# Chapter 12 Homework

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## §1 1

Since the shout comes back 2.5 seconds after it was first emitted, the total distance to the cliff and back is the distance traveled by sound within the 2.5 seconds. Therefore,

$$d = vt = \frac{343 \text{ m/s} \times 2.5 \text{ s}}{2} = \boxed{428.75 \text{ m}}$$

## §2 7

The total time T is the time for the stone to fall down ($t_{down}$) t plus the time for the sound to come back to the top of the cliff ($t_{up}$): $T = t_{up} + t_{down}$. Use constant-acceleration relationships for an object dropped from rest that falls a distance h in order to find $t_{down}$, with down as the positive direction. Use the constant speed of sound to find up t for the sound to travel a distance h.

$$h = \frac{1}{2}gt_{down}^2 = \frac{1}{2}g(T - t_{up}) = \frac{1}{2}g\left(T - \frac{h}{v_{snd}}\right)^2$$

$$h^2 - 2v_{snd}\left(\frac{v_{snd}}{g} + T\right)h + T^2v_{snd}^2 = 0$$

Since this is a quadratic, we can solve using the quadratic formula to get: $\boxed{33 \text{ m}}$

## §3 10

Compare the two power output ratings using the definition of decibels.

$$\beta = 10 \log \frac{P_{150}}{P_{100}} = \boxed{2.0 \text{ db}}$$

## §4 15

$$\beta = 130 = 10 \log \frac{I_{2.8}}{I_0} \implies I_{2.8} = 10^{13} I_0 = 10 \text{ W/m}^2$$

$$P = IA = 4\pi r^2 I = 785.4 \text{ W} \approx \boxed{790 \text{ W}}$$

## §5 26

The lowest note corresponds with the smallest frequency and as shown in Figure 12-12, the first harmonic has:

$$f_1 = \frac{v}{4\ell} \implies \ell = \frac{v}{4f_1} = \boxed{1.24 \text{ m}}$$

## §6 30

For a pipe open at both ends, the fundamental frequency is given by $f_1 = \dfrac{v}{2\ell}$, so the length for a given fundamental frequency is $\ell = \dfrac{v}{2f_1}$. Hence, $\ell_{20} = \boxed{8.6 \text{ m}}$ and $\ell_{20000} = \boxed{8.6 \times 10^{-3} \text{ m}}$.

## §7 31

Since the wavelength of the string is altered by the fingering, the overall frequency changes. Hence,

$$f_{\text{fingered}} = \boxed{\frac{1}{0.70} f_1 = 260 \text{ Hz}}$$

## §8 42

A tube closed at both ends will have standing waves with displacement nodes at each end, so it has the same harmonic structure as a string that is fastened at both ends. Thus, the wavelength of the fundamental frequency is twice the length of the hallway, $f_1 = 2\ell = 18\ \mathrm{m}$

$$f_1 = \frac{v}{\lambda_1} = \boxed{19\ \mathrm{Hz}}; \quad f_2 = 2f_1 = \boxed{38\ \mathrm{Hz}}$$