2020

AP CollegeBoard

Please note: Some of the questions in this former practice exam may no longer perfectly align with the AP exam. Even though these questions do not fully represent the 2020 exam, teachers indicate that imperfectly aligned questions still provide instructional value. Teachers can consult the Question Bank to determine the degree to which these questions align to the 2020 Exam.

This exam may not be posted on school or personal websites, nor electronically redistributed for any reason. This exam is provided by the College Board for AP Exam preparation. Teachers are permitted to download the materials and make copies to use with their students in a classroom setting only. To maintain the security of this exam, teachers should collect all materials after their administration and keep them in a secure location.

Further distribution of these materials outside of the secure College Board site disadvantages teachers who rely on uncirculated questions for classroom testing. Any additional distribution is in violation of the College Board's copyright policies and may result in the termination of Practice Exam access for your school as well as the removal of access to other online services such as the AP Teacher Community and Online Score Reports.

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 52 of the *2017-18 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 51 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 303–304 for a seating chart template and instructions. See the *2017-18 AP Coordinator's Manual* for exam seating requirements (pages 55–58).

If you are giving the regularly scheduled exam, say:
It is Tuesday morning, May 15, 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 25, 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*, 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 *2017-18 Bulletin for AP Students and Parents*.

You may now remove the shrinkwrap from your exam packet and take out the Section I booklet, but do not open the booklet or the shrinkwrapped Section II materials. Put the white seals 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. . . .

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 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, or textbooks 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. 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. . . .

Turn to the back cover and, using your pen, complete Item 1 under "Important Identification Information." Print the first two letters of your last name and the first letter of your first name in the boxes. Look up when you have finished. . . .

In Item 2, print your date of birth in the boxes. . . .

COMPLETE THIS AREA AT EACH EXAM (IF APPLICABLE).

P. SURVEY QUESTIONS — Answer the survey questions in the AP Student Pack. Do not put responses to exam questions in this section.

1	A B C D E F G H I	4	A B C D E F G H I	7	A B C D E F G H I
2	A B C D E F G H I	5	A B C D E F G H I	8	A B C D E F G H I
3	A B C D E F G H I	6	A B C D E F G H I	9	A B C D E F G H I

Q. LANGUAGE — Do not complete this section unless instructed to do so.

If this answer sheet is for the French Language and Culture, German Language and Culture, Italian Language and Culture, Spanish Language and Culture, or Spanish Literature and Culture Exam, please answer the following questions. Your responses will not affect your score.

1. Have you lived or studied for one month or more in a country where the language of the exam you are now taking is spoken?

○ Yes ○ No

2. Do you regularly speak or hear the language at home?

○ Yes ○ No

QUESTIONS 1–75

Indicate your answers to the exam questions in this section (pages 2 and 3). Mark only one response per question for Questions 1 through 120. If a question has only four answer options, do not mark option E. Answers written in the multiple-choice booklet will not be scored.

COMPLETE MARK ● EXAMPLES OF INCOMPLETE MARKS 

You must use a No. 2 pencil and marks must be complete. Do not use a mechanical pencil. It is very important that you fill in the entire circle darkly and completely. If you change your response, erase as completely as possible. Incomplete marks or erasures may affect your score.

1	A B C D E	26	A B C D E	51	A B C D E
2	A B C D E	27	A B C D E	52	A B C D E
3	A B C D E	28	A B C D E	53	A B C D E
4	A B C D E	29	A B C D E	54	A B C D E
5	A B C D E	30	A B C D E	55	A B C D E
6	A B C D E	31	A B C D E	56	A B C D E
7	A B C D E	32	A B C D E	57	A B C D E
8	A B C D E	33	A B C D E	58	A B C D E
9	A B C D E	34	A B C D E	59	A B C D E
10	A B C D E	35	A B C D E	60	A B C D E
11	A B C D E	36	A B C D E	61	A B C D E
12	A B C D E	37	A B C D E	62	A B C D E
13	A B C D E	38	A B C D E	63	A B C D E
14	A B C D E	39	A B C D E	64	A B C D E
15	A B C D E	40	A B C D E	65	A B C D E
16	A B C D E	41	A B C D E	66	A B C D E
17	A B C D E	42	A B C D E	67	A B C D E
18	A B C D E	43	A B C D E	68	A B C D E
19	A B C D E	44	A B C D E	69	A B C D E
20	A B C D E	45	A B C D E	70	A B C D E
21	A B C D E	46	A B C D E	71	A B C D E
22	A B C D E	47	A B C D E	72	A B C D E
23	A B C D E	48	A B C D E	73	A B C D E
24	A B C D E	49	A B C D E	74	A B C D E
25	A B C D E	50	A B C D E	75	A B C D E

