MATHS WORKSHEET : Intensity & dB

4/20/07
Barnett

A sound engineer doubles the amplitude of a signal (eg. at a rock concert)

By what factor does the intensity change?

How does the dB change? [Hint argue by ratios, or choose a certain I eg $1 W/m^2$ and compute using that.].

What change in amplitude results from a 10 dB increase in intensity?

20

a 20 dB increase?

1W is radiated in all directions. What intensity in dB do you record 1m from the source?

10m from the source?

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~ SOLUTIONS ~

A sound engineer doubles the amplitude of a signal (eg. at a rock concert)

$I \propto A$ so doubling A is multiplying I by 4.

By what factor does the intensity change? ∴ factor of 4.

How does the dB change?

[Hint argue by ratios, or choose a certain I eg $1 W/m^2$ and compute using Hint.]

say $I_1 = 1 W/m^2$ → $dB_1 = 10 \log_{10} \frac{1}{10^{-12}} = 120$ dB

$I_2 = 4 W/m^2$ $dB_2 = 10 \log_{10} \frac{4}{10^{-12}} = 126$ dB

so increase is by + 6dB

Or use ratio formula dB increase $= 10 \log_{10} \frac{4}{1} = 6$dB.

What change in amplitude results from a 10dB increase in intensity?

10 dB increase means $\log_{10}\left(\frac{I_2}{I_1}\right) = 1$ so $\frac{I_2}{I_1} = 10^1$ so $\frac{A_2}{A_1} = \sqrt{10}$ ampl. ratio

a 20 dB increase?

$\log_{10}\left(\frac{I_2}{I_1}\right) = 2$ so $\frac{I_2}{I_1} = 10^2$ so $\frac{A_2}{A_1} = \sqrt{10^2} = 10$

1W is radiated in all directions. What intensity in dB do you record $r = 1m$ → 1m from the source? $I = \frac{P}{4\pi r^2} = \frac{1}{4\pi} W/m^2$

$dB = 10 \log_{10} \frac{I}{I_r} = 10 \log_{10} \frac{0.08}{10^{-12}} = 109$ dB

10m from the source?

$I = \frac{P}{4\pi r^2} = \frac{1}{4\pi 10^2} \simeq 7.95 \times 10^{-4} W/m^2$

$dB = 10 \log_{10} \frac{7.95 \times 10^{-4}}{10^{-12}} = 89$ dB

down by 20dB from before.