Initial Value Problem 1:

Solve using 2 methods without a calculator.

1. $y' = 2 + \frac{1}{x^2}$ and $y(1) = 6$. Find $y(3)$.

Solve with a calculator.

3. $f'(x) = \cos\left(x^3\right)$ and $f(0) = 2$. Find $f(1)$.

4. $f'(x) = e^{-x^2}$ and $f(5) = 1$. Find $f(2)$.

Initial Value Problem 2:

Solve with a calculator.

5. A particle moving along the x-axis has position $x(t)$ at time t with the velocity of the particle $v(t) = 5\sin\left(t^2\right)$. At time $t = 6$, the particle's position is (4, 0). Find the position of the particle when $t = 7$.

6. Let $F(t)$ represent a bacteria population which is 4 million at time $t = 0$. After t hours, the population is growing at an instantaneous rate of 2^t million bacteria per hour. Find the total increase in the bacteria population during the first three hours, and find the population at $t = 3$ hours.

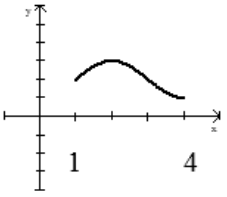
7. A particle moves along a line so that at any time $t \geq 0$ its velocity is given by $v(t) = \frac{t}{1+t^2}$. At time $t = 0$, the position of the particle is $s(0) = 5$. Determine the position of the particle at t=3.

Initial Value Problem 3 (with Graph):

Use the Fundamental Theorem of Calculus and the given graph.

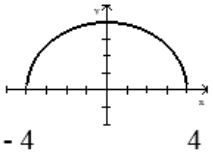
8. The graph of f' is shown on the right.

$\int_1^4 f'(x)\,dx = 6.2$ and $f(1) = 3$. Find $f(4)$.



9. The graph of f' is the semicircle shown on the right.

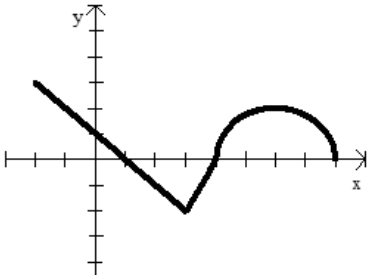
Find $f(-4)$ given that $f(4) = 7$.



10. The graph of f', consisting of two line segments and a semicircle, is shown on the right.

Given that $f(-2) = 5$, find:

(a) $f(1)$ (b) $f(4)$ (c) $f(8)$

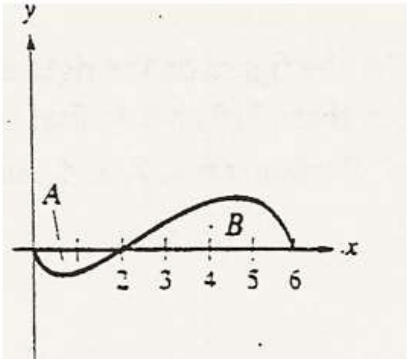


Initial Value Problem 4 (with Graph):

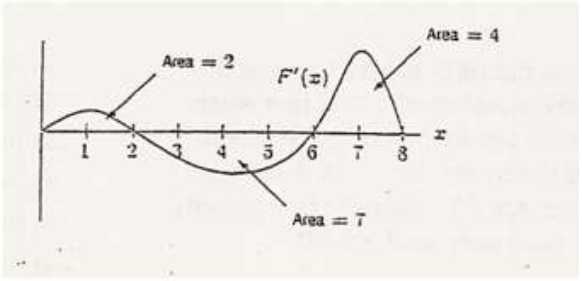
11. Region A has an area of 1.5, and $\int_0^6 f(x)\,dx = 3.5$. Find:

(a) $\int_2^6 f(x)\,dx$

(b) $\int_0^6 |f(x)|\,dx$



14. Given the figure on the right and the fact that $F(2) = 3$.



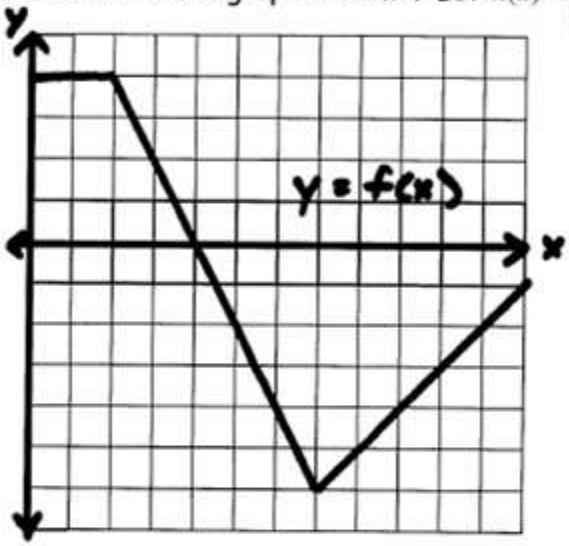
(a) Find $F(0), F(6)$, and $F(8)$.

