

Chapter 13 / **Example 6****Average and instantaneous rate of change**

During one month, the temperature of the water in a pond is modelled by the function

$$T(n) = 18 + 12ne^{-\frac{n}{3}}, \text{ where } n \text{ is measured in days and } T \text{ is measured in degrees Celsius.}$$

- Find the average rate of change in temperature during the first 18 days of the month. Include units in your answer.
- Find $T'(n)$.
- Find the exact value of the instantaneous rate of change in temperature on day 18. Check your answer using a GDC.

$$\text{Average rate of change} = \frac{T(18) - T(0)}{18 - 0}$$

Press **MENU** 5 **GRAPH** to display the equation entry screen.

Press **□** to select the fraction template.

Type (18 + 12 × 18

Press **SHIFT** **ln** (e^x), then type **(-)** and press **□**

Enter 18 in the numerator and 3 in the denominator.

Press **▶** **▶** and close the parentheses.

Continue by typing - (18 + 12 × 0

Press **SHIFT** **ln** (e^x), then type **(-)** and press **□**

Enter 0 in the numerator and 3 in the denominator.

Press **▶** **▶** and close the parentheses.

Press **▼** to navigate down to the denominator and type 18 - 0

Press **EXE**.

The average rate of change is 0.0297 °C/day

$$T'(n) = -4ne^{-\frac{n}{3}} + 12e^{-\frac{n}{3}}$$

To find $T'(18)$, calculate $-4 \times 18e^{-\frac{18}{3}} + 12e^{-\frac{18}{3}}$

The instantaneous rate of change is -0.149 °C/day

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To calculate the instantaneous rate of change press **[F4]** MATH
[F4] d/dx

The template has spaces for the variable, x , the function and the value that it is evaluated at.

Although the function is expressed in terms of n , the variable used on the GDC will be x .

Type in the function using the previous instructions as a guide. Enter 18 as the value of x and press **[=]**.

The instantaneous rate of change is -0.149 °C/day as found before.

The calculator screen displays the derivative of the function $-4 \times 18e^{-\frac{x}{3}} + 12e^{-\frac{x}{3}}$ at $x=18$. The expression is shown as $\frac{d}{dx} \left(-4 \times 18e^{-\frac{x}{3}} + 12e^{-\frac{x}{3}} \right) \Big|_{x=18}$. The result is -0.1487251306 . The bottom of the screen shows the function editor with the expression $-4 \times 18e^{-\frac{x}{3}} + 12e^{-\frac{x}{3}}$ and the variable x set to 18. The bottom status bar shows the function editor menu with options: MAT/VCT, Logab, Abs, d/dx, d²/dx², and a right arrow.