

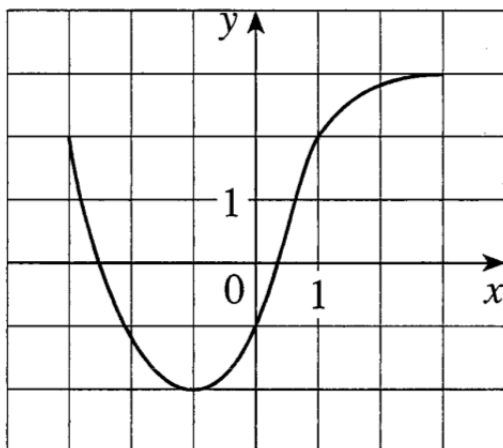
13.5 Determine $f'(x)$:

- | | | | | | |
|----|-------------------------------------|----|---------------------------------------|----|-------------------------------------|
| a) | $f(x) = 3^x$ | b) | $f(x) = 5^x$ | c) | $f(x) = 18^x$ |
| d) | $f(x) = \left(\frac{2}{3}\right)^x$ | e) | $f(x) = \left(\frac{13}{17}\right)^x$ | f) | $f(x) = \left(\frac{1}{4}\right)^x$ |
| g) | $f(x) = \left(\frac{1}{e}\right)^x$ | h) | $f(x) = \left(\frac{3}{e}\right)^x$ | i) | $f(x) = \left(\frac{e}{3}\right)^x$ |

13.6 Determine the rate of change of the function f at the indicated values of x :

- | | | | | | | |
|----|-------------------------------------|----------|-----|--------------------|------|--------------------|
| a) | $f(x) = x$ | | | | | |
| | i) | $x = 0$ | ii) | $x = 1$ | iii) | $x = -2$ |
| b) | $f(x) = x^5$ | | | | | |
| | i) | $x = 0$ | ii) | $x = 2$ | iii) | $x = -\frac{2}{3}$ |
| c) | $f(x) = x^{-4}$ | | | | | |
| | i) | $x = -1$ | ii) | $x = -\frac{4}{3}$ | iii) | $x = 0$ |
| d) | $f(x) = \left(\frac{2}{3}\right)^x$ | | | | | |
| | i) | $x = 0$ | ii) | $x = 1$ | iii) | $x = -2$ |

13.7 The graph of a function f is given as follows:



Estimate the rate of change $f'(x_0)$ at the given x_0 :

- | | | | |
|----|------------|----|------------|
| a) | $x_0 = -1$ | b) | $x_0 = 0$ |
| c) | $x_0 = 1$ | d) | $x_0 = -2$ |

Hints:

- Draw the tangent to the graph of f at the given x_0 .
- Estimate the slope of the tangent.

13.8 * The rate of change $f'(x_0)$ of f at x_0 can be determined by looking at the secant through the points $A(x_0 | f(x_0))$ and $B(x_0 + \Delta x | f(x_0 + \Delta x))$ of the graph of f . The slope of this secant tends towards the slope of the tangent at $A(x_0 | f(x_0))$ as Δx tends towards 0.

It has been showed in class how to find $f'(x_0)$ in that way for the quadratic function $f(x) = x^2$.

Find $f'(x_0)$ for the following functions f :

- | | | | |
|----|--------------|----|------------------------|
| a) | $f(x) = x^3$ | b) | $f(x) = \frac{1}{x^2}$ |
|----|--------------|----|------------------------|

Answers

- 13.1 a) i) ...
 ii) $f'(2) = 0$
 b) i) ...
 ii) $f'(x_0) = 0$
 c) i) ...
 ii) $f'(4) = 2$
 d) i) ...
 ii) $f'(x_0) = m$
 e) * i) ...
 ii) $f'(x_0) = \begin{cases} 1 & (x_0 > 0) \\ -1 & (x_0 < 0) \\ \text{not defined} & (x_0 = 0) \end{cases}$

