AP CollegeBoard

SEATING POLICY FOR AP CALCULUS AB AND CALCULUS BC EXAMS

Testing Window	Exams Administered at Schools in the United States, Canada, Puerto Rico, and the U.S. Virgin Islands	Exams Administered at Schools Outside the United States, Canada, Puerto Rico, and the U.S. Virgin Islands
Regularly Scheduled Exams	Students must be seated no less than 4 feet apart.	Students must be seated no less than 5 feet apart.
Late-Testing Exams	Students must be seated no less than 5 feet apart.	

Graphing calculators are required to answer some of the questions on the AP Calculus Exams. Before starting the exam administration, make sure each student has a graphing calculator from the approved list on page 53 of the *2018-19 AP Coordinator's Manual*. If a student does not have a graphing calculator from the approved list, you may provide one from your supply. If the student does not want to use the calculator you provide or does not want to use a calculator at all, he or she must hand copy, date, and sign the release statement on page 52 of the *AP Coordinator's Manual*.

During the administration of Section I, Part B, and Section II, Part A, students may have no more than two graphing calculators on their desks. Calculators may not be shared. **Calculator memories do not need to be cleared before or after the exam.** Students with Hewlett-Packard 48–50 Series and Casio FX-9860 graphing calculators may use cards designed for use with these calculators. Proctors should make sure infrared ports (Hewlett-Packard) are not facing each other. **Since graphing calculators can be used to store data, including text, proctors should monitor that students are using their calculators appropriately. Attempts by students to use the calculator to remove exam questions and/or answers from the room may result in the cancellation of AP Exam scores.**

The AP Calculus AB Exam and the AP Calculus BC Exam should be administered simultaneously. They may be administered in separate rooms, or in the same room if it is more convenient.

SECTION I: Multiple Choice

› **Do not begin the exam instructions below until you have completed the appropriate General Instructions for your group.**

These exams include survey questions. The time allowed for the survey questions is in addition to the actual test-taking time.

Make sure you begin the exams at the designated time. Remember, you must complete a seating chart for this exam. See pages 295–296 for a seating chart template and instructions. See the *2018-19 AP Coordinator's Manual* for exam seating requirements (pages 56–59).

> **If you are giving the regularly scheduled exam, say:**
> **It is Tuesday morning, May 14, and you will be taking either the AP Calculus AB Exam or the AP Calculus BC Exam.**
>
> **If you are giving the alternate exam for late testing, say:**
> **It is Friday morning, May 24, and you will be taking either the AP Calculus AB Exam or the AP Calculus BC Exam.**

If you are giving the *AP Calculus AB Exam*, say:

Look at your exam packet and confirm that the exam title is "AP Calculus AB." Raise your hand if your exam packet contains any title other than "AP Calculus AB," and I will help you.

If you are giving the *AP Calculus BC Exam*, say:

Look at your exam packet and confirm that the exam title is "AP Calculus BC." Raise your hand if your exam packet contains any title other than "AP Calculus BC," and I will help you.

If you are giving both the *AP Calculus AB Exam* and *AP Calculus BC Exam* in the same room, say:

Look at your exam packet and confirm that the exam title is "AP Calculus AB" or "AP Calculus BC," depending upon which exam you are taking today. Raise your hand if your exam packet contains any other title and I will help you.

Once you confirm that all students have the correct exam, say:

In a moment, you will open the exam packet. By opening this packet, you agree to all of the AP Program's policies and procedures outlined in the *2018-19 Bulletin for AP Students and Parents*.

You may now remove the shrinkwrap from the outside only of your exam packet. Do not open the Section I booklet; do not remove the shrinkwrap from the Section II materials. Put the white seals and the shrinkwrapped Section II booklet aside. . . .

Carefully remove the AP Exam label found near the top left of your exam booklet cover. Place it on page 1 of your answer sheet on the light blue box near the top right corner that reads "AP Exam Label."

