COOPERATIVE WORKSHEET #4

1. Chromatic Scales on Brass Instruments
   (a) With the slide pushed all the way in, the effective length of a trombone (as seen by a particular mode) is 275 cm. How far should the slide be pulled out to decrease the current pitch by a half-step?

   (b) Suppose that opening the first valve on a trumpet adds 8 cm to its bore length and causes the current note to drop by a whole-step. What is the total length of the instrument (as seen by this mode)?

   (c) How much length is added to the bore by opening each of the other valves?

2. Woodwind Registers
   (a) Suppose you are designing an oboe-like instrument and want to provide a key that will help players transition to the third register. If the acoustic length of the instrument is $L$, how far from the bell should you drill the hole for this key?

   (b) When designing the keying mechanism, should this hole be closed or left open by default? Why?
(c) If $L = 60\text{cm}$, what is the frequency of the lowest note that can be played when this key is open? What pitch interval separates this note from the lowest the instrument can play when this key is closed?

(d) What are two ways a flute player can transition to the second register without using a register hole?

3. **Harmonics in Brass Instruments**

(a) A bugle features the same standing wave patterns as an open-closed cylindrical pipe. However, it can still play a complete harmonic series. On the axes below, draw the standing wave pattern exhibited by the fourth mode in the series.

(b) If the $n = 3$ mode travels a distance $a$ down the bore of the instrument, how far do the $n = 5$ and $n = 7$ modes travel?