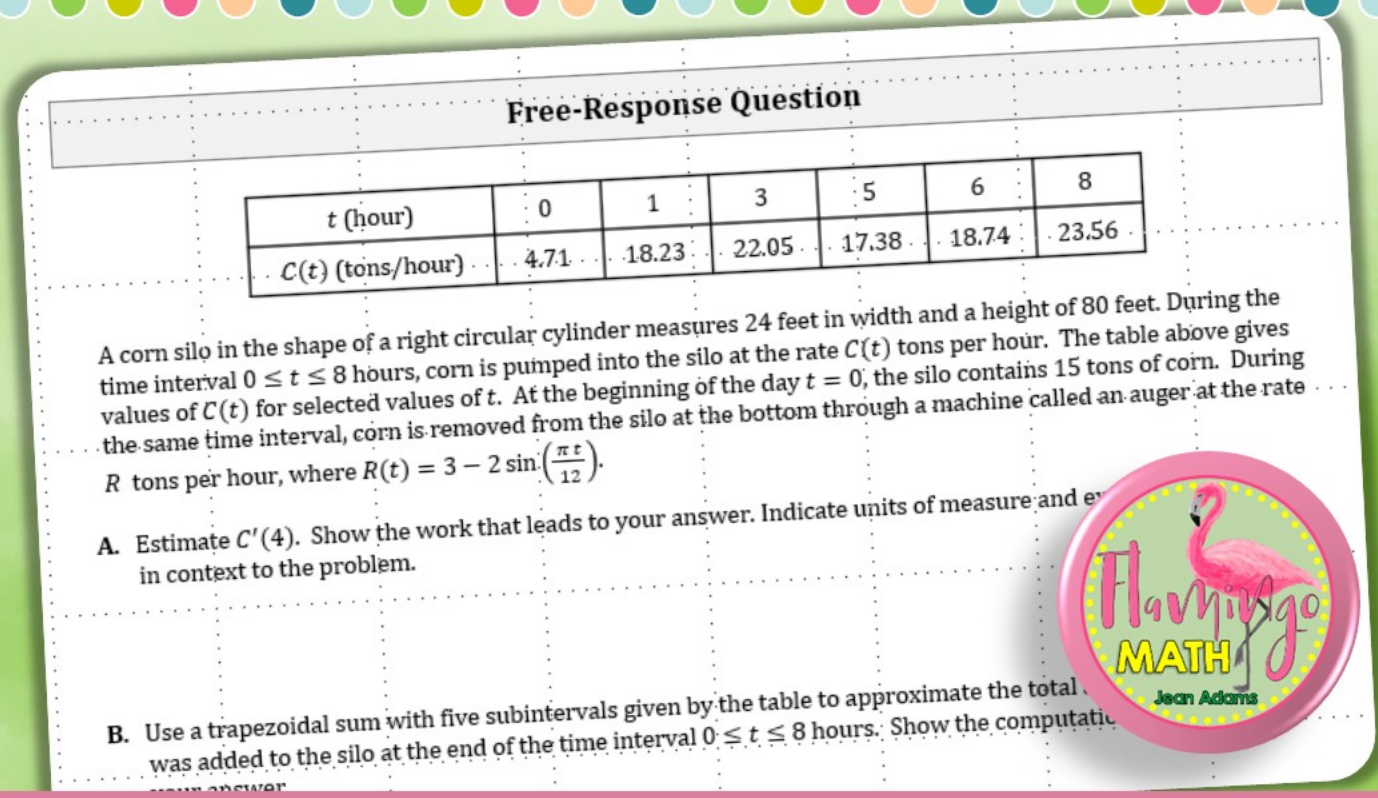
AP® Calculus AB/BC

Free Response Task Models



Free-Response Question

t (hour)	0	1	3	5	6	8
$C(t)$ (tons/hour)	4.71	18.23	22.05	17.38	18.74	23.56

A corn silo in the shape of a right circular cylinder measures 24 feet in width and a height of 80 feet. During the time interval $0 \le t \le 8$ hours, corn is pumped into the silo at the rate $C(t)$ tons per hour. The table above gives values of $C(t)$ for selected values of t. At the beginning of the day $t = 0$, the silo contains 15 tons of corn. During the same time interval, corn is removed from the silo at the bottom through a machine called an auger at the rate R tons per hour, where $R(t) = 3 - 2\sin\left(\frac{\pi t}{12}\right)$.

A. Estimate $C'(4)$. Show the work that leads to your answer. Indicate units of measure and ex
in context to the problem.

