1. The graph of $y^2 - 5y - 1 = x^2$ is a(n)
   (A) circle (D) line
   (B) ellipse (E) parabola
   (C) hyperbola

2. The domain of the function $f(x) = \frac{1}{\sqrt{4-x}}$ is
   (A) $x \geq 0$ (D) $x \geq 4$
   (B) $x > 4$ (E) $x \leq 4$
   (C) $x < 4$

3. If $f(x) = \frac{3}{x^2-2}$ and $g(x) = 4x$, then $g(f(3)) =$
   (A) $\frac{3}{7}$ (D) $\frac{12}{7}$
   (B) $\frac{2}{3}$ (E) $\frac{14}{7}$
   (C) $\frac{12}{3}$

4. $$f(x)\begin{cases}\frac{x^2-4}{x-4}, & x \neq -2,2\\ 2, & x = 2\end{cases}$$

   Which of the following statements is/are true?

   I. $\lim_{x\to 2} f(x)$ exists
   II. $f(2)$ exists
   III. f is continuous at $x = 2$

   (A) I only (D) I, II, and III
   (B) II only (E) None of the above
   (C) I and II

5. $\lim_{x\to 5} \frac{x-5}{x^2-4x-5} =$
   (A) 0 (D) 1
   (B) $\frac{1}{6}$ (E) ∞
   (C) $\frac{1}{5}$

6. $\lim_{x\to 0} \frac{1}{3+5^{1/x}} =$
   (A) 0 (D) 1
   (B) $\frac{1}{5}$ (E) nonexistent
   (C) $\frac{1}{3}$

7. $\lim_{x\to\infty} \frac{\sqrt{3x^2+5}}{x+2} =$
   (A) $\frac{\sqrt{5}}{2}$ (D) $\sqrt{3}$
   (B) $\frac{5}{2}$ (E) ∞
   (C) 3

8. Find the equation of the line tangent to the curve at $y = \sin^3(x)$ at $\pi/4$
   (A) $y - \frac{2}{4} = \frac{\sqrt{2}}{4}(x - \frac{\pi}{4})$
   (B) $y + \frac{\sqrt{2}}{4} = \frac{3\sqrt{2}}{4}(x - \frac{\pi}{4})$
   (C) $y - \frac{\pi}{4} = \frac{3\sqrt{2}}{4}(x - \frac{\sqrt{2}}{4})$
   (D) $y - \frac{2}{4} = \frac{3\sqrt{2}}{4}(x + \frac{\pi}{4})$

9. If $y = \tan x \sec x$, $\frac{dy}{dx} =$
   (A) $\sec x$ (D) $\sec^3 x + \tan^2 x \sec x$
   (B) $\sec^3 x$ (E) $\sec^3 x + \tan x \sec^2 x$
   (C) $\tan x \sec^2 x$

10. If $x = t - \cos t$ and $y = 1 - \sin t$, then $\frac{dy}{dx} =$
    (A) $\frac{\sin t}{1-\cos t}$ (D) $\frac{-\cos t}{1+\sin t}$
    (B) $-\frac{1+\sin t}{\cos t}$ (E) $\frac{1+\sin t}{t+\cos t}$
    (C) $\frac{1-x}{y}$

11. If $x^2 - y^2 = 2xy$, then $\frac{dy}{dx} =$

(A) $\frac{x-y}{x+y}$ (D) $\frac{x+y}{x-y}$

(B) $\frac{y-x}{x+y}$ (E) $\frac{x+y}{y-x}$

(C) $\frac{x-y}{y-x}$

12. The number of inflection points of $f(x) = 4x^4 - 4x^2$ is

(A) 1 (D) 4
(B) 2 (E) Zero
(C) 3

13. If $f(x)$ is continuous on the open interval from a to b, and $f(a) = -3$ and $f(b) = -3$. Assuming f is not a constant function, which of the following must be true?

(A) There is an inflection point on the interval.
(B) There is a local maximum on the interval.
(C) There is a local minimum on the interval.
(D) There is either a local maximum or a local minimum on the interval.
(E) None of these.