If students accidentally place the exam label in the space for the number label or vice versa, advise them to leave the labels in place. They should not try to remove the label; their exam can still be processed correctly.

Listen carefully to all my instructions. I will give you time to complete each step. Please look up after completing each step. Raise your hand if you have any questions.

Give students enough time to complete each step. Don't move on until all students are ready.

Read the statements on the front cover of the Section I booklet. . . .

Sign your name and write today's date. . . .

Now print your full legal name where indicated. . . .

Turn to the back cover of your exam booklet and read it completely. . . .

Give students a few minutes to read the entire cover.

Are there any questions? . . .

You will now take the multiple-choice portion of the exam. You should have in front of you the multiple-choice booklet and your answer sheet. You may never discuss the multiple-choice exam content at any time in any form with anyone, including your teacher and other students. If you disclose the multiple-choice exam content through any means, your AP Exam score will be canceled.

Open your answer sheet to page 2. You must complete the answer sheet using a No. 2 pencil only. Mark all of your responses beginning on page 2 of your answer sheet, one response per question. Completely fill in the circles. If you need to erase, do so carefully and completely. No credit will be given for

anything written in the exam booklet. Scratch paper is not allowed, but you may use the margins or any blank space in the exam booklet for scratch work.

Section I is divided into two parts. Each part is timed separately, and you may work on each part only during the time allotted for it. Calculators are not allowed in Part A. Please put your calculators under your chair. Are there any questions? . . .

You have 1 hour for Part A. Part A questions are numbered 1 through 30. Mark your responses for these questions on page 2 of your answer sheet. Open your Section I booklet and begin.

Note Start Time _____ . **Note Stop Time** _____ .

Check that students are marking their answers in pencil on page 2 of their answer sheets and that they are not looking beyond Part A. The line of A's at the top of each page will assist you in monitoring students' work.

After 50 minutes, say:

There are 10 minutes remaining.

After 10 minutes, say:

Stop working on Part A and turn to page 24 in your Section I booklet. . . .

On that page, you should see an area marked "PLACE SEAL HERE." Making sure all of your other exam materials, including your answer sheet, are out of the way, take one of your seals and press it on that area and then fold the seal over the open edge to the front cover. Be sure you don't seal the Part B section of the booklet or let the seal touch anything except the marked areas. . . .

After all students have sealed Part A, say:

Graphing calculators are required for Part B. You may get your calculators from under your chair and place them on your desk. Part B questions are numbered 76 through 90. Fold your answer sheet so only page 3 is showing and mark your responses for these questions on that page. You have 45 minutes for Part B. You may begin.

Note Start Time _____ . **Note Stop Time** _____ .

Check that students have sealed their booklets properly and are now working on Part B. The large B's in an alternating shaded pattern at the top of each page will assist you in monitoring their work. Proctors should make sure that students are using their calculators appropriately. Proctors should also make sure Hewlett-Packard calculators' infrared ports are not facing each other.

After 35 minutes, say:

There are 10 minutes remaining.

After 10 minutes, say:

Stop working and turn to page 38. You have 3 minutes to answer Questions 91–94. These are survey questions and will not affect your score. Note that each survey question has five answer options. You may not go back to work on any of the exam questions. . . .

Give students approximately 3 minutes to answer the survey questions.

Then say:

> **Close your booklet and put your answer sheet on your desk, faceup. Make sure you have your AP number label and an AP Exam label on page 1 of your answer sheet. Sit quietly while I collect your answer sheets.**

Collect an answer sheet from each student. Check that each answer sheet has an AP number label and an AP Exam label.

After all answer sheets have been collected, say:

> **Now you must seal your Section I booklet. Remove the remaining white seals from the backing and press one on each area of your exam booklet cover marked "PLACE SEAL HERE." Fold each seal over the back cover. When you have finished, place the booklet on your desk, faceup. I will now collect your Section I booklet. . . .**

Collect a Section I booklet from each student. Check that each student has signed the front cover of the sealed Section I booklet.

