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- 2014 12f** Milk taken out of a refrigerator has a temperature of  $2^{\circ}\text{C}$ . It is placed in a room of constant temperature  $23^{\circ}\text{C}$ . After  $t$  minutes the temperature,  $T^{\circ}\text{C}$ , of the milk is given by  $T = A - Be^{-0.03t}$ , where  $A$  and  $B$  are positive constants. How long does it take for the milk to reach a temperature of  $10^{\circ}\text{C}$ ? **3**

$$T = A - Be^{-0.03t}$$

When  $t \rightarrow \infty$ ,  $T = 23$

$$\therefore A = 23$$

When  $t = 0$ ,  $T = 2$ :

$$2 = 23 - Be^{-0.03(0)}$$

$$\therefore B = 21$$

$$\therefore T = 23 - 21e^{-0.03t}$$

Subs  $T = 10$  in  $T = 23 - 21e^{-0.03t}$ :

$$10 = 23 - 21e^{-0.03t}$$

$$21e^{-0.03t} = 13$$

$$e^{-0.03t} = \frac{13}{21}$$

$$-0.03t = \ln \frac{13}{21}$$

$$t = \frac{\ln \frac{13}{21}}{-0.03}$$

$$= 15.98576932\dots$$

$$= 16 \text{ (nearest whole)} \quad \therefore 16 \text{ minutes}$$

State Mean:  
**2.51**

\* These solutions have been provided by [projectmaths](#) and are not supplied or endorsed by BOSTES.

### Board of Studies: Notes from the Marking Centre

It was evident that many candidates had a sound understanding of Newton's Law of Cooling. This allowed them to find the correct values for  $A$  and  $B$  and the correct solution.

Common problems were:

- not identifying the correct values of  $A$  and  $B$
- failing to substitute  $t = 0$
- having incorrect values for  $A$  or  $B$  (or both  $A$  and  $B$ ), leading to a subsequent exponential equation that involved the logarithm of a negative number (which was ignored)
- not realising that as  $t \rightarrow \infty$ ,  $T = 23 \therefore A = 23$ .

**Source:** [http://www.boardofstudies.nsw.edu.au/hsc\\_exams/2014/pdf\\_doc/2014-maths-ext-1.pdf](http://www.boardofstudies.nsw.edu.au/hsc_exams/2014/pdf_doc/2014-maths-ext-1.pdf)