Section I: Multiple-Choice Questions

This is the multiple-choice section of the 2017 AP exam.
It includes cover material and other administrative instructions
to help familiarize students with the mechanics of the exam.
(Note that future exams may differ in look from the following content.)

AP® Calculus BC Exam

SECTION I: Multiple Choice

2017

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

At a Glance

Total Time
1 hour and 45 minutes
Number of Questions
45
Percent of Total Score
50%
Writing Instrument
Pencil required

Part A

Number of Questions
30
Time
1 hour
Electronic Device
None allowed

Part B

Number of Questions
15
Time
45 minutes
Electronic Device
Graphing calculator required

Instructions

Section I of this exam contains 45 multiple-choice questions and 4 survey questions. For Part A, fill in only the circles for numbers 1 through 30 on page 2 of the answer sheet. For Part B, fill in only the circles for numbers 76 through 90 on page 3 of the answer sheet. Because Part A and Part B offer only four answer options for each question, do not mark the (E) answer circle for any question. The survey questions are numbers 91 through 94.

Indicate all of your answers to the multiple-choice questions on the answer sheet. No credit will be given for anything written in this exam booklet, but you may use the booklet for notes or scratch work. After you have decided which of the suggested answers is best, completely fill in the corresponding circle on the answer sheet. Give only one answer to each question. If you change an answer, be sure that the previous mark is erased completely. Here is a sample question and answer.

Sample Question	Sample Answer
Chicago is a (A) state (B) city (C) country (D) continent	Ⓐ ● Ⓒ Ⓓ Ⓔ

Use your time effectively, working as quickly as you can without losing accuracy. Do not spend too much time on any one question. Go on to other questions and come back to the ones you have not answered if you have time. It is not expected that everyone will know the answers to all of the multiple-choice questions.

Your total score on the multiple-choice section is based only on the number of questions answered correctly. Points are not deducted for incorrect answers or unanswered questions.

Form I
Form Code 4NBP4-S

68

CALCULUS BC

SECTION I, Part A

Time—1 hour

Number of questions—30

NO CALCULATOR IS ALLOWED FOR THIS PART OF THE EXAM.

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

In this exam:

(1) 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.

(2) The inverse of a trigonometric function f may be indicated using the inverse function notation f^{-1} or with the prefix "arc" (e.g., $\sin^{-1} x = \arcsin x$).

GO ON TO THE NEXT PAGE.

1. If $f(x) = \cos^2(3x - 5)$, then $f'(x) =$

(A) $6\cos(3x - 5)$

(B) $-3\sin^2(3x - 5)$

(C) $-2\sin(3x - 5)\cos(3x - 5)$

(D) $-6\sin(3x - 5)\cos(3x - 5)$

---

2. $\displaystyle\int \frac{1}{t\sqrt{t}}\, dt =$

(A) $-2t^{-1/2} + C$

(B) $-\frac{3}{2}t^{-5/2} + C$

(C) $-\frac{2}{5}t^{-5/2} + C$

(D) $2t^{1/2}\ln t + C$

GO ON TO THE NEXT PAGE.

3. If $f(x) = \dfrac{5 - x}{x^3 + 2}$, then $f'(x) =$

(A) $\dfrac{-4x^3 + 15x^2 - 2}{\left(x^3 + 2\right)^2}$

(B) $\dfrac{-2x^3 + 15x^2 + 2}{\left(x^3 + 2\right)^2}$

(C) $\dfrac{2x^3 - 15x^2 - 2}{\left(x^3 + 2\right)^2}$

(D) $\dfrac{4x^3 - 15x^2 + 2}{\left(x^3 + 2\right)^2}$

GO ON TO THE NEXT PAGE.

4. The position of a particle moving in the xy-plane is given by the vector $\left\langle 4t^3, y(2t) \right\rangle$, where y is a twice-differentiable function of t. At time $t = \frac{1}{2}$, what is the acceleration vector of the particle?

