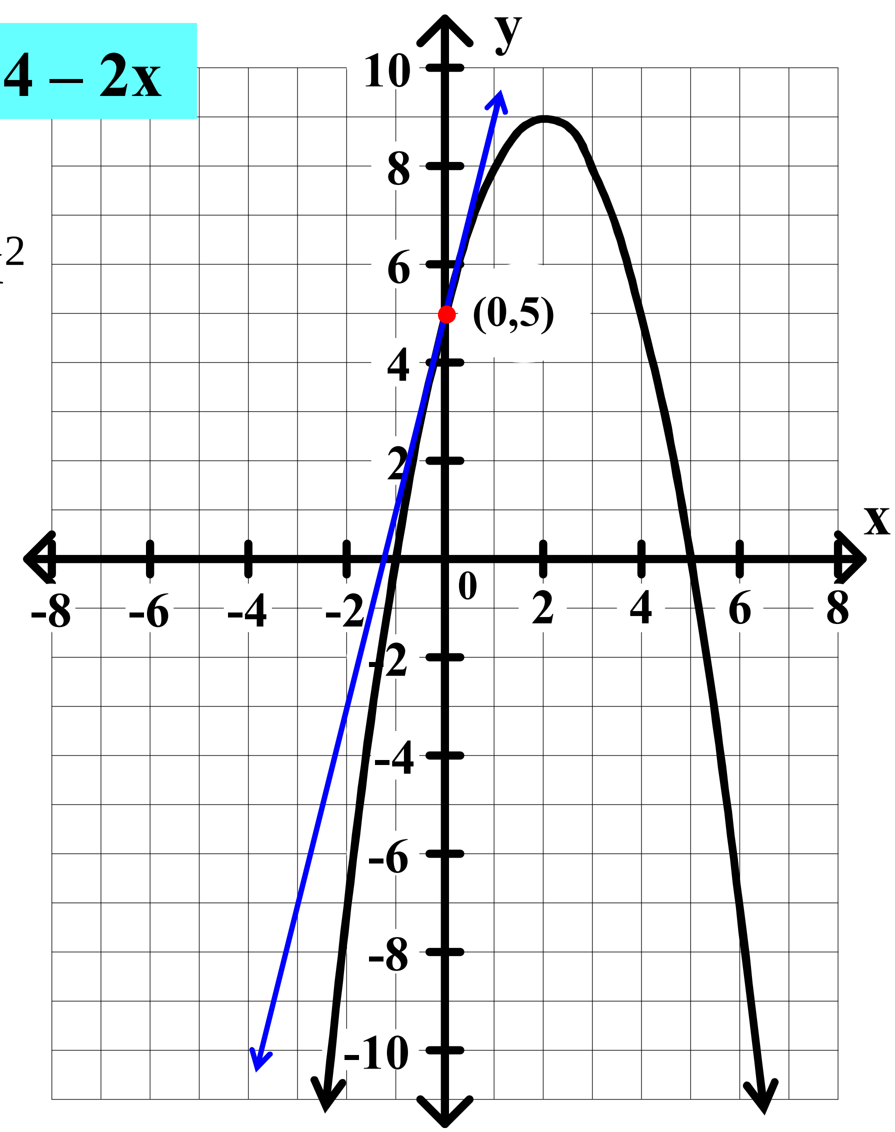
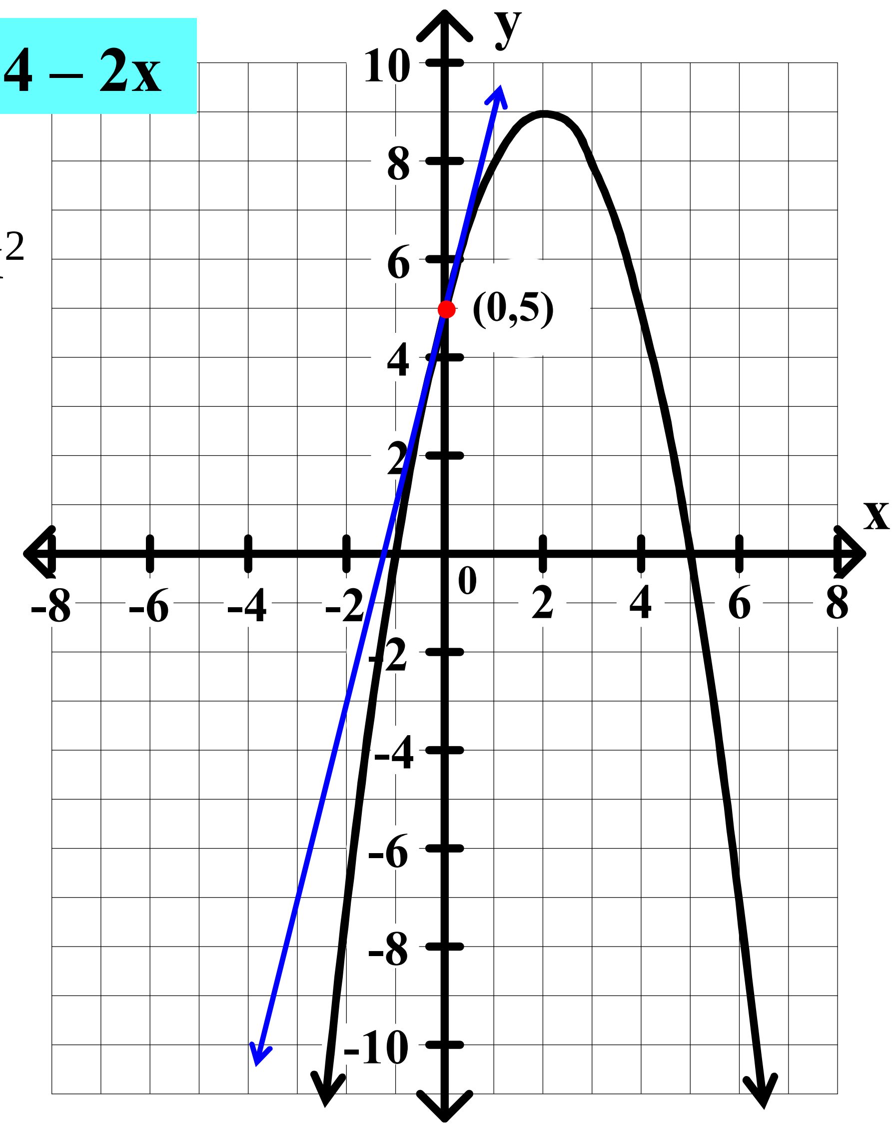


If $f(x) = 5 + 4x – x^2$, then $f\,'(x) = 4 – 2x$

Find the slope of the line tangent to the graph of $y = f(x) = 5 + 4x$ ï x^2 at P(0,5).

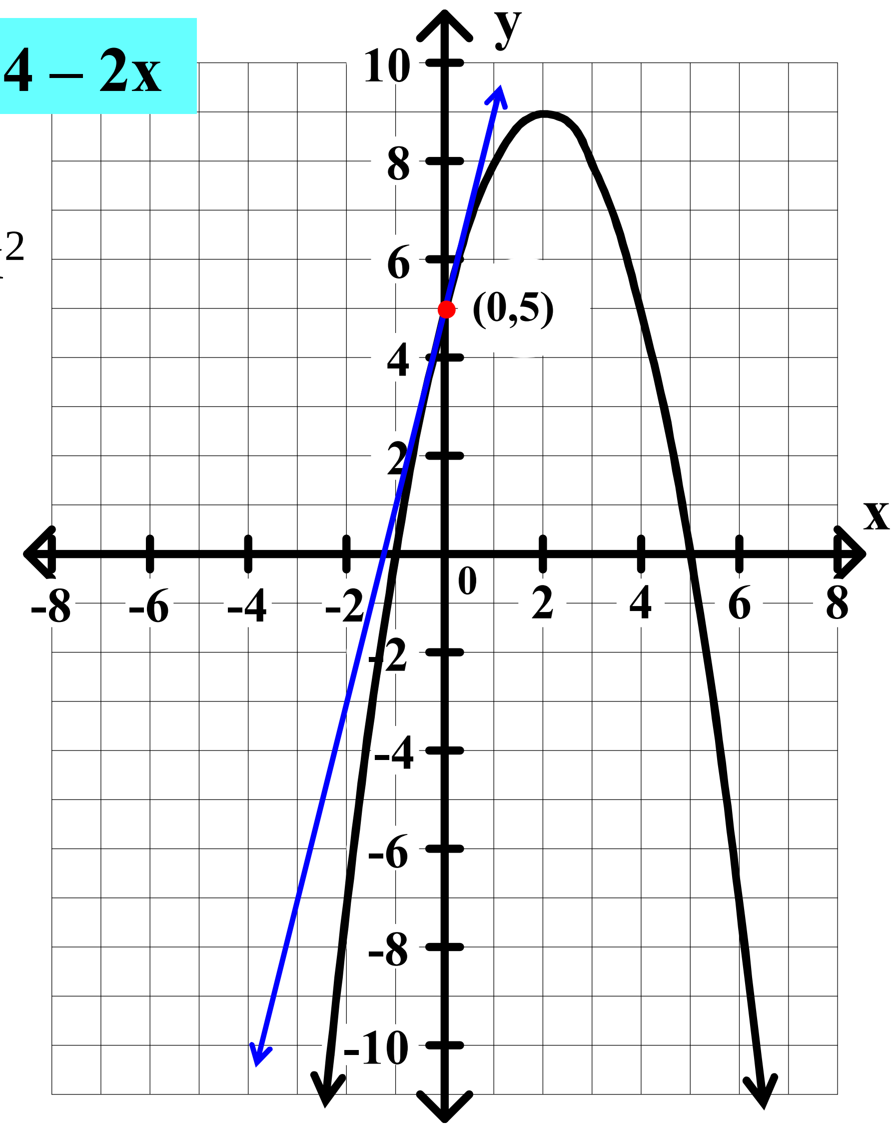
The slope of the tangent line is



If $f(x) = 5 + 4x – x^2$, then $f'(x) = 4 – 2x$

Find the slope of the line tangent to the graph of $y = f(x) = 5 + 4x$ ï x^2 at P(0,5).

