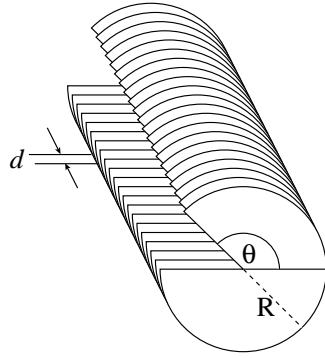


A variable air capacitor used in tuning circuits is made of N semicircular plates each of radius R and positioned d from each other. A second identical set of plates that is free to rotate is enmeshed with the first set.



Determine the capacitance as a function of the angle of rotation θ , where $\theta = 0$ corresponds to the maximum capacitance.

- A) $C = \frac{\epsilon_0 N R^2 \theta}{d}$
 B) $C = \frac{\epsilon_0 (2N) R^2 \theta}{d}$
 C) $C = \frac{\epsilon_0 N R^2 (\pi - \theta)}{d}$
 D) $C = \frac{\epsilon_0 (2N - 1) R^2 (\pi - \theta)}{d}$

Considering the situation of $\theta = 0$, the two sets of semicircular plates in fact form $2N - 1$ capacitors connected parallel, with each one having capacitance

$$C = \frac{\epsilon_0 A}{d/2} = \frac{\epsilon_0 \frac{\pi R^2}{2}}{d/2} = \frac{\epsilon_0 \pi R^2}{d}.$$

So the total capacitance would be $(2N - 1) \frac{\epsilon_0 \pi R^2}{d}$. *Note:* The common area of the two sets of plates varies linearly when one set is rotating, so the capacitance at angle θ is

$$C = \frac{\epsilon_0 (2N - 1) R^2 (\pi - \theta)}{d}.$$

Answer **D**.