2026

AP® Precalculus

Free-Response Questions

PRECALCULUS
SECTION II PART A
TIME – 30 MINUTES

Directions:

Section II, Part A has 2 free-response questions and lasts 30 minutes.

A graphing calculator is required for the questions on this part of the exam. You may use a handheld graphing calculator or the calculator available in this application. **Make sure your calculator is in radian mode.**

You may use the available paper for scratch work and planning, but only work written in the free-response booklet will be scored. Any work done on scratch paper will not be scored. In the free-response booklet, write your solution to each part of each question in the space provided for that part. Use a pencil or a pen with black or dark blue ink.

Show all of your work. Your work will be scored on the correctness and completeness of your responses, including your supporting work and answers. Answers without supporting work may not receive credit in cases where supporting work is requested.

You are expected to use your graphing calculator for tasks such as producing graphs and tables, evaluating functions, solving equations, and performing computations.

Avoid rounding intermediate computations on the way to the final result. Unless otherwise specified, any decimal approximations reported in your work should be accurate to three places after the decimal point.

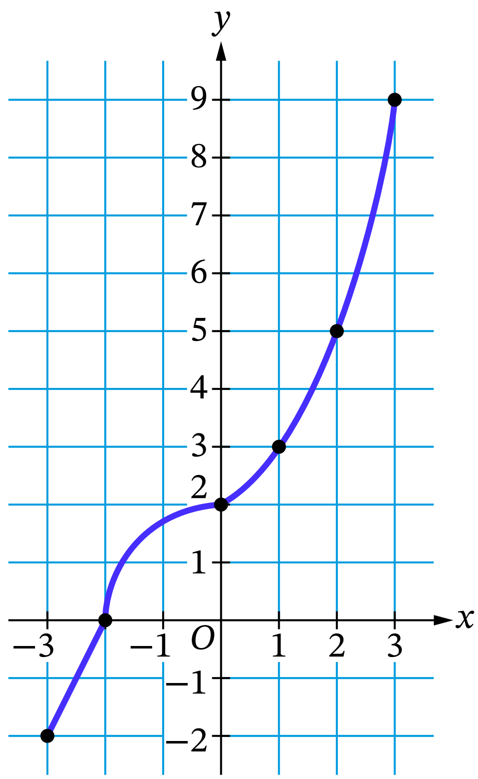
It may be helpful to use your graphing calculator to store information such as computed values for constants, functions you are working with, solutions to equations, and any intermediate values. Computations with the graphing calculator that use the stored information help to maintain as much precision as possible and ensure the desired accuracy in final answers.

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.

You can go back and forth between questions in this part until time expires. The clock will turn red when 5 minutes remain—**the proctor will not give you any time updates or warnings.**

Note: This exam was originally administered digitally. It is presented here in a format optimized for teacher and student use in the classroom.

1. The figure shows the graph of the increasing function f on its domain of $-3 \le x \le 3$.



Graph of f

The function g is given by $g(x) = -4.792 + \ln(6x - 6)$.

A.

i. The function h is defined by $h(x) = (g \circ f)(x) = g(f(x))$. Find the value of $h(2)$ as a decimal approximation, or indicate that it is not defined. Show the work that leads to your answer.

ii. Find all values of x for which $f(x) = 3$, or indicate that there are no such values.

B.

i. Find all values of x, as decimal approximations, for which $g(x) = -1.5$, or indicate that there are no such values.

ii. Determine the behavior of g as x-values decrease and get arbitrarily close to 1. Express your answer using the mathematical notation of a limit.

C.

i. Is the function f invertible?

ii. Give a reason for your answer in part C (i) based on properties of the function f. Refer to points on the graph of f in your reasoning.

2. A person purchased a car at the end of the year 2019 ($t = 0$). The car's value decreases over time. At the end of the year 2020 ($t = 1$), the car was valued at 27.2 thousand dollars. At the end of the year 2025 ($t = 6$), the car was valued at 14.8 thousand dollars.

The value of the car can be modeled by the function V given by $V(t) = ab^t$, where $V(t)$ is the value of the car, in thousands of dollars, at time t, and t is the number of years since the end of 2019.

A.

i. Use the given data to write two equations that can be used to find the values for constants a and b in the expression for $V(t)$.

ii. Find the values for a and b as decimal approximations.

