BC Calc AP Exam

Name: ________________ School: __________________ Score:

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1.

BC Calc AP Exam

Name: ___________________ School: _____________________ Score:

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BC Calc AP Exam

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CALCULUS BC

SECTION I, Part A

Time—60 Minutes

Number of questions—30

A CALCULATOR MAY NOT BE USED ON THIS PART OF THE EXAMINATION

Directions: Solve each of the following problems, using the available space for scratchwork. After examining the form of the choices, decide which is the best of the choices given and fill in the corresponding oval on the answer sheet. No credit will be given for anything written in the test book. Do not spend too much time on any one problem.

In this test: Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number.

1. $f(x)=\begin{cases} kx^3-3x+4; & x\le 2 \\ 5kx+12; & x>2 \end{cases}$

Given the function f defined above, what value of k makes the function f continuous for all real values of x ?

(A) −14
(B) −7
(C) 7
(D) 14

---

2. The velocity of an object is given by $\left\langle \frac{2}{3}t^3-t^2, 4t^2 \right\rangle$. What is the acceleration vector $a(t)$ at $t = 5$?

(A) ⟨18, 5⟩
(B) ⟨18, 8⟩
(C) ⟨40, 0⟩
(D) ⟨40, 40⟩

GO ON TO THE NEXT PAGE.

3. Find the length of the curve defined by $x = t^3 - 3t$ and $y = 3t^2$ on the interval [0, 1].

(A) 3
(B) 4
(C) 9
(D) 16

---

4. Evaluate $\int 3x\sin\frac{x}{3}\,dx$.

(A) $-9x\sin\frac{x}{3}+27\cos\frac{x}{3}+C$

(B) $9x\sin\frac{x}{3}+27\cos\frac{x}{3}+C$

(C) $-9x\cos\frac{x}{3}+27\sin\frac{x}{3}+C$

(D) $9x\cos\frac{x}{3}-27\sin\frac{x}{3}+C$

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5. Find $\frac{d^2y}{dx^2}$ if $y=e^{4+x^2}$.

(A) $2e^{4+x^2}\left(2x^2+1\right)$

(B) $2e^{4+x^2}\left(2x^2-1\right)$

(C) $4e^{4+x^2}\left(x^2+1\right)$

(D) $4e^{4+x^2}\left(x^2-1\right)$

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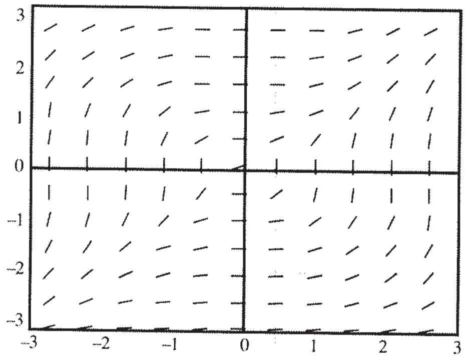
6. Which of the following is the slope field for the differential equation $\frac{dy}{dx} = \frac{y^2}{x^2}$?

(A)



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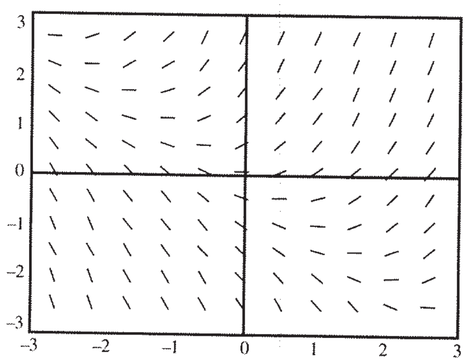

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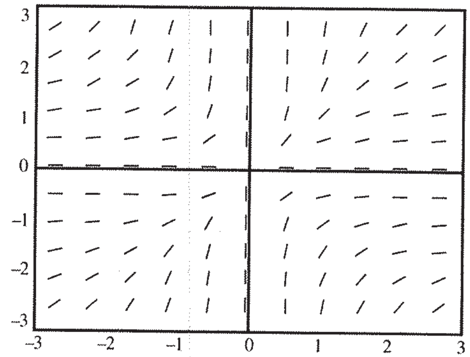