FOR OFFICIAL USE ONLY

Exam		0	1	2	3	4	5	6	7	8	9
		0	1	2	3	4	5	6	7	8	9
Exam		0	1	2	3	4	5	6	7	8	9
		0	1	2	3	4	5	6	7	8	9

SELECTED MEDIA EXAMS	R	W	O	OTHER EXAMS	R	W	O
PT02				TOTAL			
PT03				Subscore (if applicable)			
PT04				Subscore (if applicable)			

DO NOT WRITE IN THIS AREA

QUESTIONS 76–120

Be sure each mark is dark and completely fills the circle. If a question has only four answer options, do not mark option E.

76	A B C D E	91	A B C D E	106	A B C D E
77	A B C D E	92	A B C D E	107	A B C D E
78	A B C D E	93	A B C D E	108	A B C D E
79	A B C D E	94	A B C D E	109	A B C D E
80	A B C D E	95	A B C D E	110	A B C D E
81	A B C D E	96	A B C D E	111	A B C D E
82	A B C D E	97	A B C D E	112	A B C D E
83	A B C D E	98	A B C D E	113	A B C D E
84	A B C D E	99	A B C D E	114	A B C D E
85	A B C D E	100	A B C D E	115	A B C D E
86	A B C D E	101	A B C D E	116	A B C D E
87	A B C D E	102	A B C D E	117	A B C D E
88	A B C D E	103	A B C D E	118	A B C D E
89	A B C D E	104	A B C D E	119	A B C D E
90	A B C D E	105	A B C D E	120	A B C D E

QUESTIONS 121–126

For Students Taking AP Biology

Write your answer in the boxes at the top of the griddable area and fill in the corresponding circles. Mark only one circle in any column. You will receive credit only if the circles are filled in correctly.

121 122 123 124 125 126

QUESTIONS 131–142

For Students Taking AP Computer Science Principles, AP Physics 1, or AP Physics 2

Mark two responses per question. You will receive credit only if both correct responses are selected.

131	A B C D	135	A B C D	139	A B C D
132	A B C D	136	A B C D	140	A B C D
133	A B C D	137	A B C D	141	A B C D
134	A B C D	138	A B C D	142	A B C D

DO NOT WRITE IN THIS AREA

AP® Calculus AB Exam

SECTION I: Multiple Choice

2018

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 40BP4-S

66

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

GO ON TO THE NEXT PAGE.

1. If f is the function given by $f(x) = \frac{4}{x} + 5x - 1$, then $f'(2) =$

   (A) 4 (B) 6 (C) 7 (D) 11

---

2. $\int 6e^{3x}\,dx =$

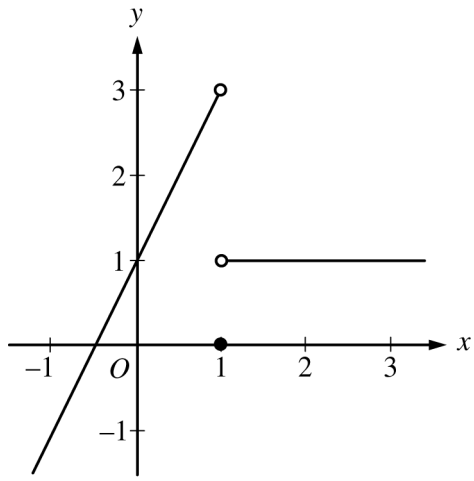
   (A) $2e^{3x} + C$

   (B) $6e^{3x} + C$

   (C) $18e^{3x} + C$

   (D) $\frac{6e^{3x+1}}{3x+1} + C$

GO ON TO THE NEXT PAGE.