B.

i. Use the given data to find the average rate of change of the value of the car, in thousands of dollars per year, from $t = 1$ to $t = 6$ years. Express your answer as a decimal approximation. Show the computations that lead to your answer.

ii. Use the average rate of change found in part B (i) to estimate the value of the car, in thousands of dollars, at $t = 3$ years. Show the work that leads to your answer.

iii. The average rate of change found in part B (i) can be used to determine the secant line for the graph of V on the interval $1 \le t \le 6$. Let $A(t)$ represent the estimate of the value of the car, in thousands of dollars, at time t years, using the secant line. For $A(3)$, found in part B (ii), it can be shown that $A(3) > V(3)$.

In general, $A(t) > V(t)$ for all t, where $1 < t < 6$. Use the secant line and the graph of V to explain why this is true.

C. When the value of the car reaches 2 thousand dollars, the car's owner plans to donate it to an auto mechanic school. As a result, the car will immediately lose all of its value. Explain how this information can be used to determine a domain limitation for the model V.

END OF PART A

PRECALCULUS
SECTION II PART B
TIME – 30 MINUTES

Directions:

Section II, Part B has 2 free-response questions and lasts 30 minutes.

No calculator is allowed for this part of the exam.

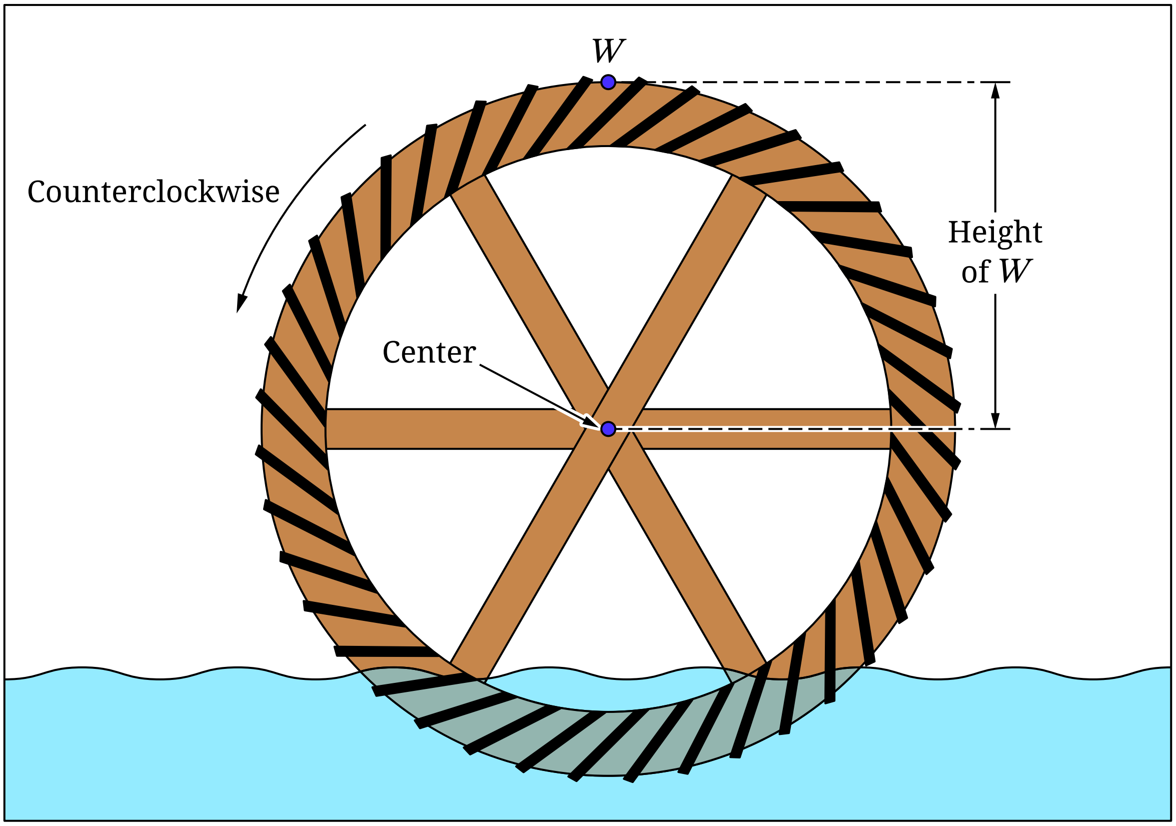
You may use the available paper for scratch work and planning, but only work written in the free-response booklet will be scored. Any work done on scratch paper will not be scored. In the free-response booklet, write your solution to each part of each question in the space provided for that part. Use a pencil or a pen with black or dark blue ink.

