Tutorial 16 Question

- Ch 32: Pr. 40 (revised).
- A radio voice signal from the Apollo crew on the Moon is beamed to a listening crowd from a radio speaker. (*a*) If you are standing $50\ \mathrm{m}$ from the loudspeaker, what is the total time lag between when you hear the sound and when the sound left the moon? (*b*) How far away from the loudspeaker do you have to stand for the signal's Moon-Earth travel time to equal the loudspeaker-you travel time?
- Other information: Assume the speed of sound is $v_s = 343\ \mathrm{m/s}$. The mean earth-moon distance is $384 \times 10^3\ \mathrm{km}$.

Solution

(*a*) What is the total time lag?

- Sound can't travel from the Moon to Earth so EM waves must be used. The time it takes to travel the distance between them is

$$t_{\mathrm{EM}} = \frac{d_{\mathrm{EM}}}{c} = \frac{3.84 \times 10^8\ \mathrm{m}}{3.00 \times 10^8\ \mathrm{m/s}} = 1.28\ \mathrm{s}.$$

- Once the EM waves reach Earth they are transmitted to the loudspeaker and sent out via sound waves.
- The time for this portion of the trip is

$$t_s = \frac{d_s}{v_s} = \frac{50\ \mathrm{m}}{343\ \mathrm{m/s}} = 0.146\ \mathrm{s}.$$

Solution, contd

- So the total travel time is

$$t = t_{\mathrm{EM}} + t_s = 1.43\ \mathrm{s}.$$

(*b*) How far away from the loudspeaker do you have to stand . . . ?

- To match travel times, $t_s = t_{\mathrm{EM}}$, you need to increase your distance from the loudspeaker to

$$d_s = v_s t_s = v_s t_{\mathrm{EM}} = (343\ \mathrm{m/s})(1.28\ \mathrm{s}) = 439\ \mathrm{m}.$$

- (So light can travel between the earth and the moon in the same time it takes sound to travel a few city blocks.) □