(b) Determine the intervals where the graph of F is increasing and decreasing. Justify your answer.

(c) Determine the intervals where the graph of F is concave up and concave down. Justify your answer.

FTC Applications FRQ 1:

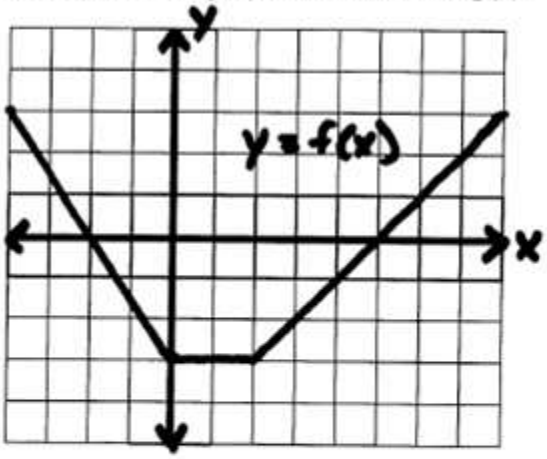
1. Let f be a continuous function whose graph is shown. Let $h(x) = \int_0^x f(t)dt$ for $0 \le x \le 12$.



A) Find $h(3)$, $h'(3)$, and $h''(3)$.
B) For what set of values of x is h decreasing?
C) At what value of x does h attain its maximum?
D) At what value of x does h attain its minimum. What is the minimum value?

FTC Applications FRQ 2:

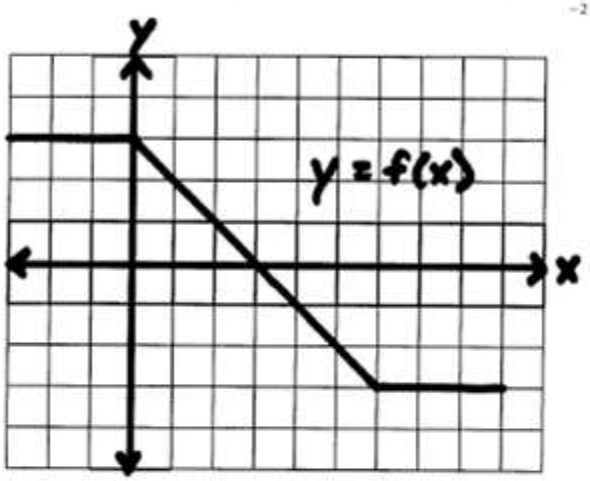
2. Let f be a continuous function whose graph is shown. Let $g(x) = \int_0^x f(t)dt$.



A) Find the values of $g(-2)$, $g(2)$, and $g(8)$.
B) Find the zeros of g.
C) Find $g'(0)$, $g'(5)$, and $g'(8)$.
D) Find $g''(3)$ and $g''(6)$.

FTC Applications FRQ 3:

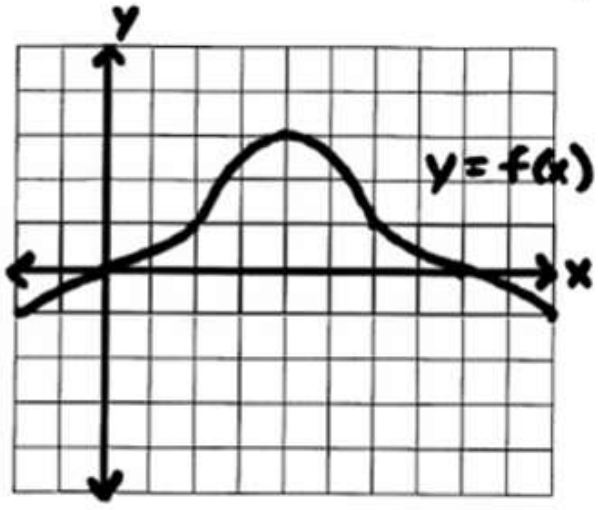
3. Let f be a continuous function whose graph is shown. Let $h(x) = \int_{-2}^{x} f(t)dt$ for $-3 \le x \le 9$.



A) Find the zeros of h.
B) On what interval(s) is h decreasing?
C) What is $h(0)$?
D) What is $h'(0)$?
E) What is $h''(0)$?
F) On what intervals is h concave down?