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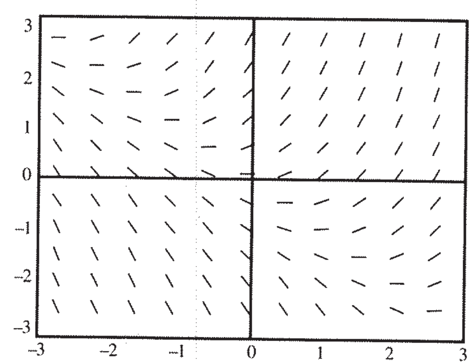

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7. Evaluate $\lim_{x \to \infty} \frac{2\cos 5x}{x^3}$.

(A) –2
(B) 0
(C) 2
(D) The limit does not exist.

GO ON TO THE NEXT PAGE.

8. Evaluate $\int x\,(x-5)^{\frac{1}{4}}\,dx$.

(A) $\frac{3}{4}(x-5)^{\frac{3}{4}}+C$

(B) $\frac{4}{5}(x-5)^{\frac{5}{4}}+C$

(C) $\frac{4}{9}(x-5)^{\frac{9}{4}}+4(x-5)^{\frac{5}{4}}+C$

(D) $\frac{4}{9}(x+5)^{\frac{9}{4}}+4(x+5)^{\frac{5}{4}}+C$

---

9. The acceleration of an object moving in the x-direction is given by $a(t) = -16t$. Its velocity at time $t = 0$ is 64 meters per second and its position at time $t = 0$ is 12 meters. Find the equation of its position.

(A) $8t^2 - 64$

(B) $-8t^2 + 64$

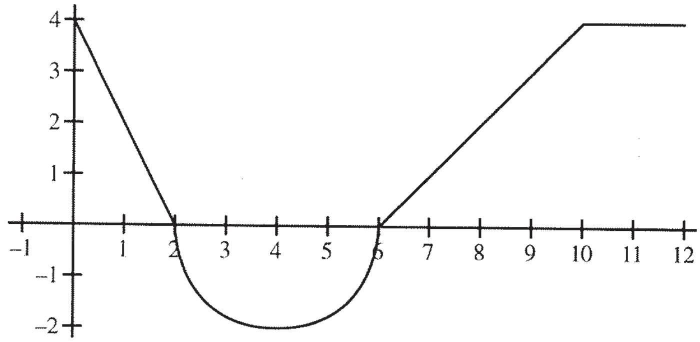
(C) $\frac{8t^3}{3}-64t-12$

(D) $-\frac{8t^3}{3}+64t+12$

---

10. On which interval(s) is the graph of $y = x^4 + 4x^3 - 48x^2 + 40x - 22$ concave up?

(A) $(-4, 2)$
(B) $(-\infty, -4) \cup (2, \infty)$
(C) $(-\infty, -2) \cup (4, \infty)$
(D) $(-2, 4)$



11.

Given the graph of function f above, which consists of three line segments and a semicircle, and the function g is defined by $g(x) = \int_0^x f(t)\,dt$, find $g(10)$.

(A) $24 - 2\pi$
(B) $12 + 2\pi$
(C) $12 - 2\pi$
(D) $2\pi - 12$

---

12. Evaluate $\int_1^\infty \frac{dx}{(x-4)^3}$.

(A) $\frac{1}{27}$
(B) $\frac{1}{18}$
(C) 9
(D) The integral does not converge.

---

13. If $r^2 = 4\sin(2\theta)$, find $\frac{dr}{d\theta}$ at $\left(12, \frac{\pi}{6}\right)$.

(A) $-\frac{\sqrt{2}}{12}$

(B) $\frac{\sqrt{2}}{12}$

(C) $\frac{1}{6}$

(D) $\frac{\sqrt{3}}{6}$

---

14. Find the slope of the tangent line to $x^2 + 3x^2y + 2y^2 = 15$ at the point (1, 2).

(A) $-\frac{14}{11}$

(B) $-\frac{11}{14}$

(C) $\frac{11}{14}$

(D) $\frac{14}{11}$

---

15. If $\frac{dy}{dx} = 6x^2y^2$ and $y(0) = \frac{1}{2}$, find y.

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

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

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

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

GO ON TO THE NEXT PAGE.

