

PHY131H1F - Class 24

Today:

The last class!!

- Finishing Ch.14 up to section 14.7:
- Standing Sound Waves
- Wind Instruments
- Course review
- Tips for the final exam

PHY131H1F	A - KI	WED 13 DEC	AM 9:00 - 11:00	EX 100
PHY131H1F	KL - ST	WED 13 DEC	AM 9:00 - 11:00	EX 200
PHY131H1F	SU - WAN	WED 13 DEC	AM 9:00 - 11:00	EX 300
PHY131H1F	WAS - Z	WED 13 DEC	AM 9:00 - 11:00	EX 310

Learning Catalytics Discussion Question

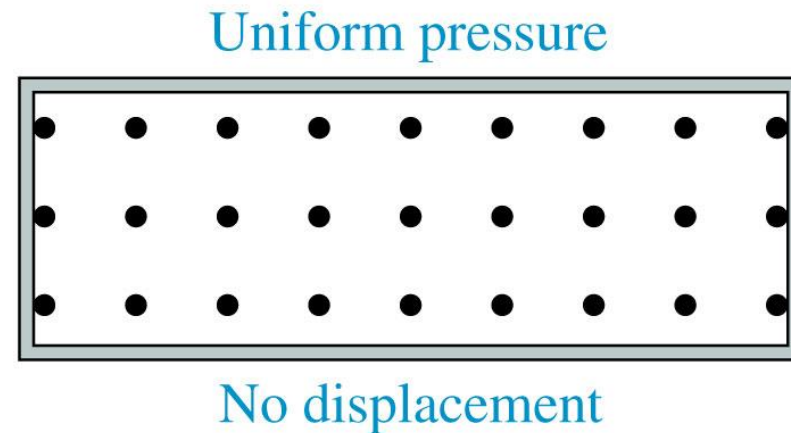
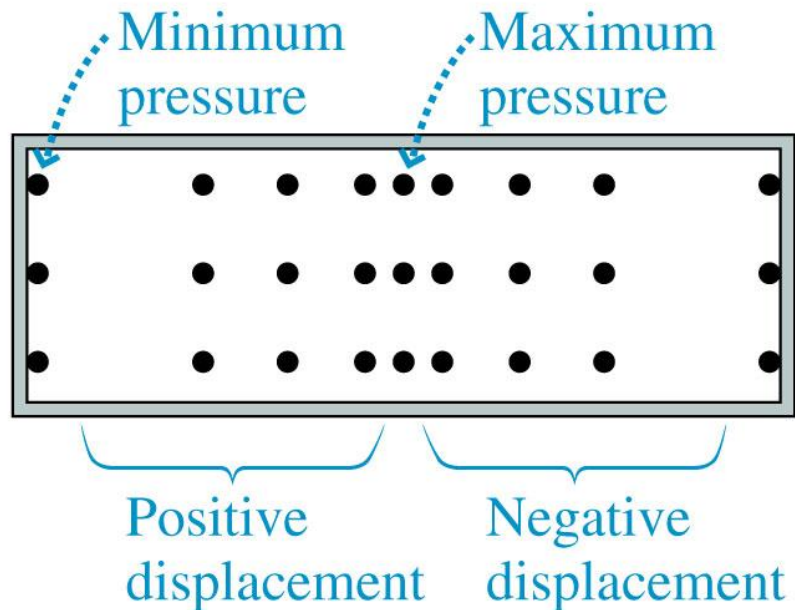
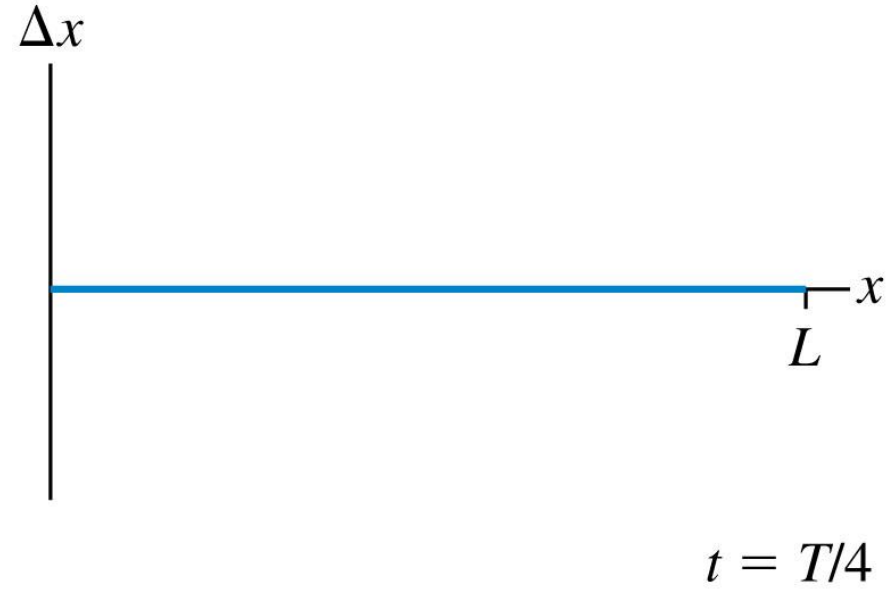
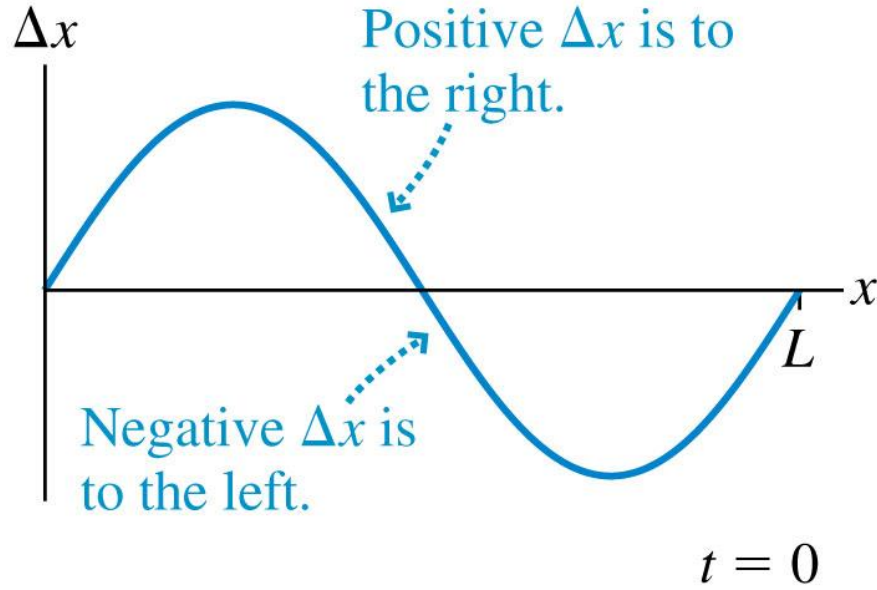
The frequency of the third harmonic of a string is

