Math 150 Exam 4
Review Problem List
Exam 4: December 19th and 20th
Professor Busken **Name:** ____________________

Directions: Please complete the Chapter 5 and 6 review sections of the Stewart (7th ed.) textbook as preparation for Exam 4, along with the homework from Sections 3, 11 and 12. The problem numbers for your consideration are listed below and a copy of the review questions and answers is attached to this cover sheet. The first day of the exam, given on Wednesday, December 19th will have two parts:

- **During the first part, a scientific calculator is allowed; but during the second part any calculator use is prohibited.**
- **After you complete and turn in part 1 (calculator section) of the exam, you will be given part 2 to complete.**
- **After you turn part 2 in you may NOT receive it back, but you will be allowed to take back and rework or double check part 1.**

The use of calculators on the second day of the exam, given on Thursday, December 20th, is prohibited.

Chapter 5 Review

Concept Check: 1,3,4,5,6,7
True-False: 1—15 odd, 12
Exercises: 1—37 odd, 4, 43—47 odd, 57

Chapter 6 Review

Exercises: 1—15 odd

Homework Sections 3, 11 and 12

Formula Card Instructions

You may use both sides of a single 3 inch by 5 inch formula card during the exam. The card must contain only identities, formulas, definitions and theorems. Worked examples are prohibited. The same card will be used for both days of the exam, and you will be required to turn in your formula card with parts 1 and 2 of the exam given on Wednesday, Dec. 19th. Furthermore, your formula card must be submitted and approved by me prior to taking the exam, or no card use will be allowed. If you intend to use a formula card for the exam, then you must submit your card for approval on Monday, December 17th. I will notify you on Tuesday, December 18th if your card needs modifying.

81. An oil storage tank ruptures at time $t = 0$ and oil leaks from the tank at a rate of $r(t) = 100e^{-0.01t}$ liters per minute. How much oil leaks out during the first hour?

82. A bacteria population starts with 400 bacteria and grows at a rate of $r(t) = (450.268)e^{1.12567t}$ bacteria per hour. How many bacteria will there be after three hours?

83. Breathing is cyclic and a full respiratory cycle from the beginning of inhalation to the end of exhalation takes about 5 s. The maximum rate of air flow into the lungs is about 0.5 L/s. This explains, in part, why the function $f(t) = \frac{1}{2}\sin(2\pi t/5)$ has often been used to model the rate of air flow into the lungs. Use this model to find the volume of inhaled air in the lungs at time t.

84. Alabama Instruments Company has set up a production line to manufacture a new calculator. The rate of production of these calculators after t weeks is

$$\frac{dx}{dt} = 5000\left(1 - \frac{100}{(t + 10)^2}\right) \text{ calculators/week}$$

(Notice that production approaches 5000 per week as time goes on, but the initial production is lower because of the workers' unfamiliarity with the new techniques.) Find the number of calculators produced from the beginning of the third week to the end of the fourth week.

85. If f is continuous and $\int_0^4 f(x)\,dx = 10$, find $\int_0^2 f(2x)\,dx$.

86. If f is continuous and $\int_0^9 f(x)\,dx = 4$, find $\int_0^3 xf(x^2)\,dx$.

87. If f is continuous on $\mathbb{R}$, prove that

$$\int_a^b f(-x)\,dx = \int_{-b}^{-a} f(x)\,dx$$

For the case where $f(x) \geqslant 0$ and $0 < a < b$, draw a diagram to interpret this equation geometrically as an equality of areas.

88. If f is continuous on $\mathbb{R}$, prove that

$$\int_a^b f(x + c)\,dx = \int_{a+c}^{b+c} f(x)\,dx$$

For the case where $f(x) \geqslant 0$, draw a diagram to interpret this equation geometrically as an equality of areas.