- 13.2 a) i) $f: \mathbb{R} \rightarrow \mathbb{R}$
 $x \rightarrow y = f(x) = 0$
 ii) ...
 b) i) $f: \mathbb{R} \rightarrow \mathbb{R}$
 $x \rightarrow y = f(x) = 0$
 ii) ...
 c) i) $f: \mathbb{R} \rightarrow \mathbb{R}$
 $x \rightarrow y = f(x) = 2$
 ii) ...
 d) i) $f: \mathbb{R} \rightarrow \mathbb{R}$
 $x \rightarrow y = f(x) = m$
 ii) ...
 e) * i) $f: \mathbb{R} \setminus \{0\} \rightarrow \mathbb{R}$
 $x \rightarrow y = f(x) = \begin{cases} 1 & (x > 0) \\ -1 & (x < 0) \end{cases}$
 ii) ...

- 13.3 a) $D = \{x: x \in \mathbb{R} \text{ and } x \geq -1\}$
 b) $D_1 = \{x: x \in \mathbb{R} \text{ and } x > -1\}$

Hints:

- The square root of a negative number is not defined.
- Division by zero is not defined.

- | | | | |
|------|----------------------------|----------------------------|---------------------------------|
| 13.4 | a) $f(x) = 0$ | b) $f(x) = 0$ | c) $f(x) = 0$ |
| | d) $f(x) = 3x^2$ | e) $f(x) = 4x^3$ | f) $f(x) = 5x^4$ |
| | g) $f(x) = 17x^{16}$ | h) $f(x) = 200x^{199}$ | i) $f(x) = 100'001x^{100'000}$ |
| | j) $f(x) = -x^{-2}$ | k) $f(x) = -2x^{-3}$ | l) $f(x) = -17x^{-18}$ |
| | m) $f(x) = -\frac{1}{x^2}$ | n) $f(x) = -\frac{3}{x^4}$ | o) $f(x) = -\frac{99}{x^{100}}$ |

- 13.5 a) $f'(x) = 3^x \ln(3)$ b) $f'(x) = 5^x \ln(5)$ c) $f'(x) = 18^x \ln(18)$
 d) $f'(x) = \left(\frac{2}{3}\right)^x \ln\left(\frac{2}{3}\right)$ e) $f'(x) = \left(\frac{13}{17}\right)^x \ln\left(\frac{13}{17}\right)$
 f) $f'(x) = \left(\frac{1}{4}\right)^x \ln\left(\frac{1}{4}\right) = -\frac{\ln(4)}{4^x}$

Hint:

- Logarithm rules (see formulary) can be applied in order to simplify the result.

- g) $f'(x) = -\frac{1}{e^x}$ h) $f'(x) = \left(\frac{3}{e}\right)^x (\ln(3) - 1)$ i) $f'(x) = \left(\frac{e}{3}\right)^x (1 - \ln(3))$
- 13.6 a) $f'(x) = 1$
 i) $f'(0) = 1$ ii) $f'(1) = 1$ iii) $f'(-2) = 1$
 b) $f'(x) = 5x^4$
 i) $f'(0) = 0$ ii) $f'(2) = 80$ iii) $f'\left(-\frac{2}{3}\right) = \frac{80}{81}$
 c) $f'(x) = -\frac{4}{x^5}$
 i) $f'(-1) = 4$ ii) $f'\left(-\frac{4}{3}\right) = \frac{243}{256}$ iii) $f'(0)$ is not defined
 d) $f'(x) = \left(\frac{2}{3}\right)^x \ln\left(\frac{2}{3}\right)$
 i) $f'(0) = \ln\left(\frac{2}{3}\right)$ ii) $f'(1) = \frac{2}{3} \ln\left(\frac{2}{3}\right)$ iii) $f'(-2) = \frac{9}{4} \ln\left(\frac{2}{3}\right)$
- 13.7 a) $f'(-1) \approx 0$ b) $f'(0) \approx 2$
 c) $f'(1) \approx \frac{3}{2}$ d) $f'(-2) \approx -\frac{5}{3}$
- 13.8 * a) ... b) ...