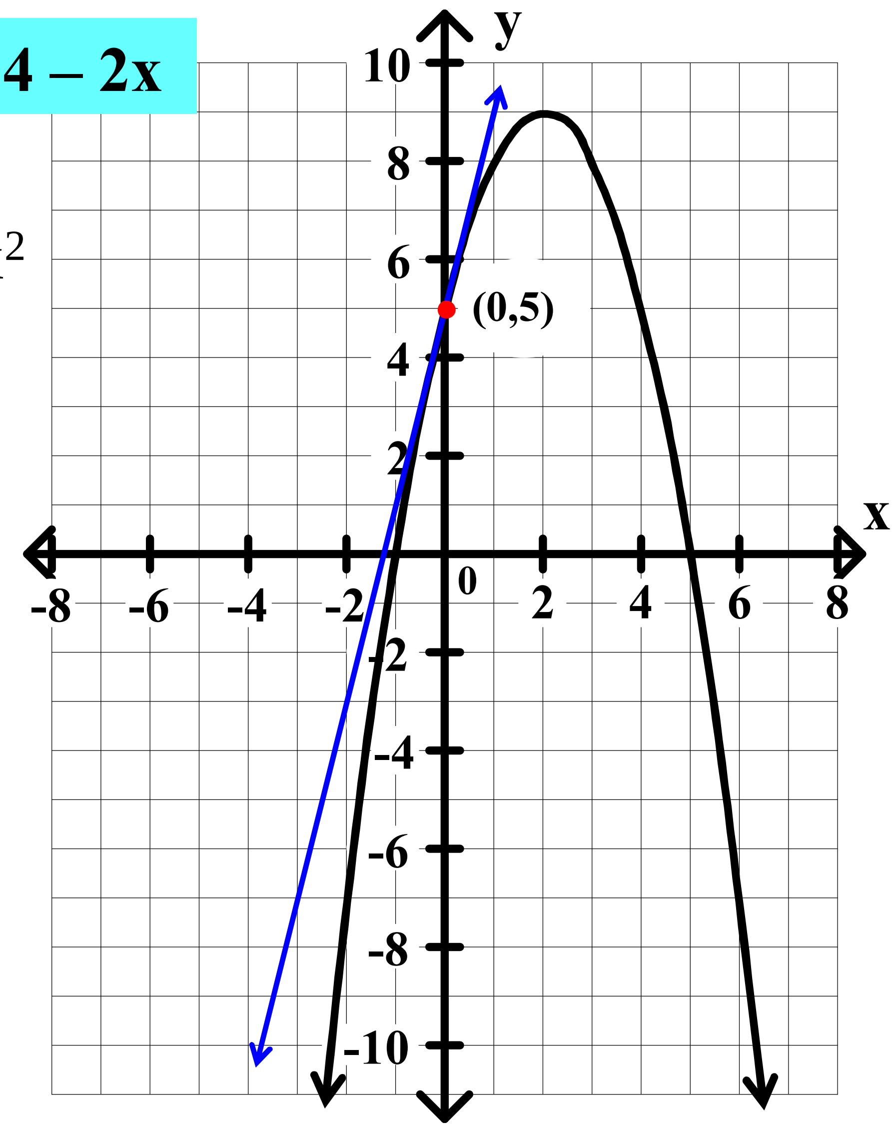
The slope of the tangent line is $f'(0)$



If $f(x) = 5 + 4x – x^2$, then $f'(x) = 4 – 2x$

Find the slope of the line tangent to the graph of $y = f(x) = 5 + 4x$ ï x^2 at P(0,5).

The slope of the tangent line is $f'(0) =$



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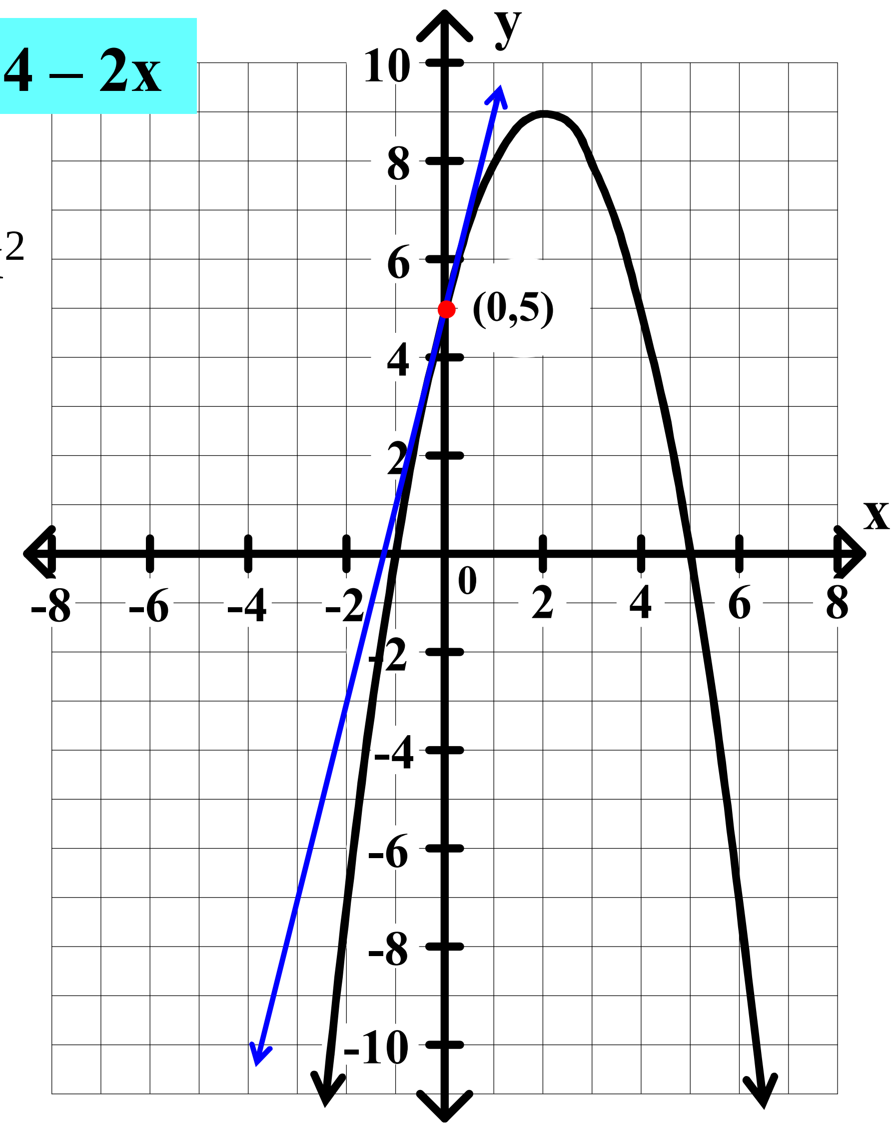