16. Evaluate $\int \cos^5 x \sin^2 x \, dx$.

(A) $\frac{\sin^7 x}{7} - \frac{2\sin^5 x}{5} + \frac{\sin^3 x}{3} + C$

(B) $\frac{\sin^7 x}{7} + \frac{2\sin^5 x}{5} + \frac{\sin^3 x}{3} + C$

(C) $-\frac{\sin^5 x}{5} + \frac{\cos^3 x}{3} + C$

(D) $\frac{\sin^5 x}{5} - \frac{\cos^3 x}{3} + C$

---

17. Find the area inside the curve $r = 2\cos(3\theta)$ on the interval $\left[0, \frac{\pi}{6}\right]$.

(A) $\frac{\pi}{6}$

(B) $\frac{\pi - 2}{3}$

(C) $\frac{\pi + 2}{3}$

(D) $\frac{2\pi}{3}$

---

18. Find $\frac{dy}{dx}$ if $y=\frac{x-\sin x}{x+\sin x}$.

(A) $\frac{(2\sin x+2x\cos x)}{(x+\sin x)^2}$

(B) $\frac{2x-2\sin x\cos x}{(x+\sin x)^2}$

(C) $\frac{(2\sin x-2x\cos x)}{(x+\sin x)^2}$

(D) $\frac{2x+2\sin x\cos x}{(x+\sin x)^2}$

---

19. Evaluate $\int_0^1 \frac{x}{1-x^2}dx$.

(A) 0
(B) 1
(C) e
(D) The integral does not converge.

---

20. If $x=1+\frac{t^2}{\pi}$ and $y=\tan t$, find $\frac{dy}{dx}$ at $t=\frac{\pi}{4}$.

(A) 1

(B) $\frac{4}{\pi}$

(C) 4

(D) 4π

GO ON TO THE NEXT PAGE.

21. Find $\dfrac{dy}{dx}$ if $y = \dfrac{\cos 2x - \sin^2 x}{2\sin^2 x}$.

(A) $\cot x \csc^2 x$
(B) $-\cot x \csc^2 x$
(C) $\cot x \csc^3 x$
(D) $-\cot x \csc^3 x$

22. An object's height above the ground (in meters) is given by the equation $y(t) = -16t^2 + 64t + 20$, $t \geq 0$, and its horizontal location (in meters) is given by the equation $x(t) = 1 + t + t^2$. What is its horizontal location when the object reaches its maximum height?

(A) 0 meters
(B) 7 meters
(C) 32 meters
(D) 64 meters

23. A circular puddle is spreading at a rate of 4π square centimeters per second. How fast is the radius of the puddle increasing when the radius is $r = 12$ centimeters?

(A) $\dfrac{1}{24}$ centimeter per second

(B) $\dfrac{1}{12}$ centimeter per second

(C) $\dfrac{1}{6}$ centimeter per second

(D) $\dfrac{1}{3}$ centimeter per second

24. Evaluate $\lim_{x \to 0} \frac{1-\cos x}{1-e^x}$.

(A) 0
(B) 1
(C) ∞
(D) The limit does not exist.