Graph of f

3. The graph of $y = f(x)$ is shown above. What is $\lim_{x \to 1} f(x)$?

(A) 0 (B) 1 (C) 3 (D) The limit does not exist.

GO ON TO THE NEXT PAGE.

4. If $f'(x) = 3x^2 + 2x$ and $f(2) = 3$, then $f(1) =$

   (A) -10 (B) -7 (C) 10 (D) 13

---

t (minutes)	0	5	10	15
$R(t)$ (people per minute)	100	100	75	55

5. During an evacuation drill, people leave a building at a rate of $R(t)$ people per minute, where t is the number of minutes since the start of the drill. Selected values of $R(t)$ are shown in the table above. Using a right Riemann sum with three subintervals and data from the table, what is the approximation of the number of people who leave the building during the first 15 minutes of the evacuation drill?

   (A) 230 (B) 1150 (C) 1375 (D) 2075

GO ON TO THE NEXT PAGE.

6. If $y = x^2\left(e^x - 1\right)$, then $\dfrac{dy}{dx} =$

   (A) $2xe^x$

   (B) $2xe^x - 2x$

   (C) $x^2e^x + 2xe^x - 2x$

   (D) $x^2e^x + 2xe^x - x^2 - 2x$

---

7. A particle moves along the x-axis so that at any time t, $t \geq 0$, its acceleration is $a(t) = -4\sin(2t)$. If the velocity of the particle at $t = 0$ is $v(0) = 7$ and its position at $t = 0$ is $x(0) = 0$, then its position at time t is $x(t) =$

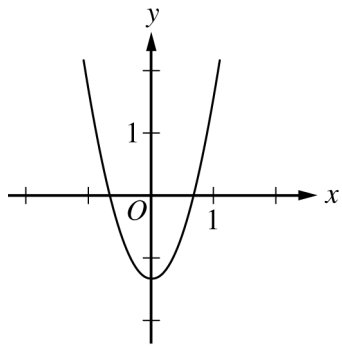
   (A) $\sin(2t) + 5t$

   (B) $\sin(2t) + 7t$

   (C) $\sin(2t) + 9t$

   (D) $16\sin(2t) + 7t$

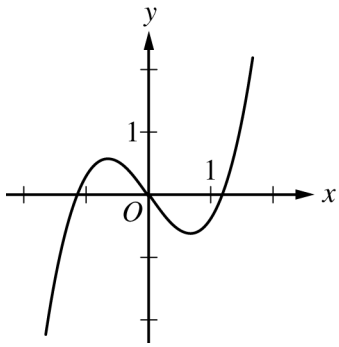
GO ON TO THE NEXT PAGE.



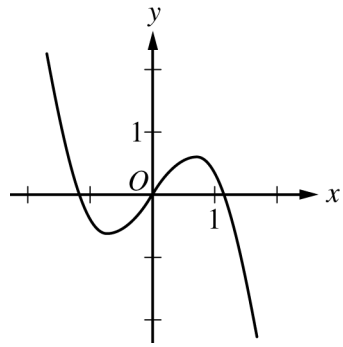
Graph of f''

8. The graph of f'', the second derivative of the function f, is shown above. Which of the following could be the graph of f ?

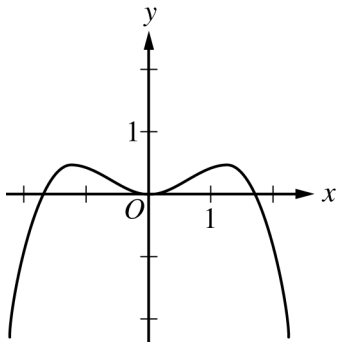
(A)



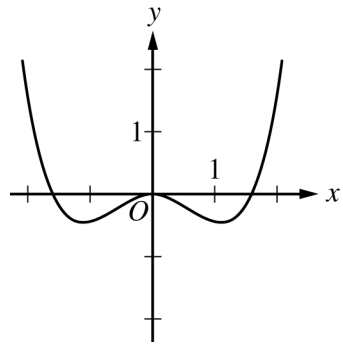
(B)