There is a 10-minute break between Sections I and II.

When all Section I materials have been collected and accounted for and you are ready for the break, say:

> **Please listen carefully to these instructions before we take a 10-minute break. All items you placed under your chair at the beginning of this exam, including your Student Pack, must stay there, and you are not permitted to open or access them in any way. Leave your shrinkwrapped Section II packet on top of your desk during the break. You are not allowed to consult teachers, other students, notes, textbooks, or any other resources during the break. You may not make phone calls, send text messages, use your calculators, check email, use a social networking site, or access any electronic or communication device. You may not leave the designated break area. Remember, you may never discuss the multiple-choice exam content with anyone, and if you disclose the content through any means, your AP Exam score will be canceled. Are there any questions? . . .**

> **You may begin your break. Testing will resume at _____ .**

SECTION II: Free Response

After the break, say:

> **May I have everyone's attention? Place your Student Pack on your desk. . . .**

> **You may now remove the shrinkwrap from the Section II packet, but do not open the Section II exam booklet until you are told to do so. . . .**

> **Read the bulleted statements on the front cover of the exam booklet. Look up when you have finished. . . .**

> **Now take an AP number label from your Student Pack and place it on the shaded box. If you don't have any AP number labels, write your AP number in the box. Look up when you have finished. . . .**

> **Read the last statement. . . .**

> **Using your pen, print the first, middle, and last initials of your legal name in the boxes and print today's date where indicated. This constitutes your signature and your agreement to the statements on the front cover. . . .**

Answer Sheet for AP Calculus AB
Practice Exam, Section I

No.	Answer
1	
2	
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No.	Answer
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80	
81	
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AP® Calculus AB Exam

SECTION I: Multiple Choice

2019

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

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 the answer sheet. For Part B, fill in only the circles for numbers 76 through 90 on 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.

CALCULUS AB

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., $\sin^{-1} x = \arcsin x$).

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GO ON TO THE NEXT PAGE.

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

(A) $\dfrac{x}{2} + C$ (B) $\dfrac{x^3}{12} + C$ (C) $\dfrac{x^3}{4} + C$ (D) $\dfrac{3x^3}{4} + C$

---

2. Which of the following is an equation of the line tangent to the graph of $y = \cos x$ at $x = \dfrac{\pi}{2}$?

(A) $y = x + \dfrac{\pi}{2}$

(B) $y = x - \dfrac{\pi}{2}$

(C) $y = -x + \dfrac{\pi}{2}$

(D) $y = -x - \dfrac{\pi}{2}$

GO ON TO THE NEXT PAGE.

3. $\dfrac{d}{dx}\left(2(\sin \sqrt{x})^2\right) =$

(A) $4\cos\left(\dfrac{1}{2\sqrt{x}}\right)$ (B) $4\sin \sqrt{x}\cos \sqrt{x}$ (C) $\dfrac{2\sin \sqrt{x}}{\sqrt{x}}$ (D) $\dfrac{2\sin \sqrt{x}\cos \sqrt{x}}{\sqrt{x}}$

4. $\displaystyle\int \dfrac{x^2 + 1}{\left(x^3 + 3x - 5\right)^3}\, dx =$

(A) $-\dfrac{3}{2}\cdot\dfrac{1}{\left(3x^2 + 3\right)^2} + C$

(B) $-\dfrac{1}{6}\cdot\dfrac{1}{\left(3x^2 + 3\right)^2} + C$

(C) $-\dfrac{3}{2}\cdot\dfrac{1}{\left(x^3 + 3x - 5\right)^2} + C$

(D) $-\dfrac{1}{6}\cdot\dfrac{1}{\left(x^3 + 3x - 5\right)^2} + C$

GO ON TO THE NEXT PAGE.