---

25. Write the first three nonzero terms of the Taylor polynomial for $f(x) = \sin(x^2)$ about $x = 0$.

(A) $1 + x^4 - x^8$

(B) $x^2 - x^6 + x^{10}$

(C) $1 - \frac{x^4}{2!} + \frac{x^8}{4!}$

(D) $x^2 - \frac{x^6}{3!} + \frac{x^{10}}{5!}$

---

26. Find the 3rd degree Maclaurin polynomial for $f(x) = \ln(1 + 2x)$.

(A) $2x + 2x^2 + \frac{8}{3}x^3$

(B) $2x - 2x^2 + \frac{8}{3}x^3$

(C) $1 - 2x + 2x^2 - \frac{8}{3}x^3$

(D) $1 + 2x + 2x^2 + \frac{8}{3}x^3$

---

27. Evaluate $\int \frac{13x+2}{2x^2-7x-4}\,dx$.

(A) $\ln|2x+1|-\ln|x-4|+C$

(B) $\ln|2x+1|+\ln|x-4|+C$

(C) $\frac{1}{2}\ln|2x+1|-6\ln|x-4|+C$

(D) $\frac{1}{2}\ln|2x+1|+6\ln|x-4|+C$

---

28. $\lim_{x\to 3^+} \frac{8}{x^3-27} =$

(A) $-\infty$
(B) 1
(C) 8
(D) $+\infty$

GO ON TO THE NEXT PAGE.

29. Evaluate $\int x^2\sqrt{4-x^3}\,dx$.

(A) $-\frac{2}{9}\left(\sqrt{4-x^3}\right)^3+C$

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

(C) $\frac{2}{9}\left(\sqrt{4-x^3}\right)^3+C$

(D) $\frac{x^3}{3}\sqrt{4+\frac{x^4}{4}}+C$

---

30. Find $\frac{dy}{dx}$ if $y=\frac{\sec x}{1-x^3}$.

(A) $-\frac{\sec x\tan x}{3x^2}$

(B) $\frac{\left(1-x^3\right)\left(\sec x\tan x\right)-\left(\sec x\right)\left(-3x^2\right)}{\left(1-x^3\right)^2}$

(C) $\frac{\left(1-x^3\right)\left(\sec^2 x\right)-\left(\sec x\right)\left(-3x^2\right)}{\left(1-x^3\right)^2}$

(D) $-\frac{\sec^2 x}{3x^2}$

END OF PART A, SECTION I

IF YOU FINISH BEFORE TIME IS CALLED, YOU MAY CHECK YOUR WORK ON PART A ONLY.

DO NOT GO ON TO PART B UNTIL YOU ARE TOLD TO DO SO.

CALCULUS BC

SECTION I, Part B

Time—45 Minutes

Number of questions—15

A GRAPHING CALCULATOR IS REQUIRED FOR SOME QUESTIONS ON THIS PART OF THE EXAMINATION

Directions: Solve each of the following problems, using the available space for scratchwork. After examining the form of the choices, decide which is the best of the choices given and fill in the corresponding oval on the answer sheet. No credit will be given for anything written in the test book. Do not spend too much time on any one problem.

In this test:

1. The **exact** numerical value of the correct answer does not always appear among the choices given. When this happens, select from among the choices the number that best approximates the exact numerical value.
2. Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number.

---

31. Which of the following integrals gives the volume of the solid that results when the region between $y = 2x^2 + 4x - 9$ and $y = 3 - x$ is revolved around the line $y = -12$?

(A) $\pi\int_{-\frac{3}{2}}^{4}\left[\left(2x^2+4x+3\right)^2-\left(15-x\right)^2\right]dx$

(B) $\pi\int_{-4}^{\frac{3}{2}}\left[\left(2x^2+4x+3\right)^2-\left(15-x\right)^2\right]dx$

(C) $\pi\int_{-\frac{3}{2}}^{4}\left[\left(15-x\right)^2-\left(2x^2+4x+3\right)^2\right]dx$

(D) $\pi\int_{-4}^{\frac{3}{2}}\left[\left(15-x\right)^2-\left(2x^2+4x+3\right)^2\right]dx$

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32. To what value does the series $\sum_{k=1}^{\infty}\left(\frac{3^k}{8^{k+1}}\right)$ converge?

(A) $\frac{3}{40}$

(B) $\frac{3}{8}$

(C) 1

(D) The series diverges.

---

33. Find the value of c that is guaranteed by the Mean Value Theorem for $f(x) = x^3 + x - 8$ on the interval [1, 2].

(A) 0.645
(B) 1.528
(C) 1.732
(D) There is no value of c.

