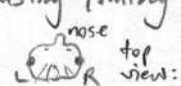
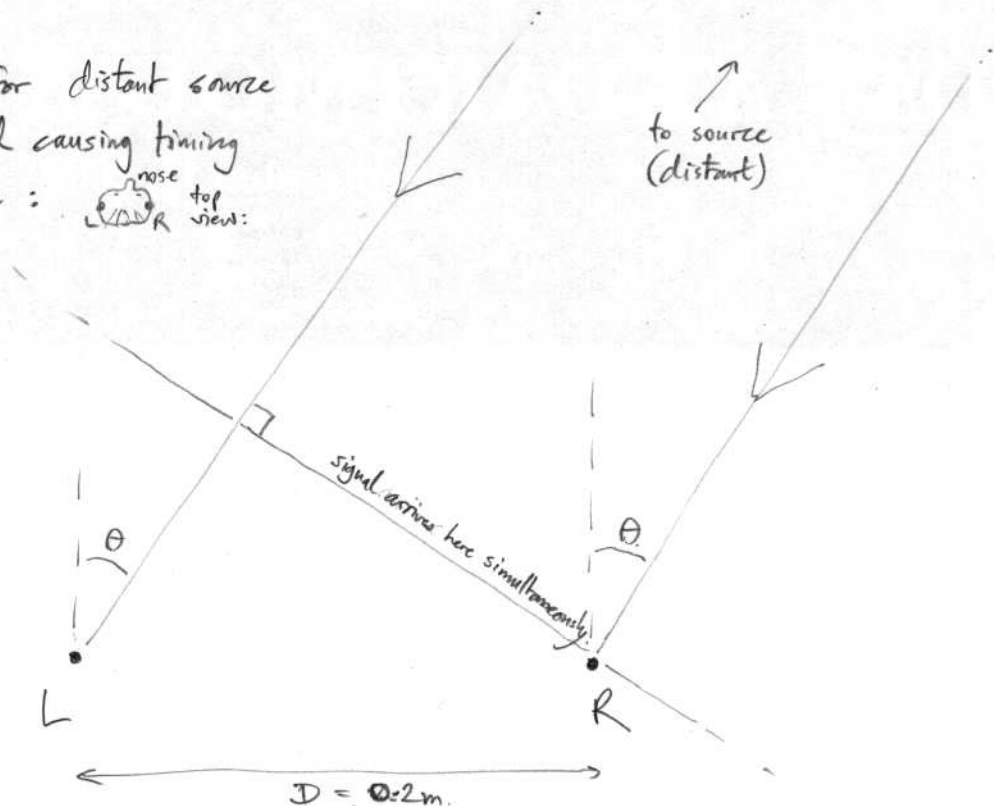


MATH 5 WORKSHEET : Directional sensitivity

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Barnett

Model for distant source
of sound causing timing
difference : 