B. Use a trapezoidal sum with five subintervals given by the table to approximate the total
was added to the silo at the end of the time interval $0 \le t \le 8$ hours. Show the computati
your answer.

10 Free Response Questions

AP Calculus AB & BC FRQ Set

KEY CONCEPTS/TOPICS:

This is a set of ten Free Response Questions for AP Calculus AB & BC that can be used to practice for the AP Exam at the end of the year review time. There are four FRQ's that are BC Only concepts for Taylor Polynomials, Euler's Method, Lagrange Error Bound, Integration by Parts, and Differential Equations.

About The Product

Free Response Set

This set of ten free response questions is designed for AP Calculus students to practice **AP-Style Free Response prompts** during your **AP Exam Review.**

What concepts are covered in the set of FRQ's?

Question #1: Graph Analysis
Question #2: Linear Motion/Particle Motion
Question #3: Rate and Accumulation
Question #4: Tables and Riemann Sums
Question #5: Rate and Accumulation
Question #6: Area and Volume
Question #7: BC Topics for Differential Equations, Euler's Method, Taylor Polynomials
Question #8: BC Topics for Taylor polynomials, Lagrange Error Bound
Question #9: BC Vector-Valued Functions and Particle Motion
Question #10: BC Polar Curves and Area

Preparation

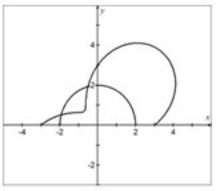
1. Copy an FRQ prompt for each student.
2. Have students work the problem set.
3. Grade on a 9-point scale, included in the key to match the AP Calculus Exam.

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Product Pages

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Free-Response Question
Calculator Required



The figure above shows the graphs of the polar curves $r = f(\theta) = 3 + 2\sin(2\theta)$ and $r = g(\theta) = 2$ for $0 \le \theta \le \pi$.

A. Find the area of the region R that is inside the graph of $r = f(\theta)$ and outside the graph of $r = g(\theta)$.

B. For the curve $r = f(\theta)$, find the value of $\frac{dr}{d\theta}$ at $\theta = \frac{\pi}{6}$. Interpret the meaning of your answer in the context of the problem.

curve r (θ) the x-c dinat the int on cur
of ch e o x-coo nat respect to θ $\frac{\pi}{4}$

A particle moves along the polar curve $r = f(\theta)$ so that its position at
where $\frac{d\theta}{dt} = 2$. Find the value of $\frac{dr}{dt}$ at the instant $\theta = \frac{\pi}{3}$.

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Free-Response Question
Calculator Required

For $0 \le t \le 4$, a particle moves along a curve in the xy-plane so that its position at time t is $(x(t), y(t))$. At time $t = 0$, the particle is at position $(5,2)$. The velocity vector of the particle at time t is given by

$$v(t) = \left(\sqrt{t^2 + 9}\ , 3\cos(e^{0.5t})\right)$$

A. Find the slope of the line tangent to the path of the particle at time $t = 2$.

B. Fin he s of the ticle at me 2, and nd ti celer vector of the particle at e $t =$

C. Find the y-coordinate of the particle's position at time $t = 3$.

D. Find the total distance traveled by the ticl ver tim $0 \le t$

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Free Response Questi
Calculator Required

Let R be the region in the first quadrant bounded by the graph of $y = 4 - x^2$ and $y = 1 + 2\sin x$.

A. Find the area of the region R.

B. d the volu of the s d generated when the region R is re

C. The region R is the base of a solid. For this solid, each cross-section perpendicular to the x-axis is a rectangle whose height is 2 times the length of its base in region R. Find the volume of this solid.

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Free-Respon Question
N Calculator Allowed

T function f has ivatives of all orders for all real numbers. It is know
f') $= f(x^3)$, and $f'''(x) = 3x^2 \cdot f'(x^3)$.

A. Find $f^{(4)}(x)$, the fourth derivative of f with respect to x. Write the fourt
Taylor polynomial for f about $x = 0$. Show the work that leads to your a

B. The fourth-degree Taylor polynomial for f about $x = 0$ is used to appro
$|f^{(5)}(x)| \le 20$ for $0 \le x \le 0.5$, use the Lagrange error bound to show t
is within $\frac{1}{10^4}$ of the exact value of $f(0.2)$.

C. Let h be the fun on such that $h(0) = 1$ and $h'(x) = e^{2x}f(x)$. Write the second-degree Taylor polynomial for h about $x = 0$.

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ree-Response Question
No Calculator Allowed

to the differential equation $\frac{dy}{dx} = (y - 1) \cdot \ln(x)$ for $x > 0$, with shown that $f''(1) = 2$.

nomial for f about $x = 1$. Use the Taylor polynomial t

1 with two steps of equal size, to approximate $f(2)$.

