

|                             |     |    |    |    |
|-----------------------------|-----|----|----|----|
| $t$<br>(minutes)            | 0   | 3  | 7  | 12 |
| $C(t)$<br>(degrees Celsius) | 100 | 85 | 69 | 55 |

1. The temperature of coffee in a cup at time  $t$  minutes is modeled by a decreasing differentiable function  $C$ , where  $C(t)$  is measured in degrees Celsius. For  $0 \leq t \leq 12$ , selected values of  $C(t)$  are given in the table shown.
- (a) Approximate  $C'(5)$  using the average rate of change of  $C$  over the interval  $3 \leq t \leq 7$ . Show the work that leads to your answer and include units of measure.
- (b) Use a left Riemann sum with the three subintervals indicated by the data in the table to approximate the value of  $\int_0^{12} C(t) \, dt$ . Interpret the meaning of  $\frac{1}{12} \int_0^{12} C(t) \, dt$  in the context of the problem.
- (c) For  $12 \leq t \leq 20$ , the rate of change of the temperature of the coffee is modeled by  $C'(t) = \frac{-24.55e^{0.01t}}{t}$ , where  $C'(t)$  is measured in degrees Celsius per minute. Find the temperature of the coffee at time  $t = 20$ . Show the setup for your calculations.
- (d) For the model defined in part (c), it can be shown that  $C''(t) = \frac{0.2455e^{0.01t}(100 - t)}{t^2}$ . For  $12 < t < 20$ , determine whether the temperature of the coffee is changing at a decreasing rate or at an increasing rate. Give a reason for your answer.

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**Write your responses to this question only on the designated pages in the separate Free Response booklet. Write your solution to each part in the space provided for that part.**