(A) $\left\langle 3, 2y''(1) \right\rangle$

(B) $\left\langle 6, 4y''(1) \right\rangle$

(C) $\left\langle 12, 2y''(1) \right\rangle$

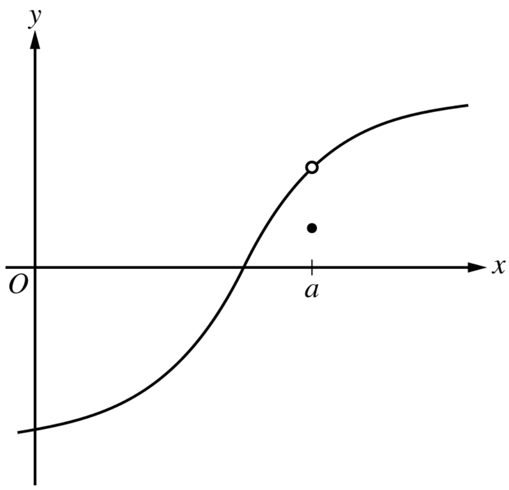
(D) $\left\langle 12, 4y''(1) \right\rangle$

---

5. To what number does the series $\displaystyle\sum_{k=0}^{\infty} \left(\frac{-e}{\pi} \right)^k$ converge?

(A) 0 (B) $\dfrac{-e}{\pi + e}$ (C) $\dfrac{\pi}{\pi + e}$ (D) The series does not converge.

GO ON TO THE NEXT PAGE.



Graph of f

6. The graph of $y = f(x)$ is shown above. Which of the following is true?

(A) $\lim\limits_{h \to 0} \dfrac{f(a+h) - f(a)}{h}$ exists.

(B) $\lim\limits_{x \to a^+} f(x) \neq \lim\limits_{x \to a^-} f(x)$

(C) $\lim\limits_{x \to a} f(x) \neq f(a)$

(D) $\lim\limits_{x \to a} f(x)$ does not exist.

7. If $\int_{4}^{-10} g(x)\,dx = -3$ and $\int_{4}^{6} g(x)\,dx = 5$, then $\int_{-10}^{6} g(x)\,dx =$

(A) -8 (B) -2 (C) 2 (D) 8

8. The length of the curve $y = \sin(3x)$ from $x = 0$ to $x = \dfrac{\pi}{6}$ is given by

(A) $\int_{0}^{\pi/6} \left(1 + 9\cos^2(3x)\right)\,dx$

(B) $\int_{0}^{\pi/6} \sqrt{1 + \sin^2(3x)}\,dx$

(C) $\int_{0}^{\pi/6} \sqrt{1 + 3\cos(3x)}\,dx$

(D) $\int_{0}^{\pi/6} \sqrt{1 + 9\cos^2(3x)}\,dx$

GO ON TO THE NEXT PAGE.

9. The slope of the line tangent to the graph of $y = xe^x$ at $x = \ln 2$ is

(A) $2 \ln 2$ (B) $2 \ln 2 + 2$ (C) $e^2(\ln 2) + e^2$ (D) $2 + \dfrac{2 \ln 2}{e}$

---

10. Let $y = f(x)$ be the solution to the differential equation $\dfrac{dy}{dx} = x - y$ with initial condition $f(2) = 8$. What is the approximation for $f(3)$ obtained by using Euler's method with two steps of equal length, starting at $x = 2$?