- A. One-third the frequency of the fundamental.
- B. Equal to the frequency of the fundamental.
- C. Three times the frequency of the fundamental.
- D. Nine times the frequency of the fundamental.

Standing Sound Waves

- A long, narrow column of air, such as the air in a tube or pipe, can support a longitudinal standing sound wave.
- A closed end of a column of air must be a displacement node. Thus the boundary conditions — nodes at the ends — are the same as for a standing wave on a string.
- It is often useful to think of sound as a pressure wave rather than a displacement wave. The pressure oscillates around its equilibrium value.
- The nodes and antinodes of the pressure wave are interchanged with those of the displacement wave.

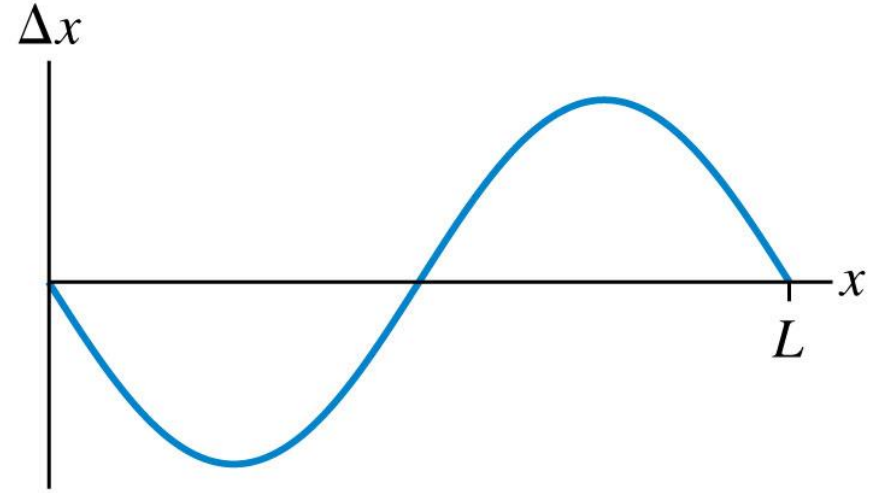
Standing Sound Waves



Standing Sound Waves

