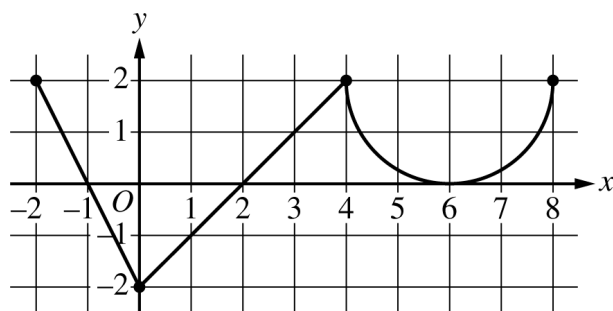
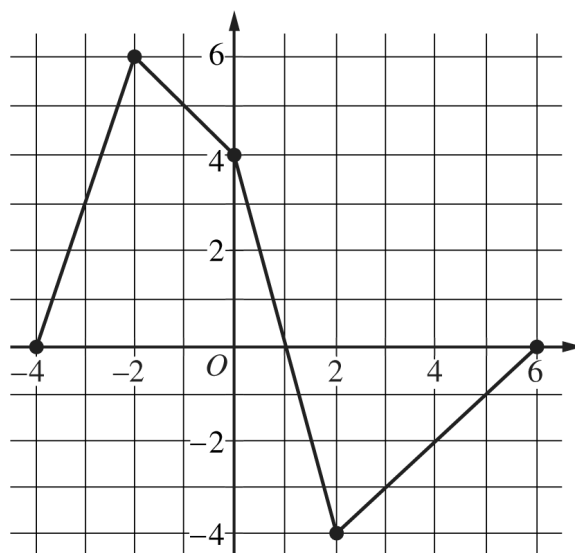


Graph of  $f'$ 

4. The function  $f$  is defined on the closed interval  $[-2, 8]$  and satisfies  $f(2) = 1$ . The graph of  $f'$ , the derivative of  $f$ , consists of two line segments and a semicircle, as shown in the figure.
- (a) Does  $f$  have a relative minimum, a relative maximum, or neither at  $x = 6$ ? Give a reason for your answer.
- (b) On what open intervals, if any, is the graph of  $f$  concave down? Give a reason for your answer.
- (c) Find the value of  $\lim_{x \rightarrow 2} \frac{6f(x) - 3x}{x^2 - 5x + 6}$ , or show that it does not exist. Justify your answer.
- (d) Find the absolute minimum value of  $f$  on the closed interval  $[-2, 8]$ . Justify 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.**

Graph of  $f$ 

Let  $f$  be a continuous function defined on the closed interval  $-4 \leq x \leq 6$ . The graph of  $f$ , consisting of four line segments, is shown above. Let  $G$  be the function defined by  $G(x) = \int_0^x f(t) \, dt$ .

(a) On what open intervals is the graph of  $G$  concave up? Give a reason for your answer.

(b) Let  $P$  be the function defined by  $P(x) = G(x) \cdot f(x)$ . Find  $P'(3)$ .

(c) Find  $\lim_{x \rightarrow 2} \frac{G(x)}{x^2 - 2x}$ .

(d) Find the average rate of change of  $G$  on the interval  $[-4, 2]$ . Does the Mean Value Theorem guarantee a value  $c$ ,  $-4 < c < 2$ , for which  $G'(c)$  is equal to this average rate of change? Justify your answer.

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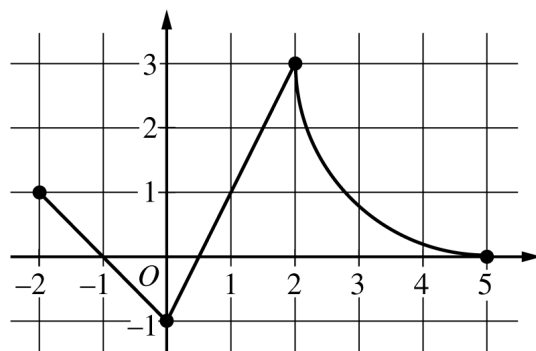
**Write your responses to this question only on the designated pages in the separate Free Response booklet. Write your solution to each part in the space provided for that part.**

**CALCULUS BC**  
**SECTION II, Part B**

**Time—1 hour**

**Number of questions—4**

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



Graph of  $f$

3. The continuous function  $f$  is defined on the closed interval  $-6 \leq x \leq 5$ . The figure above shows a portion of the graph of  $f$ , consisting of two line segments and a quarter of a circle centered at the point  $(5, 3)$ . It is known that the point  $(3, 3 - \sqrt{5})$  is on the graph of  $f$ .
- (a) If  $\int_{-6}^5 f(x) \, dx = 7$ , find the value of  $\int_{-6}^{-2} f(x) \, dx$ . Show the work that leads to your answer.
- (b) Evaluate  $\int_3^5 (2f'(x) + 4) \, dx$ .
- (c) The function  $g$  is given by  $g(x) = \int_{-2}^x f(t) \, dt$ . Find the absolute maximum value of  $g$  on the interval  $-2 \leq x \leq 5$ . Justify your answer.
- (d) Find  $\lim_{x \rightarrow 1} \frac{10^x - 3f'(x)}{f(x) - \arctan x}$ .
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4. Consider the differential equation  $\frac{dy}{dx} = x^2 - \frac{1}{2}y$ .

(a) Find  $\frac{d^2y}{dx^2}$  in terms of  $x$  and  $y$ .

(b) Let  $y = f(x)$  be the particular solution to the given differential equation whose graph passes through the point  $(-2, 8)$ . Does the graph of  $f$  have a relative minimum, a relative maximum, or neither at the point  $(-2, 8)$ ? Justify your answer.

(c) Let  $y = g(x)$  be the particular solution to the given differential equation with  $g(-1) = 2$ . Find

$\lim_{x \rightarrow -1} \left( \frac{g(x) - 2}{3(x + 1)^2} \right)$ . Show the work that leads to your answer.

(d) Let  $y = h(x)$  be the particular solution to the given differential equation with  $h(0) = 2$ . Use Euler's method, starting at  $x = 0$  with two steps of equal size, to approximate  $h(1)$ .

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