5. The function f is given by $f(x) = 4x^3 - x^4$. On what intervals is the graph of f concave up?

(A) $(-\infty, 0)$ and $(2, \infty)$

(B) $(-\infty, 3)$

(C) $(0, 2)$ only

(D) $(0, 3)$ only

---

6. If $x + 3y^{1/3} = y$, what is $\dfrac{dy}{dx}$ at the point $(2, 8)$?

(A) $\dfrac{1}{3}$ (B) $\dfrac{3}{4}$ (C) $\dfrac{5}{4}$ (D) $\dfrac{4}{3}$

GO ON TO THE NEXT PAGE.

7. $\dfrac{d}{dx}\left(x^5 - 5^x\right) =$

(A) $\dfrac{x^6}{6} - \dfrac{5^x}{\ln 5}$ (B) $5x^4 - 5^x$ (C) $5x^4 - x \cdot 5^{x-1}$ (D) $5x^4 - (\ln 5)\,5^x$

---

8. $\lim\limits_{x \to \infty} \dfrac{10 - 6x^2}{5 + 3e^x}$ is

(A) -2 (B) 0   (C) 2   (D) nonexistent

GO ON TO THE NEXT PAGE.

9. Let R be the region bounded by the graphs of $y = 2x$ and $y = 4x - x^2$. What is the area of R ?

(A) $\dfrac{2}{3}$ (B) $\dfrac{4}{3}$ (C) $\dfrac{16}{3}$ (D) $\dfrac{28}{3}$

GO ON TO THE NEXT PAGE.

Graph of f

10. The graph of a function f is shown above. If g is the function defined by $g(x) = \dfrac{x^2 + 1}{f(x)}$, what is the value of $g'(2)$?

(A) $-\dfrac{8}{9}$ (B) $\dfrac{1}{9}$ (C) 1 (D) $\dfrac{32}{9}$

GO ON TO THE NEXT PAGE.

11. $\displaystyle\int_{-1}^{1} \frac{x^2 - x}{x}\, dx$ is

(A) -2 (B) 0   (C) $\dfrac{4}{3}$ (D) nonexistent

x	0	4	8	12	16
$f(x)$	8	0	2	10	1

12. The table above gives selected values for the differentiable function f. In which of the following intervals must there be a number c such that $f'(c) = 2$?

(A) $(0, 4)$ (B) $(4, 8)$ (C) $(8, 12)$ (D) $(12, 16)$

GO ON TO THE NEXT PAGE.

13. $\lim\limits_{x \to 0} \dfrac{\sin x}{e^x - 1}$ is

(A) 1   (B) $\dfrac{1}{e}$ (C) 0   (D) nonexistent

---

14. A particle moves along a straight line so that at time $t \geq 0$ its acceleration is given by $a(t) = 12t$. At time $t = 0$, the velocity of the particle is 2 and the position of the particle is 5. Which of the following is an expression for the position of the particle at time $t \geq 0$?

(A) $6t^2 + 5$

(B) $6t^3 + 2t + 5$

(C) $2t^3 + 5$

(D) $2t^3 + 2t + 5$

GO ON TO THE NEXT PAGE.

$$f(x) = \begin{cases} -x^2 + 3 & \text{if } x \le 5 \\ -10x + 28 & \text{if } x > 5 \end{cases}$$

15. Let f be the function defined above. Which of the following statements about f is true?

    (A) f is continuous and differentiable at $x = 5$.

    (B) f is continuous but not differentiable at $x = 5$.

    (C) f is differentiable but not continuous at $x = 5$.

    (D) f is defined but neither continuous nor differentiable at $x = 5$.

GO ON TO THE NEXT PAGE.

16. If $\dfrac{dy}{dx} = 2 - y$, and if $y = 1$ when $x = 1$, then $y =$

    (A) $2 - e^{x-1}$ (B) $2 - e^{1-x}$ (C) $2 - e^{-x}$ (D) $2 + e^{-x}$

---

17. Let g be the function given by $g(x) = \displaystyle\int_3^x \left(t^2 - 5t - 14\right) dt$. What is the x-coordinate of the point of inflection of the graph of g ?