The slope of the tangent line is $f'(0) = 4$

If $f(x) = 5 + 4x - x^2$, then $f\,'(x) = 4 - 2x$

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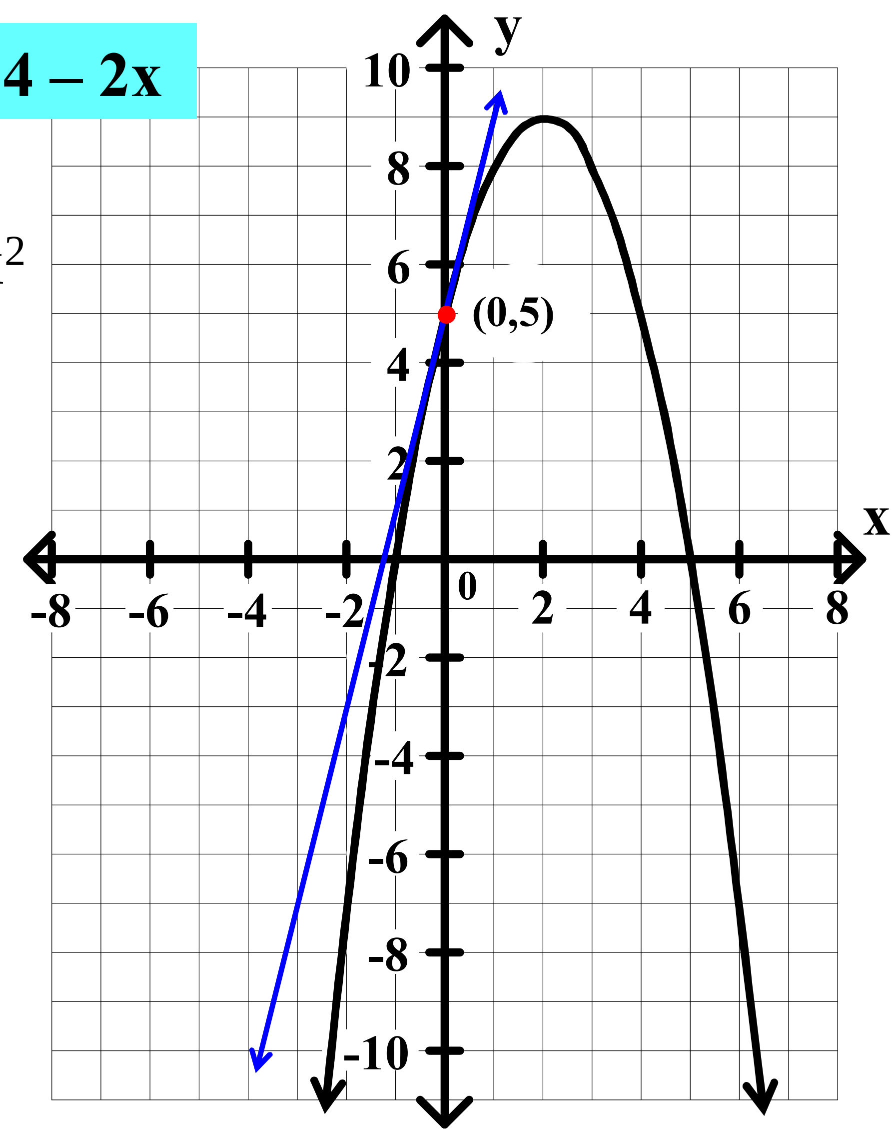
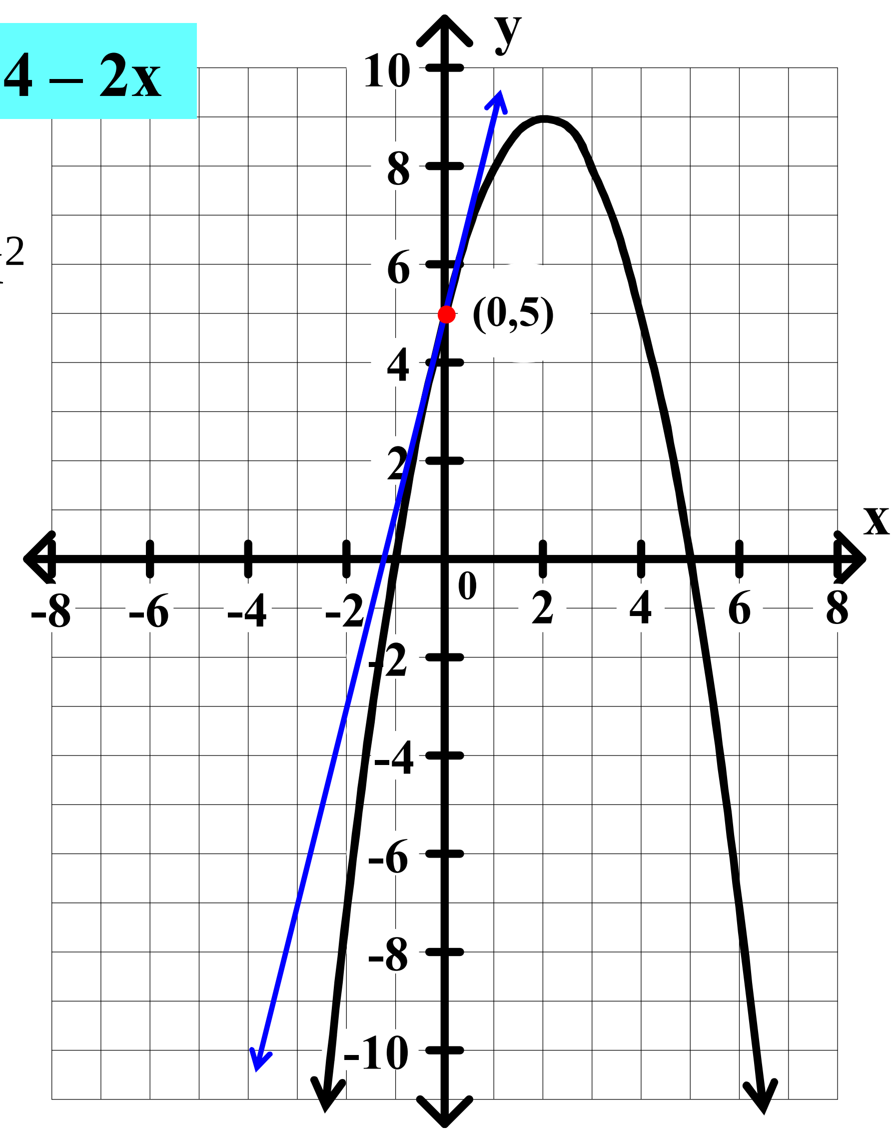


The slope of the tangent line is
f ′(0) = 4 ï

If f(x) = 5 + 4x – x^2 , then f ′(x) = 4 – 2x

Find the slope of the line tangent to the graph of y = f(x) = 5 + 4x ï x^2 at P(0,5).

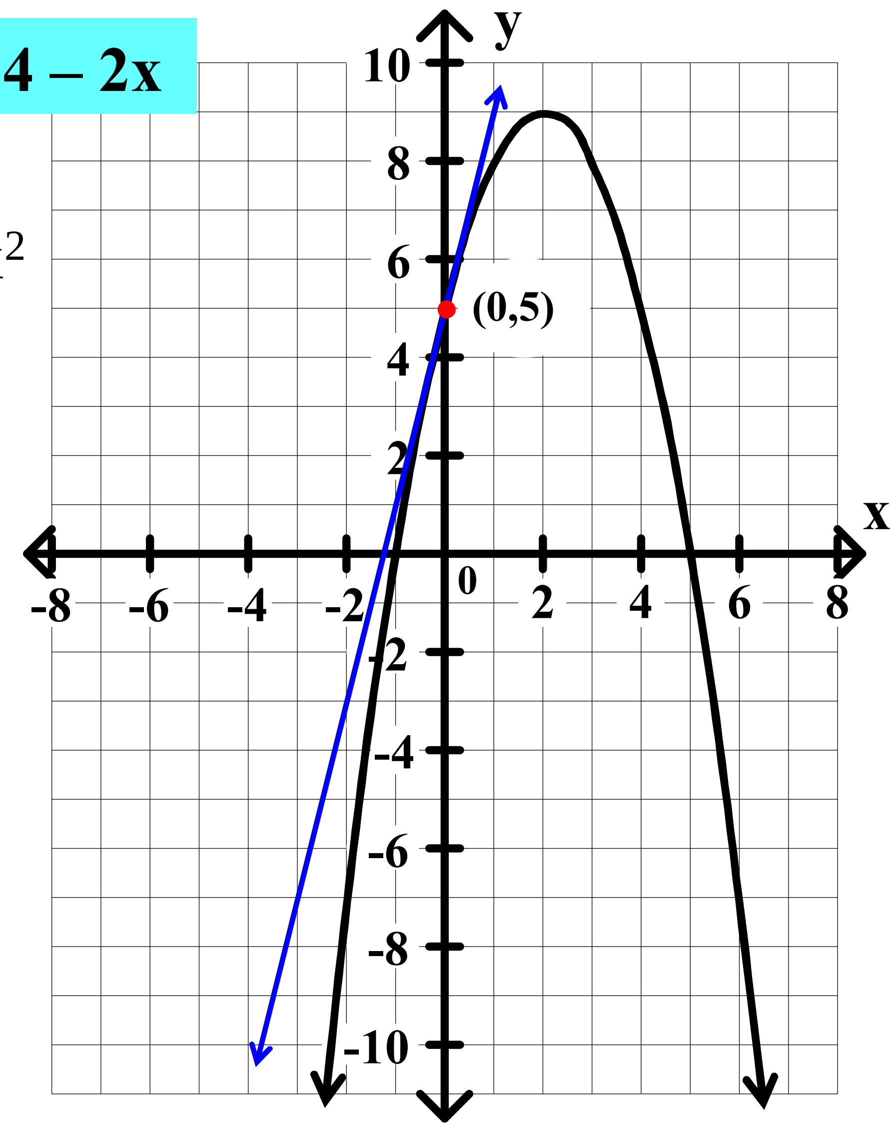
The slope of the tangent line is
f ′(0) = 4 ï 2(0)



If f(x) = 5 + 4x – x^2 , then f ′(x) = 4 – 2x

Find the slope of the line tangent to the graph of y = f(x) = 5 + 4x ï x^2 at P(0,5).