89. If a and b are positive numbers, show that

$$\int_0^1 x^a(1 - x)^b\,dx = \int_0^1 x^b(1 - x)^a\,dx$$

90. If f is continuous on $[0, \pi]$, use the substitution $u = \pi - x$ to show that

$$\int_0^\pi xf(\sin x)\,dx = \frac{\pi}{2}\int_0^\pi f(\sin x)\,dx$$

91. Use Exercise 90 to evaluate the integral

$$\int_0^\pi \frac{x\sin x}{1 + \cos^2 x}\,dx$$

92. (a) If f is continuous, prove that

$$\int_0^{\pi/2} f(\cos x)\,dx = \int_0^{\pi/2} f(\sin x)\,dx$$

(b) Use part (a) to evaluate $\int_0^{\pi/2}\cos^2 x\,dx$ and $\int_0^{\pi/2}\sin^2 x\,dx$.

5 Review

Concept Check

1. (a) Write an expression for a Riemann sum of a function f. Explain the meaning of the notation that you use.
   (b) If $f(x) \geqslant 0$, what is the geometric interpretation of a Riemann sum? Illustrate with a diagram.
   (c) If $f(x)$ takes on both positive and negative values, what is the geometric interpretation of a Riemann sum? Illustrate with a diagram.
2. (a) Write the definition of the definite integral of a continuous function from a to b.
   (b) What is the geometric interpretation of $\int_a^b f(x)\,dx$ if $f(x) \geqslant 0$?
   (c) What is the geometric interpretation of $\int_a^b f(x)\,dx$ if $f(x)$ takes on both positive and negative values? Illustrate with a diagram.
3. State both parts of the Fundamental Theorem of Calculus.
4. (a) State the Net Change Theorem.
   (b) If $r(t)$ is the rate at which water flows into a reservoir, what does $\int_{t_1}^{t_2} r(t)\,dt$ represent?
5. Suppose a particle moves back and forth along a straight line with velocity $v(t)$, measured in feet per second, and acceleration $a(t)$.
   (a) What is the meaning of $\int_{60}^{120} v(t)\,dt$?
   (b) What is the meaning of $\int_{60}^{120} |v(t)|\,dt$?
   (c) What is the meaning of $\int_{60}^{120} a(t)\,dt$?
6. (a) Explain the meaning of the indefinite integral $\int f(x)\,dx$.
   (b) What is the connection between the definite integral $\int_a^b f(x)\,dx$ and the indefinite integral $\int f(x)\,dx$?
7. Explain exactly what is meant by the statement that "differentiation and integration are inverse processes."
8. State the Substitution Rule. In practice, how do you use it?

True-False Quiz

Determine whether the statement is true or false. If it is true, explain why. If it is false, explain why or give an example that disproves the statement.

1. If f and g are continuous on $[a, b]$, then
$$\int_a^b [f(x) + g(x)]\, dx = \int_a^b f(x)\, dx + \int_a^b g(x)\, dx$$

2. If f and g are continuous on $[a, b]$, then
$$\int_a^b [f(x)g(x)]\, dx = \left(\int_a^b f(x)\, dx\right)\left(\int_a^b g(x)\, dx\right)$$

3. If f is continuous on $[a, b]$, then
$$\int_a^b 5f(x)\, dx = 5\int_a^b f(x)\, dx$$

4. If f is continuous on $[a, b]$, then
$$\int_a^b xf(x)\, dx = x\int_a^b f(x)\, dx$$

5. If f is continuous on $[a, b]$ and $f(x) \geqslant 0$, then
$$\int_a^b \sqrt{f(x)}\, dx = \sqrt{\int_a^b f(x)\, dx}$$

6. If f' is continuous on $[1, 3]$, then $\int_1^3 f'(v)\, dv = f(3) - f(1)$.

7. If f and g are continuous and $f(x) \geqslant g(x)$ for $a \leqslant x \leqslant b$, then
$$\int_a^b f(x)\, dx \geqslant \int_a^b g(x)\, dx$$

8. If f and g are differentiable and $f(x) \geqslant g(x)$ for $a < x < b$, then $f'(x) \geqslant g'(x)$ for $a < x < b$.

