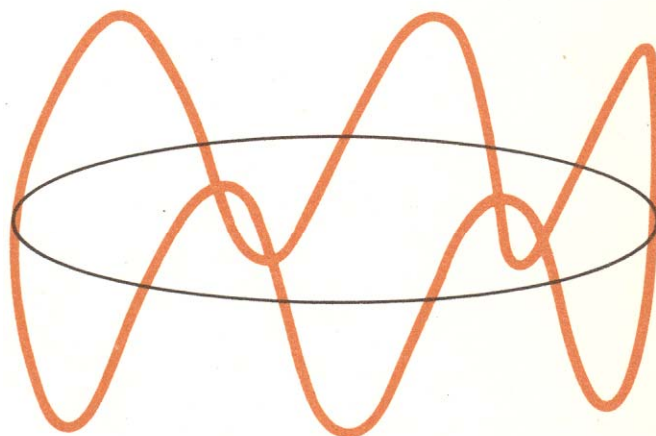




(a)



(b)

**FIGURE 12-8** Standing waves. (a) First overtone (excited state) of a guitar string. Note the node in the middle. (b) Circular standing wave on a closed loop (the fifth overtone, with ten nodes).

**Circumference:**  
 $L = 2\pi r = n(\lambda/2)$   
where  $n =$  (# of half-wavelengths)  
is a positive integer  
(just like Bohr's quantum number!)