(C)



(D)



9. When $x = 2e$, $\lim_{h \to 0} \dfrac{\ln(x+h) - \ln(x)}{h}$ is

(A) $\dfrac{1}{2e}$ (B) 1 (C) $\ln(2e)$ (D) nonexistent

---

10. If $\dfrac{dy}{dx} = x^4 - 2x^3 + 3x - 1$, then $\dfrac{d^3y}{dx^3}$ evaluated at $x = 2$ is

(A) 11 (B) 24 (C) 26 (D) 125

GO ON TO THE NEXT PAGE.

$$f(x) = \begin{cases} x^2 & \text{for } x < 0 \\ -1 & \text{for } x = 0 \\ x & \text{for } x > 0 \end{cases}$$

11. Let f be the function defined above. What is $\int_{-1}^{1} f(x)\,dx$?

(A) $\frac{5}{6}$ (B) $\frac{2}{3}$ (C) $-\frac{1}{6}$ (D) nonexistent

GO ON TO THE NEXT PAGE.

12. Given that $3x - \tan y = 4$, what is $\frac{dy}{dx}$ in terms of y ?

(A) $\frac{dy}{dx} = 3\sin^2 y$

(B) $\frac{dy}{dx} = 3\cos^2 y$

(C) $\frac{dy}{dx} = 3\cos y \cot y$

(D) $\frac{dy}{dx} = \frac{3}{1 + 9y^2}$

GO ON TO THE NEXT PAGE.

13. For time $t \geq 1$, the position of a particle moving along the x-axis is given by $p(t) = \sqrt{t} - 2$. At what time t in the interval $1 \leq t \leq 16$ is the instantaneous velocity of the particle equal to the average velocity of the particle over the interval $1 \leq t \leq 16$?

(A) 1 (B) $\frac{121}{25}$ (C) $\frac{25}{4}$ (D) 25

---

14. If f is a differentiable function and $y = \sin\left(f\left(x^2\right)\right)$, what is $\frac{dy}{dx}$ when $x = 3$?

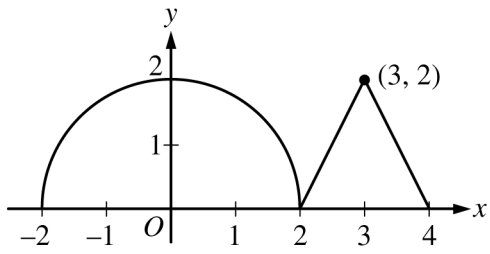
(A) $\cos(f'(9))$

(B) $6\cos(f(9))$

(C) $f'(9)\cos(f(9))$

(D) $6f'(9)\cos(f(9))$

GO ON TO THE NEXT PAGE.



Graph of g'

15. The graph of g', the first derivative of the function g, consists of a semicircle of radius 2 and two line segments, as shown in the figure above. If $g(0) = 1$, what is $g(3)$?

(A) $\pi + 1$ (B) $\pi + 2$ (C) $2\pi + 1$ (D) $2\pi + 2$

---

16. Let f be the function given by $f(x) = x^3 - 6x^2 - 15x$. What is the maximum value of f on the interval $[0, 6]$?

(A) 0 (B) 5 (C) 6 (D) 8

GO ON TO THE NEXT PAGE.

17. $\displaystyle\int \frac{1}{x^2 + 4x + 5}\,dx =$

(A) $\arctan(x + 2) + C$

(B) $\arcsin(x + 2) + C$

(C) $\ln\left|x^2 + 4x + 5\right| + C$

(D) $\dfrac{1}{\frac{1}{3}x^3 + 2x^2 + 5x} + C$

---

18. Let f be the function defined by $f(x) = \sqrt[3]{x}$. What is the approximation for $f(10)$ found by using the line tangent to the graph of f at the point $(8, 2)$?