9. $\displaystyle\int_{-1}^1 \left(x^5 - 6x^9 + \frac{\sin x}{(1 + x^4)^2}\right) dx = 0$

10. $\displaystyle\int_{-5}^5 (ax^2 + bx + c)\, dx = 2\int_0^5 (ax^2 + c)\, dx$

11. All continuous functions have derivatives.

12. All continuous functions have antiderivatives.

13. $\displaystyle\int_0^3 e^{x^2}\, dx = \int_0^5 e^{x^2}\, dx + \int_5^3 e^{x^2}\, dx$

14. If $\int_0^1 f(x)\, dx = 0$, then $f(x) = 0$ for $0 \leqslant x \leqslant 1$.

15. If f is continuous on $[a, b]$, then
$$\frac{d}{dx}\left(\int_a^b f(x)\, dx\right) = f(x)$$
False, since $\int_a^b f\,dx$ is a constant

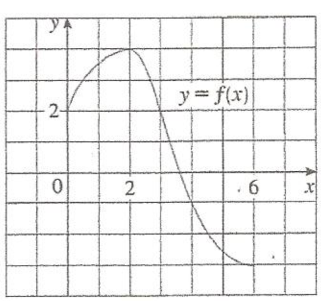
16. $\int_0^2 (x - x^3)\, dx$ represents the area under the curve $y = x - x^3$ from 0 to 2.

17. $\displaystyle\int_{-2}^1 \frac{1}{x^4}\, dx = -\frac{3}{8}$

18. If f has a discontinuity at 0, then $\int_{-1}^1 f(x)\, dx$ does not exist.

Exercises

1. Use the given graph of f to find the Riemann sum with six subintervals. Take the sample points to be (a) left endpoints and (b) midpoints. In each case draw a diagram and explain what the Riemann sum represents.



2. (a) Evaluate the Riemann sum for
$$f(x) = x^2 - x \qquad 0 \leqslant x \leqslant 2$$
with four subintervals, taking the sample points to be right endpoints. Explain, with the aid of a diagram, what the Riemann sum represents.
(b) Use the definition of a definite integral (with right endpoints) to calculate the value of the integral
$$\int_0^2 (x^2 - x)\, dx$$
(c) Use the Fundamental Theorem to check your answer to part (b).
(d) Draw a diagram to explain the geometric meaning of the integral in part (b).

Graphing calculator or computer required CAS Computer algebra system required

3. Evaluate

$$\int_0^1 \left(x + \sqrt{1 - x^2}\right) dx$$

by interpreting it in terms of areas.

4. Express

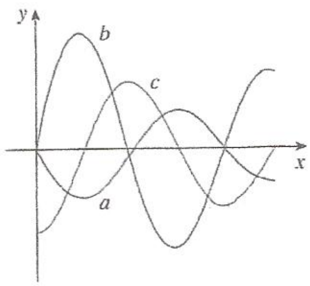
$$\lim_{n \to \infty} \sum_{i=1}^{n} \sin x_i \, \Delta x$$

as a definite integral on the interval $[0, \pi]$ and then evaluate the integral.

5. If $\int_0^6 f(x)\,dx = 10$ and $\int_0^4 f(x)\,dx = 7$, find $\int_4^6 f(x)\,dx$.

CAS **6.** (a) Write $\int_1^5 (x + 2x^5)\,dx$ as a limit of Riemann sums, taking the sample points to be right endpoints. Use a computer algebra system to evaluate the sum and to compute the limit.
(b) Use the Fundamental Theorem to check your answer to part (a).

7. The following figure shows the graphs of f, f', and $\int_0^x f(t)\,dt$. Identify each graph, and explain your choices.



8. Evaluate:

(a) $\displaystyle\int_0^1 \frac{d}{dx}\left(e^{\arctan x}\right) dx$ (b) $\displaystyle\frac{d}{dx}\int_0^1 e^{\arctan x}\,dx$

(c) $\displaystyle\frac{d}{dx}\int_0^x e^{\arctan t}\,dt$

9–38 Evaluate the integral.

