College Physics I: 1511 Mechanics & Thermodynamics

Professor Jasper Halekas
Van Allen Lecture Room 1
MWF 8:30-9:20 Lecture

Extended Office Hours

- This week:
  - Tuesday 2:00-3:30 pm
  - Wednesday 9:30-11:00 am
  - Thursday 3:00-5:00 pm
  - Friday 3:00-4:00 pm
- Next week
  - Monday 8:00-11:00 am

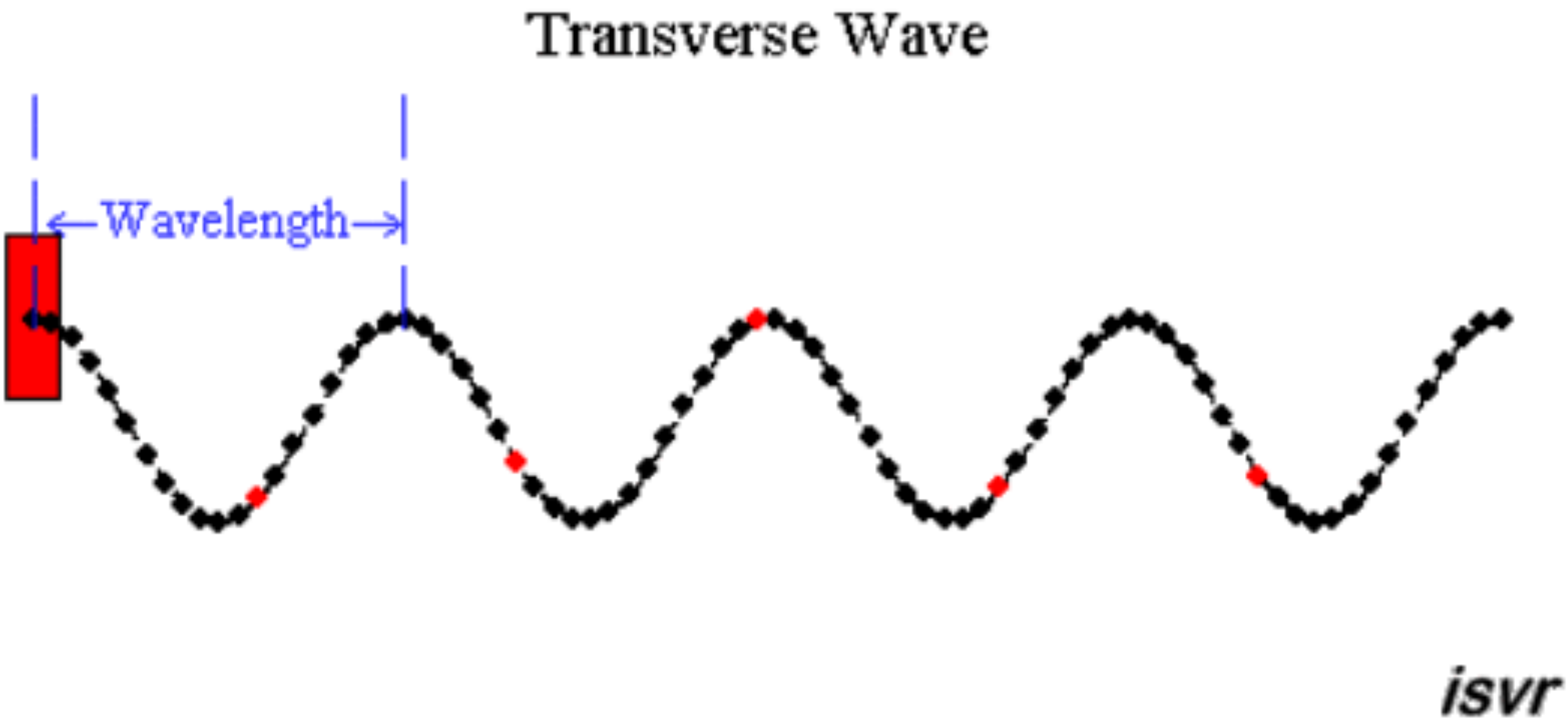
Material Covered on Final

Chapter 2: All Sections	
Chapter 3: All Sections	
Chapter 4: All Sections	
Chapter 5: Sections 5.1-5.3 and 5.7	Not 5.4-5.6
Chapter 6: Sections 6.1-6.6	Not 6.7-6.9
Chapter 7: All Sections	
Chapter 8: Sections 8.1-8.6	Not 8.7
Chapter 9: All Sections	
Chapter 10: Sections 10.1-10.4	Not 10.5-10.8
Chapter 11: Sections 11.1-11.8	Not 11.9-11.11
Chapter 12: Sections 12.1-12.8	Not 12.9-12.10
Chapter 13: Sections 13.1-13.3	Not 13.4
Chapter 14: Sections 14.1-14.3	Not 14.4
Chapter 15: Sections 15.1-15.9,15.11	Not 15.10, 15.12
Chapter 16: Sec. 16.1-16.3, 16.5-16.6	Not 16.4,16.7-16.9