(A) $\dfrac{11}{6}$ (B) $\dfrac{25}{12}$ (C) $\dfrac{13}{6}$ (D) $\dfrac{7}{3}$

GO ON TO THE NEXT PAGE.

19. $\lim_{x \to 0} \dfrac{4x^2}{e^{4x} - 4x - 1}$ is

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

---

20. Let g be a twice-differentiable, increasing function of t. If $g(0) = 20$ and $g(10) = 220$, which of the following must be true on the interval $0 < t < 10$?

(A) $g'(t) = 0$ for some t in the interval.

(B) $g'(t) = 20$ for some t in the interval.

(C) $g''(t) = 0$ for some t in the interval.

(D) $g''(t) > 0$ for all t in the interval.

GO ON TO THE NEXT PAGE.

21. $\dfrac{d}{dx}\displaystyle\int_e^{x^3} \ln\left(t^2+1\right)\,dt =$

(A) $\ln\left(x^6+1\right)$

(B) $3x^2\ln\left(x^2+1\right)$

(C) $3x^2\ln\left(x^6+1\right)$

(D) $\ln\left(x^6+1\right) - \ln\left(e^2+1\right)$

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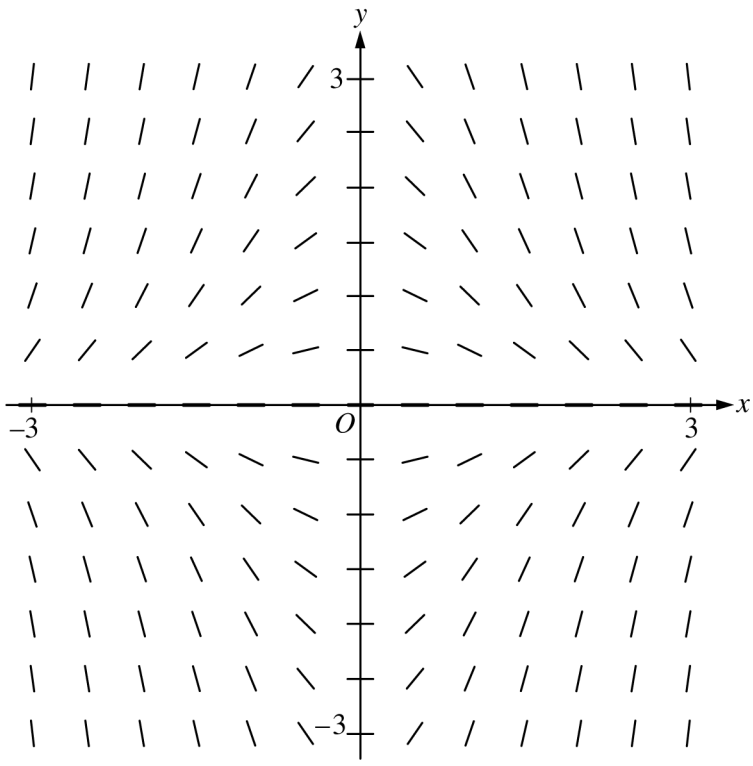

22. Shown above is a slope field for which of the following differential equations?

(A) $\frac{dy}{dx} = \frac{x}{y}$

(B) $\frac{dy}{dx} = -\frac{x}{y}$

(C) $\frac{dy}{dx} = xy$

(D) $\frac{dy}{dx} = -xy$

23. Using the substitution $u = x + 1$, $\displaystyle\int \frac{x}{\sqrt{x+1}}\,dx$ is equivalent to

(A) $\displaystyle\int \frac{1}{u+1}\,du$ (B) $\displaystyle\int u^{-1/2}\,du$ (C) $\displaystyle\int \left(u^{1/2} - u^{-1/2}\right)du$ (D) $\displaystyle(u-1)\int u^{-1/2}\,du$

---

24. Let f be the function given by $f(x) = \dfrac{2x^2 + 14x - 16}{x^2 - 9x + 8}$. For what values of x does f have a removable discontinuity?

(A) 1 only (B) 8 only (C) -8 and 1 (D) 1 and 8

GO ON TO THE NEXT PAGE.