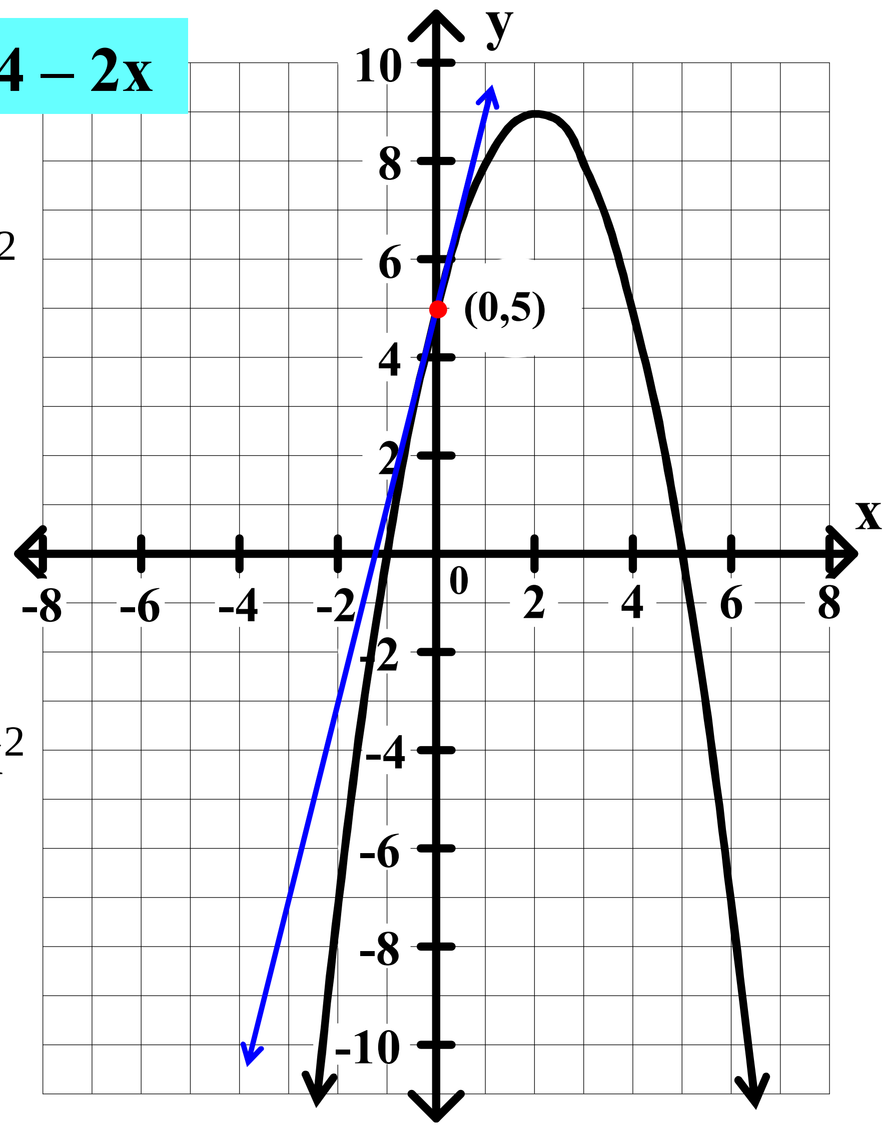
The slope of the tangent line is
f ′(0) = 4 ï 2(0) = **4**



If $f(x) = 5 + 4x – x^2$, then $f'(x) = 4 – 2x$

Find the slope of the line tangent to the graph of $y = f(x) = 5 + 4x$ ï x^2 at P(0,5).

The slope of the tangent line is $f'(0) = 4$ ï $2(0) =$ **4**



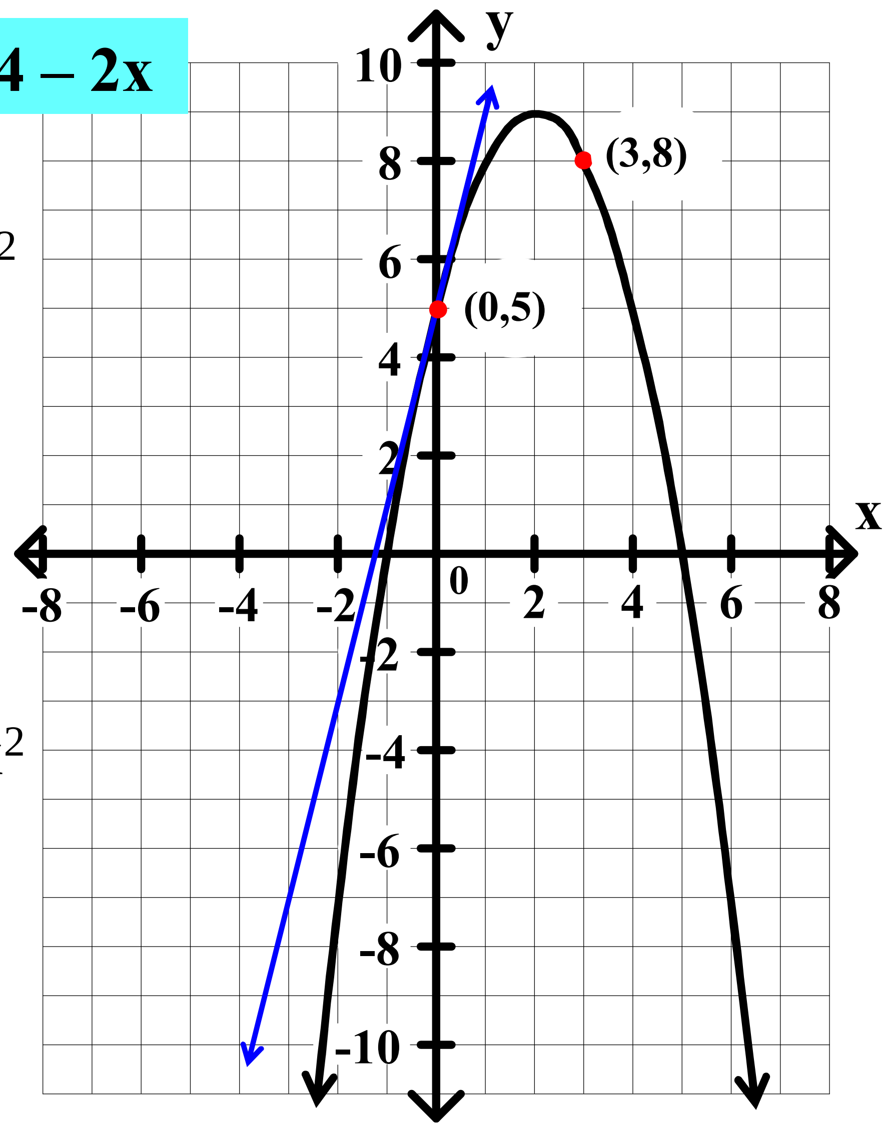
Find the slope of the line tangent to the graph of $y = f(x) = 5 + 4x$ ï x^2 at P(3,8).

If $f(x) = 5 + 4x – x^2$, then $f'(x) = 4 – 2x$

Find the slope of the line tangent to the graph of $y = f(x) = 5 + 4x$ ï x^2 at P(0,5).

The slope of the tangent line is $f'(0) = 4$ ï $2(0) =$ **4**

Find the slope of the line tangent to the graph of $y = f(x) = 5 + 4x$ ï x^2 at P(3,8).



If $f(x) = 5 + 4x – x^2$, then $f'(x) = 4 – 2x$

Find the slope of the line tangent to the graph of y = f(x) = 5 + 4x ï x^2 at P(0,5).

The slope of the tangent line is
f ′(0) = 4 ï 2(0) = **4**

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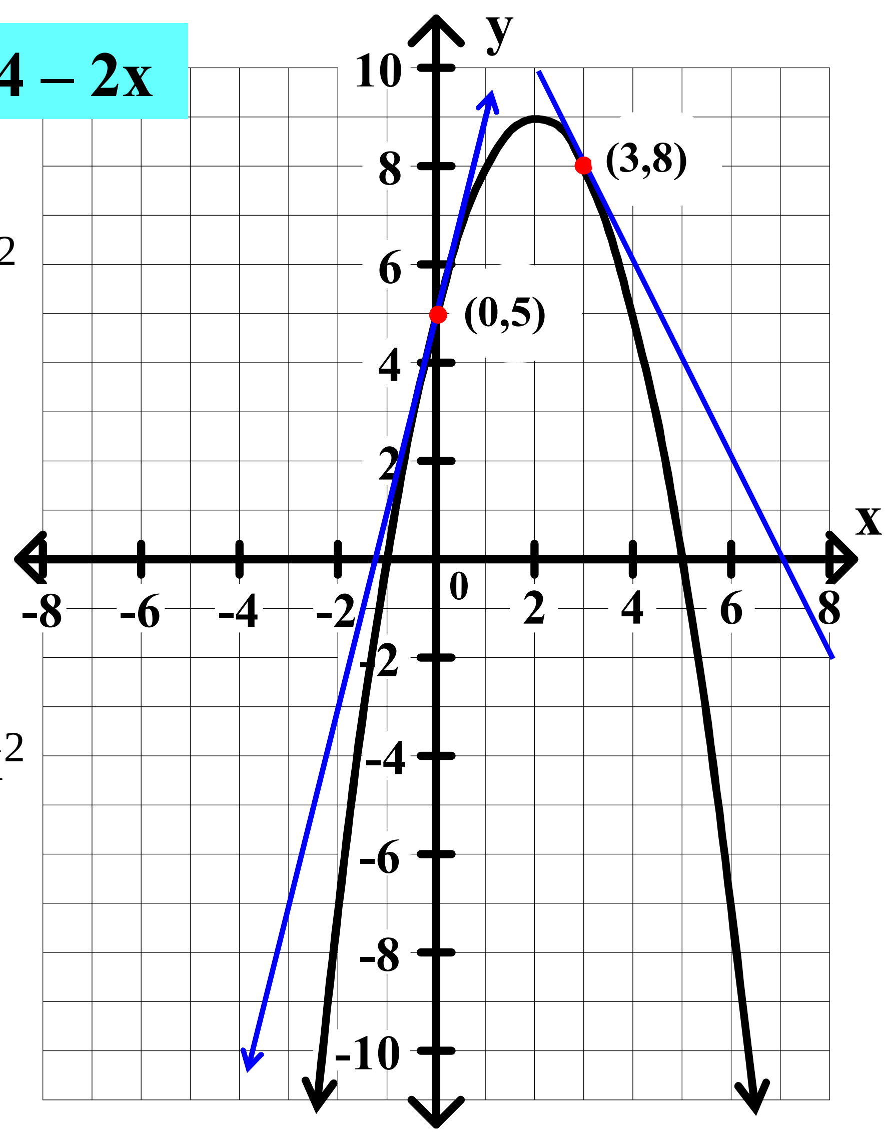