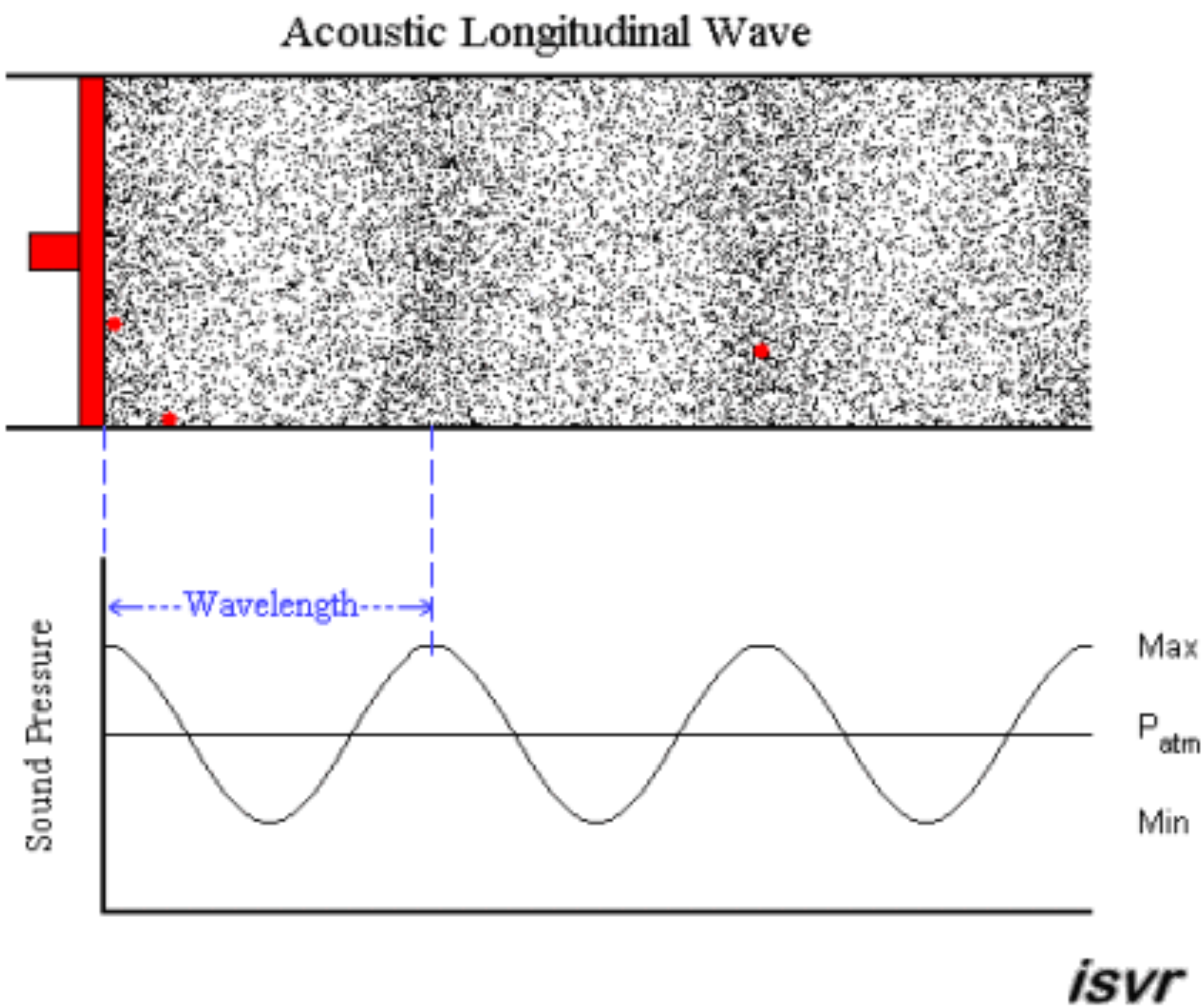
Distribution of Questions

- 8 on material from first midterm
- 8 on material from second midterm
- 8 on material since second midterm
  - 2 on heat
  - 2 on ideal gas
  - 3 on thermodynamics
  - 1 on waves