(A) 2 (B) $\dfrac{5}{2}$ (C) $\dfrac{15}{4}$ (D) $\dfrac{61}{4}$

11. If $x^2 + xy - 3y = 3$, then at the point $(2, 1)$, $\frac{dy}{dx} =$

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

---

12. $\displaystyle\int \frac{3x+1}{x^2 - 4x + 3}\, dx =$

(A) $-2\ln|x-3| + 5\ln|x-1| + C$

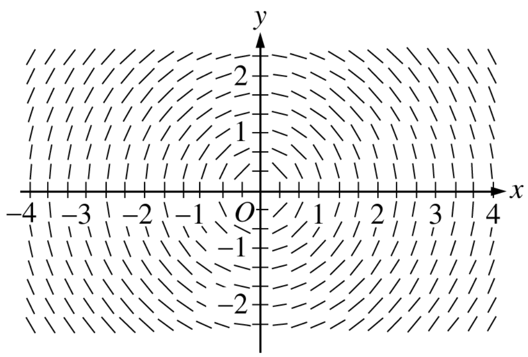
(B) $\frac{1}{5}\ln|x-3| - \frac{1}{2}\ln|x-1| + C$

(C) $\frac{1}{2}\ln|x-3| - \frac{1}{2}\ln|x-1| + C$

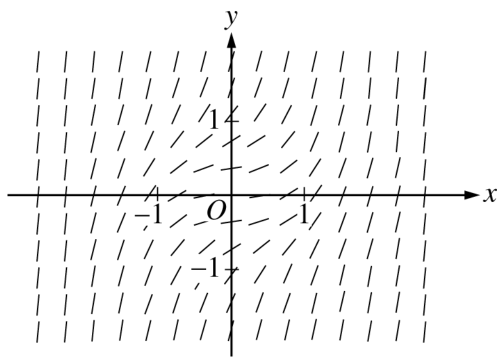
(D) $5\ln|x-3| - 2\ln|x-1| + C$

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

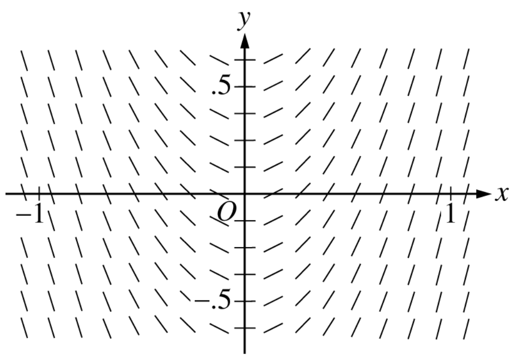
(A)



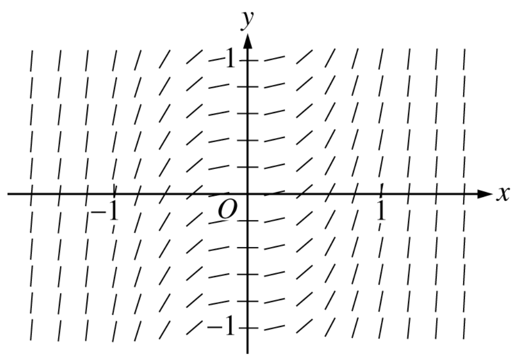
(B)



(C)



(D)



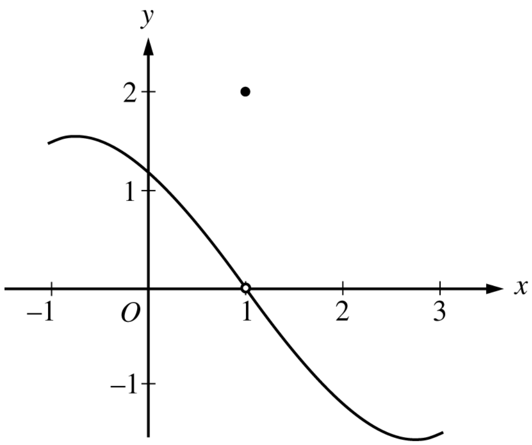
14. If $f(x) = 3x^2 + 2x$, then $f'(x) =$

(A) $\lim\limits_{h \to 0} \dfrac{\left(3x^2 + 2x + h\right) - \left(3x^2 + 2x\right)}{h}$