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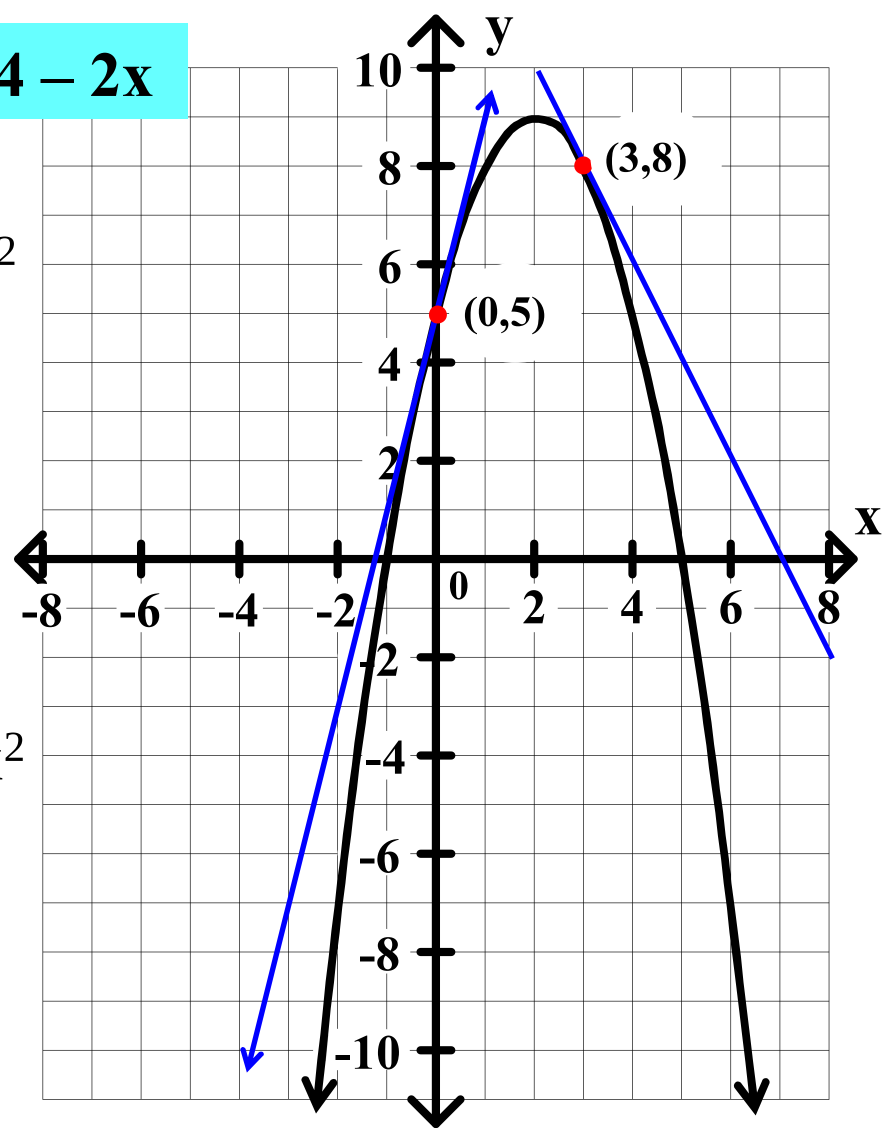


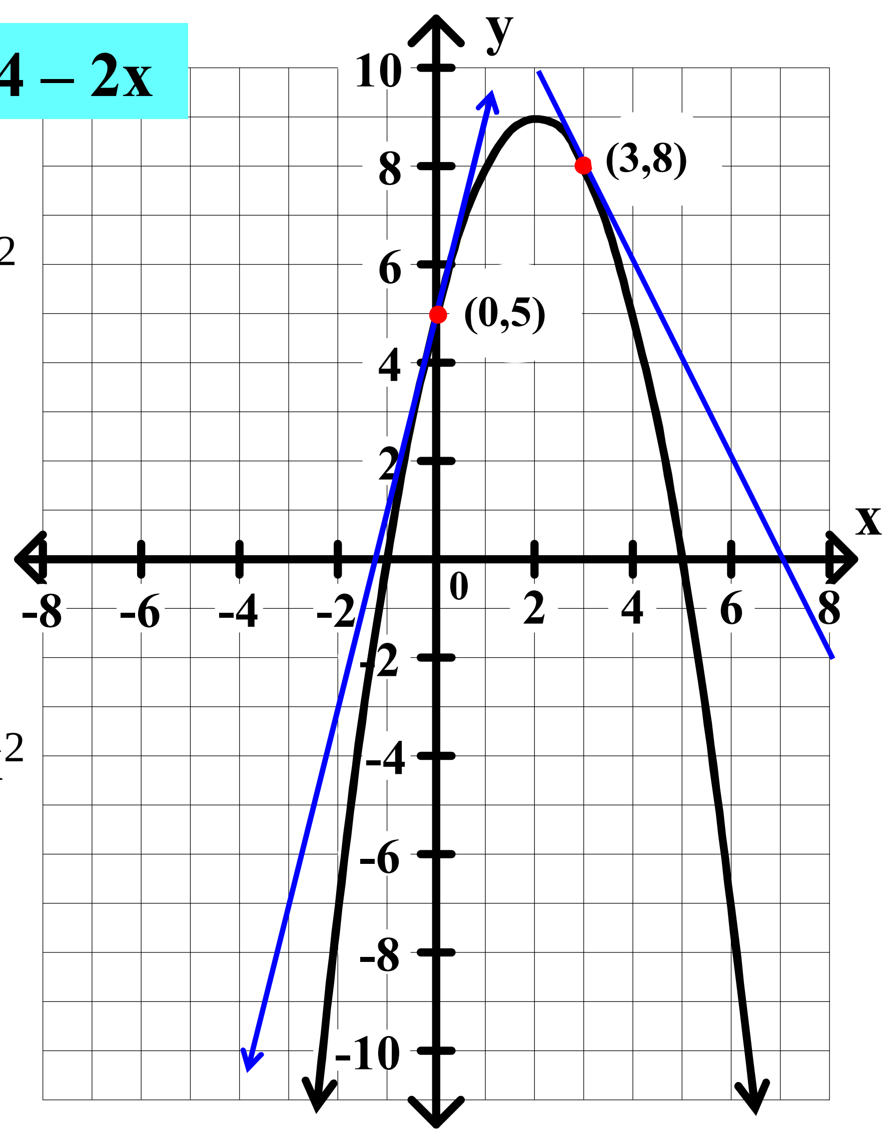
If f(x) = 5 + 4x – x^2 , then f ′(x) = 4 – 2x

Find the slope of the line tangent to the graph of y = f(x) = 5 + 4x ï x^2 at P(0,5).

The slope of the tangent line is
f ′(0) = 4 ï 2(0) = **4**

Find the slope of the line tangent to the graph of y = f(x) = 5 + 4x ï x^2 at P(3,8).

The slope of the tangent line is
f ′(3)



If f(x) = 5 + 4x – x^2 , then f ′(x) = 4 – 2x

Find the slope of the line tangent to the graph of y = f(x) = 5 + 4x ï x^2 at P(0,5).

