Past-paper walk-through

Rates of Change ▪ 1.2

eXercise

Questions in this set

- 2026 Q2
- 2026 Q3
- 2025 Q2
- 2024 Q2

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 2

2026 ▪ Q2

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 $V(t)$.

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

Question 2

2026 ▪ Q2

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.

(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.

(b)(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.

Question 2

(b)(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 $1 \leq t \leq 6$. 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.

Question 2

2026 ▪ Q2

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(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.

Question 3

2026 ▪ Q3

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.

[Diagram of a circular waterwheel partially submerged in water. The wheel has spokes radiating from a labeled "Center" point, and hatched paddles around the rim. Point W is labeled at the top of the wheel. An arrow labeled "Counterclockwise" indicates the direction of rotation. A vertical double-headed arrow labeled "Height of W" shows the vertical distance from the horizontal dashed line through the center up to W. The bottom portion of the wheel is submerged in wavy water. Note: Figure not drawn to scale.]

Question 3

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.

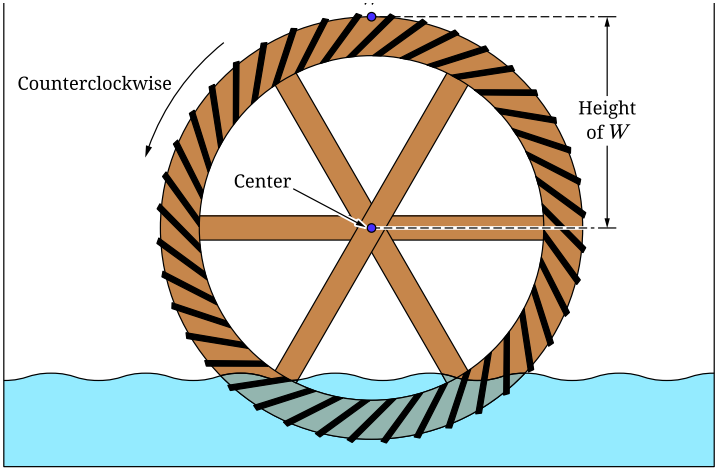
[Graph of h: a sinusoidal (cosine-shaped) curve with a dashed horizontal midline, showing two full cycles. No axes or scale are shown — only the curve and the midline. Point F is labeled at the first (leftmost) maximum of the curve. Point G is labeled where the curve crosses the midline, descending, between the first maximum and the first minimum. Point J is labeled at the minimum of the curve (between the two maxima). Point K is labeled where the curve crosses the midline, ascending, between

Question 3

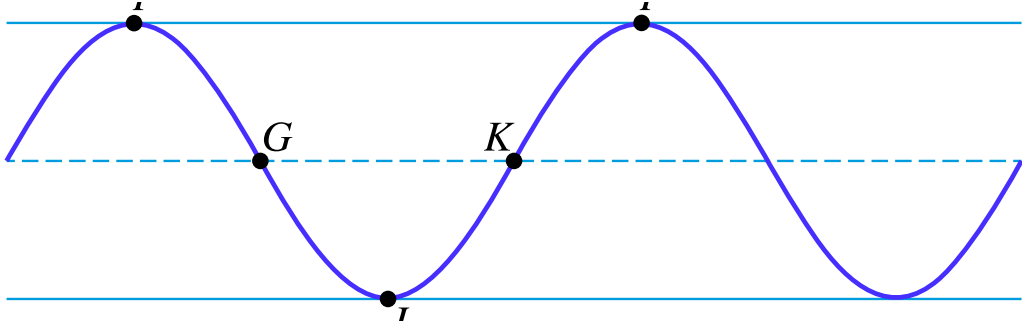
the minimum and the second maximum. Point P is labeled at the second maximum of the curve.]

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

Question 3



Question 3



Question 3

2026 ▪ Q3

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.

[Diagram of a circular waterwheel partially submerged in water. The wheel has spokes radiating from a labeled "Center" point, and hatched paddles around the rim. Point W is labeled at the top of the wheel. An arrow labeled "Counterclockwise" indicates the direction of rotation. A vertical double-headed arrow labeled "Height of W" shows the vertical distance from the horizontal dashed line through the center up to W. The bottom portion of the wheel is submerged in wavy water. 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 $h(t)$

Question 3

indicates W is above the line through the center; a negative value of $h(t)$ indicates W is below the line through the center.

(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.

Question 3

2026 ▪ Q3

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Question 3

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(c)(i) 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.

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.

(c)(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.

Question 2

2025 ▪ Q2

A musician released a new song on a streaming service. A streaming service is an online entertainment source that allows users to play music on their computers and mobile devices.

Several months later, the musician began using an app (at time $t = 0$) that counts the total number of plays for the song since its release. A "play" is a single stream of the song on the streaming service. The table gives the total number of plays, in thousands, for selected times t months after the musician began using the app. At $t = 0$, the total number of plays was 25 thousand. At $t = 2$, the total number of plays was 30 thousand. At $t = 4$, the total number of plays was 34 thousand.

Question 2

Months after the musician began using the app	0	2	4
Total number of plays for the song since its release (thousands)	25	30	34

The total number of plays, in thousands, for the song since its release can be modeled by the function D given by $D(t) = at^2 + bt + c$, where $D(t)$ is the total number of plays, in thousands, for the song since its release, and t is the number of months after the musician began using the app.

Question 2

(a)(i) Use the given data to write three equations that can be used to find the values for constants a, b, and c in the expression for $D(t)$.
(a)(ii) Find the values for a, b, and c as decimal approximations.

Question 2

Months after the musician began using the app	0	2	4
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