25. Which of the following is a solution to the differential equation $y'' - 4y = 0$?

(A) $y = e^{2x}$ (B) $y = 2e^{x}$ (C) $y = \sin(2x)$ (D) $y = \cos(2x)$

GO ON TO THE NEXT PAGE.

x	10	11	12	13	14
$f(x)$	5	2	3	6	5

26. The table above gives values of the continuous function f at selected values of x. If f has exactly two critical points on the open interval $(10, 14)$, which of the following must be true?

(A) $f(x) > 0$ for all x in the open interval $(10, 14)$.

(B) $f'(x)$ exists for all x in the open interval $(10, 14)$.

(C) $f'(x) < 0$ for all x in the open interval $(10, 11)$.

(D) $f'(12) \neq 0$

GO ON TO THE NEXT PAGE.

27. The positive variables p and c change with respect to time t. The relationship between p and c is given by the equation $p^2 = (20 - c)^3$. At the instant when $\frac{dp}{dt} = 41$ and $c = 15$, what is the value of $\frac{dc}{dt}$?

(A) $-\frac{82}{75}$ (B) $-\frac{2\sqrt{5}}{3}$ (C) $-\frac{3\sqrt{5}}{2}$ (D) $-\frac{82\sqrt{5}}{15}$

---

28. $\lim_{x \to -\infty} \frac{3 + 2^x}{4 - 5^x}$ is

(A) $-\frac{2}{5}$ (B) 0 (C) $\frac{3}{4}$ (D) nonexistent

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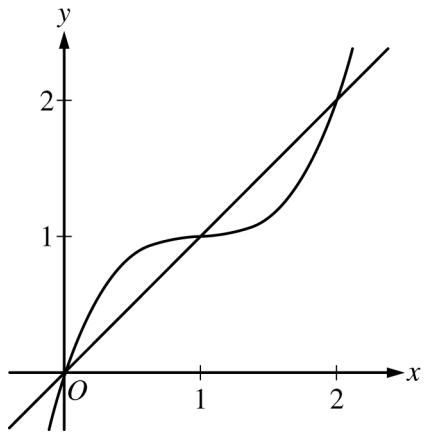

29. The graphs of the function g and the line $y = x$ are shown in the figure above. The graphs intersect at the points $(0, 0)$, $(1, 1)$, and $(2, 2)$. Which of the following expressions give the area enclosed by the graphs?

I. $\left| \int_0^2 (x - g(x))\, dx \right|$

II. $\int_0^2 \left| x - g(x) \right| dx$

III. $\int_0^1 (g(x) - x)\, dx + \int_1^2 (x - g(x))\, dx$

(A) II only

(B) III only

(C) I and II only

(D) II and III only

GO ON TO THE NEXT PAGE.

30. A student attempts to solve the differential equation $\frac{dy}{dx} = xy^3$ with the initial condition that $y = 2$ when $x = 0$. The steps of the student's solution are shown below. In which of the following steps does an error first appear?

Step 1: $\int \frac{1}{y^3}\, dy = \int x\, dx$

Step 2: $\ln \left| y^3 \right| = \frac{x^2}{2} + C$

Step 3: $\left| y^3 \right| = Ke^{x^2/2}$

Step 4: $\left| y^3 \right| = 4e^{x^2/2}$

Step 5: $y = \sqrt[3]{4e^{x^2/2}}$

(A) Step 1 (B) Step 2 (C) Step 3 (D) Step 4

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

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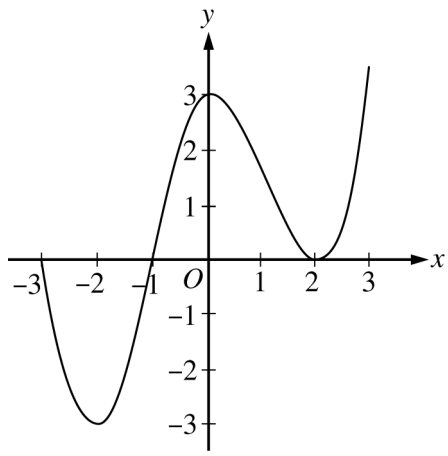

Graph of f'

76. The graph of f', the derivative of the function f, is shown above for $-3 \le x \le 3$. On what intervals is f increasing?