The slope of the tangent line is
f ′(0) = 4 ï 2(0) = **4**

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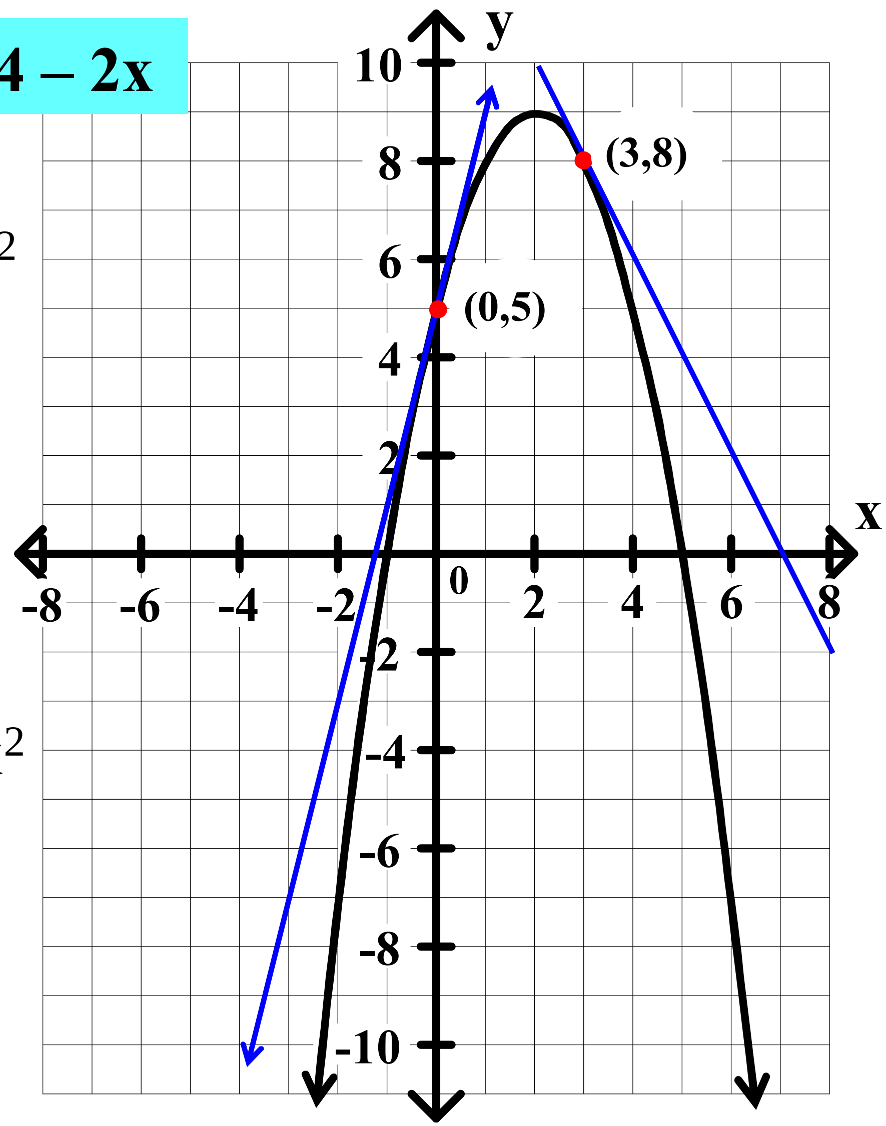


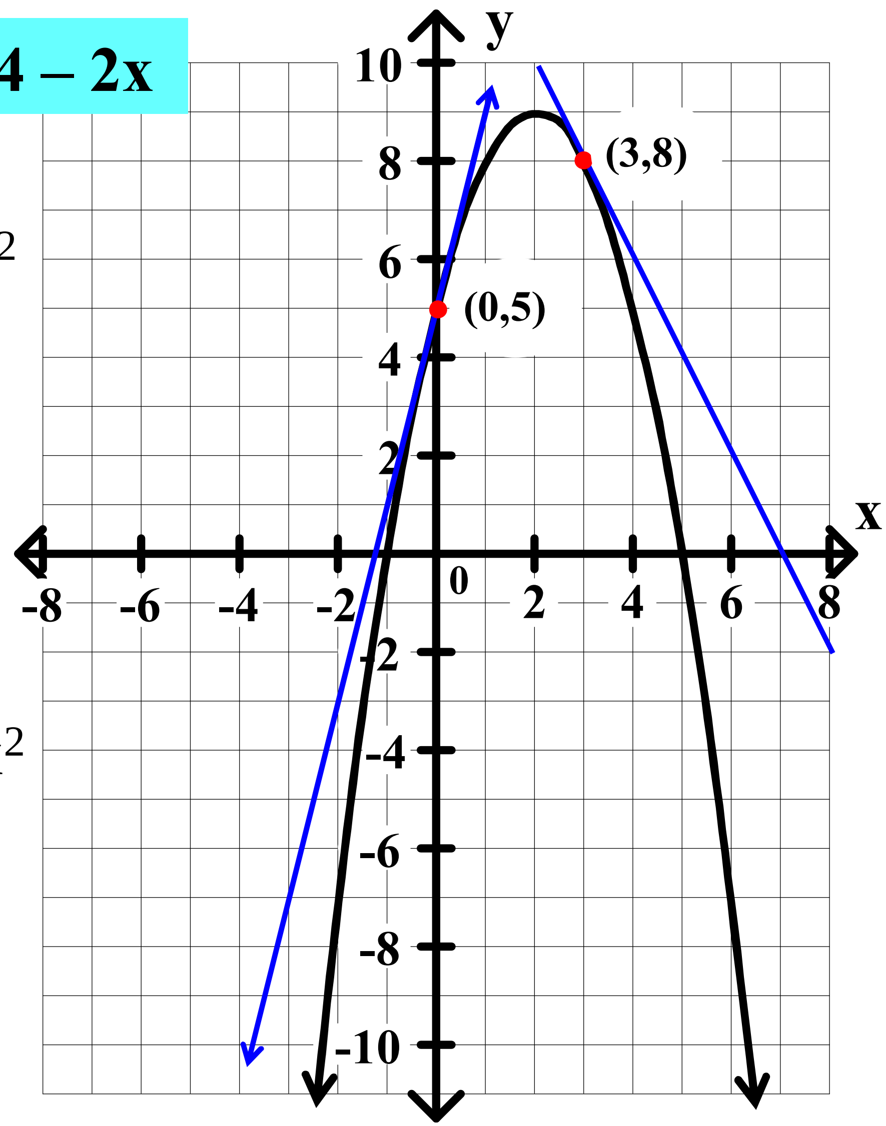
If $f(x) = 5 + 4x – x^2$, then $f'(x) = 4 – 2x$

Find the slope of the line tangent to the graph of $y = f(x) = 5 + 4x$ ï x^2 at P(0,5).

The slope of the tangent line is $f'(0) = 4$ ï $2(0) =$ **4**

Find the slope of the line tangent to the graph of $y = f(x) = 5 + 4x$ ï x^2 at P(3,8).

The slope of the tangent line is $f'(3) = 4$



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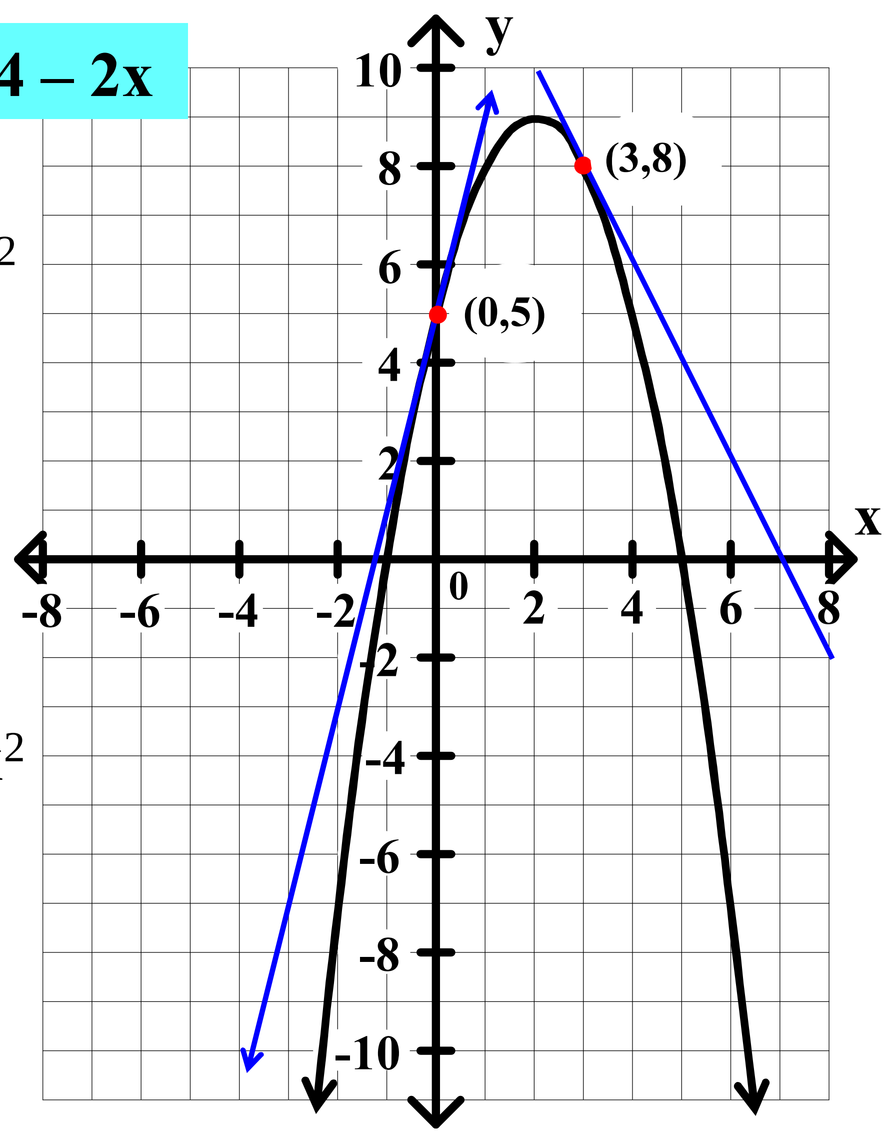