    (A) -2 (B) $\dfrac{5}{2}$ (C) 3 (D) 7

GO ON TO THE NEXT PAGE.

18. $\dfrac{d}{dx}\left(x^3 \sec(2x)\right) =$

(A) $6x^2 \sec(2x)\tan(2x)$

(B) $2x^3 \tan^2(2x) + 3x^2 \sec(2x)$

(C) $x^3 \sec(2x)\tan(2x) + 3x^2 \sec(2x)$

(D) $2x^3 \sec(2x)\tan(2x) + 3x^2 \sec(2x)$

---

19. A particle moves along the y-axis so that at time $t \geq 0$ its position is given by $y(t) = t^3 - 4t^2 + 4t + 3$. Which of the following statements describes the motion of the particle at time $t = 1$?

(A) The particle is moving down the y-axis with decreasing velocity.

(B) The particle is moving down the y-axis with increasing velocity.

(C) The particle is moving up the y-axis with decreasing velocity.

(D) The particle is moving up the y-axis with increasing velocity.

GO ON TO THE NEXT PAGE.

20. If $\int_1^4 f(x)\, dx = 8$ and $\int_1^4 g(x)\, dx = -2$, which of the following cannot be determined from the information given?

(A) $\int_4^1 g(x)\, dx$

(B) $\int_1^4 3f(x)\, dx$

(C) $\int_1^4 3f(x)\,g(x)\, dx$

(D) $\int_1^4 (3f(x) + g(x))\, dx$

GO ON TO THE NEXT PAGE.

21. For any real number x, $\displaystyle\lim_{h \to 0} \frac{\sin(2(x+h)) - \sin(2x)}{h} =$

    (A) 0   (B) 1   (C) $\cos(2x)$ (D) $2\cos(2x)$

GO ON TO THE NEXT PAGE.

22. Shown above is a slope field for which of the following differential equations?

(A) $\dfrac{dy}{dx} = |x + y|$ (B) $\dfrac{dy}{dx} = x^3$ (C) $\dfrac{dy}{dx} = y^3$ (D) $\dfrac{dy}{dx} = y^2$

GO ON TO THE NEXT PAGE.

23. The base of a solid is the region in the first quadrant bounded by the y-axis, the x-axis, the graph of $y = e^x$, and the vertical line $x = 1$. For this solid, each cross section perpendicular to the x-axis is a square. What is the volume of the solid?

(A) $e - 1$

(B) $\dfrac{1}{2}e^2 - \dfrac{1}{2}$

(C) $e^2 - 1$

(D) $2e^2 - 2$

GO ON TO THE NEXT PAGE.

Graph of f

24. The graph of the piecewise linear function f is shown above. What is the value of $\int_0^{12} f'(x)\, dx$?

(A) -8 (B) -6 (C) 0 (D) 22

GO ON TO THE NEXT PAGE.

25. The equation $y = 2e^{6x} - 5$ is a particular solution to which of the following differential equations?

   (A) $y' - 6y - 30 = 0$

   (B) $2y' - 12y + 5 = 0$

   (C) $y'' - 5y' - 6y = 0$

   (D) $y'' - 2y' + y + 5 = 0$

---

26. What is the value of x at which the minimum value of $y = 3x^{4/3} - 2x$ occurs on the closed interval $[0, 1]$?

   (A) 0   (B) $\dfrac{1}{8}$ (C) $\dfrac{1}{2}$ (D) 1

GO ON TO THE NEXT PAGE.

27. At time $t = 0$, a storage tank is empty and begins filling with water. For $t > 0$ hours, the depth of the water in the tank is increasing at a rate of $W(t)$ feet per hour. Which of the following is the best interpretation of the statement $W'(2) > 3$?

(A) Two hours after the tank begins filling with water, the depth of the water is increasing at a rate greater than 3 feet per hour.