9. $\int_1^2 (8x^3 + 3x^2)\,dx$

10. $\int_0^T (x^4 - 8x + 7)\,dx$

11. $\int_0^1 (1 - x^9)\,dx$

12. $\int_0^1 (1 - x)^9\,dx$

13. $\displaystyle\int_1^9 \frac{\sqrt{u} - 2u^2}{u}\,du$

14. $\int_0^1 (\sqrt[4]{u} + 1)^2\,du$

15. $\int_0^1 y(y^2 + 1)^5\,dy$

16. $\int_0^2 y^2\sqrt{1 + y^3}\,dy$

17. $\displaystyle\int_1^5 \frac{dt}{(t - 4)^2}$

18. $\int_0^1 \sin(3\pi t)\,dt$

19. $\int_0^1 v^2 \cos(v^3)\,dv$

20. $\displaystyle\int_{-1}^1 \frac{\sin x}{1 + x^2}\,dx$

21. $\displaystyle\int_{-\pi/4}^{\pi/4} \frac{t^4 \tan t}{2 + \cos t}\,dt$

22. $\displaystyle\int_0^1 \frac{e^x}{1 + e^{2x}}\,dx$

23. $\displaystyle\int \left(\frac{1 - x}{x}\right)^2 dx$

24. $\displaystyle\int_1^{10} \frac{x}{x^2 - 4}\,dx$

25. $\displaystyle\int \frac{x + 2}{\sqrt{x^2 + 4x}}\,dx$

26. $\displaystyle\int \frac{\csc^2 x}{1 + \cot x}\,dx$

27. $\int \sin \pi t \cos \pi t\,dt$

28. $\int \sin x \cos(\cos x)\,dx$

29. $\displaystyle\int \frac{e^{\sqrt{x}}}{\sqrt{x}}\,dx$

30. $\displaystyle\int \frac{\cos(\ln x)}{x}\,dx$

31. $\int \tan x \ln(\cos x)\,dx$

32. $\displaystyle\int \frac{x}{\sqrt{1 - x^4}}\,dx$

33. $\displaystyle\int \frac{x^3}{1 + x^4}\,dx$

34. $\int \sinh(1 + 4x)\,dx$

35. $\displaystyle\int \frac{\sec\theta \tan\theta}{1 + \sec\theta}\,d\theta$

36. $\int_0^{\pi/4} (1 + \tan t)^3 \sec^2 t\,dt$

37. $\int_0^3 |x^2 - 4|\,dx$

38. $\int_0^4 |\sqrt{x} - 1|\,dx$

39–40 Evaluate the indefinite integral. Illustrate and check that your answer is reasonable by graphing both the function and its antiderivative (take $C = 0$).

39. $\displaystyle\int \frac{\cos x}{\sqrt{1 + \sin x}}\,dx$

40. $\displaystyle\int \frac{x^3}{\sqrt{x^2 + 1}}\,dx$

41. Use a graph to give a rough estimate of the area of the region that lies under the curve $y = x\sqrt{x}$, $0 \leq x \leq 4$. Then find the exact area.

42. Graph the function $f(x) = \cos^2 x \sin x$ and use the graph to guess the value of the integral $\int_0^{2\pi} f(x)\,dx$. Then evaluate the integral to confirm your guess.

43–48 Find the derivative of the function.

43. $\displaystyle F(x) = \int_0^x \frac{t^2}{1 + t^3}\,dt$

44. $\displaystyle F(x) = \int_x^1 \sqrt{t + \sin t}\,dt$

45. $\displaystyle g(x) = \int_0^{x^4} \cos(t^2)\,dt$

46. $\displaystyle g(x) = \int_1^{\sin x} \frac{1 - t^2}{1 + t^4}\,dt$

47. $\displaystyle y = \int_{\sqrt{x}}^x \frac{e^t}{t}\,dt$

48. $\displaystyle y = \int_{2x}^{3x+1} \sin(t^4)\,dt$

49–50 Use Property 8 of integrals to estimate the value of the integral.

49. $\int_1^3 \sqrt{x^2 + 3}\,dx$

50. $\displaystyle\int_3^5 \frac{1}{x + 1}\,dx$

51–54 Use the properties of integrals to verify the inequality.

