t (hours)	0	0.4	0.8	1.2	1.6	2.0	2.4
$v(t)$ (miles per hour)	0	11.8	9.5	17.2	16.3	16.8	20.1

1. Ruth rode her bicycle on a straight trail. She recorded her velocity $v(t)$, in miles per hour, for selected values of t over the interval $0 \le t \le 2.4$ hours, as shown in the table above. For $0 < t \le 2.4$, $v(t) > 0$.

(a) Use the data in the table to approximate Ruth's acceleration at time $t = 1.4$ hours. Show the computations that lead to your answer. Indicate units of measure.

(b) Using correct units, interpret the meaning of $\int_0^{2.4} v(t)\,dt$ in the context of the problem. Approximate $\int_0^{2.4} v(t)\,dt$ using a midpoint Riemann sum with three subintervals of equal length and values from the table.

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Continue problem 1 on page 5.

(c) For $0 \le t \le 2.4$ hours, Ruth's velocity can be modeled by the function g given by $g(t) = \dfrac{24t + 5\sin(6t)}{t + 0.7}$. According to the model, what was Ruth's average velocity during the time interval $0 \le t \le 2.4$?

(d) According to the model given in part (c), is Ruth's speed increasing or decreasing at time $t = 1.3$? Give a reason for your answer.

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2. A store is having a 12-hour sale. The total number of shoppers who have entered the store t hours after the sale begins is modeled by the function S defined by $S(t) = 0.5t^4 - 16t^3 + 144t^2$ for $0 \le t \le 12$. At time $t = 0$, when the sale begins, there are no shoppers in the store.

(a) At what rate are shoppers entering the store 3 hours after the start of the sale?

(b) Find the value of $\frac{1}{3}\int_6^9 S'(t)\, dt$. Using correct units, explain the meaning of $\frac{1}{3}\int_6^9 S'(t)\, dt$ in the context of this problem.

Continue problem 2 on page 7.

(c) The rate at which shoppers leave the store, measured in shoppers per hour, is modeled by the function L defined by $L(t) = -80 + \dfrac{4400}{t^2 - 14t + 55}$ for $0 \le t \le 12$. According to the model, how many shoppers are in the store at the end of the sale (time $t = 12$)? Give your answer to the nearest whole number.

(d) Using the given models, find the time t, $0 \le t \le 12$, at which the number of shoppers in the store is the greatest. Justify your answer.

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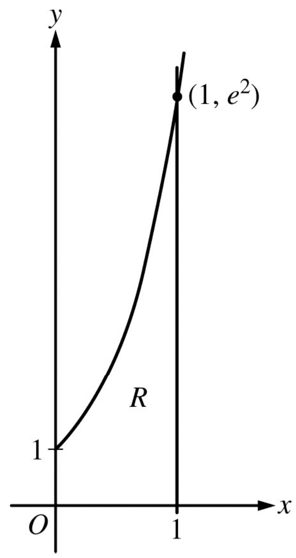

3. Let $f(x) = e^{2x}$. Let R be the region in the first quadrant bounded by the graph of $y = f(x)$ and the vertical line $x = 1$, as shown in the figure above.

   (a) Write an equation for the line tangent to the graph of f at $x = 1$.

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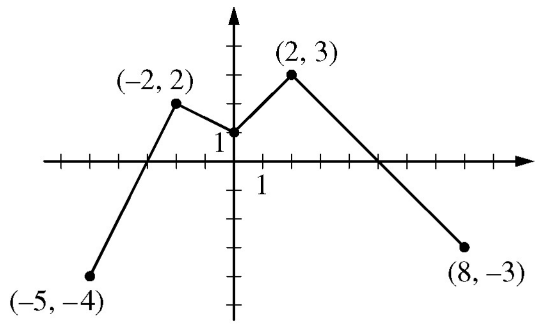
Continue problem 3 on page 15.

(b) Find the area of R.

(c) Region R forms the base of a solid whose cross sections perpendicular to the y-axis are squares. Write, but do not evaluate, an expression involving one or more integrals that gives the volume of the solid.

NO CALCULATOR ALLOWED



Graph of f

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 above. Let g be the function given by $g(x) = 2x + \int_{-2}^{x} f(t)\, dt$.

(a) Find $g(0)$ and $g(-5)$.

(b) Find $g'(x)$ in terms of $f(x)$. For each of $g''(4)$ and $g''(-2)$, find the value or state that it does not exist.

Continue problem 4 on page 17.

NO CALCULATOR ALLOWED

(c) On what intervals, if any, is the graph of g concave down? Give a reason for your answer.

(d) The function h is given by $h(x) = g\left(x^3 + 1\right)$. Find $h'(1)$. Show the work that leads to your answer.

NO CALCULATOR ALLOWED

5. Particle X moves along the positive x-axis so that its position at time $t \geq 0$ is given by $x(t) = 5t^3 - 9t^2 + 7$.

(a) Is particle X moving toward the left or toward the right at time $t = 1$? Give a reason for your answer.

(b) At what time $t \geq 0$ is particle X farthest to the left? Justify your answer.

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Continue problem 5 on page 19.

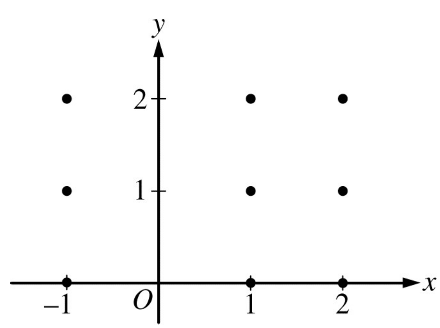
(c) A second particle, Y, moves along the positive y-axis so that its position at time t is given by $y(t) = 7t + 3$. At any time t, $t \geq 0$, the origin and the positions of the particles X and Y are the vertices of a triangle in the first quadrant. Find the rate of change of the area of the triangle at time $t = 1$. Show the work that leads to your answer.

NO CALCULATOR ALLOWED

6. Consider the differential equation $\frac{dy}{dx} = \left(1 - \frac{2}{x^2}\right)(y - 1)$, where $x \neq 0$. Let $y = f(x)$ be the particular solution to the differential equation with initial condition $f(1) = 2$.

(a) Find the slope of the line tangent to the graph of f at the point $(1, 2)$.

(b) On the axes provided, sketch a slope field for the given differential equation at the nine points indicated.



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Continue problem 6 on page 21.

NO CALCULATOR ALLOWED

(c) Find the particular solution $y = f(x)$ to the differential equation $\frac{dy}{dx} = \left(1 - \frac{2}{x^2}\right)(y - 1)$ with initial condition $f(1) = 2$.

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