---

34. Evaluate $\int \sqrt{\sin x}\cos^3 x\, dx$.

(A) $\frac{3\sin^{\frac{3}{2}} x}{2} + \frac{\cos^4 x}{4} + C$

(B) $\frac{2\sin^{\frac{3}{2}} x}{3} - \frac{\cos^4 x}{4} + C$

(C) $\frac{2}{3}\sin^{\frac{3}{2}} x + \frac{2}{5}\sin^{\frac{5}{2}} x + C$

(D) $\frac{2}{3}\sin^{\frac{3}{2}} x - \frac{2}{7}\sin^{\frac{7}{2}} x + C$

GO ON TO THE NEXT PAGE.

35. The rate of growth of fungus spores on a log can be modeled by $\frac{dy}{dt} = 0.85y$, where t is measured in days. If initially there are 515 fungus spores on the log, how many will there be after 5.8 days? Round your answer to the nearest thousand.

(A) 1000
(B) 7000
(C) 71,000
(D) 170,000

36. A rectangle is inscribed between the x-axis and $y = \sqrt{20 - x^2}$. What is the maximum area of the rectangle?

(A) 10
(B) 20
(C) $20\sqrt{2}$
(D) 40

37. A particle is moving along the x-axis with its position given by the function $x_1(t) = t^2 + 5t$, where t is in seconds. A second particle is moving along the x-axis with its position given by the function $x_2(t) = t^3$. At what time t are the velocities equal on the interval [0, 10]?

(A) $t = 0$ seconds

(B) $t = \frac{3}{5}$ second

(C) $t = 1$ second

(D) $t = \frac{5}{3}$ seconds

GO ON TO THE NEXT PAGE.

38. Find y if $\frac{dy}{dx} = \frac{e^x}{y^2}$ and $y(\ln 2) = 3$.

(A) $y = (3e^x + 21)^3$

(B) $y = 3e^x + 21$

(C) $y = \sqrt[3]{3e^x + 21}$

(D) $y = \sqrt{3e^x + 21}$

---

39. A box with a no top and rectangular sides is to be cut from a rectangular sheet of tin with dimensions 8 inches by 14 inches by cutting identical squares from the four corners and folding up the sides. What is the maximum volume of the box?

(A) 4.402 cubic inches
(B) 50.389 cubic inches
(C) 82.981 cubic inches
(D) 184.609 cubic inches

---

40. Find the area of the region formed by the y-axis, $y = \sin x^2$, and $y = e^{-x}$ on the interval $[0, 2]$.

(A) 0.345
(B) 0.391
(C) 1.083
(D) 1.229

GO ON TO THE NEXT PAGE.

41. If $f'(x) = x^3 + 4x - 7$ and $f(0) = -1$, find $f(2)$.

(A) −7
(B) −3
(C) 13
(D) 15

42. What is the absolute maximum of $f(x) = x^3 - 9x - 2$ on the interval $[-3, 3]$?

(A) 0.732
(B) 1.732
(C) 8.392
(D) 12.392

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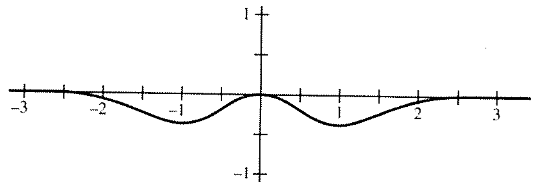
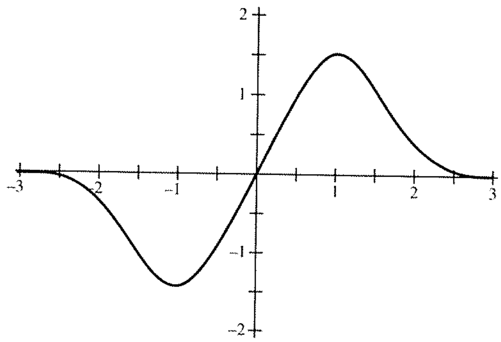


43. The figure above shows the graph of $f(x)$. Which of the following is the graph of $f'(x)$?

(A)