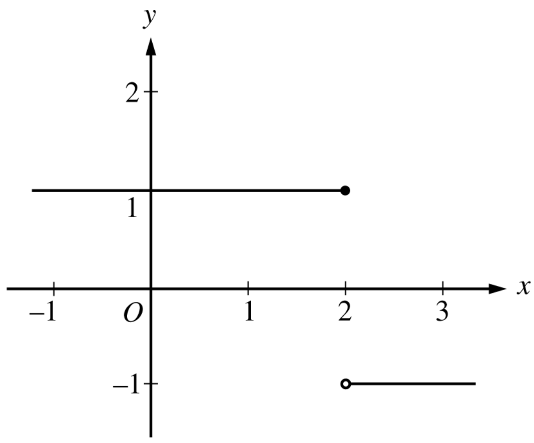
(B) $\lim\limits_{x \to 0} \dfrac{\left(3x^2 + 2x + h\right) - \left(3x^2 + 2x\right)}{h}$

(C) $\lim\limits_{h \to 0} \dfrac{\left(3(x + h)^2 + 2(x + h)\right) - \left(3x^2 + 2x\right)}{h}$

(D) $\lim\limits_{x \to 0} \dfrac{\left(3(x + h)^2 + 2(x + h)\right) - \left(3x^2 + 2x\right)}{h}$



Graph of f



Graph of g

15. The graphs of the functions f and g are shown in the figures above. Which of the following statements is false?

(A) $\lim_{x \to 1} f(x) = 0$

(B) $\lim_{x \to 2} g(x)$ does not exist.

(C) $\lim_{x \to 1} \left(f(x)\,g(x+1)\right)$ does not exist.

(D) $\lim_{x \to 1} \left(f(x+1)\,g(x)\right)$ exists.

GO ON TO THE NEXT PAGE.

16. Which of the following is the interval of convergence for the series $\sum_{n=0}^{\infty} \frac{(x+2)^n}{2^n}$?

(A) $-4 < x < 0$

(B) $-4 \le x < 0$

(C) $-2 < x < 2$

(D) $-2 \le x < 2$

---

17. $\int_0^5 \sqrt{\frac{5-x}{5}}\, dx =$

(A) $\frac{2}{3}$ (B) $\frac{10}{3}$ (C) 5 (D) $\frac{50\sqrt{5}}{3}$

18. Which of the following limits are equal to -1 ?

I. $\lim\limits_{x \to 0^-} \dfrac{|x|}{x}$

II. $\lim\limits_{x \to 3} \dfrac{x^2 - 7x + 12}{3 - x}$

III. $\lim\limits_{x \to \infty} \dfrac{1 - x}{1 + x}$

(A) I only (B) I and III only (C) II and III only (D) I, II, and III

---

19. Let f be the function given by $f(x) = 2\cos x + 1$. What is the approximation for $f(1.5)$ found by using the line tangent to the graph of f at $x = \dfrac{\pi}{2}$?

(A) -2 (B) 1 (C) $\pi - 2$ (D) $4 - \pi$

GO ON TO THE NEXT PAGE.

20. A particle moves in the xy-plane so that its position for $t \geq 0$ is given by the parametric equations $x = \ln(t+1)$ and $y = kt^2$, where k is a positive constant. The line tangent to the particle's path at the point where $t = 3$ has slope 8. What is the value of k ?

(A) $\frac{1}{192}$ (B) $\frac{1}{3}$ (C) $\frac{4}{3}$ (D) $\frac{16}{3}$

Time (weeks)	0	2	6	10
Level	210	200	190	180

21. The table above gives the level of a person's cholesterol at different times during a 10-week treatment period. What is the average level over this 10-week period obtained by using a trapezoidal approximation with the subintervals [0, 2], [2, 6], and [6, 10] ?

