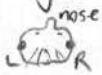
MATH 5 WORKSHEET : Directional sensitivity

11/19/08
Barnett.

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]

b) If time delay is $\frac{1}{3400}$ s, compute ℓ :

c) Use this ℓ to solve for θ :

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]

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?

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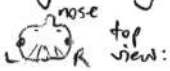
11/19/08
Bamitt.

~ 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]

$$\sin\theta = \ell/D$$

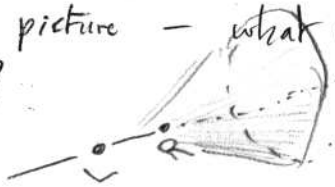
b) If time delay is $\frac{1}{3400}$ s, compute ℓ : $\ell = ct = \frac{340}{3400}$

$= 0.1$ m

c) Use this ℓ to solve for θ:

$$\theta = \sin^{-1}\left(\frac{\ell}{D}\right) = \sin^{-1}\left(\frac{.1}{.2}\right) = 30^\circ \text{ or } \pi/6$$

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



anywhere in 30° cone with axis the line through L & R.

e) How many ears would actually need to pinpoint direction in 3D? [Hint: stool]

three ears (!) (3 points define a plane in 3d)

f) Back to 2D, if smallest angle θ we can detect is 0.1 rad, what is smallest time delay? so $\ell \approx 0.1\,D \approx 2$cm

g) Are you more sensitive to directions ahead, or to the side? ahead since $\sin^{-1}(\theta) = \theta$ is larger than $\cos\theta$ 5.9×10^{-5}s $\times$ 60 NS !