

## **2018 AP® CALCULUS AB FREE-RESPONSE QUESTIONS**

2. A particle moves along the  $x$ -axis with velocity given by  $v(t) = \frac{10 \sin(0.4t^2)}{t^2 - t + 3}$  for time  $0 \leq t \leq 3.5$ .

The particle is at position  $x = -5$  at time  $t = 0$ .

(a) Find the acceleration of the particle at time  $t = 3$ .

(b) Find the position of the particle at time  $t = 3$ .

(c) Evaluate  $\int_0^{3.5} v(t) \, dt$ , and evaluate  $\int_0^{3.5} |v(t)| \, dt$ . Interpret the meaning of each integral in the context of the problem.

(d) A second particle moves along the  $x$ -axis with position given by  $x_2(t) = t^2 - t$  for  $0 \leq t \leq 3.5$ . At what time  $t$  are the two particles moving with the same velocity?

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**END OF PART A OF SECTION II**

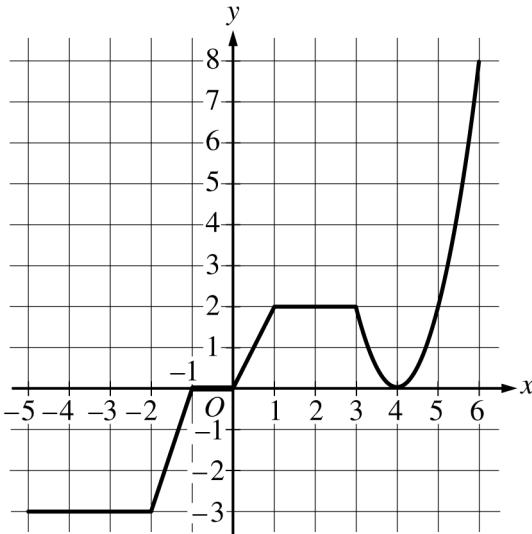
**2018 AP® CALCULUS AB FREE-RESPONSE QUESTIONS**

**CALCULUS AB  
SECTION II, Part B**

**Time—1 hour**

**Number of questions—4**

**NO CALCULATOR IS ALLOWED FOR THESE QUESTIONS.**



Graph of  $g$

3. The graph of the continuous function  $g$ , the derivative of the function  $f$ , is shown above. The function  $g$  is piecewise linear for  $-5 \leq x < 3$ , and  $g(x) = 2(x - 4)^2$  for  $3 \leq x \leq 6$ .
- (a) If  $f(1) = 3$ , what is the value of  $f(-5)$ ?
- (b) Evaluate  $\int_1^6 g(x) dx$ .
- (c) For  $-5 < x < 6$ , on what open intervals, if any, is the graph of  $f$  both increasing and concave up? Give a reason for your answer.
- (d) Find the  $x$ -coordinate of each point of inflection of the graph of  $f$ . Give a reason for your answer.

**AP® CALCULUS AB  
2018 SCORING GUIDELINES**

**Question 2**

(a)  $v'(3) = -2.118$

The acceleration of the particle at time  $t = 3$  is  $-2.118$ .

(b)  $x(3) = x(0) + \int_0^3 v(t) dt = -5 + \int_0^3 v(t) dt = -1.760213$

The position of the particle at time  $t = 3$  is  $-1.760$ .

(c)  $\int_0^{3.5} v(t) dt = 2.844$  (or  $2.843$ )

$$\int_0^{3.5} |v(t)| dt = 3.737$$

The integral  $\int_0^{3.5} v(t) dt$  is the displacement of the particle over the time interval  $0 \leq t \leq 3.5$ .

The integral  $\int_0^{3.5} |v(t)| dt$  is the total distance traveled by the particle over the time interval  $0 \leq t \leq 3.5$ .

(d)  $v(t) = x_2'(t)$

$$v(t) = 2t - 1 \Rightarrow t = 1.57054$$

The two particles are moving with the same velocity at time  $t = 1.571$  (or  $1.570$ ).

1 : answer

3 :  $\begin{cases} 1 : \int_0^3 v(t) dt \\ 1 : \text{uses initial condition} \\ 1 : \text{answer} \end{cases}$

3 :  $\begin{cases} 1 : \text{answers} \\ 2 : \text{interpretations of } \int_0^{3.5} v(t) dt \\ \quad \text{and } \int_0^{3.5} |v(t)| dt \end{cases}$

2 :  $\begin{cases} 1 : \text{sets } v(t) = x_2'(t) \\ 1 : \text{answer} \end{cases}$