14. $\int \frac{x\,dx}{\sqrt{5+3x^2}} =$

(A) $\frac{1}{3}\sqrt{5+3x^2} + C$ (D) $\sqrt{\frac{5}{3}}\sin^{-1}\sqrt{3}x + C$

(B) $\frac{1}{6}\ln\sqrt{5+3x^2} + C$ (E) $\sqrt{\frac{5}{3}}\tan^{-1}\sqrt{3}x + C$

(C) $\frac{1}{6}\sqrt{5+3x^2} + C$

15. $\int_0^1 x^2 e^{x^3}\,dx =$

(A) $e - 1$ (D) $\frac{1}{2}e - \frac{1}{2}$
(B) $\frac{1}{3}e - 1$ (E) $\frac{1}{3}e - \frac{1}{3}$
(C) $3(e - 1)$

16. What is the area of the region between the two curves $y = x^3 - x^2$ and $y = 2x$ between $x = 0$ and $x = 2$?

(A) $\frac{1}{6}$ (D) $\frac{7}{12}$
(B) $\frac{2}{3}$ (E) $\frac{1}{12}$
(C) $\frac{5}{4}$

17. What is the volume of the solid generated by revolving the region bounded by $y = 4x - x^2$ and $y = 0$ about the x-axis?

(A) $\pi\int_0^4 \left(4x - x^2\right) dx$ (D) $2\pi\int_0^4 \left(4x - x^2\right) dx$

(B) $\pi\int_0^4 \left(4x - x^2\right)^2 dx$ (E) $2\pi\int_0^2 \left(4x - x^2\right) dx$

(C) $2\pi\int_0^4 \left(4x - x^2\right) dx$

18. Find the length of the curve with the parametric equations $x = 2\cos t$, $y = 4\sin t$ from $t = \pi/2$ to $t = \pi$.

(A) 5.102 (D) 4.844
(B) 3.142 (E) 4.872
(C) 4.472

19. $\int \frac{x+2}{x^2+7x+12}\,dx =$

(A) $-\ln|x+3| + 2\ln|x+4| + C$

(B) $\ln|x+3| + 2\ln|x+4| + C$

(C) $-\ln|x+3| - 2\ln|x+4| + C$

(D) $\ln|x+3| - 2\ln|x+4| + C$

(E) $\ln\left|\frac{x+3}{x+4} + C\right|$

20. The area of the region enclosed by the polar curve $r = 4 \sin(3\theta)$ is

(A) 8π
(B) $\frac{4}{3}$
(C) 4π
(D) $\frac{4\pi}{3}$
(E) 16π

21. The velocity of a particle moving along a straight line is given by the equation $v(t) = 5 + 3t^2$, where v is in m/s and t is in seconds. What is the average velocity during the interval $t = 0$ to $t = 3$?

(A) 42 m/s
(B) 31 m/s
(C) 28 m/s
(D) 14 m/s
(E) 12 m/s

22. The acceleration of a car traveling on a straight track along the y-axis is given by the equation $a = 5$, where a is in meters per second squared and t is in seconds. If at $t = 0$ the car's velocity is 3 m/s, what is its velocity at $t = 2$?

(A) 15 m/s
(B) 13 m/s
(C) 3 m/s
(D) 10 m/s
(E) 5 m/s

23. What is the radius of the series

$$\sum_{n=0}^{+\infty} 2^n x^n$$

(A) 1
(B) 2
(C) $\frac{1}{2}$
(D) 4
(E) $\frac{1}{4}$

24. What is the sum of the series $\frac{1}{3} - \frac{2}{9} + \frac{4}{27} - \frac{8}{81} + \ldots$?

(A) 1
(B) $\frac{3}{5}$
(C) $\frac{2}{5}$
(D) $\frac{1}{5}$
(E) Does not converge

25. The interval of convergence of the series $\sum_{k=1}^{\infty} \frac{(x+1)^k}{k}$ is

(A) $0 < x < 2$
(B) $-2 < x < 0$
(C) $-2 \le x < 0$
(D) $0 \le x < 2$
(E) $-2 \le x \le 0$

26. Given a function $f(x)$ with the following properties, $f(2) = \frac{1}{2}, f'(2) = -\frac{1}{4}, f''(2) = -1, f'''(2) = 2$. Which of the following polynomials best approximates $f(x)$ at $x = 2$?

