



Supporting Success in AP Calculus – A Vertical Approach

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About the Dana Center

— Equity — Access — Excellence —

Dana Center by the Numbers



Dana Center by the Numbers

By the close of 2017, the Dana Center had contributed to the **implementation of math pathways** in higher education systems, institutions, and campuses in **29 states**.



Dana Center by the Numbers



We engaged with **118 districts in 23 states** to provide middle and high school math courses of the **highest quality**, as recognized by rigorous national and state reviews, including EdReports.org, Louisiana Department of Education, and Texas Education Agency panels.

Success in AP

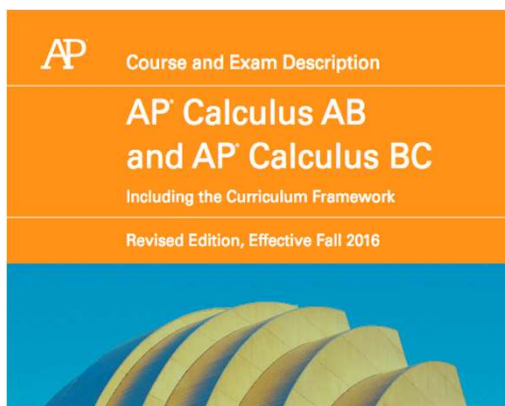
- **Depends on a rigorous, cohesive, and accessible curriculum in courses leading to AP**
- **Requires immersing students in Pre-AP instructional strategies in courses leading to AP**

Pre-AP Strategies for ALL Students

- **Comprehensive problems linking key concepts**
- **Contextual word problems**
- **Questions with multiple parts**
- **Information in graphical, numerical and algebraic forms**
- **Justification of solutions in written forms with conclusions drawn from work**
- **Conceptual understanding**

AP Calculus Curriculum Framework

- **Mathematical Practices for AP Calculus (MPACs)**
- **Big Idea 1: Limits**
- **Big Idea 2: Derivatives**
- **Big Idea 3: Integrals and the Fundamental Theorem of Calculus**
- **Big Idea 4: Series (BC)**



Processes vs. Practices

- **MPAC 1: Reasoning with definitions and theorems**
- **MPAC 2: Connecting concepts**
- **MPAC 3: Implementing algebraic/computational processes**
- **MPAC 4: Connecting multiple representations**
- **MPAC 5: Building notational fluency**
- **MPAC 6: Communicating**

Leaking Oil Tanker Problem

- **Work the problem with a partner.**
- **Look for connections to AP Calculus.**

AP Calculus Essential Knowledge (Students will know that...)

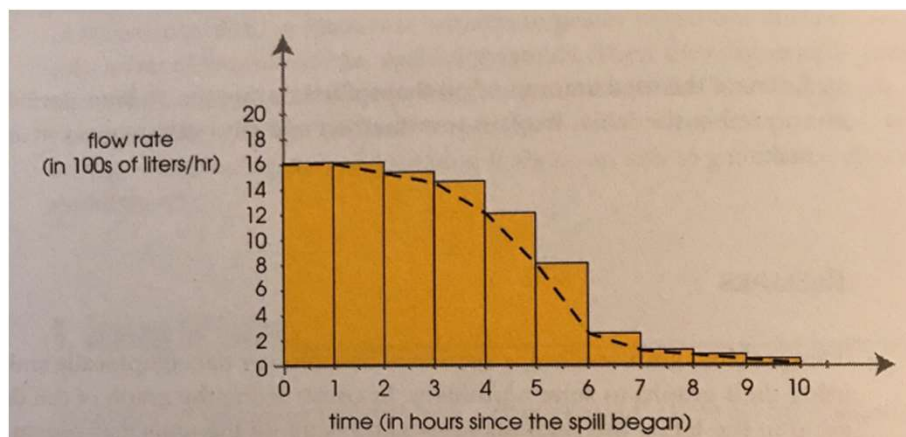
EK 3.2B1: Definite integrals can be approximated for functions that are represented graphically, numerically, algebraically, and verbally.

EK 3.2B2: Definite integrals can be approximated using a left Riemann sum, a right Riemann sum, a midpoint Riemann sum, or a trapezoidal sum; approximations can be computed using either uniform or nonuniform partitions.

EK 3.4A1: A function defined as an integral represents an accumulation of a rate of change.

EK.3.4A2: The definite integral of the rate of change of a quantity over an interval gives the net change of that quantity over that interval.

Leaking Oil Tanker



Advanced Placement Program® Mathematics Vertical Teams Toolkit, College Entrance Examination Board and Educational Testing Service, 1998

AP[®] Calculus AB 2016 Free Response Question 1

t (hours)	0	1	3	6	8
$R(t)$ (liters / hour)	1340	1190	950	740	700

Water is pumped into a tank at a rate modeled by $W(t) = 2000e^{-t^2/20}$ liters per hour for $0 \leq t \leq 8$, where t is measured in hours. Water is removed from the tank at a rate modeled by $R(t)$ liters per hour, where R is differentiable and decreasing on $0 \leq t \leq 8$. Selected values of $R(t)$ are shown in the table above. At time $t = 0$, there are 50,000 liters of water in the tank.

- Estimate $R'(2)$. Show the work that leads to your answer. Indicate units of measure.
- Use a left Riemann sum with the four subintervals indicated by the table to estimate the total amount of water removed from the tank during the 8 hours. Is this an overestimate or an underestimate of the total amount of water removed? Give a reason for your answer.
- Use your answer from part (b) to find an estimate of the total amount of water in the tank, to the nearest liter, at the end of 8 hours.
- For $0 \leq t \leq 8$, is there a time t when the rate at which water is pumped into the tank is the same as the rate at which water is removed from the tank? Explain why or why not.

AP Calculus AB Exam (2016)

<https://apcentral.collegeboard.org/courses/ap-calculus-ab/exam/past-exam-questions>

Fish Tank Problem

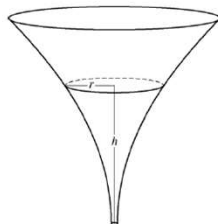
- **Work the problem with a partner.**
- **Look for connections to AP Calculus.**

Big Idea 2: Derivatives

AP Calculus Essential Knowledge (Students will know that...)

EK 2.3C2: The derivative can be used to solve related rates problems, that is, finding a rate at which one quantity is changing by relating it to other quantities whose rates of change are known.

AP[®] Calculus AB 2016 Free Response Question 2



The inside of a funnel of height 10 inches has circular cross sections, as shown in the figure above. At height h , the radius of the funnel is given by $r = \frac{1}{20}(3 + h^2)$, where $0 \leq h \leq 10$. The units of r and h are inches.

- Find the average value of the radius of the funnel.
- Find the volume of the funnel.
- The funnel contains liquid that is draining from the bottom. At the instant when the height of the liquid is $h = 3$ inches, the radius of the surface of the liquid is decreasing at a rate of $\frac{1}{5}$ inch per second. At this instant, what is the rate of change of the height of the liquid with respect to time?

AP Calculus AB Exam (2016)

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In and Out Activity

I teach _____(course). (Pick one course)

At the beginning of my course, my students should have a solid understanding of _____.

At the end of my course, my students should have a solid understanding of _____.

Contact Information

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