(B) Over the first two hours after the tank begins filling with water, the depth of the water is always increasing at a rate greater than 3 feet per hour.

(C) Two hours after the tank begins filling with water, the rate at which the depth of the water is rising is increasing at a rate greater than 3 feet per hour per hour.

(D) Over the first two hours after the tank begins filling with water, the rate at which the depth of the water is rising is always increasing at a rate greater than 3 feet per hour per hour.

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28. A person stands 30 feet from point P and watches a balloon rise vertically from the point, as shown in the figure above. The balloon is rising at a constant rate of 2 feet per second. What is the rate of change, in radians per second, of angle θ at the instant when the balloon is 40 feet above point P ?

(A) $\dfrac{3}{100}$ (B) $\dfrac{3}{125}$ (C) $\dfrac{1}{12}$ (D) $\dfrac{5}{27}$

---

29. How many vertical asymptotes does the graph of $y = \dfrac{x-2}{x^4-16}$ have?

(A) One   (B) Two   (C) Three   (D) Four

GO ON TO THE NEXT PAGE.

30. For what value of b does the integral $\int_1^b x^2 \, dx$ equal $\displaystyle\lim_{n\to\infty} \sum_{k=1}^{n}\left(1 + \frac{2k}{n}\right)^2 \frac{2}{n}$?

    (A) $b = 2$ only

    (B) $b = 3$ only

    (C) b could be any real number.

    (D) There is no such value of b.

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.

CALCULUS AB
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 FILL IN THE CIRCLES ON THE ANSWER SHEET THAT CORRESPOND TO QUESTIONS NUMBERED 76–90.

YOU MAY NOT RETURN TO QUESTIONS NUMBERED 1–30.

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., $\sin^{-1} x = \arcsin x$).

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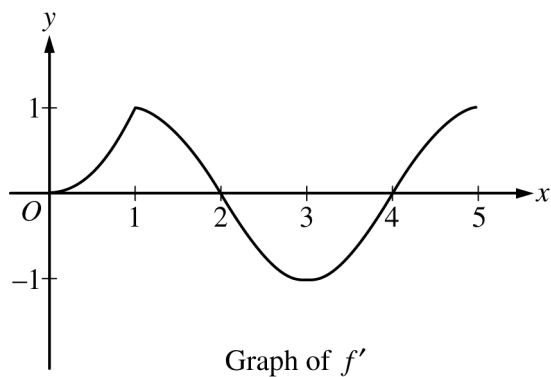
Graph of f'

76. The function f is continuous on the closed interval $[0, 5]$. The graph of f', the derivative of f, is shown above. On which of the following intervals is f increasing?

(A) $[0, 1]$ and $[2, 4]$

(B) $[0, 1]$ and $[3, 5]$

(C) $[0, 1]$ and $[4, 5]$ only

(D) $[0, 2]$ and $[4, 5]$

GO ON TO THE NEXT PAGE.

77. The height of an object at time $t \geq 1$ is given by $h(t) = t^2 - \dfrac{16}{t} + 15$. What is the velocity of the object at time $t = 3$?

(A) 0.815   (B) 7.778   (C) 18.667   (D) 21.089

---

78. The function g is differentiable and satisfies $g(-1) = 4$ and $g'(-1) = 2$. What is the approximation of $g(-1.2)$ using the line tangent to the graph of g at $x = -1$?

(A) 3.6   (B) 3.8   (C) 4.2   (D) 4.4

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79. Tara's heart rate during a workout is modeled by the differentiable function h, where $h(t)$ is measured in beats per minute and t is measured in minutes from the start of the workout. Which of the following expressions gives Tara's average heart rate from $t = 30$ to $t = 60$?

