Second exam: Monday November 5, 2001
12:05 lecture: Room 1300 Sterling
1:20 lecture: Room 125 OLD Biochem Bldg
420 Henry Mall (corner Univ Ave)

the exam covers: Homework 4-7
Lab 5-8
Study Guide

the material refers to p. 71-138 in "The Science of Sights and Sounds" on reserve at Helen C. White and at Physics library

- Review Sessions in Room 3335 Sterling
- Emre 1-3 pm Saturday, November 3
- Santhosh 1-3 pm, Sunday, November 4
- Eva 3-5 pm Sunday, November 4

stretched partials 

Other cultures - other scales……

Example:
measurements on Burmese Xylophone show that whole tones are smaller and half tones larger than Western scales, tending toward seven almost equal steps.
Similar scales are used in tuning of the Burmese harp.

Tuning matters mostly in polyphonic music -
Only when playing cords is consonance the main issue
Became wide spread only in late Renaissance (after 1600)

What do musicians actually play when not bound to a fixed scale (e.g violin)

Measurements on violin soloists (Green 1937)

	ratio (ave)	just	tempered
Minor third	1.186	6/5 = 1.200	1.189
Major third	1.264	5/4 = 1.250	1.260
Fifth	1.505	3/2 = 1.50	1.498

Maybe one likes what one is used to……

Evidence: originally, tempered scale sounded bad

now just or meantone sounds out of tune

Changing pitch on instruments:

Strings - where place finger on fingerboard?

remember: frequency changes in inverse proportion to length

example 1: guitar frets are located to play tempered scale if string is 65.0 cm long, how far from neck is fret to play B_3 on G_3-string?

example 2: a violin string tuned to D_4 is 50 cm long. What tone will it play if the musician reduces the vibrating length to 30 cm?To 15 cm?

Answers on next slide

Answers to above examples

example 1:

B to G is four semitones. The new vibrating length must be the old length divided by $(1.0595)^4$: L = 65.0/1.260=51.6cm

distance from neck = 65.0-51.6 = 13.4cm

example 2

freq ratio is reciprocal of length ratio: 50/30 = 5/3

5/3 interval is a just sixth (such as C-A see table of just ratios)

Thus tone is just sixth above D_4 = B_4.

For 15 cm string, ratio is 50/15 = 10/3. This ratio is an octave above 5/3 (since 2x5/3 = 10/3) B_5

Brass: entire scale with only three valves - how?

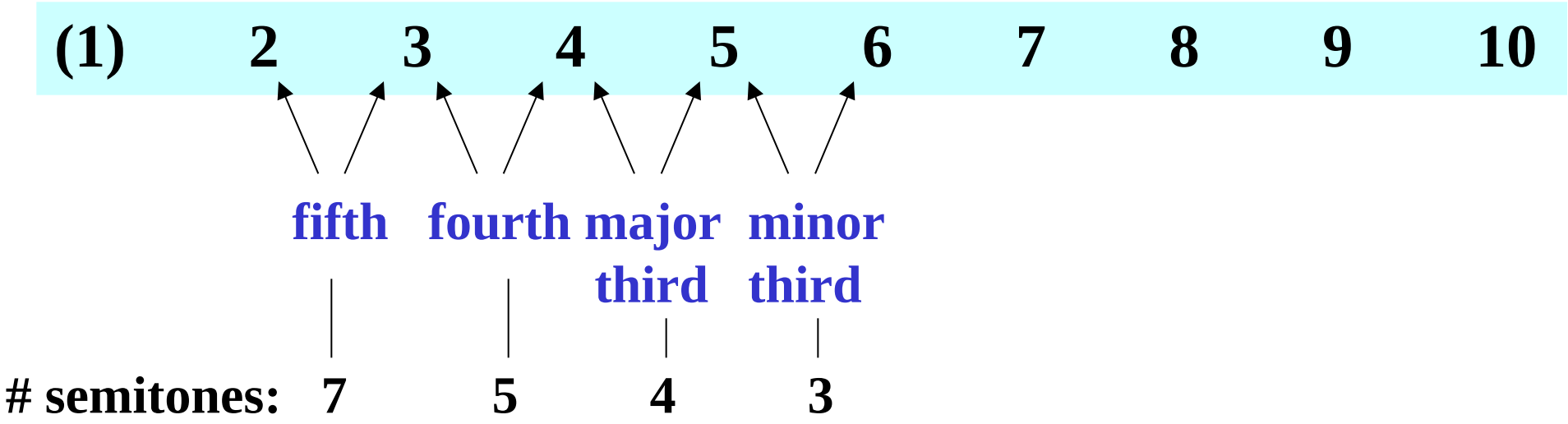
French Horn

Trumpet

note three valves to change length of air column

need to bridge the gaps in the natural scale:

first mode normally not used - biggest gap is FIFTH



lower pitch 1 semitone by adding length l_1 to original length l_o	
2	l_2
3	l_3
4	$l_1 + l_3$
5	$l_2 + l_3$
6	$l_1 + l_2 + l_3$

example: if the air column of a horn is 2.6 m long how much additional length is needed to lower the pitch by one semitone? by 3 semitones? by 4 semitones?

answer:

one semitone: lower pitch requires larger length (inverse proportion)
new length = old length times semitone ratio
new length = 260cmx1.0595 = 275.5cm.
additional length needed = 275.5-260.0 = 15.5cm
three semitones: new length = 260cmx $(1.0595)^3$ = 309.2cm
additional length needed = 309.2-260.0 = 49.2cm
four semitones: 260cmx $(1.0595)^4$ = 327.6cm
additional length needed = 327.6-260.0 = 67.6cm
Note: the way the horn is used, when the player want to lower the pitch by 4 semitones he adds 15.5cm + 49.2 cm=64.7 cm but should be 67.6 for correct tuning! He is off 3cm/327cm or about 1%, which is 1/6 of a semitone. Not perfect but not bad.