

Driver matching, phase and delay

Solutions · step by step

- 01**
1. Difference: $92 - 88 = 4 \text{ dB}$.
 2. Initially attenuate tweeter by 4 dB.
 3. Then measure crossover region.

$$\Delta L = 92 - 88 = 4 \text{ dB}$$

- 02**
1. $P = U^2/R$.
 2. $2.83^2/4 = 2.002 \text{ W}$.
 3. Here 2.83 V means about 2 W, not 1 W.

$$P = \frac{2.83^2}{4} \approx 2 \text{ W}$$

- 03**
1. Initial power is about 2 W.
 2. Half power reduces level by 3.01 dB.
 3. Result about 87 dB/1 W/1 m.

$$L_{1W} = 90 - 10\log_{10}(2) \approx 87 \text{ dB}$$

- 04**
1. Wavelength = speed/frequency.
 2. $343/1000$.
 3. Wavelength = $0.343 \text{ m} = 34.3 \text{ cm}$.

$$\lambda = \frac{c}{f} = 0.343 \text{ m}$$

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- 05**
1. Path difference in m: 0.0343.
 2. Delay = distance/speed.
 3. Delay = 0.1 ms.

$$\Delta t = \frac{0.0343}{343} = 0.1 \text{ ms}$$

- 06**
1. Period is 1 ms.
 2. 0.1 ms is one tenth of a cycle.
 3. Magnitude: 36°. Delayed branch lags.

$$|\varphi| = 360^\circ f \Delta t = 36^\circ$$

- 07**
1. Frequency triples.
 2. Phase magnitude triples.
 3. 108°.

$$|\varphi| = 360^\circ \cdot 3000 \cdot 0.0001 = 108^\circ$$

- 08**
1. Add pressure ratios: 2.
 2. $20 \log_{10}(2)$.
 3. Sum is 6.02 dB above one signal.

$$\Delta L = 20 \log_{10} 2 = 6.02 \text{ dB}$$

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- 09**
1. One signal has opposite sign.
 2. $1 + (-1) = 0$.
 3. Complete cancellation; real systems usually retain some residual.

- 10**
1. Add perpendicular components quadratically.
 2. Magnitude = $\sqrt{2}$.
 3. Relative to one signal: +3.01 dB.

$$|p_{\Sigma}| = \sqrt{1^2 + 1^2} = \sqrt{2}$$

- 11**
1. Magnitude = $\sqrt{(0.5^2 + 0.5^2)} = 0.7071$.
 2. $20 \log_{10}(0.7071)$.
 3. Sum is 3.01 dB below target.

$$|p_{\Sigma}| = \sqrt{0.5^2 + 0.5^2} = 0.7071$$

- 12**
1. Delay the earlier branch.
 2. Added delay: 0.2 ms.
 3. Check crossover region afterward; acoustic centres are not always constant.

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- 13**
1. Polarity inversion gives 180° at all frequencies.
 2. Delay-induced phase grows with frequency.
 3. They can coincide only at particular frequencies.

$$\varphi_{\text{delay}} = -360^\circ f \Delta t$$

- 14**
1. Distance in m: 0.17.
 2. $f = c/d$.
 3. $f = 2017.65 \text{ Hz}$; this alone does not define a safe crossover.

$$f = \frac{343}{0.17} = 2017.65 \text{ Hz}$$

- 15**
1. Horizontal and vertical radiation may be discontinuous.
 2. Room reflections contain off-axis energy.
 3. Check multiple angles, distortion and power handling.

- 16**
1. There is no obvious clean usable overlap.
 2. Do not simply choose a midpoint.
 3. Consider another driver pairing or add a midrange.

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- 17**
1. Excursion is approximately inversely proportional to frequency squared.
 2. Half frequency requires four times excursion.
 3. Result: 4 mm; enclosure effects excluded here.

$$x_2 = x_1 \left(\frac{f_1}{f_2} \right)^2 = 4 \text{ mm}$$

- 18**
1. Nominal equivalent: 4 Ω.
 2. At constant voltage total current doubles in the resistive model.
 3. Check amplifier capability and actual impedance curve.

$$R_p = \frac{8 \cdot 8}{8 + 8} = 4 \Omega$$

- 19**
1. Relative timing determines phase difference.
 2. Independent shifts remove real delay differences.
 3. Use a shared time reference or correctly restore known offsets.

- 20**
1. Measure installed drivers with impedance and shared timing.
 2. Check overlap, choose targets, filter branches and match levels.
 3. Verify complex sum; check angles, impedance and loading, then iterate.