2. A particle moves along a straight line. For $0 \le t \le 5$, the velocity of the particle is given by
$v(t) = -2 + \left(t^2 + 3t\right)^{6/5} - t^3$, and the position of the particle is given by $s(t)$. It is known that $s(0) = 10$.

   (a) Find all values of t in the interval $2 \le t \le 4$ for which the speed of the particle is 2.

   (b) Write an expression involving an integral that gives the position $s(t)$. Use this expression to find the position of the particle at time $t = 5$.

   (c) Find all times t in the interval $0 \le t \le 5$ at which the particle changes direction. Justify your answer.

   (d) Is the speed of the particle increasing or decreasing at time $t = 4$? Give a reason for your answer.

END OF PART A OF SECTION II

GO ON TO THE NEXT PAGE.

CALCULUS AB
SECTION II, Part B
Time—60 minutes
Number of problems—4

No calculator is allowed for these problems.

t (minutes)	0	1	2	3	4	5	6
$C(t)$ (ounces)	0	5.3	8.8	11.2	12.8	13.8	14.5

3. Hot water is dripping through a coffeemaker, filling a large cup with coffee. The amount of coffee in the cup at time t, $0 \leq t \leq 6$, is given by a differentiable function C, where t is measured in minutes. Selected values of $C(t)$, measured in ounces, are given in the table above.

   (a) Use the data in the table to approximate $C'(3.5)$. Show the computations that lead to your answer, and indicate units of measure.

   (b) Is there a time t, $2 \leq t \leq 4$, at which $C'(t) = 2$? Justify your answer.

   (c) Use a midpoint sum with three subintervals of equal length indicated by the data in the table to approximate the value of $\frac{1}{6}\int_0^6 C(t)\, dt$. Using correct units, explain the meaning of $\frac{1}{6}\int_0^6 C(t)\, dt$ in the context of the problem.

   (d) The amount of coffee in the cup, in ounces, is modeled by $B(t) = 16 - 16e^{-0.4t}$. Using this model, find the rate at which the amount of coffee in the cup is changing when $t = 5$.

_____

Question 2

A particle moves along a straight line. For $0 \leq t \leq 5,$ the velocity of the particle is given by

$v(t) = -2 + \left(t^2 + 3t\right)^{6/5} - t^3,$ and the position of the particle is given by $s(t).$ It is known that $s(0) = 10.$

(a) Find all values of t in the interval $2 \leq t \leq 4$ for which the speed of the particle is 2.

(b) Write an expression involving an integral that gives the position $s(t).$ Use this expression to find the position of the particle at time $t = 5.$

(c) Find all times t in the interval $0 \leq t \leq 5$ at which the particle changes direction. Justify your answer.

(d) Is the speed of the particle increasing or decreasing at time $t = 4$? Give a reason for your answer.

(a) Solve $|v(t)| = 2$ on $2 \leq t \leq 4.$

$t = 3.128$ (or 3.127) and $t = 3.473$

$2 : \begin{cases} 1 : \text{considers } |v(t)| = 2 \\ 1 : \text{answer} \end{cases}$

(b) $s(t) = 10 + \int_0^t v(x)\, dx$

$s(5) = 10 + \int_0^5 v(x)\, dx = -9.207$

$2 : \begin{cases} 1 : s(t) \\ 1 : s(5) \end{cases}$

(c) $v(t) = 0$ when $t = 0.536033,\ 3.317756$

$v(t)$ changes sign from negative to positive at time $t = 0.536033.$

$v(t)$ changes sign from positive to negative at time $t = 3.317756.$

Therefore, the particle changes direction at time $t = 0.536$ and time $t = 3.318$ (or 3.317).

$3 : \begin{cases} 1 : \text{considers } v(t) = 0 \\ 2 : \text{answers with justification} \end{cases}$

(d) $v(4) = -11.475758 < 0,\ a(4) = v'(4) = -22.295714 < 0$

The speed is increasing at time $t = 4$ because velocity and acceleration have the same sign.

$2 : \text{conclusion with reason}$