(A) 188 (B) 193 (C) 195 (D) 198

22. $\displaystyle\int \frac{x}{2} e^{-3x/4}\, dx =$

(A) $-\dfrac{3x}{4} e^{-3x/4} + \dfrac{3}{4} e^{-3x/4} + C$

(B) $-\dfrac{2x}{3} e^{-3x/4} - \dfrac{8}{9} e^{-3x/4} + C$

(C) $-\dfrac{x}{2} e^{-3x/4} + \dfrac{3}{8} e^{-3x/4} + C$

(D) $\dfrac{x}{2} e^{-3x/4} - \dfrac{1}{2} e^{-3x/4} + C$

23. If $f(x) = \sum_{n=1}^{\infty} \frac{x^{2n}}{n!}$, then $f'(x) =$

(A) $\frac{x^3}{3} + \frac{x^5}{5 \cdot 2!} + \frac{x^7}{7 \cdot 3!} + \frac{x^9}{9 \cdot 4!} + \cdots + \frac{x^{(2n+1)}}{(2n+1)n!} + \cdots$

(B) $x + \frac{3x^3}{2!} + \frac{5x^5}{3!} + \frac{7x^7}{4!} + \cdots + \frac{(2n-1)x^{(2n-1)}}{n!} + \cdots$

(C) $2 + 2x^2 + x^4 + \frac{x^6}{3} + \cdots + \frac{2x^{2(n-1)}}{(n-1)!} + \cdots$

(D) $2x + 2x^3 + x^5 + \frac{x^7}{3} + \cdots + \frac{2nx^{(2n-1)}}{n!} + \cdots$

---

24. If the average value of a continuous function f on the interval $[-2, 4]$ is 12, what is $\int_{-2}^{4} \frac{f(x)}{8}\, dx$?

(A) $\frac{3}{2}$ (B) 3 (C) 9 (D) 72

25. What is the radius of convergence of the Maclaurin series for $\frac{2x}{1+x^2}$?

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

---

26. Let f be the function with $f(0) = \frac{1}{\pi^2}$, $f(2) = \frac{1}{\pi^2}$, and derivative given by $f'(x) = (x+1)\cos(\pi x)$. How many values of x in the open interval $(0, 2)$ satisfy the conclusion of the Mean Value Theorem for the function f on the closed interval $[0, 2]$?

(A) None

(B) One

(C) Two

(D) More than two

GO ON TO THE NEXT PAGE.

27. The number of students in a cafeteria is modeled by the function P that satisfies the logistic differential equation $\frac{dP}{dt} = \frac{1}{2000}P(200 - P)$, where t is the time in seconds and $P(0) = 25$. What is the greatest rate of change, in students per second, of the number of students in the cafeteria?

(A) 5 (B) 25 (C) 100 (D) 200

28. A cube with edges of length x centimeters has volume $V(x) = x^3$ cubic centimeters. The volume is increasing at a constant rate of 40 cubic centimeters per minute. At the instant when $x = 2$, what is the rate of change of x, in centimeters per minute, with respect to time?

(A) $\frac{10}{3}$ (B) $\sqrt{\frac{40}{3}}$ (C) 5 (D) 10

29. Which of the following is a power series expansion of $\dfrac{e^x + e^{-x}}{2}$?

(A) $1 + \dfrac{x^2}{2!} + \dfrac{x^4}{4!} + \dfrac{x^6}{6!} + \cdots + \dfrac{x^{2n}}{(2n)!} + \cdots$

(B) $1 - \dfrac{x^2}{2!} + \dfrac{x^4}{4!} - \dfrac{x^6}{6!} + \cdots + (-1)^n \dfrac{x^{2n}}{(2n)!} + \cdots$

(C) $x + \dfrac{x^3}{3!} + \dfrac{x^5}{5!} + \dfrac{x^7}{7!} + \cdots + \dfrac{x^{2n+1}}{(2n+1)!} + \cdots$

(D) $x - \dfrac{x^3}{3!} + \dfrac{x^5}{5!} - \dfrac{x^7}{7!} + \cdots + (-1)^n \dfrac{x^{2n+1}}{(2n+1)!} + \cdots$

30. Which of the following statements about the series $\sum_{n=1}^{\infty} \frac{1}{2^n - n}$ is true?

(A) The series diverges by the nth term test.

