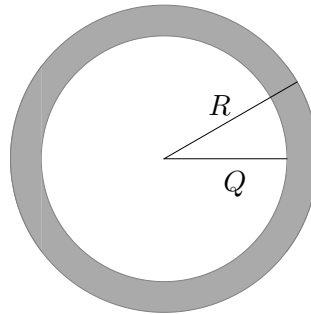


8. [12 points] Mitch puts a thin metal ring in an oven. A picture of the ring, which is made by removing a solid metal circular region of radius Q cm from a solid metal circular region of radius R cm, is below. The circles have the same center.



The ring expands as the temperature gets hotter, and so R and Q are each functions of the time, t , measured in minutes since Mitch put the ring into the oven. The following table gives some values for the functions R and Q , as well as their derivatives.

| | | | |
|---------|------|------|------|
| t | 19 | 20 | 21 |
| $R(t)$ | 1.95 | 2 | 2.06 |
| $Q(t)$ | 1.8 | 1.75 | 1.68 |
| $R'(t)$ | .04 | .05 | .05 |
| $Q'(t)$ | -.06 | -.06 | -.04 |

- a. [2 points] Assuming that $R(t)$ is an invertible function, compute

$$(R^{-1})'(2.06).$$

Do not give an approximation.

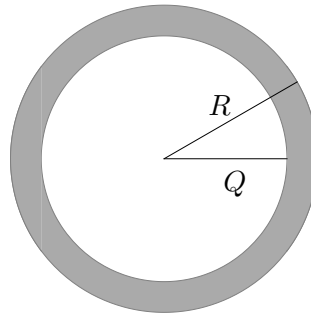
- b. [2 points] Compute the exact value of

$$\int_{19}^{21} Q'(t) dt.$$

Do not give an approximation.

8. (continued)

The figure and table below are reproduced from the previous page, in case you need them on this page.



| | | | |
|---------|------|------|------|
| t | 19 | 20 | 21 |
| $R(t)$ | 1.95 | 2 | 2.06 |
| $Q(t)$ | 1.8 | 1.75 | 1.68 |
| $R'(t)$ | .04 | .05 | .05 |
| $Q'(t)$ | -.06 | -.06 | -.04 |

c. [2 points] Write an expression for $A(t)$, the area of the ring t minutes after Mitch put it in the oven, in terms of $R(t)$ and $Q(t)$.

d. [6 points] How fast is the area of the ring growing 20 minutes after Mitch puts the ring in the oven? Include units in your answer.