Show all of your work. Your work will be scored on the correctness and completeness of your responses, including your supporting work and answers. Answers without supporting work may not receive credit in cases where supporting work is requested.

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.

You can go back and forth between questions in this part until time expires. The clock will turn red when 5 minutes remain—**the proctor will not give you any time updates or warnings.**

3. The figure shows a circular waterwheel that rotates in a counterclockwise direction at a constant rate and completes 1 revolution in 10 seconds. At time $t = 0$, point W on the edge of the waterwheel is at a height of 6 feet directly above the center of the waterwheel. The height of point W from the horizontal line through the center of the waterwheel periodically decreases and increases as the waterwheel moves.

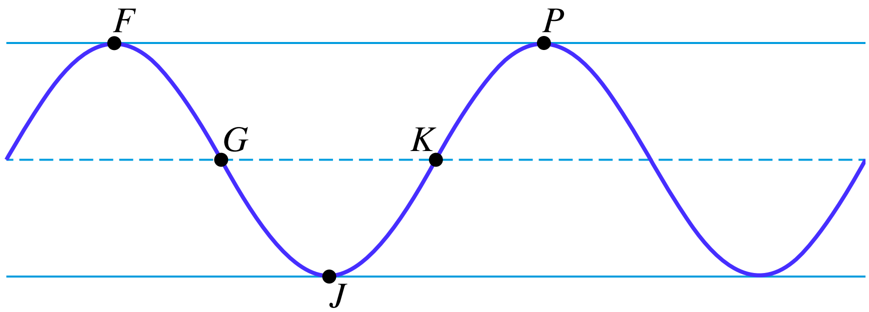


Note: Figure not drawn to scale.

The sinusoidal function h models the height of point W from the horizontal line through the center of the waterwheel, in feet, as a function of time t, in seconds. A positive value of $h(t)$ indicates W is above the line through the center; a negative value of $h(t)$ indicates W is below the line through the center.

A. The graph of *h* and its dashed midline for two full cycles is shown. Five points, *F*, *G*, *J*, *K*, and *P*, are labeled on the graph. No scale is indicated, and no axes are presented.

Determine possible coordinates $(t, h(t))$ for the five points: *F*, *G*, *J*, *K*, and *P*.



B. The function *h* can be written in the form $h(t) = a \sin(b(t + c)) + d$. Find values of constants *a*, *b*, *c*, and *d*.

C. Refer to the graph of *h* in part A. The *t*-coordinate of *J* is t_1, and the *t*-coordinate of *K* is t_2.

i. On the interval (t_1, t_2), which of the following is true about *h*?

a. *h* is positive and increasing.

b. *h* is positive and decreasing.

c. *h* is negative and increasing.

d. *h* is negative and decreasing.

ii. On the interval (t_1, t_2), describe the concavity of the graph of *h* and determine whether the rate of change of *h* is increasing or decreasing.

4. Directions:

- 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. Angle measures for trigonometric functions are assumed to be in radians.
- Solutions to equations must be real numbers. Determine the exact value of any expression that can be obtained without a calculator. For example, $\log_2 8$, $\cos\left(\frac{\pi}{2}\right)$, and $\sin^{-1}(1)$ can be evaluated without a calculator.
- Unless otherwise specified, combine terms using algebraic methods and rules for exponents and logarithms, where applicable. For example, $2x + 3x$, $5^2 \cdot 5^3$, $\frac{x^5}{x^2}$, and $\ln 3 + \ln 5$ should be rewritten in equivalent forms.
- For each part of the question, show the work that leads to your answers.

A. The functions *g* and *h* are given by

$g(x) = e^{2x}$
$h(x) = \log_2(5x)$

i. Solve $g(x) = \frac{1}{e^6}$ for values of *x* in the domain of *g*.

ii. Solve $h(x) = 3$ for values of *x* in the domain of *h*.

B. The functions *j* and *k* are given by

$j(x) = 7^{(3x+1)} \cdot 7^x$
$k(x) = \sin(2x) \sec x$

i. Rewrite $j(x)$ as an expression of the form $7^{(\text{expression})}$.

ii. Rewrite $k(x)$ as an expression in which $\sin x$ appears exactly once and no other trigonometric functions are involved.

C. The function *m* is given by $m(x) = \tan^2(3x)$.

Find all input values for *m* in the interval $\left[0, \frac{\pi}{2}\right]$ that yield an output value of 1.

STOP

END OF EXAM