(B) The series diverges by limit comparison to the harmonic series $\sum_{n=1}^{\infty} \frac{1}{n}$.

(C) The series converges by the nth term test.

(D) The series converges by limit comparison to the geometric series $\sum_{n=1}^{\infty} \frac{1}{2^n}$.

END OF PART A

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.

PART B STARTS ON PAGE 26.

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 EXAM.

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

BE SURE YOU ARE USING PAGE 3 OF THE ANSWER SHEET TO RECORD YOUR ANSWERS TO QUESTIONS NUMBERED 76–90.

YOU MAY NOT RETURN TO PAGE 2 OF THE ANSWER SHEET.

In this exam:

(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.

(3) The inverse of a trigonometric function f may be indicated using the inverse function notation f^{-1} or with the prefix "arc" (e.g., $\sin^{-1} x = \arcsin x$).

76. Let f be a twice-differentiable function for all real numbers x. Which of the following additional properties guarantees that f has a relative minimum at $x = c$?

(A) $f'(c) = 0$

(B) $f'(c) = 0$ and $f''(c) < 0$

(C) $f'(c) = 0$ and $f''(c) > 0$

(D) $f'(x) > 0$ for $x < c$ and $f'(x) < 0$ for $x > c$

---

77. Let $H(x)$ be an antiderivative of $\dfrac{x^3 + \sin x}{x^2 + 2}$. If $H(5) = \pi$, then $H(2) =$

(A) -9.008 (B) -5.867 (C) 4.626 (D) 12.150

GO ON TO THE NEXT PAGE.

78. The continuous function f is positive and has domain $x > 0$. If the asymptotes of the graph of f are $x = 0$ and $y = 2$, which of the following statements must be true?

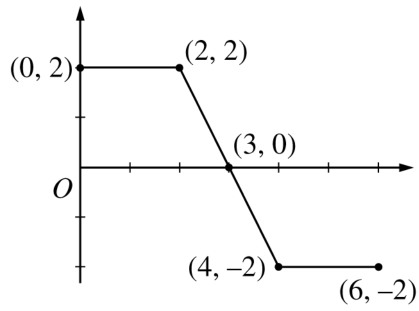
(A) $\lim\limits_{x \to 0^+} f(x) = \infty$ and $\lim\limits_{x \to 2} f(x) = \infty$

(B) $\lim\limits_{x \to 0^+} f(x) = 2$ and $\lim\limits_{x \to \infty} f(x) = 0$

(C) $\lim\limits_{x \to 0^+} f(x) = \infty$ and $\lim\limits_{x \to \infty} f(x) = 2$

(D) $\lim\limits_{x \to 2} f(x) = \infty$ and $\lim\limits_{x \to \infty} f(x) = 2$

GO ON TO THE NEXT PAGE.



Graph of f

79. The graph of a function f, consisting of three line segments, is shown above. The function f is defined on the closed interval [0, 6]. Let $g(x) = \int_2^x f(t)\,dt$. What is the maximum value of $g(x)$ for $0 \le x \le 6$?

(A) 0 (B) 1 (C) 5 (D) 10

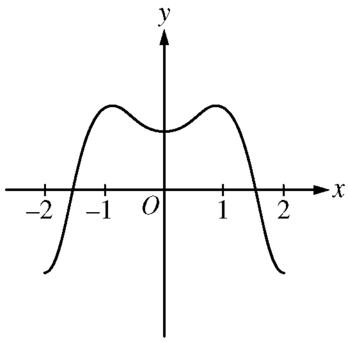
80. The position of an object moving along a path in the xy-plane is given by the parametric equations $x(t) = 5\sin(\pi t)$ and $y(t) = (2t - 1)^2$. The speed of the particle at time $t = 0$ is