C. Find the particular solution $y = f(x)$ to the differential equation $\frac{dy}{dx} = (y - 1) \cdot \ln(x)$ with the initial condition $f(1) = 3$.

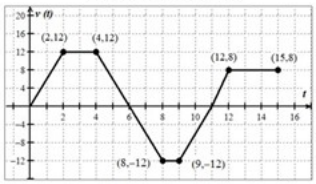
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Free-Response Question
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Randy the Roach begins to crawl out from a paper bag along the floor toward a potato chip crumb at time $t = 0$ in a straight line. For time $0 \le t \le 15$, Randy's velocity is modeling by the piecewise-linear function defined by the graph above.

A. At what times in the interval $0 < t < 15$, if any, does Randy change direction? Give a reason for your answer.

B. At what time in the interval $0 \le t \le 15$ is Randy farthest from the bag? How far from the bag is Randy at this time?

D. Write expressions for Randy the Roach's acceleration $a(t)$, velocity

bag that are valid for the time interval $4 < t < 8$.

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Free Response Question
Calculator Required

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A corn silo in the shape of a right circular cylinder measures 24 feet in width and a height of 80 feet. During the time interval $0 \le t \le 8$ hours, corn is pumped into the silo at the rate $C(t)$ tons per hour. The table abo gives values of $C(t)$ for selected values of t. At the beginning of the day $t = 0$, the silo contains 15 ns of cor During the same time interval, corn is removed from the s t the bottom through a m ine calle nger he rate R tons per hour, where $R(t) = 3 - 2\sin\left(\frac{\pi t}{12}\right)$.

A. Estimate $C'(4)$. Show the work that leads to ir ower. ic measure xplain t eaning in context to the problem.

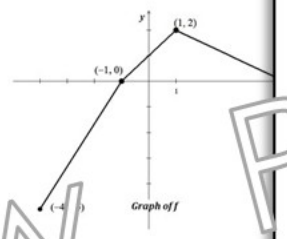
B. U a trape al sum with e subintervals given by the table to approximate the total amount of corn that w added to ilo at nd of the time interval $0 \le t \le 8$ hours. Show the computations that lead to yo answer.

C. Calculate $\frac{1}{8}\int_0^8 R(t)dt$ and explain the meaning in context of the problem.

D. What is the total amount of corn remaining, the rest in the end time int al $0 \le t \le 8$ hours. Show the co tations th lead ou wer.

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Free-Response Question
No Calculator Allowed



functi defi n the interval $-4 \le x \le c$, where $c >$ consists of line seg ents, shown above.

Find the average rate of change of f over the interval $[-4, 0]$. Show the computations that lead to your answer.

B. For $-4 \le x \le c$, let g be the function defined by $g(x) = \int_{-1}^{x} f(t)\,dt$. Find the x-coordinate of each point of inflection of the graph of g. Justify your answer.

C. Set up an equation that can be used to find the value of c when the average value of f over the interval $-4 \le x \le c$ is $\frac{1}{2}$.

D. The function h is defined by $h(x) = f(2x)$. Find $h'(1)$ in of c.

E. Find $\int_{-4}^{1} f(x)\,dx$.

Free Respse Questi
Calculator Required

Fertilizer is ma rom phosphate rock that is mined using opencast d
On a given workday, the rate, in tons per hour at which phosphate rock
$P(t) = 75 + 40\cos\left(\frac{t^2}{16}\right)$ where t is measured in hours and $0 \le t \le 8$.
there are 400 tons of phosphate rock ready for transport to the fertiliz
$0 \le t \le 8$, trucks can transport the mined phosphate rock at a constan

A. Find $P'(4)$. Using correct units, interpret your answer in the contex

B. Find the total amount of phosphate rock being mined during the ho
workday.

C. Is the amount of mined phosphate rock ilable for nsp tio ssing of t easing a e $t = 4$
hours? Show the work o your wer.

D. What is the maximum amount of phosphate rock mined and transported , during the hours of operation, on this particular workday? Justify your answer.

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ree Response Question
Calculator Required

ith velocity given by $v(t) = \frac{12\sin(0.5t^2)}{t^2 - t + 2}$ for time $0 \le t \le 4$.
t time $t = 0$.
article at time $t = 3.5$.

cle at e $t = 5$.

ate $\int_0^4 |v(t)|\,dt$. Interpret the meaning of each integral in the

D. A second particle moves along the x-axis with position given by $x_2(t) = t^2 - 2t$ for $1 \le t \le 4$. At what time t are the two particles moving with the same velocity?

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