FTC Applications FRQ 4:

4. The graph of a differentiable function f on the closed interval $[-2,10]$ is shown. The graph of f has a horizontal tangent line at $x = 4$. Let $g(x) = 5 + \int_{4}^{x} f(t)dt$ for $-2 \le x \le 10$.



A) Find $g(4)$, $g'(4)$, and $g''(4)$.
B) On what interval(s) is g decreasing. Justify your answer.
C) On what interval(s) is the graph of g concave down? Justify your answer.
D) At what x-value(s) does g have a point of inflection? Justify your answer.

Motion FRQ 1:

1. (Non-Calculator) The velocity of a moving particle on a coordinate line is given by $v(t) = t^2 + 3t - 10$ ft/min, where t is measured in minutes and $t \geq 0$.
   a. Find the displacement of the particle during the first 3 minutes.
   b. Find when the particle's speed is decreasing. Justify.
   c. Write, but do not evaluate, an integral expression to find the total distance traveled by the particle for the first 5 minutes.

Motion FRQ 2:

2. (Non-Calculator) Given the acceleration of the particle is $a(t) = -4$ ft/sec^2 and $v(0) = 12$ ft/sec during the interval $0 \leq t \leq 8$.
   a. Find the average velocity of the particle for the interval $0 \leq t \leq 8$.
   b. Find when the instantaneous velocity of the particle is equal to the average velocity from part (a).
   c. Find when the velocity is increasing.
   d. Find the total distance traveled by the particle during the interval $0 \leq t \leq 8$.

Motion FRQ 3:

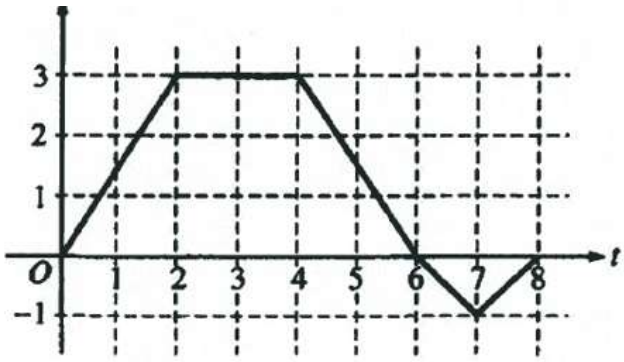
3. (Calculator) The velocity function of a moving particle is $v(t) = 3\cos(2t)$ in/hr for $0 \leq t \leq 2\pi$ hours.
   a. Determine when the particle is moving to the right. Justify.
   b. Find the total distance traveled by the particle during the time interval $0 \leq t \leq 2\pi$ hours.
   c. Given $x(0) = 5$, find $x(6)$.
   d. Find when the particle is speeding up.

Motion FRQ 4:

4. (Non-Calculator) A particle moves along the x-axis so that, at any time $t \geq 0$, its acceleration is given by $a(t) = 6t + 6$. At time $t = 0$, the velocity of the particle is -9 and its position is -27.
   a) Find $v(t)$, the velocity of the particle at any time $t \geq 0$.
   b) For what values of $t \geq 0$ is the particle moving to the right?
   c) Find $x(t)$, the position of the particle at any time $t \geq 0$.

Motion MC 1 (Calculator Inactive):

A bug begins to crawl up a vertical wire at time $t = 0$. The velocity v of the bug at time t, $0 \le t \le 8$, is given by the function whose graph is shown above.



2. What is the total distance the bug traveled from $t = 0$ to $t = 8$?

   a. 14
   b. 13
   c. 11
   d. 8
   e. 6

5. A particle moves along the x-axis so that its acceleration at any time t is $a(t) = 2t - 7$. If the initial velocity of the particle is 6, at what time t during the interval $0 \le t \le 4$ is the particle farthest to the right?

   a. 0
   b. 1
   c. 2
   d. 3
   e. 4

Motion MC (Calculator Active):

8. At time $t \ge 0$, the acceleration of a particle moving on the x-axis is $a(t) = t + \sin t$. At $t = 0$, the velocity of the particle is -2. For what value of t will the velocity of the particle be zero?

   a. 1.02
   b. 1.48
   c. 1.85
   d. 2.81
   e. 3.14

11. A particle moves along the x-axis so that at any time $t \ge 0$, its velocity is given by $v(t) = \cos\left(2 - t^2\right)$. The position of the particle is 3 at time $t = 0$. What is the position of the particle when its velocity is first equal to 0?

   a. 0.411
   b. 1.310
   c. 2.816
   d. 3,091
   e. 3.411