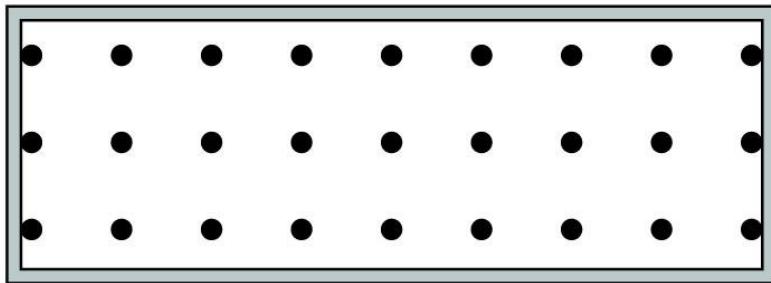


$t = T/4$



$t = T/2$

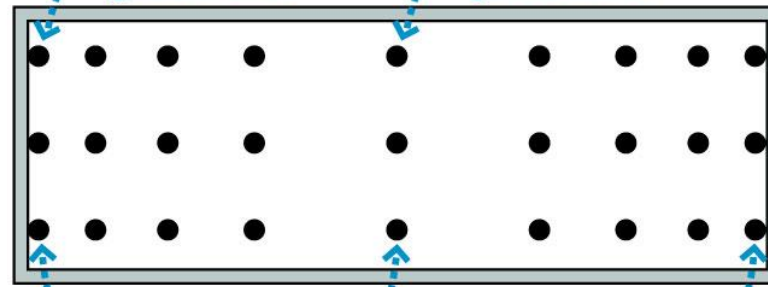
Uniform pressure



No displacement

Maximum pressure

Minimum pressure

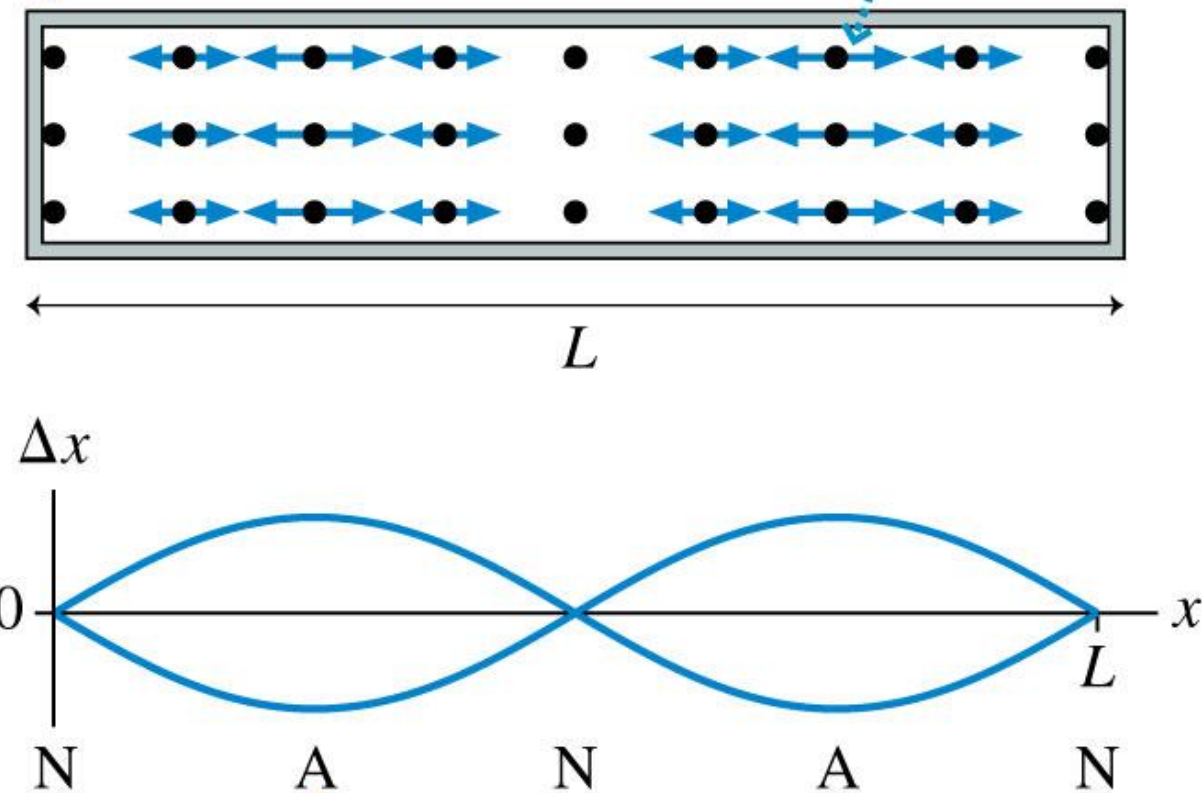


Displacement nodes. These molecules aren't moving.

- Displacement Δx and pressure graphs for the $m = 2$ mode of standing sound waves in a closed-closed tube.
- The nodes and antinodes of the pressure wave are interchanged with those of the displacement wave.

The closed end is a displacement node and a pressure antinode.

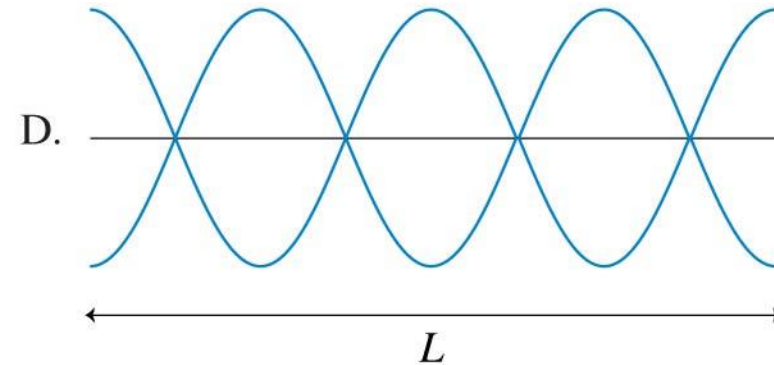
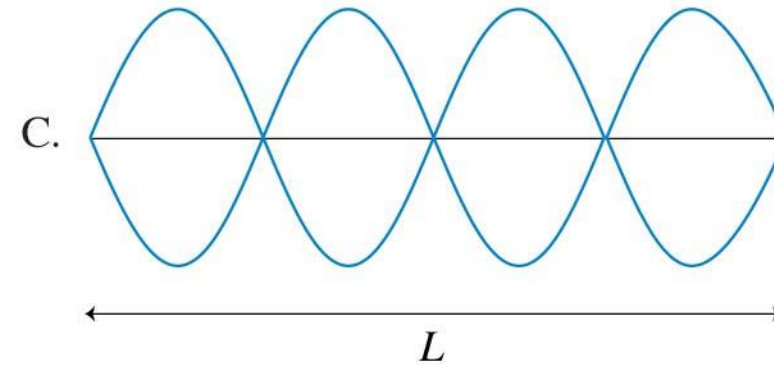
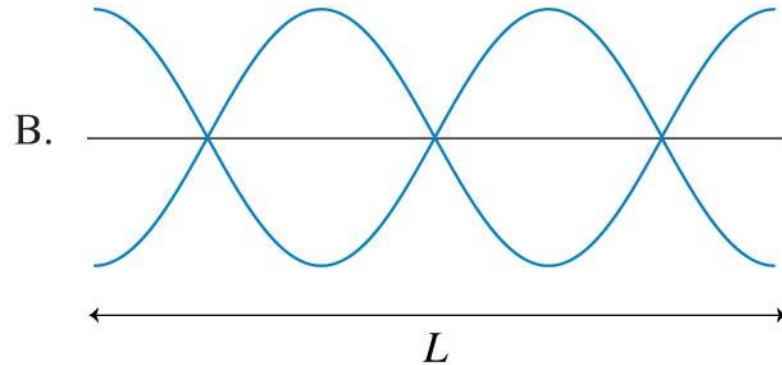
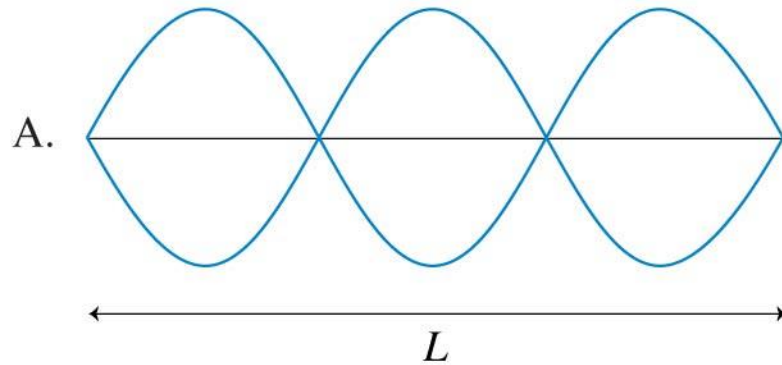
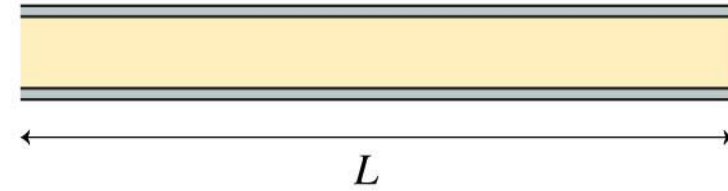
Air molecules undergo longitudinal oscillations. This is a displacement antinode and a pressure node.

