Classroom to Campus: Math and Stats Challenge

Grade 11 – MCF3M

Topic B: Exponential Functions

Monitoring Coffee Cooling Dynamics in a Café

In a bustling downtown café, the barista is keen on perfecting the serving temperature of their coffee to ensure customer satisfaction. Customers have expressed that coffee served too hot can be uncomfortable, while coffee that cools too quickly loses its appeal. To address this, the barista decides to monitor the cooling process of a standard cup of coffee after it is served.

The barista pours a freshly brewed cup of coffee at a temperature higher than the ideal serving temperature. They use a thermometer to track the cooling process and observe how quickly the coffee reaches an optimal drinking temperature. The temperature D (in $℃$) of the coffee as a function of time t (in minutes) is modeled by the following equation:

$$D(t) = 21.5 + 39e^{-0.1t}$$

where t represents the time elapsed since the coffee was served.

a) Determine the initial temperature of the coffee immediately after it is poured. *(Round your final answer to two decimal places. Include units.)*

b) Calculate the temperature of the coffee 5 minutes after it is served. *(Round your final answer to two decimal places. Include units.)*

c) How long it will take (in minutes) for the coffee to cool to $40℃$, a common optimal drinking temperature. *(Round your final answer to two decimal places. Include units.)*

d) How long does it take for the coffee to cool to half of its initial temperature? *(Round your final answer to two decimal places. Include units.)*

e) What is the room temperature assumed in the model (the temperature the coffee will eventually stabilize at, assuming it will not cool below a certain value)? *(Round your answer to two decimal places. Include units.)*