

Marked example

Paper 2 style · Graphic display calculator

18

6 marks SL 5.1 · 5.6

●○○ Routine

A cup of tea is left to cool in a room. The temperature of the tea, in °C, t minutes after it is poured, is modelled by

$$T(t) = 21 + 64e^{-0.085t}, \quad t \geq 0.$$

- (a) Write down the temperature of the tea when it is poured. [1]
- (b) Find $T'(10)$. [2]
- (c) Interpret your answer to part (b) in the context of the question. [1]
- (d) Find the time at which the temperature of the tea is decreasing at a rate of 1 °C per minute. [2]

MARKSCHEME (a)

85 °C

A1

Total 1 mark

MARKSCHEME (b)

attempt to differentiate, or use of GDC

(M1)

$T'(10) = -2.33$ ($-2.32513 \dots$)

A1

Total 2 marks

MARKSCHEME (c)

10 minutes after it is poured, the temperature of the tea is decreasing at about 2.33 °C per minute

R1

Total 1 mark

Note Both the idea of decreasing and a rate in °C per minute are needed. FT from their answer to (b).

MARKSCHEME (d)

$T'(t) = -1$ OR $5.44e^{-0.085t} = 1$

(M1)

$t = 19.9$ minutes ($19.9268 \dots$)

A1

Total 2 marks

Note Award M1 for $T'(t) = 1$ only if followed by a correct interpretation of the sign.

ON THE CALCULATOR

TI-Nspire CX II

(b) Calculator: menu → 4 Calculus → 1 Numerical Derivative at a Point, Value: 10, then type $21 + 64e^{-0.085x}$ in the template → -2.32514 .

(d) Differentiate by hand: $T'(t) = -5.44e^{-0.085t}$. Graph: $f_1(x) = -5.44e^{-0.085x}$, $f_2(x) = -1$; menu → 6 Analyze Graph → 4 Intersection → $x = 19.9268$.

NumWorks

(b) Calculation: Toolbox → Calculus → Derivative, type $21 + 64e^{-0.085x}$, then the value 10 → -2.325137 .

(d) With $T'(t) = -5.44e^{-0.085t}$: Functions: $f(x) = -5.44e^{-0.085x}$, $g(x) = -1$; Graph → Calculate → Find → Intersection → $x = 19.92681$.