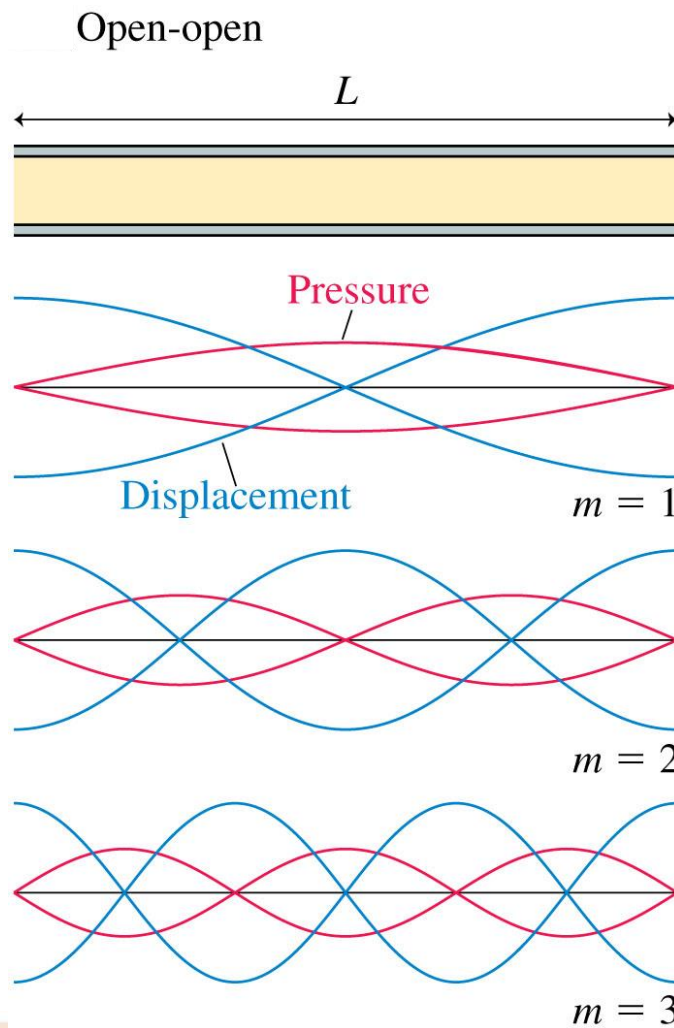


The displacement and pressure nodes

Learning Catalytics Discussion Question

An open-open tube of air has length L . Which is the displacement graph of the $m = 3$ standing wave in this tube?





$$\begin{cases} \lambda_m = \frac{2L}{m} \\ f_m = m \frac{v}{2L} = mf_1 \end{cases} \quad \begin{array}{l} m = 1, 2, 3, 4, \dots \\ \text{(open-open or closed-closed tube)} \end{array}$$

Preclass question from yesterday morning

3. multiple choice

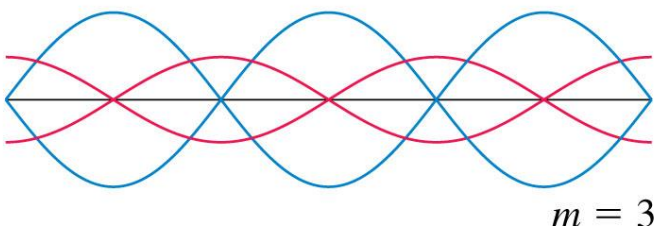
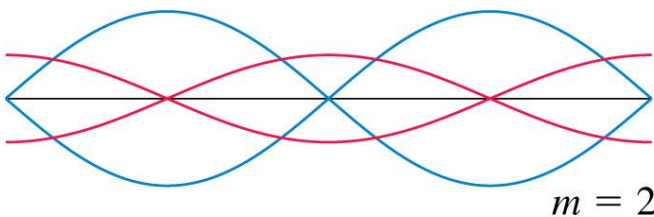
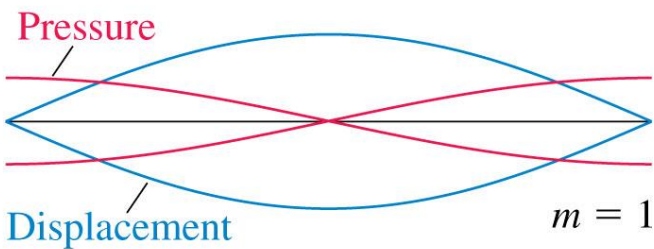
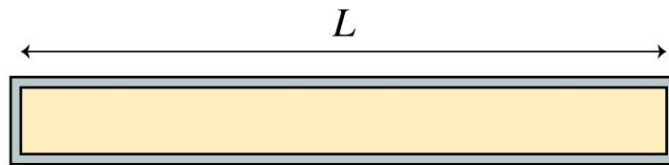
In a resonating pipe that is open at both ends, there

- A. are displacement nodes at each end.
- B. are displacement antinodes at each end.**
- C. is a displacement node at one end and a displacement antinode at the other end.

