First exam: Monday October 8, 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
Lab through Strings
Study Guide

the material is covered in Ch. 2-4 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, October 6
- Santhosh 1-3 pm, Sunday, October 7
- Eva 3-5 pm Sunday, October 7

Strings, Pipes

Vibration of Strings:

Fundamental frequency f_1

$$f_1 = \frac{v}{2L}$$

$$f_1 = \frac{1}{2L}\sqrt{\frac{T}{\rho}}$$

T : tension in N
L: length in m
ρ: mass per unit length in kg/m

changing the frequency:

- **change length (guitar, violin etc):shorter L → higher pitch**
- **change tension (tuning): higher T → higher pitch**
- **change mass per unit length: heavier string → lower pitch**

Examples: (sent to class by e-mail include answers)

1. string frequency 300 Hz for T= 40 N. Find frequency for 50 N tension

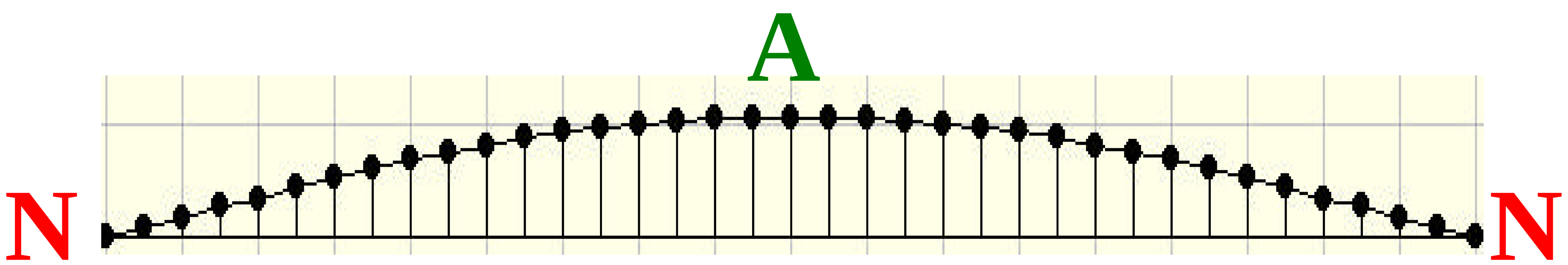
2. 60 cm long string plays a certain tone. What length will produce a tone an octave higher (double the frequency)?

3. A cello string is 80 cm long and has a mass of 1.2 g.
   a) Find the mass per unit length.
   b) Find the tension required to obtain a frequency of 200 Hz.