51. $\int_0^1 x^2 \cos x\,dx \leqslant \frac{1}{3}$

52. $\int_{\pi/4}^{\pi/2} \frac{\sin x}{x}\,dx \leqslant \frac{\sqrt{2}}{2}$

53. $\int_0^1 e^x \cos x\,dx \leqslant e - 1$

54. $\int_0^1 x \sin^{-1} x\,dx \leqslant \pi/4$

55. Use the Midpoint Rule with $n = 6$ to approximate $\int_0^3 \sin(x^3)\,dx$.

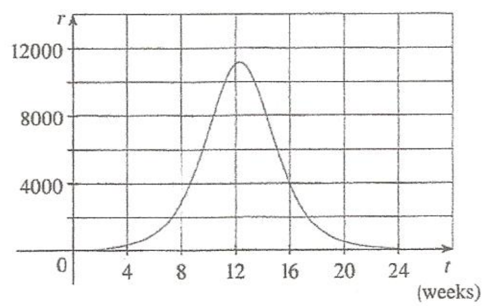
56. A particle moves along a line with velocity function $v(t) = t^2 - t$, where v is measured in meters per second. Find (a) the displacement and (b) the distance traveled by the particle during the time interval $[0, 5]$.

57. Let $r(t)$ be the rate at which the world's oil is consumed, where t is measured in years starting at $t = 0$ on January 1, 2000, and $r(t)$ is measured in barrels per year. What does $\int_0^8 r(t)\,dt$ represent?

58. A radar gun was used to record the speed of a runner at the times given in the table. Use the Midpoint Rule to estimate the distance the runner covered during those 5 seconds.

t (s)	v (m/s)	t (s)	v (m/s)
0	0	3.0	10.51
0.5	4.67	3.5	10.67
1.0	7.34	4.0	10.76
1.5	8.86	4.5	10.81
2.0	9.73	5.0	10.81
2.5	10.22		

59. A population of honeybees increased at a rate of $r(t)$ bees per week, where the graph of r is as shown. Use the Midpoint Rule with six subintervals to estimate the increase in the bee population during the first 24 weeks.



60. Let

$$f(x) = \begin{cases} -x - 1 & \text{if } -3 \leqslant x \leqslant 0 \\ -\sqrt{1 - x^2} & \text{if } 0 \leqslant x \leqslant 1 \end{cases}$$

Evaluate $\int_{-3}^{1} f(x)\,dx$ by interpreting the integral as a difference of areas.

61. If f is continuous and $\int_0^2 f(x)\,dx = 6$, evaluate $\int_0^{\pi/2} f(2 \sin\theta) \cos\theta\,d\theta$.

62. The Fresnel function $S(x) = \int_0^x \sin\left(\frac{1}{2}\pi t^2\right) dt$ was introduced in Section 5.3. Fresnel also used the function

$$C(x) = \int_0^x \cos\left(\tfrac{1}{2}\pi t^2\right) dt$$

in his theory of the diffraction of light waves.

(a) On what intervals is C increasing?

(b) On what intervals is C concave upward?

CAS (c) Use a graph to solve the following equation correct to two decimal places:

$$\int_0^x \cos\left(\tfrac{1}{2}\pi t^2\right) dt = 0.7$$

CAS (d) Plot the graphs of C and S on the same screen. How are these graphs related?

63. Estimate the value of the number c such that the area under the curve $y = \sinh cx$ between $x = 0$ and $x = 1$ is equal to 1.

64. Suppose that the temperature in a long, thin rod placed along the x-axis is initially $C/(2a)$ if $|x| \leqslant a$ and 0 if $|x| > a$. It can be shown that if the heat diffusivity of the rod is k, then the temperature of the rod at the point x at time t is

$$T(x, t) = \frac{C}{a\sqrt{4\pi kt}} \int_0^a e^{-(x-u)^2/(4kt)}\,du$$

To find the temperature distribution that results from an initial hot spot concentrated at the origin, we need to compute

$$\lim_{a \to 0} T(x, t)$$

Use l'Hospital's Rule to find this limit.

65. If f is a continuous function such that

$$\int_1^x f(t)\,dt = (x - 1)e^{2x} + \int_1^x e^{-t} f(t)\,dt$$

for all x, find an explicit formula for $f(x)$.

66. Suppose h is a function such that $h(1) = -2$, $h'(1) = 2$, $h''(1) = 3$, $h(2) = 6$, $h'(2) = 5$, $h''(2) = 13$, and h'' is continuous everywhere. Evaluate $\int_1^2 h''(u)\,du$.