(A) $\displaystyle\int_{30}^{60} h(t)\, dt$

(B) $\displaystyle\frac{1}{30}\int_{30}^{60} h(t)\, dt$

(C) $\displaystyle\frac{1}{30}\int_{30}^{60} h'(t)\, dt$

(D) $\displaystyle\frac{h'(30) + h'(60)}{2}$

80. Let g be the function with first derivative $g'(x) = \sqrt{x^3 + x}$ for $x > 0$. If $g(2) = -7$, what is the value of $g(5)$?

(A) 4.402   (B) 11.402   (C) 13.899   (D) 20.899

GO ON TO THE NEXT PAGE.

81. If f is a function that has a removable discontinuity at $x = 3$, which of the following could be the graph of f ?

(A)

(B)

(C)

(D)

GO ON TO THE NEXT PAGE.
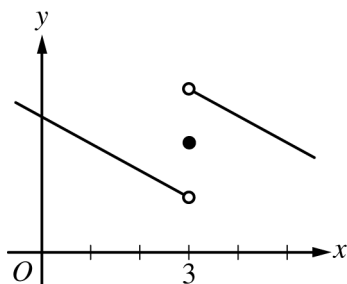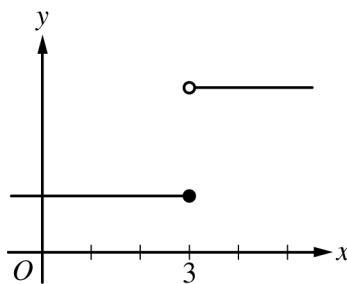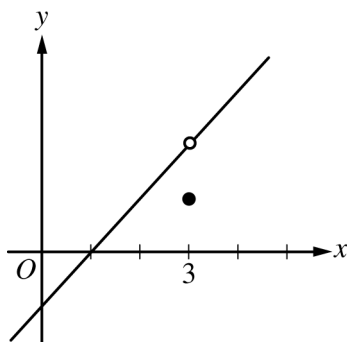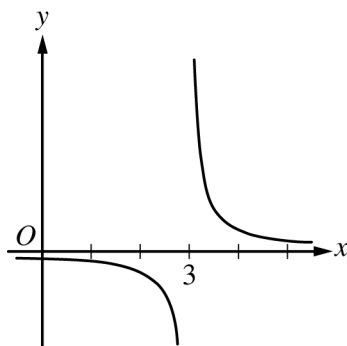
82. Let f be a continuous function such that $\int_0^{17} f(x)\, dx = 8$, $\int_{17}^{20} f(x)\, dx = -3$, and $\int_{13}^{20} f(x)\, dx = 7$. What is the value of $\int_0^{13} f(x)\, dx$?

(A) -2 (B) 4   (C) 12   (D) 18

$$f(x) = \begin{cases} k^3 + x & \text{for } x < 3 \\ \dfrac{16}{k^2 - x} & \text{for } x \geq 3 \end{cases}$$

83. Let f be the function defined above, where k is a positive constant. For what value of k, if any, is f continuous?

(A) 2.081   (B) 2.646   (C) 8.550   (D) There is no such value of k.

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x	$f(x)$
-5	-9
0	1
2	5

84. The table above gives values of a continuous function f at selected values of x. Based on the information in the table, which of the following statements must be true?

(A) f has at most one zero.

(B) f has a relative maximum at $x = 2$.

(C) There exists a value c, where $-5 < c < 2$, such that $f(c) = 4$.

(D) There exists a value c, where $-5 < c < 2$, such that $f'(c) = 2$.

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85. The function f is an antiderivative of the function g defined by $g(x) = 3 - \sqrt{x^2 + x + 4 \cos x}$. Which of the following is the x-coordinate of the location of a local maximum for the graph of $y = f(x)$?

