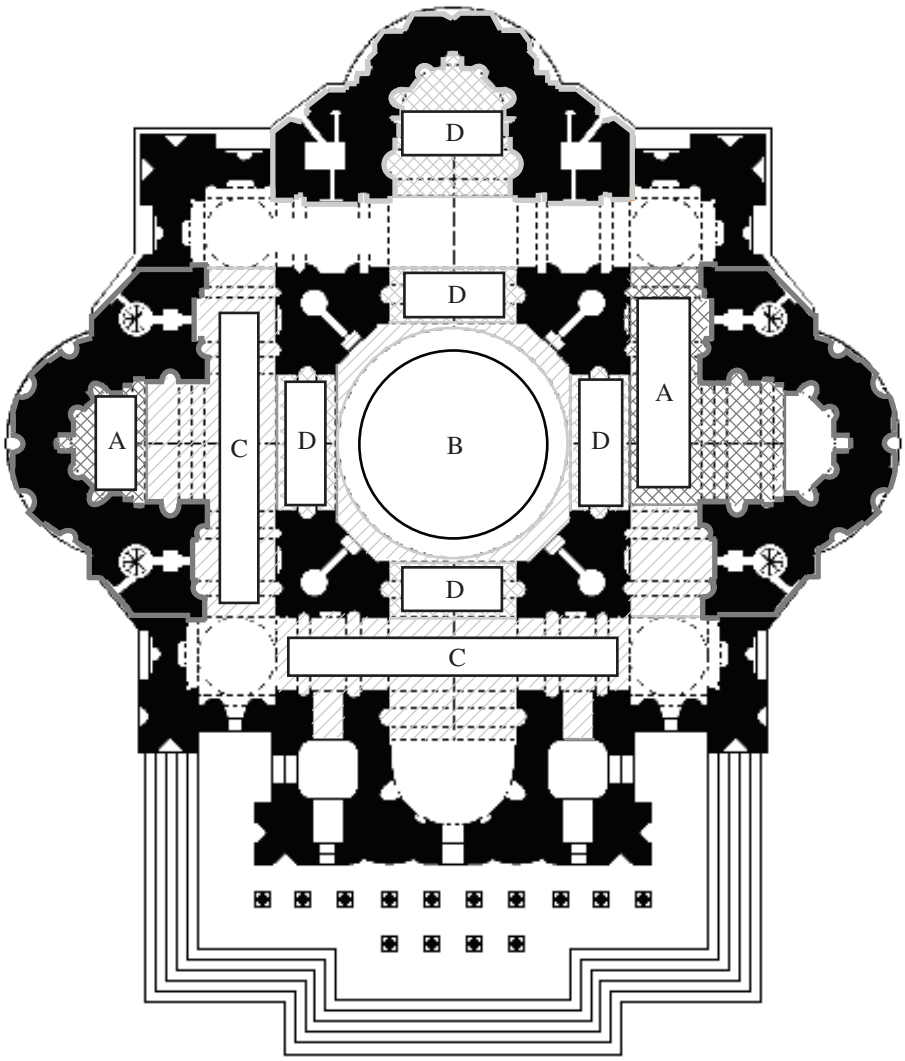
Final Math 10-270, May 6, 2013. Name

Please Note: Calculators may be used in elementary mode only, not in Calculus mode.

Below is a depiction of Michelangelo's plan for the new St. Peter's basilica. All but one of the architects: Alberti, Bernini, Bramante, Della Porta, Maderno, Michelangelo, Raphael, Sangallo, and Vignola were at one time or another capomaestri of St. Peter's.



1. (10 pts) The exception is

2. (20 pts) The sections labelled A, those labelled B, those labelled C, and those labelled D were, respectively, built by the same capomaestro. Match the sections of the structure with the capomaestro that built them:

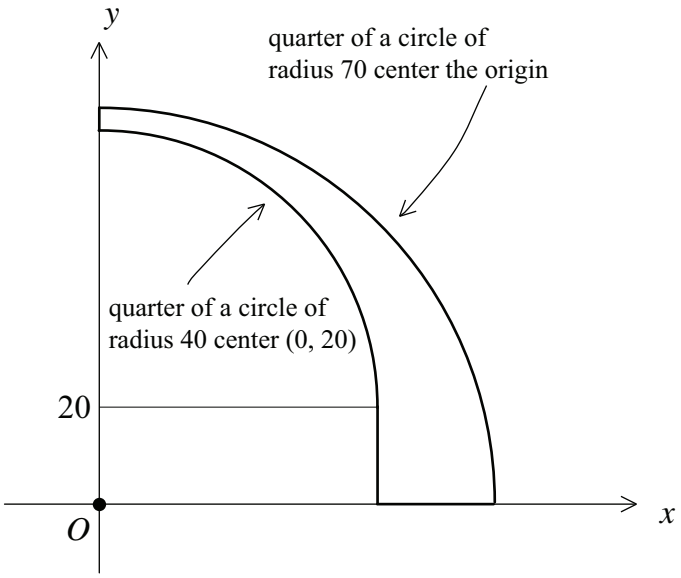
A: **B:** **C:** **D:**

3. (15 pts) Describe the parts of St. Peter's were built during the time that Michelangelo was capomaestro. Discuss the impact that Michelangelo had on the overall design of the basilica.

4. (10 pts) Let $y = f(x)$ be a function and let $[a, b]$ be a closed interval on the x-axis over which the function is continuous. The symbol $\int_a^b f(x)\,dx$ is a number that depends on the function as well as a and b. The definition of this number is the result of a process. Describe this process precisely (making use of the number line below) and distinguish along the way between the "working definition" of $\int_a^b f(x)\,dx$ and the true value of $\int_a^b f(x)\,dx$. (Your description of this process should be "abstract" and should **not mention** rectangles, areas, anti-derivatives, or the Fundamental Theorem of Calculus.)

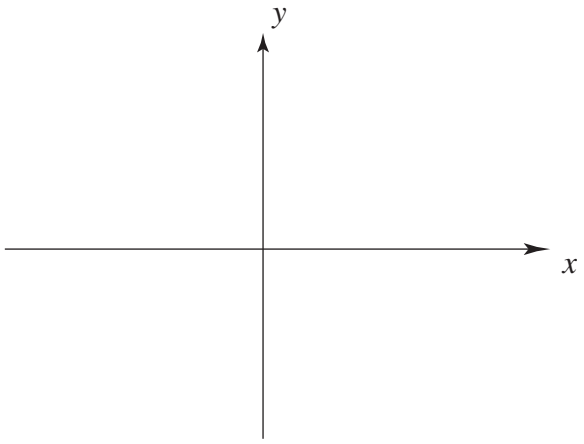
5. (10 pts) Let $f(x) = x^3$. Make use of the definition of the derivative to explain why $(5.0003)^3$ is approximately equal to $5^3 + 3(5^2)(0.0003)$.

6. (20 pts) The vertical section of the shell of a dome and its geometry is shown. All lengths are given in feet. The entire shell is the solid obtained by rotating the section shown one complete revolution around the y-axis. Express the volume of the shell in terms of one or more definite integrals. Place the integral(s) into the box below but don't evaluate it/them.



7. (15 pts) The parabola $y = 2x^2$ and the line $y = mx - 5$ are given. For what two values of m is the line tangent to the parabola? Put the two values into the box provided below.

8. (15 pts) Consider the function $f(x) = \sqrt{4 - x^2}$. Sketch its graph into the coordinate plane below. Then determine the value of the integral $\int_0^2 \sqrt{1 + (f'(x))^2}\, dx$. Put your answer into the box below.



9. (25 pts) Describe the important structural aspects of the domes of St. Paul's in London, the Pantheon of Paris, St. Isaac's in St. Petersburgh, and the U.S. Capitol Building. What do these domes tell us about progress in structural engineering from around 1700 to 1860?

Formulas and expressions: $\frac{\sin\alpha}{a} = \frac{\sin\beta}{b} = \frac{\sin\gamma}{c}$ $c^2 = a^2 + b^2 - 2ab\cos\theta$ $H_0 = \frac{W}{2} \cdot \frac{1}{\tan\frac{\alpha}{2}}$, $H_1 = W \cdot \frac{1}{\tan\frac{3\alpha}{2}}$, $H_2 = W \cdot \frac{1}{\tan\frac{5\alpha}{2}}$, $P_0 = \frac{W}{2} \cdot \frac{1}{\sin\frac{\alpha}{2}}$, $P_1 = W \cdot \frac{1}{\sin\frac{3\alpha}{2}}$, $P_2 = W \cdot \frac{1}{\sin\frac{5\alpha}{2}}$, $\sin\alpha = \frac{L/2}{P}$, $\tan\alpha = \frac{L/2}{H}$, $L \approx 2w\sqrt{d^2+h^2}$, $H \approx wd\sqrt{1+\frac{d^2}{h^2}}$ $y = mx + b$ $(x-h)^2 + (y-k)^2 = r^2$ $\int_a^b \pi f(x)^2\,dx$ $\int_a^b \sqrt{1+f'(x)^2}\,dx$