67. If f' is continuous on $[a, b]$, show that

$$2\int_a^b f(x) f'(x)\,dx = [f(b)]^2 - [f(a)]^2$$

68. Find $\lim_{h \to 0} \frac{1}{h} \int_2^{2+h} \sqrt{1 + t^3}\,dt$.

69. If f is continuous on $[0, 1]$, prove that

$$\int_0^1 f(x)\,dx = \int_0^1 f(1 - x)\,dx$$

70. Evaluate

$$\lim_{n \to \infty} \frac{1}{n} \left[\left(\frac{1}{n}\right)^9 + \left(\frac{2}{n}\right)^9 + \left(\frac{3}{n}\right)^9 + \cdots + \left(\frac{n}{n}\right)^9 \right]$$

71. Suppose f is continuous, $f(0) = 0$, $f(1) = 1$, $f'(x) > 0$, and $\int_0^1 f(x)\,dx = \frac{1}{3}$. Find the value of the integral $\int_0^1 f^{-1}(y)\,dy$.

6 Review

Concept Check

1. (a) Draw two typical curves $y = f(x)$ and $y = g(x)$, where $f(x) \geqslant g(x)$ for $a \leqslant x \leqslant b$. Show how to approximate the area between these curves by a Riemann sum and sketch the corresponding approximating rectangles. Then write an expression for the exact area.
   (b) Explain how the situation changes if the curves have equations $x = f(y)$ and $x = g(y)$, where $f(y) \geqslant g(y)$ for $c \leqslant y \leqslant d$.

2. Suppose that Sue runs faster than Kathy throughout a 1500-meter race. What is the physical meaning of the area between their velocity curves for the first minute of the race?

3. (a) Suppose S is a solid with known cross-sectional areas. Explain how to approximate the volume of S by a Riemann sum. Then write an expression for the exact volume.
   (b) If S is a solid of revolution, how do you find the cross-sectional areas?

4. (a) What is the volume of a cylindrical shell?
   (b) Explain how to use cylindrical shells to find the volume of a solid of revolution.
   (c) Why might you want to use the shell method instead of slicing?

5. Suppose that you push a book across a 6-meter-long table by exerting a force $f(x)$ at each point from $x = 0$ to $x = 6$. What does $\int_0^6 f(x)\,dx$ represent? If $f(x)$ is measured in newtons, what are the units for the integral?

6. (a) What is the average value of a function f on an interval $[a, b]$?
   (b) What does the Mean Value Theorem for Integrals say? What is its geometric interpretation?

Exercises

1–6 Find the area of the region bounded by the given curves.

1. $y = x^2$, $y = 4x - x^2$
2. $y = 1/x$, $y = x^2$, $y = 0$, $x = e$
3. $y = 1 - 2x^2$, $y = |x|$
4. $x + y = 0$, $x = y^2 + 3y$
5. $y = \sin(\pi x/2)$, $y = x^2 - 2x$
6. $y = \sqrt{x}$, $y = x^2$, $x = 2$

7–11 Find the volume of the solid obtained by rotating the region bounded by the given curves about the specified axis.

7. $y = 2x$, $y = x^2$; about the x-axis
8. $x = 1 + y^2$, $y = x - 3$; about the y-axis
9. $x = 0$, $x = 9 - y^2$; about $x = -1$
10. $y = x^2 + 1$, $y = 9 - x^2$; about $y = -1$
11. $x^2 - y^2 = a^2$, $x = a + h$ (where $a > 0$, $h > 0$); about the y-axis

12–14 Set up, but do not evaluate, an integral for the volume of the solid obtained by rotating the region bounded by the given curves about the specified axis.

12. $y = \tan x$, $y = x$, $x = \pi/3$; about the y-axis
13. $y = \cos^2 x$, $|x| \leqslant \pi/2$, $y = \frac{1}{4}$; about $x = \pi/2$
14. $y = \sqrt{x}$, $y = x^2$; about $y = 2$

15. Find the volumes of the solids obtained by rotating the region bounded by the curves $y = x$ and $y = x^2$ about the following lines.
    (a) The x-axis (b) The y-axis (c) $y = 2$

16. Let $\mathcal{R}$ be the region in the first quadrant bounded by the curves $y = x^3$ and $y = 2x - x^2$. Calculate the following quantities.
    (a) The area of $\mathcal{R}$
    (b) The volume obtained by rotating $\mathcal{R}$ about the x-axis
    (c) The volume obtained by rotating $\mathcal{R}$ about the y-axis