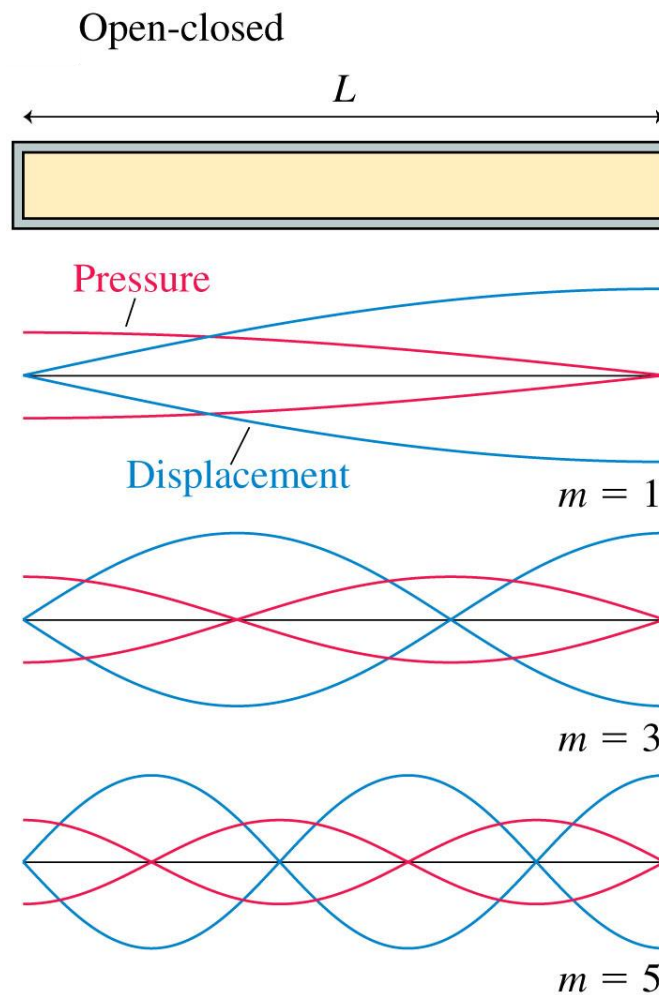
Example from a past test

A metal pipe, open at both ends, can create a standing wave in the second harmonic with a frequency of 483 Hz. What is the length of the pipe?

Closed-closed



$$\begin{cases} \lambda_m = \frac{2L}{m} \\ f_m = m \frac{v}{2L} = mf_1 \end{cases} \quad \begin{array}{l} m = 1, 2, 3, 4, \dots \\ \text{(open-open or closed-closed tube)} \end{array}$$

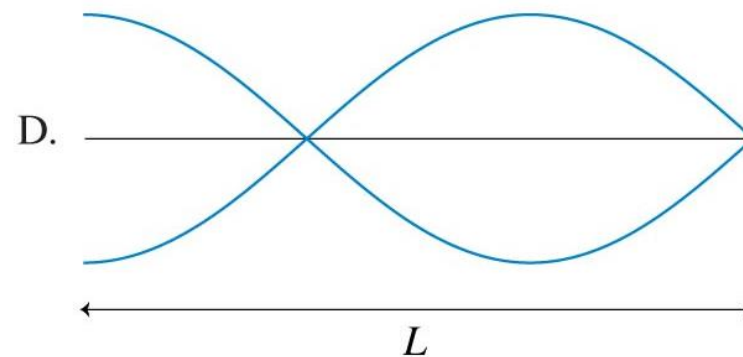
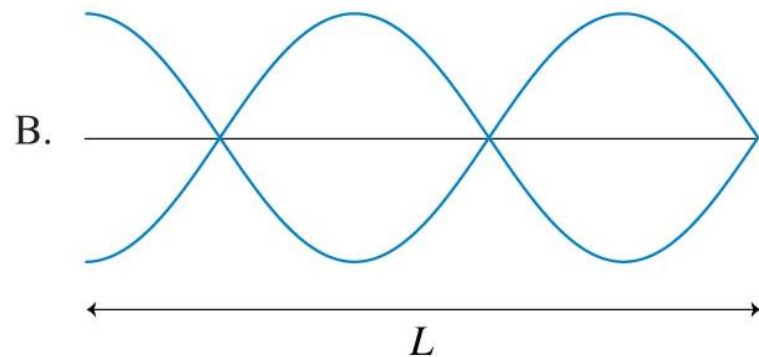
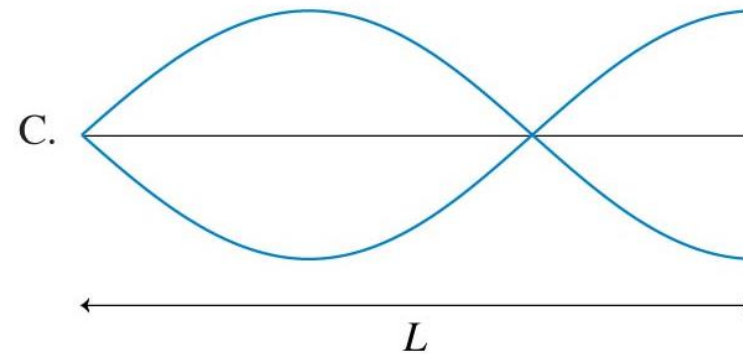
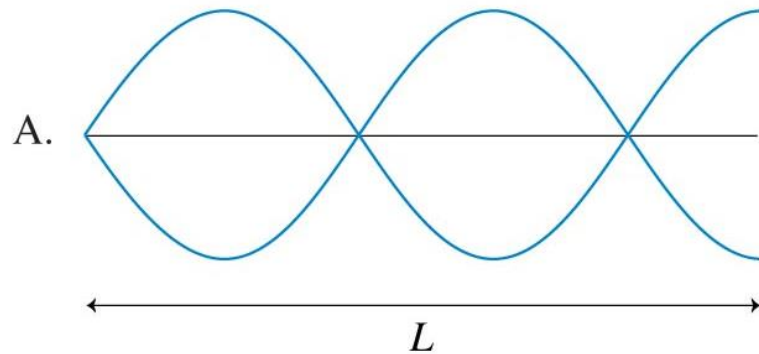
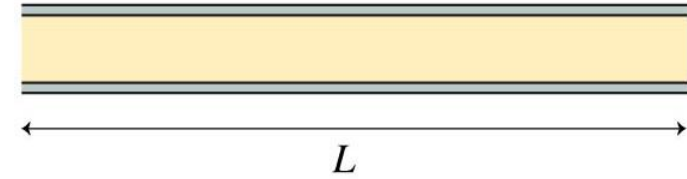