(A) $\frac{1}{2} - \frac{1}{2}(x-2) - \frac{1}{4}(x-2)^2 + 3(x-2)^3$

(B) $\frac{1}{2} - \frac{1}{4}(x-2) - \frac{1}{2}(x-2)^2 + \frac{1}{3}(x-2)^3$

(C) $\frac{1}{2} - \frac{1}{4}(x-2) - (x-2)^2 + 2(x-2)^3$

(D) $\frac{1}{2} - \frac{1}{4}(x-2) - (x-2)^2 + \frac{1}{3}(x-2)^3$

27. If $y = \pi^5$, then $\frac{dy}{dx} =$

(A) $5\pi^4$
(B) $5\pi^5$
(C) $5\pi^6$
(D) $\frac{1}{5}\pi^6$
(E) Zero

28. Base your answer on the chart below.

x	0	1	2	3	4
$f(x)$	1	6	-1	2	0
$f'(x)$	4	-1	2	-3	7

If $g(x) = (f(x))^2$, then $g'(2) =$

(A) 1
(B) 2
(C) -2
(D) 4
(E) -4

29. [Calculator]

x	0.3	0.4	0.5	0.6	0.7	0.8
$f(x)$	0.141	0.258	0.327	0.354	0.345	0.306

What is the best estimate of $f'(0.10)$ using the chart above?
(A) .47 (B) .94 (C) 1.08 (D) 1.17 (E) 1.47

30. The slope of the curve $y^2 - xy = 3$ at the point where $y = 1$ is
(A) $\frac{1}{2}$
(B) 2
(C) –2
(D) $\frac{1}{4}$
(E) $-\frac{1}{4}$

31. $\lim_{x\to+\infty}\left(1-\frac{2}{x}\right)^x$
(A) e^2
(B) e^{-2}
(C) $-\infty$
(D) $+\infty$
(E) Zero

32. If $f(x) = 5x^2 - 3$, what is the equation for the normal line to the curve when $x = -1$?
(A) $y = 10(x+1)+2$
(B) $y = 10(x-2)+1$
(C) $y = -10(x+1)+2$
(D) $y = \frac{1}{10}(x+1)+2$
(E) $y = \frac{-1}{10}(x+1)+2$

33. The position of a particle moving along the x-axis is given by the equation $s(t) = 2 + 3t^2$, where s is in meters and t is in seconds. What is the average velocity during the interval $t = 0$ to $t = .5$?
(A) 1.5 m/s
(B) 2 m/s
(C) 3 m/s
(D) 4 m/s
(E) 5 m/s

34. A cylindrical tank with a radius of 4 meters is filled with a liquid at a rate of 64π m^3/sec. How fast is the height increasing?
(A) 8 m/sec
(B) 16 m/sec
(C) 24 m/sec
(D) 4 m/sec
(E) 32 m/sec

35. Two cars start at the same place at the same time. One car travels due east at a constant speed of 40 miles per hour and a second car travels due north at a constant speed of 50 miles per hour. Approximately how fast is the distance between them changing 2 hours later.
(A) 60 miles per hour
(B) 56 miles per hour
(C) 64 miles per hour
(D) 70 miles per hour
(E) 128 miles per hour

36. Which point in the first quadrant on the curve $y = e^x$ is closest to the point (1,1)?
(A) (0.365,4.224)
(B) (0.365,1.441)
(C) (1.441,.0365)
(D) (1.441,4.224)
(E) (4.224,.0365)

37. Using the Trapezoidal Rule, what is the area under the curve $y = \sqrt{x}$ from $x = 1$ to $x = 3$ when $n = 4$?
(A) 2.610
(B) 2.793
(C) 2.797
(D) 2.800
(E) 2.976

38. At which point does the function $y = -3x^2 - 1$ assume its average value over the interval [–2, 0].
(A) (–1, –4)
(B) $\left(-\frac{\sqrt{3}}{3}, -2\right)$
(C) $\left(\frac{2\sqrt{3}}{3}, -5\right)$
(D) $\left(\frac{-2\sqrt{3}}{3}, -5\right)$

39. What is an approximation for $\cos\frac{\pi}{6}$ using the first three terms of the Taylor series $f(x) = \cos x$ about $x = 0$?
(A) .500
(B) .533
(C) .866
(D) .877
(E) .888

40. $\int \frac{dx}{1+x^2} =$

(A) $\cos^{-1} x + C$
(B) $\sin^{-1} x + C$
(C) $-\sin^{-1} x + C$
(D) $\tan^{-1} x + C$
(E) $-\tan^{-1} x + C$

41.

During the time period from $t = 0$ to $t = 4$ seconds, a particle moves along the path given by $x(t) = 6\sin(\pi t)$ and $y(t) = 8\cos(\pi t)$.

