# Physics 225

Homework Assignment 9

Due 3 April 2008

## 1 Reed instrument

Suppose a clarinet reed is 1.0 cm across, with an opening which is 1.0 mm wide when the mouth pressure is atmospheric. A mouth pressure of 5 kilopascal ($5 \times 10^3$ N/m$^2$) above atmospheric is enough to force the opening closed.

When the mouth pressure is half this large, and assuming the pressure inside the instrument chamber is just atmospheric pressure, what is the air velocity through the reed?

What is the total air flow (m$^3$/s) through the reed when the mouth pressure is 2.5 kilopascal? If the player's lung volume is 3 liters, how long can they sustain this rate of airflow?

As the pressure is increased from 2.5 KPa to 5.0 KPa, the reed opening goes completely closed. Express the ratio of this pressure change to the airflow change, that is, $\Delta P/\Delta U$ with $\Delta P$ the difference between 2.5 KPa and 5 KPa and $\Delta U$ the difference in the airflow between these pressures. Check that its units are the same as an acoustic impedance ($Z_A = \rho c_s/A$).

Compute the intrinsic impedance of the pipe of a clarinet, assuming a bore radius of 0.75 cm. (The intrinsic impedance of the bore is $Z_A = \rho c_s / A$ with $A$ the cross-sectional area of the bore.)

As discussed in class, the impedance presented by the instrument needs to be higher than the impedance you found for the reed, if sound is to be amplified. Can the reed produce sounds at typical frequencies (where the input impedance is of order the intrinsic pipe impedance), or only close to a resonant frequency (where the input impedance is much larger than the intrinsic pipe impedance)?