(A) -3.961 (B) -2.161 (C) 1.494 (D) 3.140

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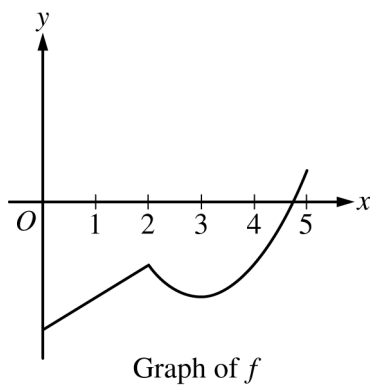
Graph of f

86. The graph of $y = f(x)$ on the interval $0 < x < 5$ is shown above. Which of the following could be the graph of $y = f'(x)$?
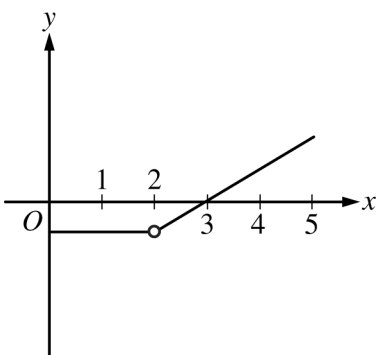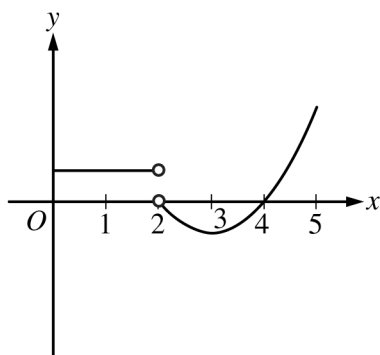
(A)

(B)

(C)

(D)

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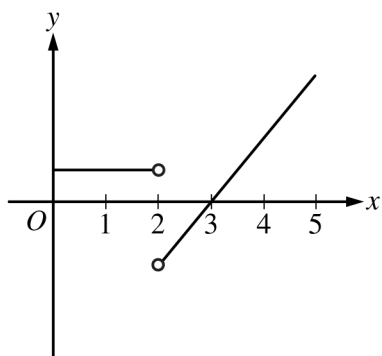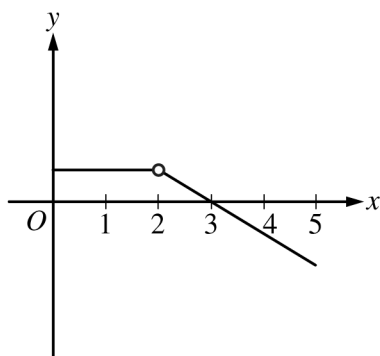
87. At time t, $0 < t < 2$, the velocity of a particle moving along the x-axis is given by $v(t) = t \sin\left(t^3\right)$. Let $t = b$ be the time at which the particle changes direction from moving left to moving right. What is the total distance traveled by the particle during the time interval $0 < t < b$?

    (A) 0.212   (B) 0.612   (C) 1.011   (D) 1.208

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88. Let f be the function defined by $f(x) = \frac{1}{4}x^4 - \frac{2}{3}x^3 + \frac{1}{2}x^2 - \frac{1}{2}x$. For how many values of x in the open interval $(0, 1.565)$ is the instantaneous rate of change of f equal to the average rate of change of f on the closed interval $[0, 1.565]$?

    (A) Zero   (B) One   (C) Three   (D) Four

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89. Let g be a twice-differentiable function with $g'(x) > 0$ and $g''(x) > 0$ for all real numbers x, such that $g(3) = 12$ and $g(5) = 18$. Which of 20, 21, and 22 are possible values for $g(6)$?

(A) 21 only   (B) 22 only   (C) 20 and 21 only   (D) 21 and 22 only

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x	2	3	4
$f(x)$	1	2	6
$f'(x)$	4	5	3

90. The table above gives values of the differentiable function f and its derivative at selected values of x. If g is the inverse function of f, which of the following is an equation of the line tangent to the graph of g at the point where $x = 2$?

(A) $y = -\dfrac{1}{5}(x - 2) + 3$

(B) $y = -\dfrac{1}{4}(x - 2) + 1$

(C) $y = \dfrac{1}{5}(x - 2) + 3$

(D) $y = 4(x - 2) + 1$

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