20.27. Model: Microwaves are electromagnetic waves that travel with a speed of 3×10^8 m/s.
Solve: **(a)** The frequency of the microwave is

$$f_{\text{microwaves}} = \frac{c}{\lambda} = \frac{3.0 \times 10^8 \text{ m/s}}{3.0 \times 10^{-2} \text{ m}} = 1.0 \times 10^{10} \text{ Hz} = 10 \text{ GHz}$$

(b) The refractive index of air is 1.0003, so the speed of microwaves in air is $v_{\text{air}} = c/1.00 \approx c$. The time for the microwave signal to travel is

$$t = \frac{50 \text{ km}}{v_{\text{air}}} = \frac{50 \times 10^3 \text{ m}}{\left(3.0 \times 10^8 \text{ m}/1.00\right)} = 0.167 \text{ ms}$$

Assess: A small time of 0.167 ms for the microwaves to cover a distance of 50 km shows that the electromagnetic waves travel very fast.