(A) 3.422

(B) 11.708

(C) 15.580

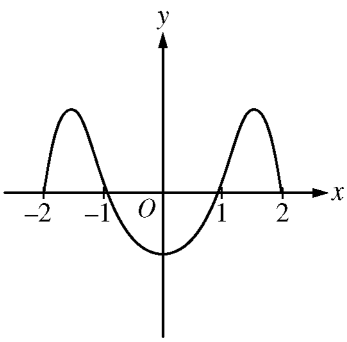
(D) 16.209



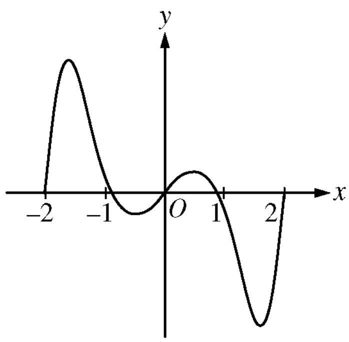
Graph of f

81. The graph of the function f is shown above for $-2 \le x \le 2$. Which of the following could be the graph of an antiderivative of f ?

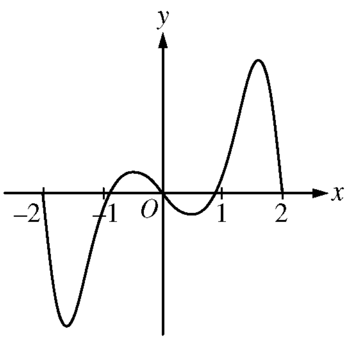
(A)



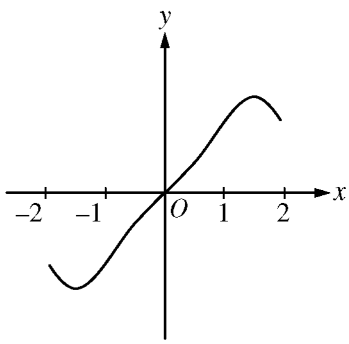
(B)



(C)



(D)



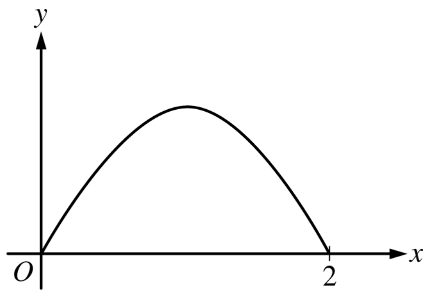
82. The derivative of the function f is given by $f'(x) = e^{-x}\cos\left(x^2\right)$, for all real numbers x. What is the minimum value of $f(x)$ for $-1 \le x \le 1$?

(A) $f(-1)$

(B) $f(-0.762)$

(C) $f(1)$

(D) There is no minimum value of $f(x)$ for $-1 \le x \le 1$.



83. The base of a solid is the region bounded by a portion of the graph of $y = \sin\left(\frac{\pi}{2}x\right)$ and the x-axis, as shown in the figure above. For the solid, each cross section perpendicular to the x-axis is a rectangle of height 3. Which of the following expressions gives the volume of the solid?

(A) $\int_0^2 3\sin\left(\frac{\pi}{2}x\right)\,dx$

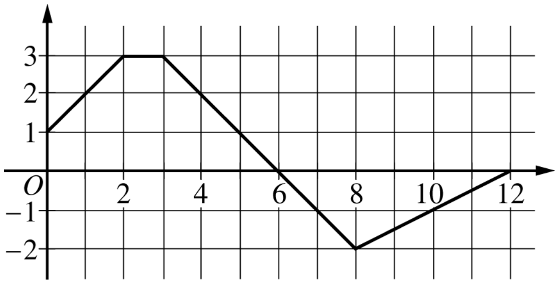
(B) $\int_0^2 3\sin^2\left(\frac{\pi}{2}x\right)\,dx$