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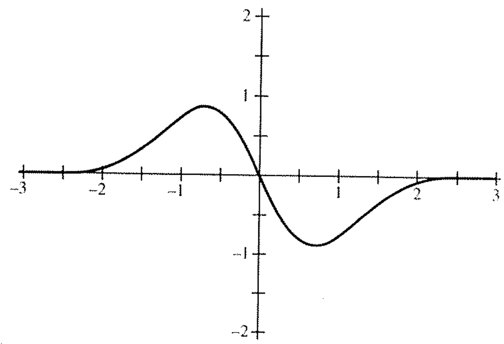

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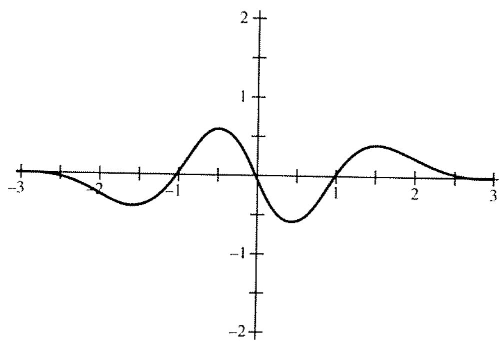

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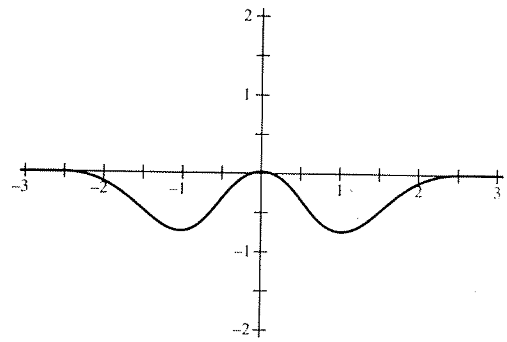


44. Find the radius of convergence for the series $\sum_{k=0}^{\infty} \frac{3^k}{k^3} x^k$.

(A) $\frac{1}{27}$

(B) 3

(C) $\frac{1}{3}$

(D) The series does not converge.

---

45. Find the length of the curve $y = \ln x$ on the interval $[1, e^3]$.

(A) 18.540
(B) 19.528
(C) 20.036
(D) 45.985

STOP

END OF PART B, SECTION I

IF YOU FINISH BEFORE TIME IS CALLED, YOU MAY CHECK YOUR WORK ON PART B ONLY.

DO NOT GO ON TO SECTION II UNTIL YOU ARE TOLD TO DO SO.

SECTION II
GENERAL INSTRUCTIONS

You may wish to look over the problems before starting to work on them, since it is not expected that everyone will be able to complete all parts of all problems. All problems are given equal weight, but the parts of a particular problem are not necessarily given equal weight.

A GRAPHING CALCULATOR IS REQUIRED FOR SOME PROBLEMS OR PARTS OF PROBLEMS ON THIS SECTION OF THE EXAMINATION.

- You should write all work for each part of each problem in the space provided for that part in the booklet. Be sure to write clearly and legibly. If you make an error, you may save time by crossing it out rather than trying to erase it. Erased or crossed-out work will not be graded.
- Show all your work. You will be graded on the correctness and completeness of your methods as well as your answers. Correct answers without supporting work may not receive credit.
- Justifications require that you give mathematical (non-calculator) reasons and that you clearly identify functions, graphs, tables, or other objects you use.
- You are permitted to use your calculator to solve an equation, find the derivative of a function at a point, or calculate the value of a definite integral. However, you must clearly indicate the setup of your problem, namely the equation, function, or integral you are using. If you use other built-in features or programs, you must show the mathematical steps necessary to produce your results.
- Your work must be expressed in standard mathematical notation rather than calculator syntax. For example, $\int_1^5 x^2\,dx$ may not be written as fnInt (X^2, X, 1, 5).
- Unless otherwise specified, answers (numeric or algebraic) need not be simplified. If your answer is given as a decimal approximation, it should be correct to three places after the decimal point.
- Unless otherwise specified, the domain of a function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number.

GO ON TO THE NEXT PAGE.