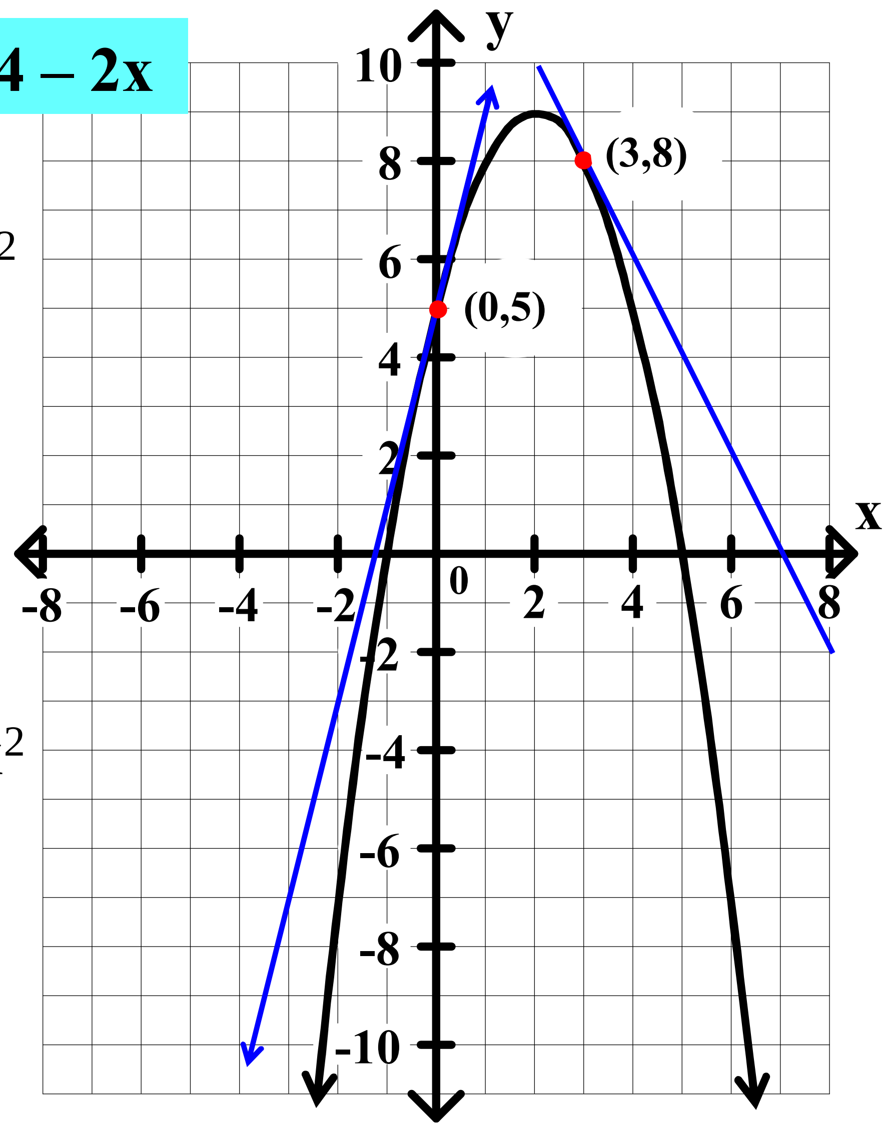
If $f(x) = 5 + 4x – x^2$, then $f'(x) = 4 – 2x$

Find the slope of the line tangent to the graph of $y = f(x) = 5 + 4x$ ï x^2 at P(0,5).

The slope of the tangent line is
$f'(0) = 4$ ï $2(0) =$ **4**

Find the slope of the line tangent to the graph of $y = f(x) = 5 + 4x$ ï x^2 at P(3,8).

The slope of the tangent line is
$f'(3) = 4$ ï $2(3)$



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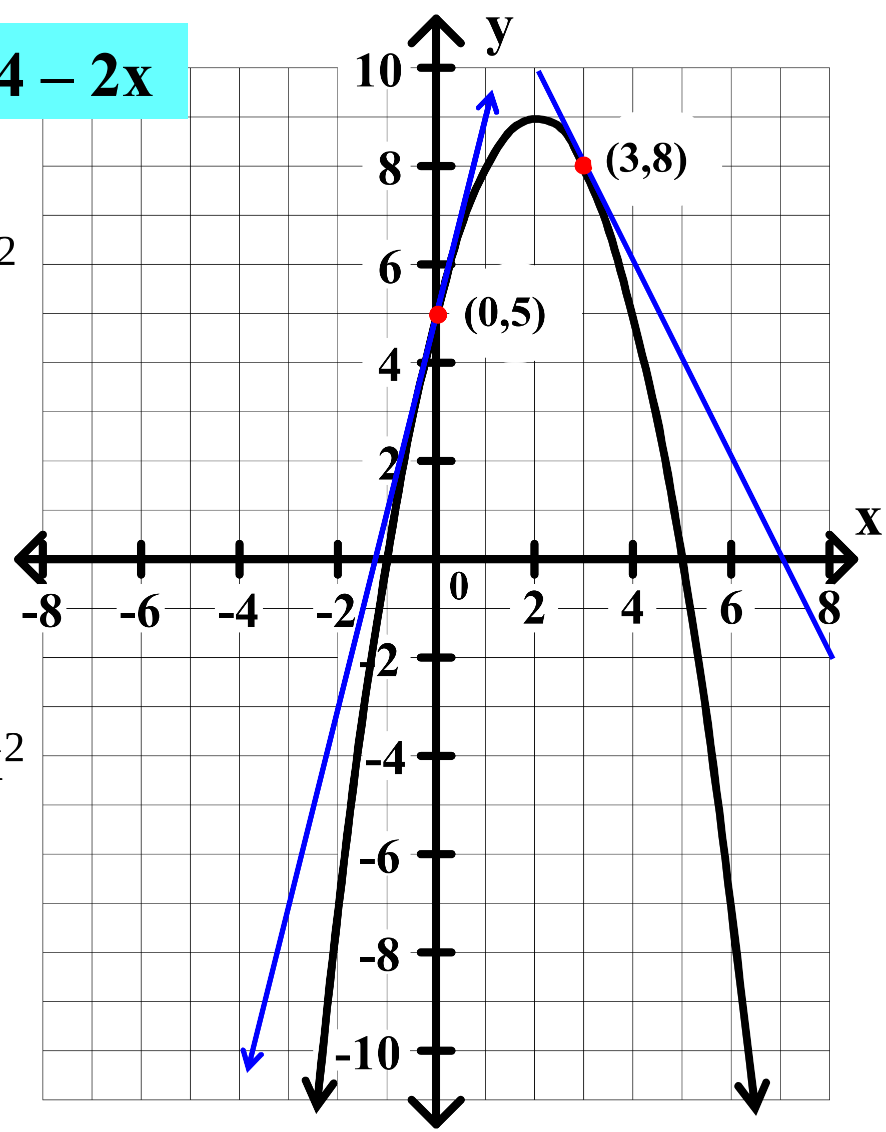
The slope of the tangent line is
f ′(0) = 4 ï 2(0) = **4**

Find the slope of the line tangent to the graph of y = f(x) = 5 + 4x ï x^2 at P(3,8).