(C) $\int_0^2 3\pi\sin\left(\frac{\pi}{2}x\right)\,dx$

(D) $\int_0^2 3\pi\sin^2\left(\frac{\pi}{2}x\right)\,dx$

84. If g is a twice-differentiable function, where $g(1) = 0.5$ and $\lim_{x \to \infty} g(x) = 4$, then $\int_1^\infty g'(x)\,dx$ is

(A) -3.5 (B) 3.5 (C) 4.5 (D) nonexistent



Graph of f

85. The graph of the function f is shown above. If g is the function defined by $g(x) = \int_2^x f(t)\,dt$, what is the value of $g(10) \cdot g'(10)$?

(A) $\frac{25}{4}$ (B) $\frac{5}{4}$ (C) $-\frac{5}{2}$ (D) $-\frac{25}{2}$

$$f''(x) = x(x-1)^2(x+2)^3$$
$$g''(x) = x(x-1)^2(x+2)^3 + 1$$
$$h''(x) = x(x-1)^2(x+2)^3 - 1$$

86. The twice-differentiable functions f, g, and h have second derivatives given above. Which of the functions f, g, and h have a graph with exactly two points of inflection?

(A) g only

(B) h only

(C) f and g only

(D) f, g, and h

---

87. The velocity vector of a particle moving in the xy-plane has components given by $\frac{dx}{dt} = \sin(t^2)$ and $\frac{dy}{dt} = e^{\cos t}$. At time $t = 4$, the position of the particle is $(2, 1)$. What is the y-coordinate of the position vector at time $t = 3$?

(A) 0.410 (B) 0.590 (C) 0.851 (D) 1.410

88. The function f is increasing on the interval $[1, 3]$ and nowhere else. The first derivative of f, f', is continuous for all real numbers. Which of the following could be a table of values for $f'(x)$?

(A)

x	$f'(x)$
0	–1
1	0
2	2
3	0
4	–2

(B)

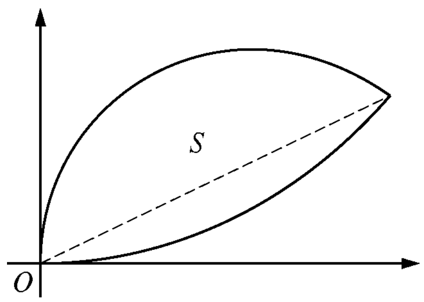
x	$f'(x)$
0	–1
1	1
2	2
3	1
4	–2

(C)

x	$f'(x)$
0	1
1	0
2	1
3	2
4	0

(D)

x	$f'(x)$
0	1
1	0
2	2
3	0
4	–2



89. Let S be the region in the first quadrant bounded above by the graph of the polar curve $r = \cos\theta$ and bounded below by the graph of the polar curve $r = 2\theta$, as shown in the figure above. The two curves intersect when $\theta = 0.450$. What is the area of S ?

(A) 0.232 (B) 0.243 (C) 0.271 (D) 0.384

---

90. If the infinite series $S = \sum_{n=1}^{\infty} (-1)^{n+1} \frac{2}{n}$ is approximated by $P_k = \sum_{n=1}^{k} (-1)^{n+1} \frac{2}{n}$, what is the least value of k for which the alternating series error bound guarantees that $\left|S - P_k\right| < \frac{3}{100}$?

(A) 64 (B) 66 (C) 68 (D) 70

END OF 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.

MAKE SURE YOU HAVE DONE THE FOLLOWING.

- **PLACED YOUR AP NUMBER LABEL ON YOUR ANSWER SHEET**
- **WRITTEN AND GRIDDED YOUR AP NUMBER CORRECTLY ON YOUR ANSWER SHEET**
- **TAKEN THE AP EXAM LABEL FROM THE FRONT OF THIS BOOKLET AND PLACED IT ON YOUR ANSWER SHEET**

AFTER TIME HAS BEEN CALLED, TURN TO PAGE 38 AND ANSWER QUESTIONS 91–94.