

# 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 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  $v_s = 343 \text{ m/s}$ . The mean earth-moon distance is  $384 \times 10^3 \text{ km}$ .



# 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

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

- 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

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



# Solution, contd

- So the total travel time is

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

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

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

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

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

