

## Lab 6 solutions

### Part I

- 1) The amplitudes of the higher harmonics are greater for the violin than the guitar.
- 2) The spacing between the harmonics would increase if the pitch is increased. The number of contributing harmonics would be similar.
- 3) A bowed violin string would have more harmonics, with most of the contribution to the sound coming from the higher harmonics.
- 4)  $2093 \text{ Hz} / 196 \text{ Hz} \sim 10$  which is between 3 and 4 octaves (factor of 8 and 16)

### Part II

- 1) The frequency spectrum of the slide whistle is dominated by the fundamental.
- 2) If you overblow the lowest note, you would see contributions from the 3rd and (maybe) 5th harmonics (only odd harmonics because the tube is closed at one end).

### Part III

- 1)  $f = v/4L$ ,  $v=346 \text{ m/s}$ ,  $L=0.17 \text{ m} \rightarrow f = 509 \text{ Hz} \sim 500 \text{ Hz}$   
Next three harmonics: 1500, 2500, 3500 Hz

- 2) Male: formant regions around 200, 1000, 1700 Hz.  
Female: formant regions around 200, 1200, 2000 Hz  
These formant regions are located around similar frequencies.

- 3) To change the resonant frequencies of the formant regions you should change the position of your jaw, tongue, lips. To change the frequency of the vocal folds, you need to change the tension in the vocal folds.
- 4) 300–3000 Hz is sufficient for telephones since the typical frequency range of speech lies in this band.