The slope of the tangent line is
f ′(3) = 4 ï 2(3) =



If $f(x) = 5 + 4x – x^2$, then $f'(x) = 4 – 2x$

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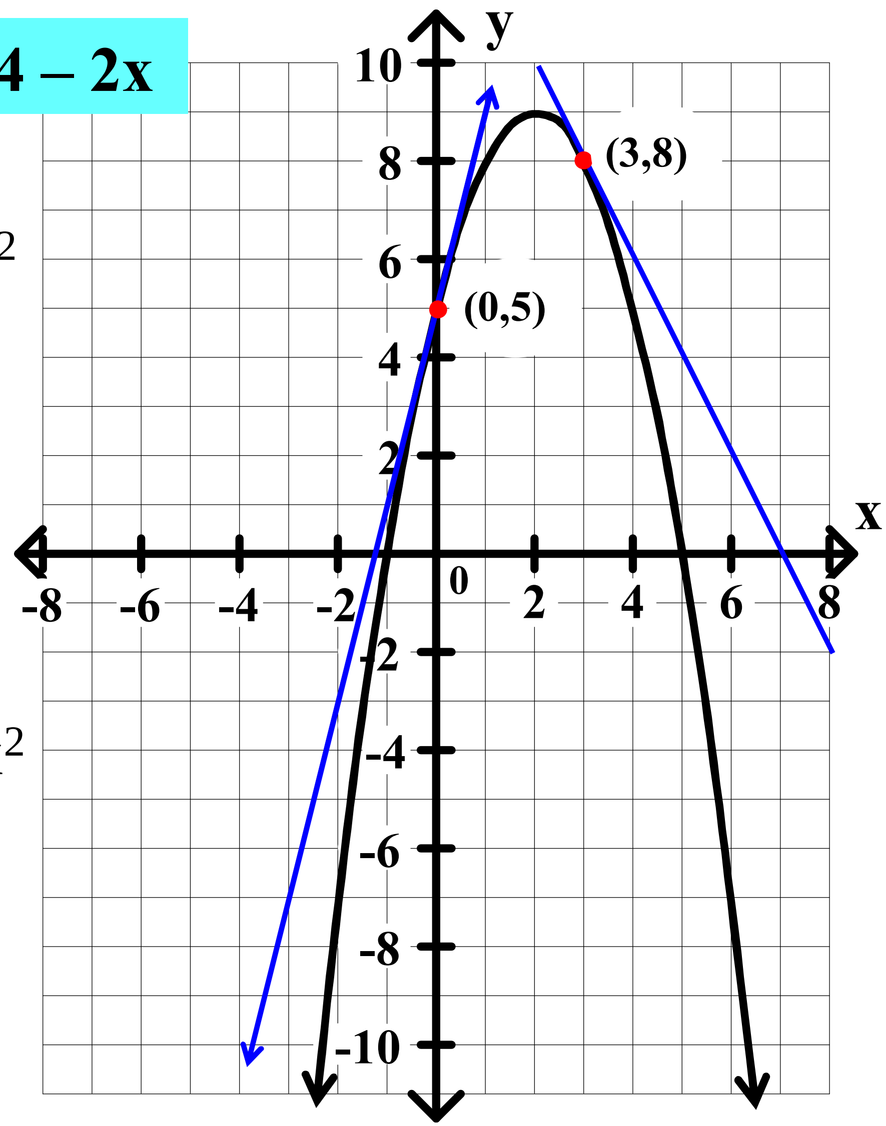
The slope of the tangent line is
f ′(0) = 4 ï 2(0) = **4**

Find the slope of the line tangent to the graph of y = f(x) = 5 + 4x ï x^2 at P(3,8).

The slope of the tangent line is
f ′(3) = 4 ï 2(3) = **-2**



Sample problem #3: Given $\mathbf{f(x) = 4x - 1}$. Find $f'(x)$.

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Step 1:

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Step 1: **f(x + Δx)** = 4(x + Δx) ï 1 =

Sample problem #3: Given $\mathbf{f(x) = 4x - 1}$. Find $f'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 4(x + \Delta x)$ ï $1 =$

$$\mathbf{= 4x}$$

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Step 1: $\mathbf{f(x + \Delta x)} = 4(x + \Delta x)$ ï 1 =

$\mathbf{= 4x +}$

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Step 1: $\mathbf{f(x + \Delta x)} = 4(x + \Delta x)$ ï 1 =

$$\mathbf{= 4x + 4\Delta x}$$

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Step 1: $\mathbf{f(x + \Delta x)} = 4(x + \Delta x)$ ï 1 =

$$\mathbf{= 4x + 4\Delta x -}$$

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Step 1: **f(x + Δx)** = 4(x + Δx) ï 1 =

= 4x + 4Δx – 1

Sample problem #3: Given $\mathbf{f(x) = 4x - 1}$. Find $f'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 4(x + \Delta x)$ ï $1 =$

$$\mathbf{= 4x + 4\Delta x - 1}$$

Step 2:

Sample problem #3: Given $\mathbf{f(x) = 4x - 1}$. Find $f'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 4(x + \Delta x)$ ï 1 =

$$\mathbf{= 4x + 4\Delta x - 1}$$

Step 2: $\mathbf{f(x + \Delta x)}$

Sample problem #3: Given **f(x) = 4x – 1**. Find f ′(x).

Step 1: **f(x + Δx)** = 4(x + Δx) ï 1 =

= 4x + 4Δx – 1

Step 2: **f(x + Δx) –**

Sample problem #3: Given **f(x) = 4x – 1**. Find f ′(x).

Step 1: **f(x + Δx)** = 4(x + Δx) ï 1 =

= 4x + 4Δx – 1

Step 2: **f(x + Δx) – f(x)**

Sample problem #3: Given **f(x) = 4x – 1**. Find f ′(x).

Step 1: **f(x + Δx)** = 4(x + Δx) ï 1 =

= 4x + 4Δx – 1

Step 2: **f(x + Δx) – f(x)** =

Sample problem #3: Given **f(x) = 4x – 1**. Find $f'(x)$.

Step 1: **f(x + Δx)** = 4(x + Δx) ï 1 =

= 4x + 4Δx – 1

Step 2: **f(x + Δx) – f(x)** =

= (4x + 4Δx ï 1)

Sample problem #3: Given $\mathbf{f(x) = 4x – 1}$. Find $f'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 4(x + \Delta x)$ ï 1 =

$\mathbf{= 4x + 4\Delta x – 1}$

Step 2: $\mathbf{f(x + \Delta x) – f(x)} =$

= (4x + 4Δx ï 1) ï

Sample problem #3: Given **f(x) = 4x – 1**. Find f ′(x).

Step 1: **f(x + Δx)** = 4(x + Δx) ï 1 =

= 4x + 4Δx – 1

Step 2: **f(x + Δx) – f(x)** =

= (4x + 4Δx ï 1) ï (4x ï 1)

Sample problem #3: Given **f(x) = 4x – 1**. Find f ′(x).

Step 1: **f(x + Δx)** = 4(x + Δx) ï 1 =

= 4x + 4Δx – 1

Step 2: **f(x + Δx) – f(x)** =

= (4x + 4Δx ï 1) ï (4x ï 1) =

=

Sample problem #3: Given $\mathbf{f(x) = 4x - 1}$. Find $f'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 4(x + \Delta x)$ ï 1 =

$$\mathbf{= 4x + 4\Delta x - 1}$$

Step 2: $\mathbf{f(x + \Delta x) - f(x)} =$

= $(4x + 4\Delta x$ ï 1) ï (4x ï 1) =

= $4x + 4\Delta x$ ï 1

Sample problem #3: Given **f(x) = 4x – 1**. Find f ′(x).

Step 1: **f(x + Δx)** = 4(x + Δx) ï 1 =

= 4x + 4Δx – 1

Step 2: **f(x + Δx) – f(x)** =

= (4x + 4Δx ï 1) ï (4x ï 1) =

= 4x + 4Δx ï 1 ï 4x

Sample problem #3: Given **f(x) = 4x – 1**. Find f ′(x).

Step 1: **f(x + Δx)** = 4(x + Δx) ï 1 =

= 4x + 4Δx – 1

Step 2: **f(x + Δx) – f(x)** =

= (4x + 4Δx ï 1) ï (4x ï 1) =

= 4x + 4Δx ï 1 ï 4x + 1

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Step 1: **f(x + Δx)** = 4(x + Δx) ï 1 =

= 4x + 4Δx – 1

Step 2: **f(x + Δx) – f(x)** =

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$$= (4x + 4\Delta x - 1) - (4x - 1) =$$

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If $f(x) = 4x - 1$, then $f'(x) = 4$.

Note: Since this is a linear function, the derivative (slope) is a constant.

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Sample problem #4: Given $\mathbf{f(x) = 2x^2 - 3x + 5}$. Find $f'(x)$.

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Step 1: $\mathbf{f(x + \Delta x)} = 2(x + \Delta x)^2$

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Sample problem #4: Given **$f(x) = 2x^2 – 3x + 5$** . Find $f'(x)$.

Step 1: **$f(x + \Delta x)$** $= 2(x + \Delta x)^2$ ï 3(

Sample problem #4: Given $\mathbf{f(x) = 2x^2 - 3x + 5}$. Find $f'(x)$.

Step 1: $\mathbf{f(x + \Delta x)} = 2(x + \Delta x)^2$ ï $3(x + \Delta x)$

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Step 1: **$f(x + \Delta x)$** $= 2(x + \Delta x)^2$ ï $3(x + \Delta x) +$

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$= 2(x^2 + 2x\Delta x + \Delta x^2)$ ï

Sample problem #4: Given **f(x) = $2x^2 - 3x + 5$** . Find f ′(x).

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Sample problem #4: Given **f(x) = 2x² – 3x + 5** . Find f ′(x).

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$= 2x^2$

Sample problem #4: Given **f(x) = 2x^2 – 3x + 5** . Find f ′(x).

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= **2x^2 + 4xΔx + 2Δx^2 – 3x – 3Δx + 5**

Step 2: **f(x + Δx) – f(x)** =

= (2x^2 + 4xΔx + 2Δx^2 ï 3x ï 3Δx + 5) ï (2x^2 ï 3x + 5) =

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= 4xΔx + 2Δx^2 – 3Δx

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= 2(x^2 + 2xΔx + Δx^2) ï 3x ï 3Δx + 5 =

= **2x^2 + 4xΔx + 2Δx^2 – 3x – 3Δx + 5**

Step 2: **f(x + Δx) – f(x)** =

= (2x^2 + 4xΔx + 2Δx^2 ï 3x ï 3Δx + 5) ï (2x^2 ï 3x + 5) =

= 2x^2 + 4xΔx + 2Δx^2 ï 3x ï 3Δx + 5 ï 2x^2 + 3x ï 5 =

= 4xΔx + 2Δx^2 – 3Δx

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0

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Good luck on your homework !!

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(0 — arrow pointing to $2\Delta x$)

If $f(x) = 2x^2 - 3x + 5$, then $f'(x) = 4x - 3$