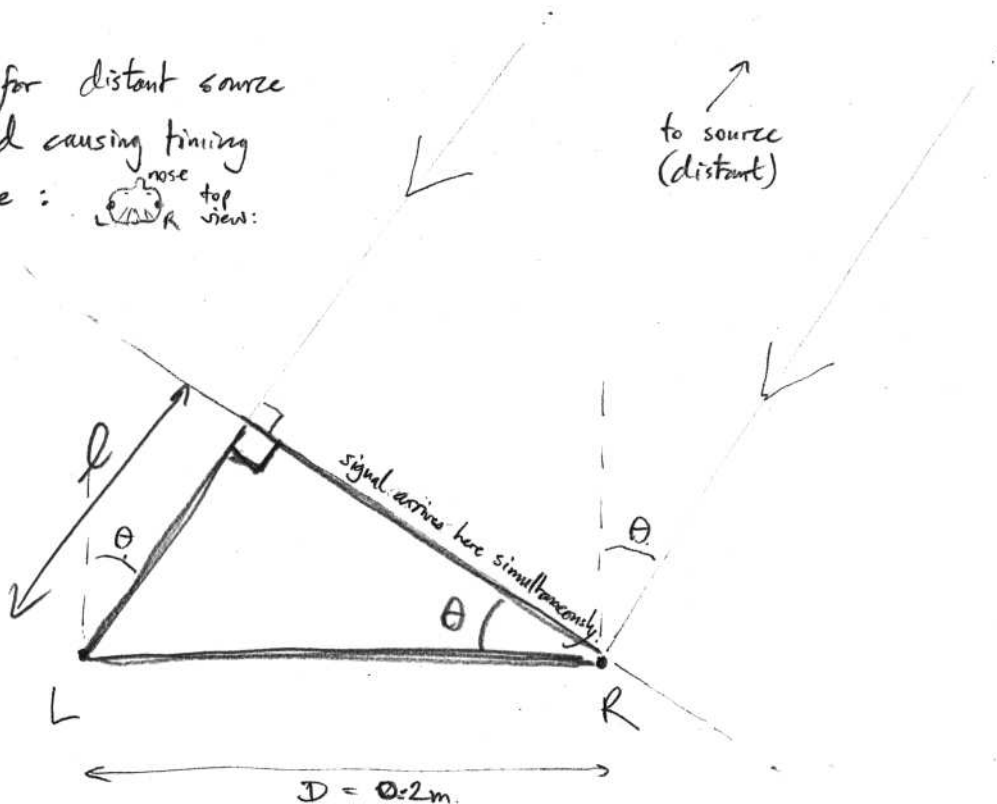
- Use trig. to write a relation between θ , D , and the path difference l (label it on your diagram). [hint: triangle]
 - If time delay is $\frac{1}{3400}\text{ s}$, compute l :
 - Use this l to solve for θ :
 - The above diagram shows only a 2D picture - what other directions (in 3D) could the sound be coming from?
 - How many ears would actually need to pinpoint direction in 3D? [Hint: stool]
 - Back to 2D, if smallest angle θ we can detect is 0.1 rad , what is smallest time delay?
- 3) Are you more sensitive to directions ahead, or to the side?

MATH 5 WORKSHEET : Directional sensitivity

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SOLUTIONS

Model for distant source of sound causing timing difference:



a) Use trig. to write a relation between θ , D , and the path difference l (label it on your diagram). [hint: triangle]

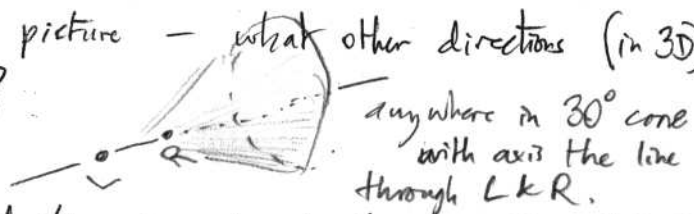
$$\sin \theta = \frac{l}{D}$$

b) If time delay is $\frac{1}{3400}$ s, compute l : $l = ct = \frac{340}{3400} = 0.1\text{m}$

c) Use this l to solve for θ :

$$\theta = \sin^{-1}\left(\frac{l}{D}\right) = \sin^{-1}\left(\frac{0.1}{0.2}\right) = 30^\circ \text{ or } \frac{\pi}{6}$$

d) The above diagram shows only a 2D picture - what other directions (in 3D) could the sound be coming from?



e) How many ears would actually need to pinpoint direction in 3D? [Hint: stool] three ears (!) (3 points define a plane in 3d) so $l \approx 0.1D \approx 2\text{cm}$

f) Back to 2D, if smallest angle θ we can detect is 0.1 rad, what is smallest time delay?
g) Are you more sensitive to directions ahead, or to the side? ahead since $\sin^{-1}(\theta) = \frac{\text{opposite}}{\text{hypotenuse}}$ $5.9 \times 10^{-5} \text{s} \times 60 \text{ms}!$