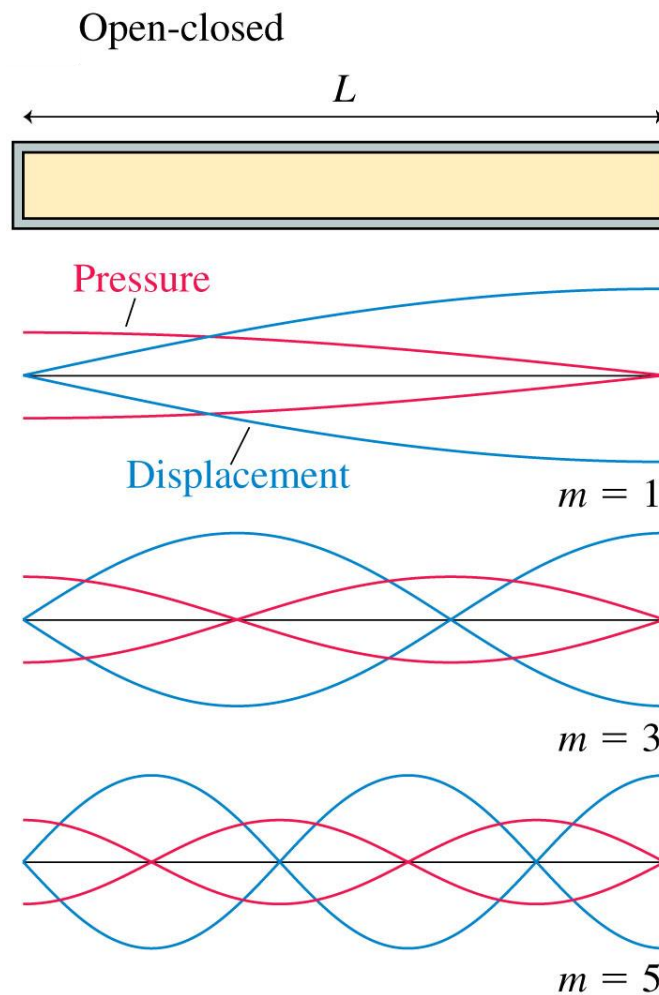
$$\begin{cases} \lambda_m = \frac{4L}{m} \\ f_m = m \frac{v}{4L} = mf_1 \end{cases} \quad \begin{array}{l} m = 1, 3, 5, 7, \dots \\ \text{(open-closed tube)} \end{array}$$

Learning Catalytics Discussion Question

An open-closed tube of air of length L has the closed end on the right.

Which is the displacement graph of the $m = 3$ standing wave in this tube?





$$\begin{cases} \lambda_m = \frac{4L}{m} \\ f_m = m \frac{v}{4L} = mf_1 \end{cases} \quad \begin{array}{l} m = 1, 3, 5, 7, \dots \\ \text{(open-closed tube)} \end{array}$$

Musical Instruments

- With a wind instrument, blowing into the mouthpiece creates a standing sound wave inside a tube of air.
- The player changes the notes by using her fingers to cover holes or open valves, changing the length of the tube and thus its fundamental frequency:

$$f_1 = \frac{v}{2L} \quad \text{for an open-open tube instrument, such as a flute}$$

$$f_1 = \frac{v}{4L} \quad \text{for an open-closed tube instrument, such as a clarinet}$$

- In both of these equations, v is the speed of sound in the air *inside* the tube.
- Overblowing wind instruments can sometimes produce higher harmonics such as $f_2 = 2f_1$ and $f_3 = 3f_1$.

Review: Gravitational Potential Energy

- The correct, general equation for the gravitational potential energy of a system consisting of two masses M and m a distance r apart is:

$$U(r) = -\frac{GMm}{r}$$

- Where the zero point is arbitrarily set so that $U = 0$ when $r = \infty$.
- Consider an object of mass m , a small distance h above the surface of a planet of mass M and radius R . Let's do a Taylor Expansion of $U(h)$:

Review: Conservation of Mechanical Energy

$$K_1 + U_1 = K_2 + U_2$$

$$K_1 = 0$$
$$U_1 = 10,000 \text{ J}$$



$$K_2 = 2,500 \text{ J}$$
$$U_2 = 7,500 \text{ J}$$



$$K_3 = 7,500 \text{ J}$$
$$U_3 = 2,500 \text{ J}$$



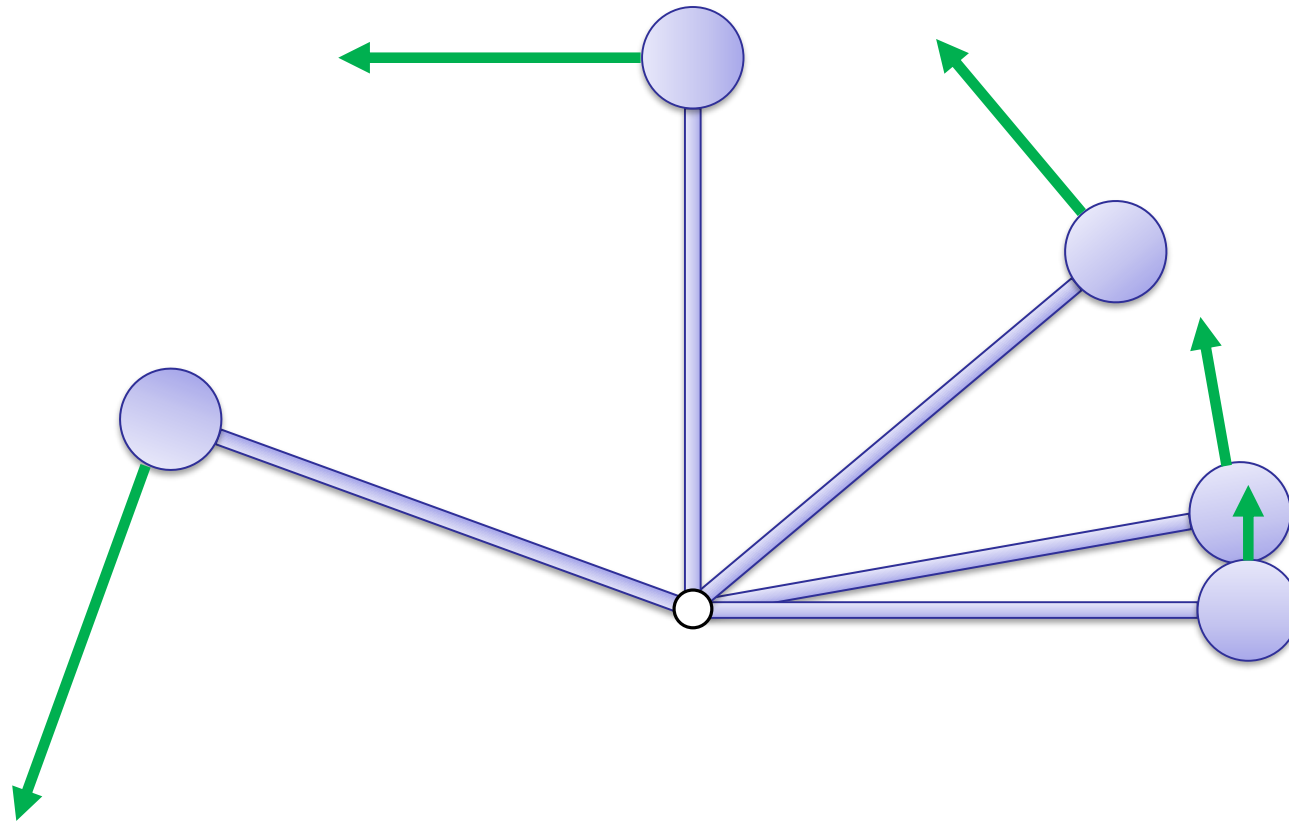
$$K_4 = 10,000 \text{ J}$$
$$U_4 = 0$$



Review: Angular Acceleration

- Angular acceleration α is the rate of change of angular velocity.

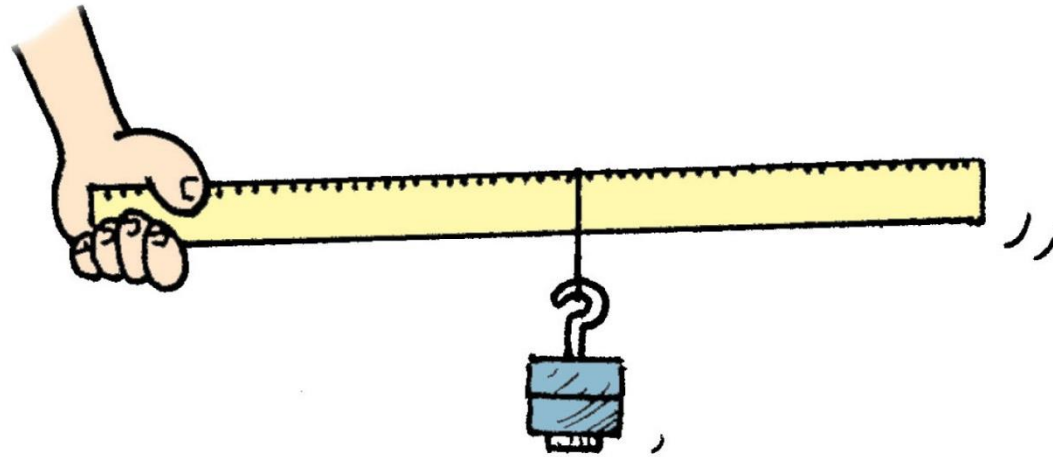
Average: $\bar{\alpha} = \frac{\Delta\omega}{\Delta t}$ Instantaneous: $\alpha = \frac{d\omega}{dt}$



Review: Torque

- The equation for Torque is

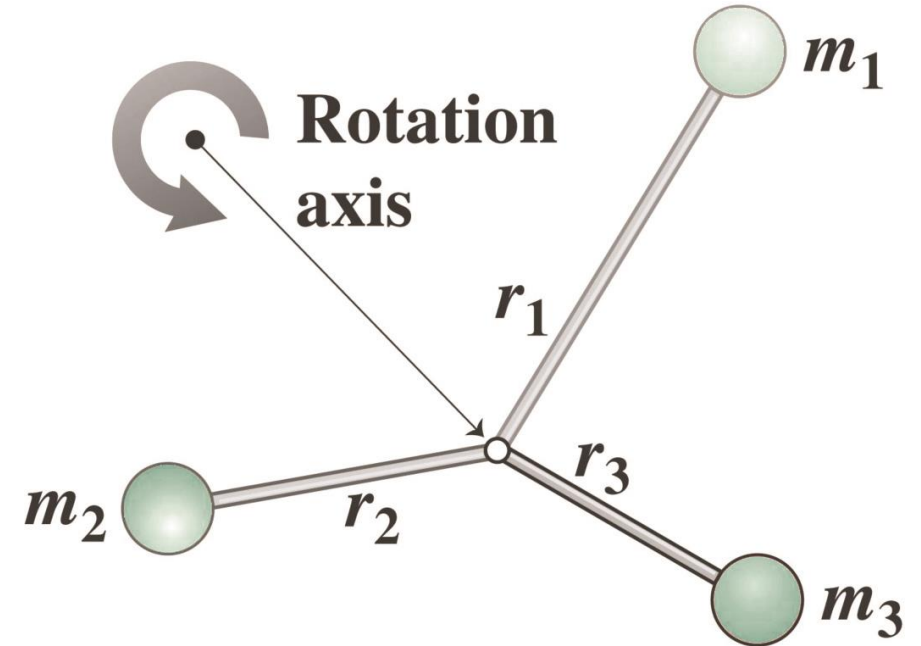
$$\vec{\tau} \equiv \vec{r} \times \vec{F}$$