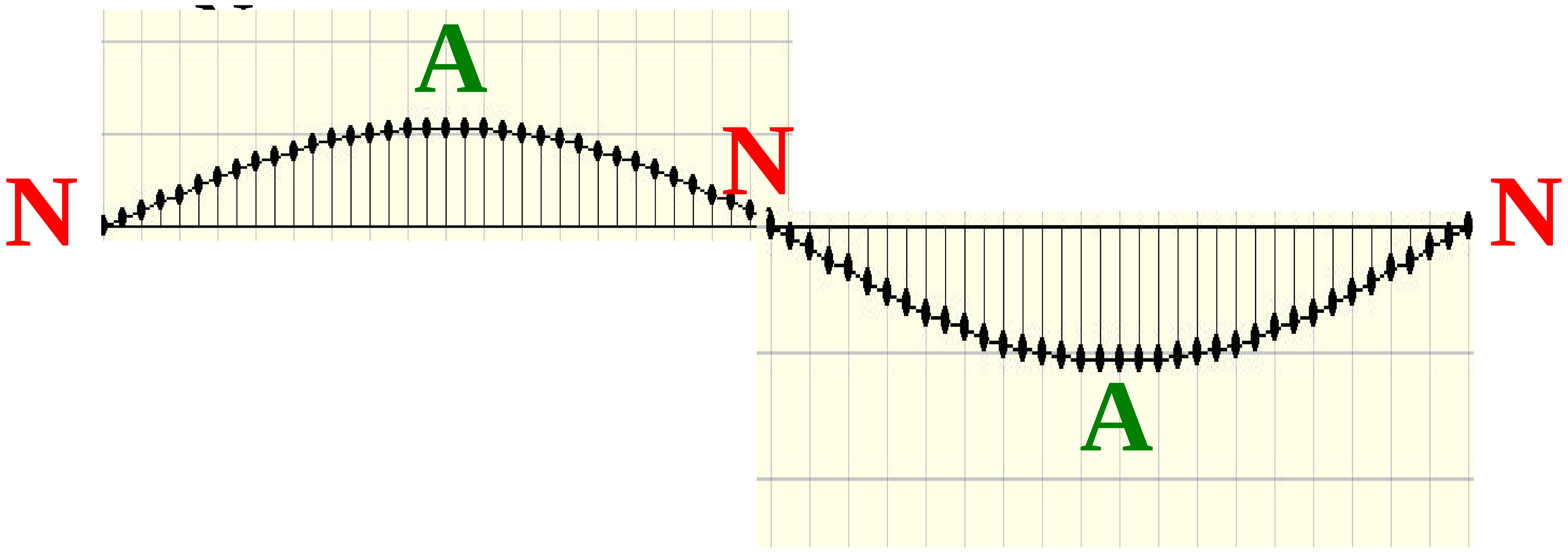
HIGHER MODES OF STRING

- An oscillation is called a "MODE" if each point makes simple harmonic motion

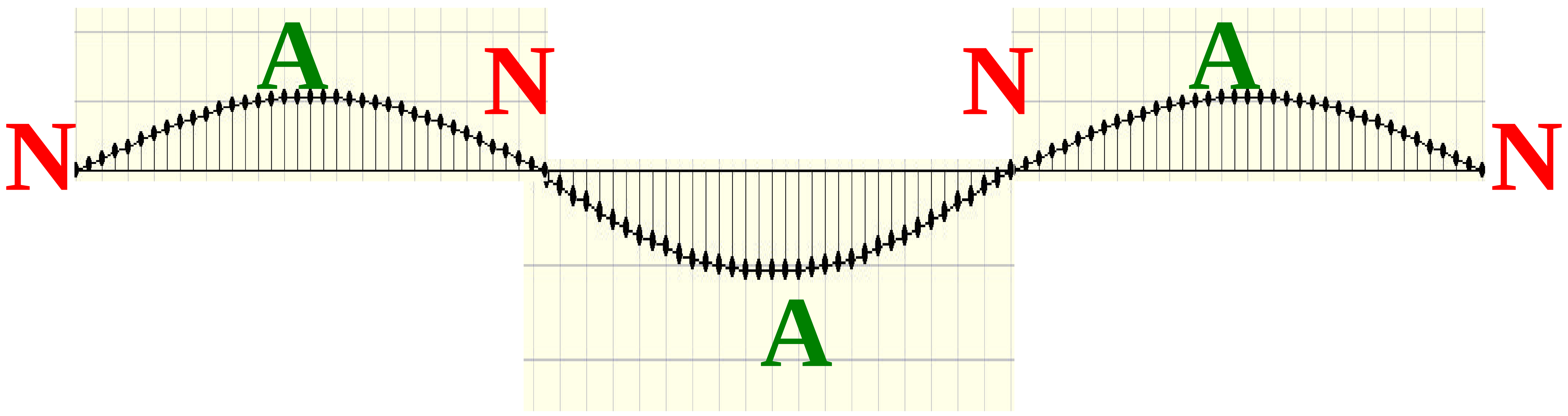
- NODE: place where string does not move
- ANTINODE (BELLY): largest amplitude of motion



first mode: freq. f_1
"fundamental"



2nd mode: freq. $f_2 = 2f_1$
"first overtone"



3rd mode: freq. $f_3 = 3f$
"second overtone"

Standing Waves

wave on string is reflected at both ends of the string

RESULT:

SUPERPOSITION of waves travelling in opposite directions makes “standing wave”

2 waves travelling in opposite directions (Quicktime Movie)

2 waves with superposition (Quicktime Movie)

Only superposition (Quicktime Movie)

Harmonics and Partials

- The overtones are called “HARMONICS” if they their frequencies are whole-number <u>multiples</u> of the fundamental

- when a string is bowed or plucked, many modes oscillate at the same time (shape of string: superposition of modes!)

demos: **shape of string;**
tone from different modes

- musicians call the sound made by the different modes the “PARTIALS” of the tone

Plucked String

example: pluck string at 1/4 point from end.
which harmonics will be strong?
which harmonics will be absent?

Answer:

2nd harmonic has belly where string is plucked: **STRONGEST**

4th harmonic has NODE where string is plucked: **ABSENT**

8th harmonic …. **ABSENT**

other harmonics: more or less present, depending how much amplitude they have at pt. where plucked.