17. Let $\mathcal{R}$ be the region bounded by the curves $y = \tan(x^2)$, $x = 1$, and $y = 0$. Use the Midpoint Rule with $n = 4$ to estimate the following quantities.
    (a) The area of $\mathcal{R}$
    (b) The volume obtained by rotating $\mathcal{R}$ about the x-axis

18. Let $\mathcal{R}$ be the region bounded by the curves $y = 1 - x^2$ and $y = x^6 - x + 1$. Estimate the following quantities.
    (a) The x-coordinates of the points of intersection of the curves
    (b) The area of $\mathcal{R}$
    (c) The volume generated when $\mathcal{R}$ is rotated about the x-axis
    (d) The volume generated when $\mathcal{R}$ is rotated about the y-axis

19–22 Each integral represents the volume of a solid. Describe the solid.

19. $\int_0^{\pi/2} 2\pi x \cos x\,dx$
20. $\int_0^{\pi/2} 2\pi \cos^2 x\,dx$

Graphing calculator or computer required

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Exercises

1. $\frac{8}{3}$ **3.** $\frac{7}{12}$ **5.** $\frac{4}{3} + 4/\pi$ **7.** $64\pi/15$ **9.** $1656\pi/5$

11. $\frac{4}{3}\pi(2ah + h^2)^{3/2}$ **13.** $\int_{-\pi/3}^{\pi/3} 2\pi(\pi/2 - x)(\cos^2 x - \frac{1}{4})\,dx$

15. (a) $2\pi/15$ (b) $\pi/6$ (c) $8\pi/15$

17. (a) 0.38 (b) 0.87

19. Solid obtained by rotating the region $0 \leq y \leq \cos x$, $0 \leq x \leq \pi/2$ about the y-axis

21. Solid obtained by rotating the region $0 \leq x \leq \pi$, $0 \leq y \leq 2 - \sin x$ about the x-axis

23. 36 **25.** $\frac{125}{3}\sqrt{3}\ \text{m}^3$ **27.** 3.2 J

29. (a) $8000\pi/3 \approx 8378$ ft-lb (b) 2.1 ft

31. $f(x)$

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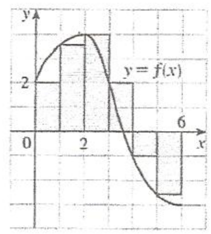
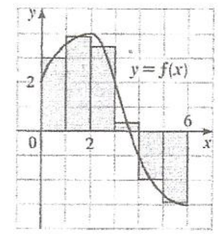
True-False Quiz

1. True **3.** True **5.** False **7.** True **9.** True
11. False **13.** True **15.** False **17.** False

Exercises

1. (a) 8 (b) 5.7





3. $\frac{1}{2} + \pi/4$ **5.** 3 **7.** f is c, f' is b, $\int_0^x f(t)\,dt$ is a

9. 37 **11.** $\frac{9}{10}$ **13.** -76 **15.** $\frac{21}{4}$ **17.** Does not exist

19. $\frac{1}{3}\sin 1$ **21.** 0 **23.** $-(1/x) - 2\ln|x| + x + C$

25. $\sqrt{x^2 + 4x} + C$ **27.** $\dfrac{1}{2\pi}\sin^2 \pi t + C$

29. $2e^{\sqrt{x}} + C$ **31.** $-\frac{1}{2}[\ln(\cos x)]^2 + C$

33. $\frac{1}{4}\ln(1 + x^4) + C$ **35.** $\ln|1 + \sec\theta| + C$ **37.** $\frac{23}{3}$

39. $2\sqrt{1 + \sin x} + C$ **41.** $\frac{64}{5}$ **43.** $F'(x) = x^2/(1 + x^3)$

45. $g'(x) = 4x^3\cos(x^8)$ **47.** $y' = (2e^x - e^{\sqrt{x}})/(2x)$

49. $4 \leq \int_1^3 \sqrt{x^2 + 3}\,dx \leq 4\sqrt{3}$ **55.** 0.280981

57. Number of barrels of oil consumed from Jan. 1, 2000, through Jan. 1, 2008