



**Problem P10.3**

A waveguide is often designed such that only the fundamental mode is able to propagate. The reason is that two different propagating modes travel with different velocities, which leads to the difficulty of receiving the clear signals at the other end of the waveguide. Consider a rectangular waveguide as shown in the figure, where  $a = 2b = 3$  cm and the length  $\ell = 300$  m. It is known that signals travel with their group velocity.

- (a) If a signal is modulated at 6 GHz and travels from one end of this waveguide to the other end, how much time will it take?
- (b) If a signal is modulated at 10.5 GHz, how many propagating modes can carry this signal? How much time will it take for each of these modes to reach the other end of the waveguide?