(A) $[-3, -1]$ only (B) $[-1, 3]$ (C) $[-2, 0]$ and $[2, 3]$ (D) $[-3, -1]$ and $[1, 3]$

77. The rate at which water leaks from a tank, in gallons per hour, is modeled by R, a differentiable function of the number of hours after the leak is discovered. Which of the following is the best interpretation of $R'(3)$?

(A) The amount of water, in gallons, that has leaked out of the tank during the first three hours after the leak is discovered

(B) The amount of change, in gallons per hour, in the rate at which water is leaking during the three hours after the leak is discovered

(C) The rate at which water leaks from the tank, in gallons per hour, three hours after the leak is discovered

(D) The rate of change of the rate at which water leaks from the tank, in gallons per hour per hour, three hours after the leak is discovered

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78. A particle moves along the x-axis. The velocity of the particle at time t is given by $v(t) = \dfrac{4}{t^3 + 1}$. If the position of the particle is $x = 1$ when $t = 2$, what is the position of the particle when $t = 4$?

(A) 0.617 (B) 0.647 (C) 1.353 (D) 5.713

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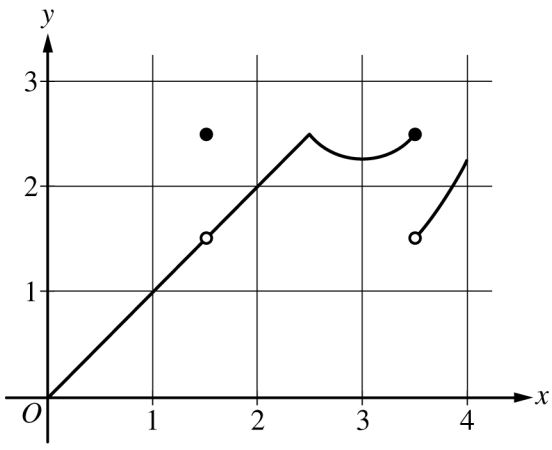

Graph of f

79. The graph of the function f is shown above. Of the following intervals, on which is f continuous but not differentiable?

(A) $(0, 1)$ (B) $(1, 2)$ (C) $(2, 3)$ (D) $(3, 4)$

80. The first derivative of the function f is defined by $f'(x) = \left(x^2 + 1\right)\sin(3x - 1)$ for $-1.5 < x < 1.5$. On which of the following intervals is the graph of f concave up?

(A) $(-1.5, -1.341)$ and $(-0.240, 0.964)$

(B) $(-1.341, -0.240)$ and $(0.964, 1.5)$

(C) $(-0.714, 0.333)$ and $(1.381, 1.5)$

(D) $(-1.5, -0.714)$ and $(0.333, 1.381)$

---

81. During a rainfall, the depth of water in a rain gauge increases at a rate modeled by $R(t) = 0.5 + t\cos\left(\frac{\pi t^3}{80}\right)$, where t is the time in hours since the start of the rainfall and $R(t)$ is measured in centimeters per hour. How much did the depth of water in the rain gauge increase from $t = 0$ to $t = 3$ hours?

(A) 1.233 cm (B) 1.466 cm (C) 1.966 cm (D) 5.401 cm

GO ON TO THE NEXT PAGE.

82. Let f be a function such that $f(1) = -2$ and $f(5) = 7$. Which of the following conditions ensures that $f(c) = 0$ for some value c in the open interval $(1, 5)$?

(A) $\int_1^5 f(x)\,dx$ exists.

(B) f is increasing on the closed interval $[1, 5]$.

(C) f is continuous on the closed interval $[1, 5]$.

(D) f is defined for all values of x in the closed interval $[1, 5]$.

---

83. The acceleration of a particle moving along the x-axis is given by $a(t) = (t - 8)\sin t$ for $0 \le t \le 8$. At what value of t is the particle's velocity decreasing most rapidly?

(A) 0 (B) 1.420 (C) 3.142 (D) 4.439

GO ON TO THE NEXT PAGE.

