

# Assignment 7 Solutions

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6. Figure 9.10 shows the motions of specific points along a string when it is plucked at its midpoint. From the appropriate figure determine the fraction of each cycle that a point 0.1L from one end of the string is stationary. To figure this out you can study Fig. 9.10, but you can also reason from the animation of this plucked string which was shown in class and is contained in the mathematica notebook waves3.nb (also the “Assignment 7 Solutions.nb” notebook). The midpoint is always in motion for a string plucked in the middle while the points at the ends are always stationary. All the points in between are stationary in proportion to their distance from the midpoint. For a point located 0.1L from the end, it is 20% of the way to the middle which is at 0.5L. Since the ends are always stationary and our point is 20% of the way to the middle, it is stationary 100%-20% of the time and in motion 100%-80% of the time.

10. The frequency of an edge tone depends on the velocity of the stream emanating from the orifice. How does the frequency change as the jet stream velocity increases? This is discussed in the text but can be summarized as follows: As the velocity of the stream increases the pitch rises continuously reaching a point of instability and jumping up to a higher level. This cycle can repeat more than once. The continuous rise in pitch is proportional to the velocity of the air stream. Eventually, the edge tone is lost as the velocity goes higher.

14. In a homemade instrument, strings are mounted on a wood base. The response characteristics of the base are evaluated by driving the base at various frequencies with a reference signal having an intensity of  $I_{ref} = 10^{-6} \text{W/m}^2$ . The data collected are shown in the Table below. We calculate the response in decibels using the formula  $R = 10 \log \left( \frac{I}{I_{ref}} \right)$ . The response R is shown in the last column. See the mathematic notebook “Assignment 7 Solutions.nb” for the details of these calculations, and also plots of the results.

| Frequency | Intensity           | R    |
|-----------|---------------------|------|
| (Hz)      | (W/m <sup>2</sup> ) | (db) |
| 100       | $1 \times 10^{-4}$  | 20.0 |
| 200       | $4 \times 10^{-4}$  | 26.0 |
| 300       | $8 \times 10^{-4}$  | 29.0 |
| 400       | $2 \times 10^{-3}$  | 33.0 |
| 500       | $3 \times 10^{-4}$  | 24.8 |
| 600       | $2 \times 10^{-3}$  | 33.0 |
| 700       | $9 \times 10^{-4}$  | 29.5 |
| 800       | $5 \times 10^{-4}$  | 27.0 |
| 900       | $2 \times 10^{-4}$  | 23.0 |
| 1000      | $1 \times 10^{-4}$  | 20.0 |

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15. From the response curve obtained in the previous problem, suggest how the transmitted sound would be shaped by the resonator if a string mounted upon it were tuned to oscillate with a fundamental frequency of 100 Hz and if the string were:

- (a) Plucked at the midpoint.
- (b) Plucked at a point  $1/4 L$  from one end.

See the accompanying mathematica notebook, Assignment 7 Solutions.nb for the discussion of this exercise and also detailed calculations and plots of the results.