Review: Rotational Inertia

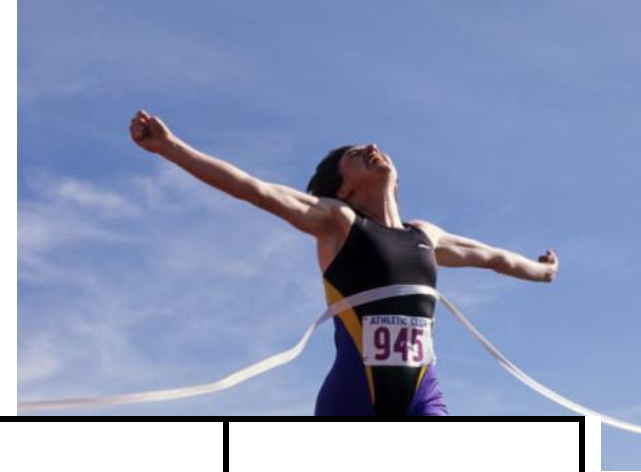
- For a system of discrete masses, the rotational inertia is the sum of the rotational inertias of the individual masses:

$$I = \sum m_i r_i^2$$



Newton's Second Law for Rotation:

The last thing in PHY131 you have to do: The Final Exam



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PHY131H1F	WAS - Z	WED 13 DEC	AM 9:00 - 11:00	EX 310

- EX is Central Exams Facility, 255 McCaul St. (just south of College St.)

What to expect

- 2 hours.
- 12 multiple choice questions worth 2 points each (24 points total)
- 3 long-answer problems worth 6 points each for which you must show your work (18 points total).
- Final exam is out of 42 points.
- Expect an even spread of material over the entire course: Chs.1-14.

Suggested Study Plan

1. Review **reading** and **lecture notes** and **Practicals Activities** for the entire course.
2. Work through the **MasteringPhysics Homeworks 1-11**. Make sure you can do these problems on paper.
3. Work through all **suggested end-of-chapter exercises**, and then **problems**.
4. Work through all the **Practice Problems** from the first hours of **Practicals**.
5. After you have done the above, if you have time, try some past exams or past midterms.

Study Groups – working with Peers

- Find student (students) in class that you work well with on MasteringPhysics, end-of-chapter suggested problems, and past tests.



- ***The best way to learn is to teach!*** If you can't explain to someone else what you have done, you haven't really understood it! (This is harder than you think!)



SEARCH EXAMS

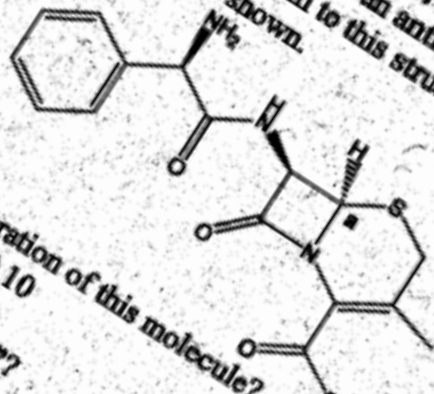
PHY

Go

Part A: Multiple Choice

The structure of the prescription drug, cephalexin, is shown below. It is commonly marketed under the trade name Keflex and is an antibiotic that is active against a broad range of bacteria. Questions 1 to 4 pertain to this structure. Note that lonepairs of electrons and formal charges are not shown.

(2 marks each)



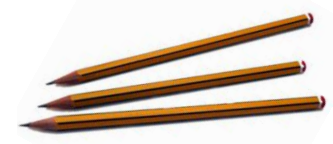
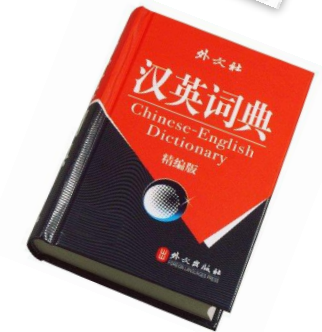
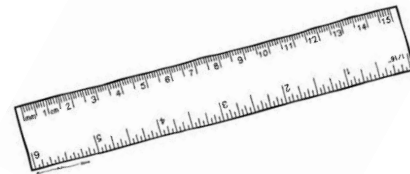
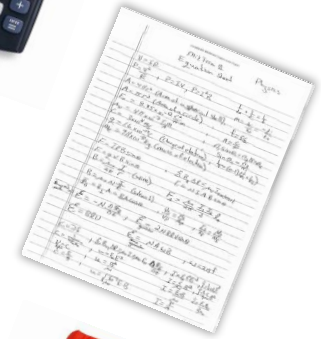
1. What is the degree of unsaturation of this molecule?
(a) 6 (b) 7 (c) 8 (d) 9 (e) 10
2. What is the stereochemistry at "a"?
(a) R (b) S (c) E (d) Z (e) none

Past Tests and Exams

- The purpose of obtaining and going through old tests and exams is to get to know “the system”.
- Each course and prof will have a certain pattern and style. Knowing the pattern in advance gives you an edge.
- Don't count on lightning to strike twice – memorizing old test questions rarely works!

Aids Allowed on the Final Exam

- Any calculator without communication capability.
- Aid sheet: one single, original, handwritten 8 1/2 × 11 inch sheet of paper, which may be written on both sides.
- A ruler.
- A **paper** copy of an English translation dictionary.
- Also:



During the Exam

- Exam begins at **9:00am SHARP!!!** Seating will begin at 8:50am, pens hit paper at 9:00.
- This exam is run by the faculty, not the physics department, so be extra careful about the rules.
- Skim over the entire exam from front to back **before** you begin. Look for problems that you have confidence to solve first.
- If you start a problem but can't finish it, leave it, make a mark on the edge of the paper beside it, and come back to it after you have solved all the easy problems.
- Quite snacks or drinks are allowed, and recommended by me.



Tuesday Dec. 12 after 6:00pm, you **must**:
Relax, watch Netflix, then go to bed.



- The evening before a test is NOT the best time to study (it is just the most popular)
- Don't worry – you have been studying since the 1st week of classes!
- You need to **relax** and get your mind **physically** ready to focus on Wednesday at 9:00am.

See you at the final!

- The faculty runs a final exam for this course on Wednesday Dec.13 at 9:00am. See you there!
- Professor Wilson and I will be giving back-to-back “Exam Jam” lectures tomorrow (Friday) from 1:00-3:00pm in SS2117. I have posted a hand-out for Exam Jam on my slides, and I will post any written notes from Exam Jam on the portal after Friday.
- Please email me (jharlow@physics.utoronto.ca) with any questions. Keep in touch! It’s been a really fun course for me!

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