84. If the average value of the function f over the closed interval $[2, 4]$ is 3 and if $f(x) \geq 0$ for all x in $[2, 4]$, what is the area of the region enclosed by the graph of $y = f(x)$, the lines $x = 2$ and $x = 4$, and the x-axis?

(A) 12 (B) 6 (C) 3 (D) $\frac{3}{2}$

x	-0.1	-0.01	-0.001	0.001	0.01	0.1
$f(x)$	-0.1054	-0.0101	-0.001	0.001	0.0099	0.0953

85. The function f is continuous and increasing for $x > -1$. The table above gives values of f at selected values of x. Of the following, which is the best approximation for $\lim_{x \to 0} e^{-2f(x)}$?

(A) -2

(B) 0

(C) 1

(D) The limit does not exist.

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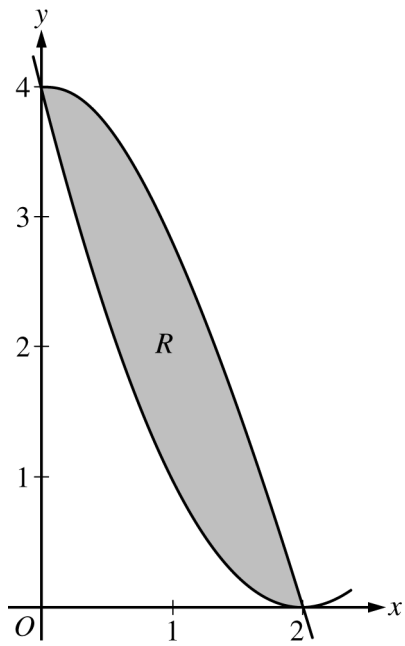

86. Let R be the region in the first quadrant bounded by the graphs of $y = 4\cos\left(\frac{\pi x}{4}\right)$ and $y = (x-2)^2$, as shown in the figure above. The region R is the base of a solid. For the solid, each cross section perpendicular to the x-axis is an isosceles right triangle with a leg in region R. What is the volume of the solid?

(A) 1.775 (B) 3.549 (C) 4.800 (D) 5.575

GO ON TO THE NEXT PAGE.

87. Let f and g be continuous functions. If $\int_2^6 f(x)\,dx = 5$ and $\int_6^2 g(x)\,dx = 7$, then $\int_2^6 (3f(x) + g(x))\,dx =$

(A) -6 (B) 8 (C) 22 (D) 36

---

88. Let f be a twice-differentiable function such that $f''(x) < 0$ for all x. The graph of $y = S(x)$ is the secant line passing through the points $(3, f(3))$ and $(5, f(5))$. The graph of $y = T(x)$ is the line tangent to the graph of f at $x = 4$. Which of the following is true?

(A) $f(4.2) < S(4.2) < T(4.2)$

(B) $f(4.2) < T(4.2) < S(4.2)$

(C) $S(4.2) < f(4.2) < T(4.2)$

(D) $T(4.2) < f(4.2) < S(4.2)$

GO ON TO THE NEXT PAGE.

89. The number of insects in a certain population at time t days is modeled by the function P with first derivative $P'(t) = 0.3t^2 + 12t + 210$. At time $t = 0$, the number of insects in the population is 40. Which of the following statements are true?

I. At time $t = 10$, the number of insects in the population is 2840.

II. At time $t = 10$, the number of insects in the population is increasing at a rate of 360 insects per day.

III. At time $t = 10$, the rate of change of the number of insects in the population is increasing at a rate of 18 insects per day per day.

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

GO ON TO THE NEXT PAGE.

x	3	7
$h(x)$	7	22
$h'(x)$	5	10

90. Selected values of the increasing function h and its derivative h' are shown in the table above. If g is a differentiable function such that $h(g(x)) = x$ for all x, what is the value of $g'(7)$?

(A) $-\frac{1}{10}$ (B) $\frac{1}{10}$ (C) $\frac{1}{5}$ (D) $\frac{7}{5}$

GO ON TO THE NEXT PAGE.