SECTION II, PART A
Time—30 minutes
Number of problems—2

A GRAPHING CALCULATOR IS REQUIRED FOR SOME PROBLEMS OR PARTS OF PROBLEMS

During the timed portion for Part A, you may work only on the problems in Part A.

On Part A, you are permitted to use your calculator to solve an equation, find the derivative of a function at a point, or calculate the value of a definite integral. However, you must clearly indicate the setup of your problem, namely the equation, function, or integral you are using. If you use other built-in features or programs, you must show the mathematical steps necessary to produce your results.

1. Oil is being pumped into a cavern for storage. The cavern is 400 meters deep. The area of the horizontal cross section of the chamber at a depth y is given by the function A, where $A(y)$ is measured in square meters. The function A is continuous and decreases as depth increases. Selected values for $A(y)$ are given in the table below.

y (meters)	0	100	150	250	400
$A(y)$ (square meters)	65	38.4	30.6	20.2	11.3

(a) Use a right Riemann sum with the four subintervals indicated by the data in the table to approximate the volume of the chamber. Indicate the units of measure.

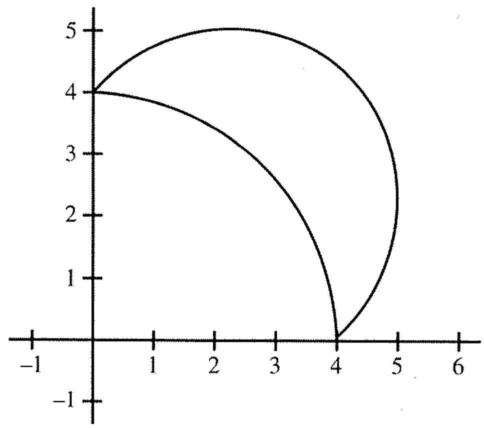
(b) Does the approximation in part (a) overestimate or underestimate the volume of the cavern? Explain your reasoning.

(c) The area in square meters of the horizontal cross section at depth y is modelled by the function f given by $f(y)=\dfrac{65}{e^{0.004y}+.002y}$. Based on this model, find the volume of the tank. Indicate the units of measure.

(d) Oil is pumped into the cavern. When the depth of the oil is 200 meters, the depth is increasing at a rate of 0.45 meter per minute. Using the model from part (c), find the rate at which the volume of oil is changing with respect to time when the depth of the oil is 200 meters. Indicate the units of measure.

GO ON TO THE NEXT PAGE.

2. The graphs of the polar curves $r = 4$ and $r = 4 + 2\sin(2\theta)$ are shown in the figure below for $0 \le \theta \le \frac{\pi}{2}$.



(a) Let R be the region inside the graph of $r = 4 + 2\sin(2\theta)$ and outside of the graph of $r = 4$. Find the area of R.

(b) Find $\frac{dx}{d\theta}$ at $\theta = \frac{\pi}{4}$ for the curve $r = 4 + 2\sin(2\theta)$.

(c) A particle is moving along the curve $r = 4 + 2\sin(2\theta)$ so that $\frac{d\theta}{dt} = 4$ at all times where $t \ge 0$. Find $\frac{dr}{dt}$ at $\theta = \frac{\pi}{6}$.

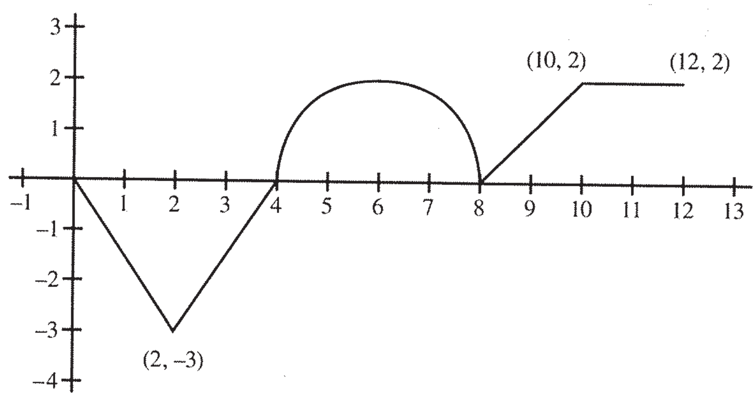
(d) Find the rate at which the distance between the two curves is changing with respect to θ when $\theta = \frac{\pi}{6}$.