(a) Write and equation in terms of x and y that gives the position of the particle.
(b) Find the position of the particle when $t = 1.5$
(c) How many times during the interval $0 < t < 4$ does the particle pass through the point found in part (b) ?
(d) How many times during the interval $0 < t < 4$ is the tangent line to the curve undefined ?
(e) What is the total distance traveled by the particle over the interval $0 < t < 4$?

42. Consider the curve defined by $2y^2 - x^2 = 3xy + 5$.

(a) Find $\frac{dy}{dx}$.
(b) Write an equation of the line tangent to the curve at the point (1,1).
(c) Does the tangent line found in part (b) lie above or below the curve. Justify your answer.
(d) The line $y = -12x + 38$ is tangent to the curve at the point P. Find the coordinates of point P.

43. Let f be the function defined by $f(x) = x^2e^{-3x}$ for all real numbers x.

(a) For what values of x is f increasing?
(b) Find the x–coordinate of each point of inflection of f.
(c) Find the x– and y– coordinates of the point, if any, where $f(x)$ attains its absolute minimum.

44. The maximum value of the function $y = -3\sqrt{4-x}$ is

(A) 1
(B) 4
(C) –3
(D) –4
(E) Zero

45. (a) Determine whether the series

$$\frac{1}{2} - \frac{2^2}{2^2} + \frac{3^2}{2^3} - \frac{4^2}{2^4} + \ldots + \sum_{n=1}^{\infty} \frac{(-1)^{n-1} n^2}{2^n}$$

is convergent or divergent. Justify your answer.

(b) Find the interval of convergence for the series $\sum_{n=1}^{\infty} \frac{(x-1)^n}{(n)(2^n)}$. Show all work and justify your answer.

46. Let f be the function defined as follows:

$$f(x) = \begin{cases} ax^2 + bx, & \text{for } x \le -4 \\ 2|x+4| + 2, & \text{for } x > -4 \end{cases}$$

(a) Describe the values of a in terms b for which f is a continuous function for all x.
(b) Which values of a and b make f both a continuous and differentiable function for all x.
(c) Write but do not evaluate an integral expression that represents the area under $f(x)$ from $x = -6$ to $x = -2$.

47. Let f be function given by $f(x) = x^2$ and let g be the function given by $g(x) = kx - 4$, where k is a positive constant such that g is tangent to the graph of f.
(a) Find the value of k.
(b) Find the area bounded on top by the line perpendicular to g and on the bottom by $f(x)$.
(c) Find the volume of the solid generated by revolving the region from part (b) about the line $y = 0$.

48. If $f(x) = \frac{5}{x^4}$, then $f'(2) =$

(A) $\frac{-5}{2}$
(B) $\frac{-5}{8}$
(C) $\frac{-5}{16}$
(D) $\frac{5}{16}$
(E) $\frac{5}{8}$

Answer Key

1. C
2. C
3. D
4. C
5. B
6. E
7. D
8. D
9. D
10. D
11. A
12. B
13. D
14. A
15. E
16. C
17. B
18. D
19. A
20. C
21. D
22. B
23. C
24. D
25. C
26. B
27. E
28. E
29. A
30. D
31. B
32. D
33. C
34. A
35. C
36. B
37. B
38. D
39. C
40. D

41. (a) $x^2/36 + y^2/64 = 1$.
(b) (–6, 0)
(c) 2 times
(d) 4 times
(e) 1973.92

42. (a) $\frac{dy}{dx} = \frac{3y+2x}{4y-3x}$
(b) $y = 5x - 4$
(c) Above the curve because it is concave down at (1,1)
(d) (3,2)

43. (a) $0 \le x \le \frac{2}{3}$
(b) $x = \frac{\sqrt{2}+2}{3}$ and $x = \frac{-\sqrt{2}+2}{3}$
(c) (0,0)

Answer Key

44. E

45. (a) Convergent
(b) $-1 \le x < 3$

46. (a) $8a = 1 + 2b$
(b) $a = \frac{-5}{8}$, $b = -3$
(c) $\int_{-6}^{-4}\left(\frac{-5}{8}x^2 - 3x\right)dx + \int_{-4}^{-2}\left(2|x+4|+2\right)dx$

47. a) k = 4
b) 44.667
c) 385.36

48. B

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1: III. INTEGRALS\2. Definite Integrals\D. Definite Integrals\1. Definite Integrals - (15)
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1: III. INTEGRALS\4. Applications\B. Volumes\1. Volumes - (17)
1: III. INTEGRALS\4. Applications\E. Arc Length\1. Arc Length - (18)
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AP Calculus Sample Exam

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