<table>
<tr><th colspan="2">The Fundamental Theorem of Calculus (FTC)</th></tr>
<tr><td>Part 1</td><td>Part 2</td></tr>
<tr><td>If f is continuous on $[a,b]$, then the function
$F(x)=\int_a^x f(t)dt$
has a derivative at every point x in $[a,b]$, and
$\frac{dF}{dx}=\frac{d}{dx}\int_a^x f(t)dt=$ ___________</td><td>If f is continuous on $[a,b]$, and if is any antiderivative of f on $[a,b]$, then
$\int_a^b f(x)dx=$ ____________________</td></tr>
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1. Find $\frac{dy}{dx}$

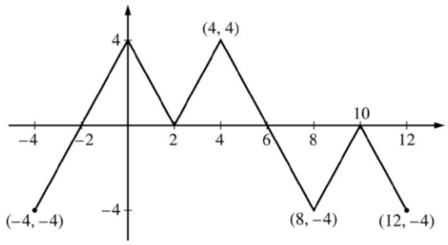
a. $y=\int_2^x (3t+\cot(t^2))dt$

c. $y=\int_6^{x^2} \cot 3t\ dt$

b. $y=\int_4^x e^u \sec u du$

d. $y=\int_{3x^2}^{5x} \ln(2+p^2)dp$

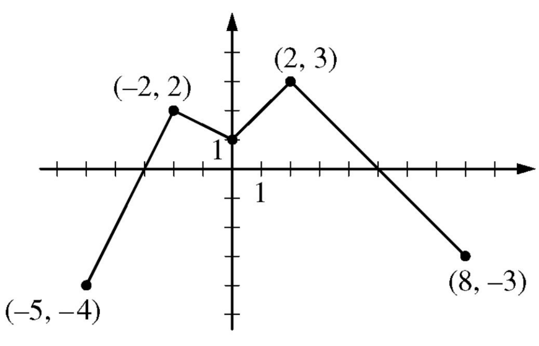
2. The figure below shows the graph of the piecewise-linear function f. For $-4\le x\le 12$, the function g is defined by $g(x)=\int_{-4}^{x} f(t)dt$. Does g have a relative minimum, a relative maximum, or neither at $x=10$? Justify your answer.



Graph of f

3. The functions f and g are given by $f(x) = \int_0^{3x} \sqrt{4+t^2}\,dt$ and $g(x) = f(\sin x)$. Find $f'(x)$ and $g'(x)$.

4. The continuous function f is defined on the interval $-5 \le x \le 8$. The graph of f which consists of four line segments is shown in the figure below. Let g be the function given by $g(x) = 2x + \int_{-2}^{x} f(t)\,dt.$ Find $g'(x)$ in terms of $f(x)$. For each of $g''(4)$ and $g''(-2)$, find the value of state that it does not exist.



Graph of f

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5. Evaluate each integral using the Evaluation Part of the Fundamental Theorem:

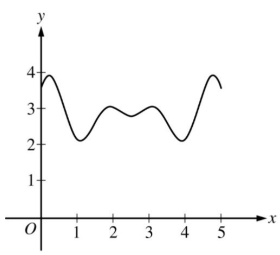
   a. $\int_2^{-1} 3^x\,dx$

b. $\int_0^5 x^{\frac{3}{2}}\, dx$

d. $\int_0^4 \frac{1-\sqrt{u}}{\sqrt{u}}\, du$

c. $\int_{\frac{\pi}{6}}^{\frac{5\pi}{6}} \csc^2\theta\, d\theta$

6. The graph of f', the derivative of f, is shown below. If $f(0) = 20$, which of the following could be the value of $f(5)$?



Graph of f'

(A) 15

(B) 20

(C) 25

(D) 35

(E) 40

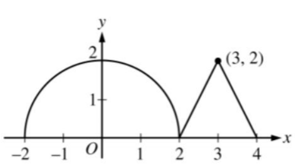
7. The graph of g', the first derivative of g, consists of a semicircle of radius 2 and two line segments, as shown in the figure below. If $g(0) = 1$, what is $g(3)$?

(A) $\pi + 1$

(B) $\pi + 2$

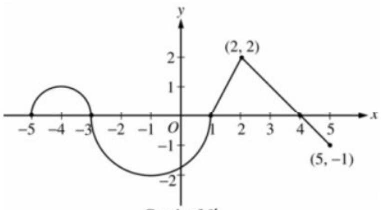
(C) $2\pi + 1$

(D) $2\pi + 2$



Graph of g'

8. Let f be a function defined on the closed interval $-5 \le x \le 5$ with $f(1) = 3$. The graph of f' the derivative of f, consists of two semicircles and two line segments, as shown below. Find the absolute minimum value of $f(x)$ over the closed interval $-5 \le x \le 5$. Explain your reasoning.



Graph of f'

9. Find the total area of the region bounded between the curve and the x-axis of $y = 3x^2 - 3$ on $-2 \leq x \leq 2$