SECTION II, PART B
Time—1 hour
Number of problems—4

NO CALCULATOR IS ALLOWED FOR THESE PROBLEMS

During the timed portion for Part B, you may continue to work on the problems in Part A without the use of any calculator.

3.



Graph of $f'(x)$

The function f is differentiable on the closed interval [0, 12] and $f(0) = 7$. The graph of $f'(x)$ above consists of a semicircle and four line segments.

(a) Find the values of $f(4)$ and $f(12)$.

(b) On which intervals is f decreasing? Justify your answer.

(c) Find the absolute minimum value of f on the closed interval [0, 12]. Justify your answer.

(d) Find $f''(1)$.

GO ON TO THE NEXT PAGE.

4. At time $t = 0$, an iron ingot is taken from a furnace and placed on an anvil to cool. The internal temperature of the ingot is 286 degrees Celsius at time $t = 0$ and the internal temperature is greater than room temperature, 30 degrees Celsius. The internal temperature of the ingot at time t minutes can be modelled by the function I that satisfies the differential equation $\frac{dI}{dt} = -\frac{1}{32}(I - 30)$, where $I(t)$ is measured in degrees Celsius and $I(0) = 286$.

(a) Write an equation for the line tangent to the graph of I at $t = 0$. Use this equation to approximate the internal temperature of the ingot at time $t = 0$.

(b) Use $\frac{d^2I}{dt^2}$ to determine whether your answer in part (a) is an overestimate or an underestimate of the internal temperature of the ingot at time $t = 8$.

(c) If we immerse the ingot in a cooling bath, another model of the internal temperature of the ingot at time t minutes is the function B that satisfies the differential equation $\frac{dB}{dt} = -(B - 30)^{\frac{3}{4}}$, where $B(t)$ is measured in degrees Celsius and $B(0) = 286$. Using this model, what is the internal temperature of the ingot at time $t = 8$?

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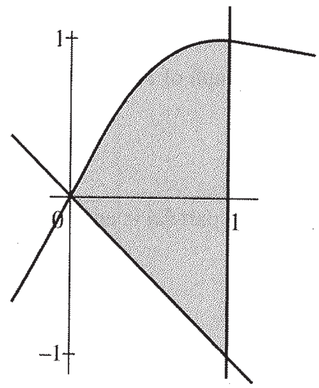
5. Let R be the region bounded by the graphs of $y = \dfrac{2x}{x^2+1}$, $y = -x$ and the vertical line $x = 1$, as shown in the figure below.



(a) Find the area of R.

(b) Set up but do not evaluate an integral expression that gives the volume of the solid generated when R is revolved about the line $y = -1$.

(c) Set up but do not evaluate an integral expression that gives the length of the curve $y = \dfrac{2x}{x^2+1}$ from $x = 0$ to $x = 1$.

6. The Taylor series for a function f about $x = 1$ is given by $\sum_{n=1}^{\infty}(-1)^{n+1}\frac{4^n}{n}(x-1)^n$ and converges to $f(x)$ for $|x| < R$, where R is the radius of convergence of the Taylor series.

(a) Find the value of R.

(b) Find the general term of the Taylor series for f', the derivative of f, and the first four terms about $x = 0$.

(c) The Taylor series for f' about $x = 0$, which you found in part (b) is a geometric series. Find the function f' to which the series converges for $|x| < R$. Use this function to determine f for $|x| < R$.

STOP

END OF EXAM

T1

1. B	2. D	3. B	4. C	5. A	6. C	7. B	8. C	9. D	10. B
11. C	12. B	13. C	14. A	15. B	16. A	17. A	18. C	19. D	20. C
21. B	22. B	23. C	24. A	25. D	26. B	27. D	28. D	29. A	30. B
31. D	32. A	33. B	34. D	35. C	36. B	37. D	38. C	39. C	40. B
41. B	42. C	43. B	44. C	45. B					