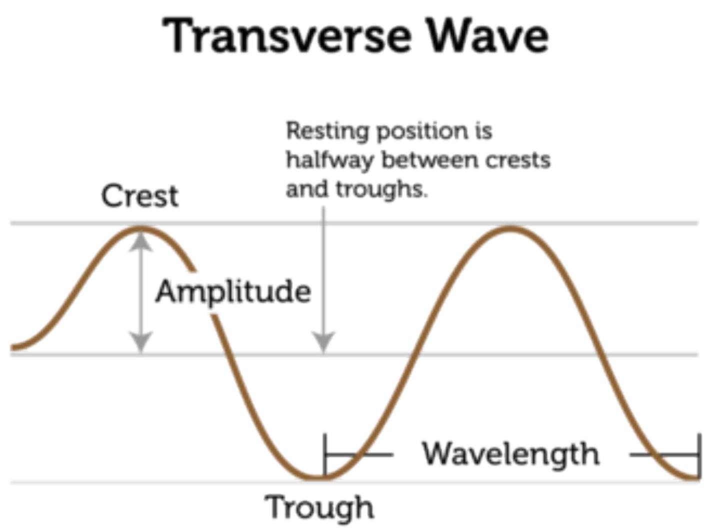
Transverse Waves

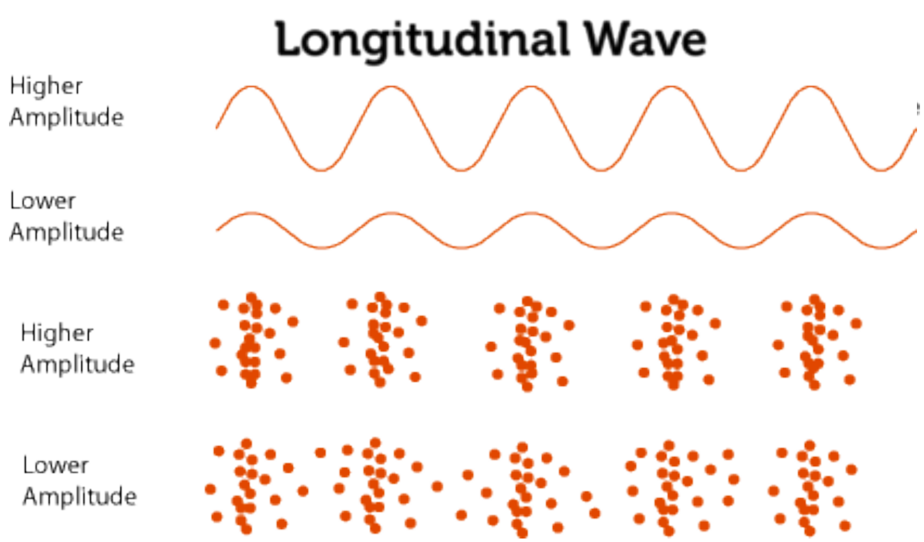


Longitudinal (Compressional) Waves

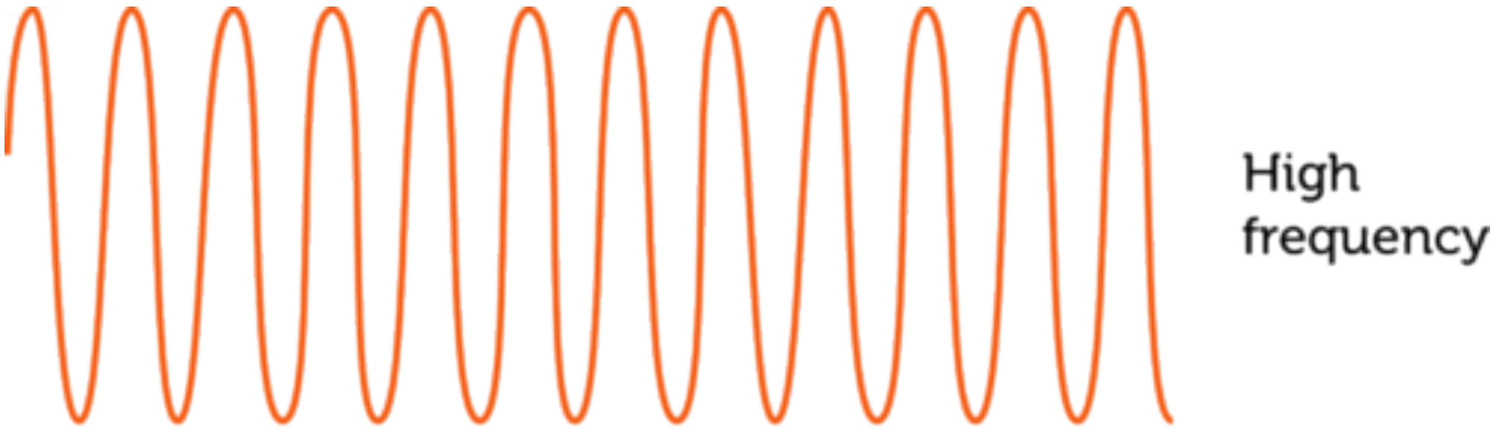


Amplitude of Waves





Frequency and Period of Waves

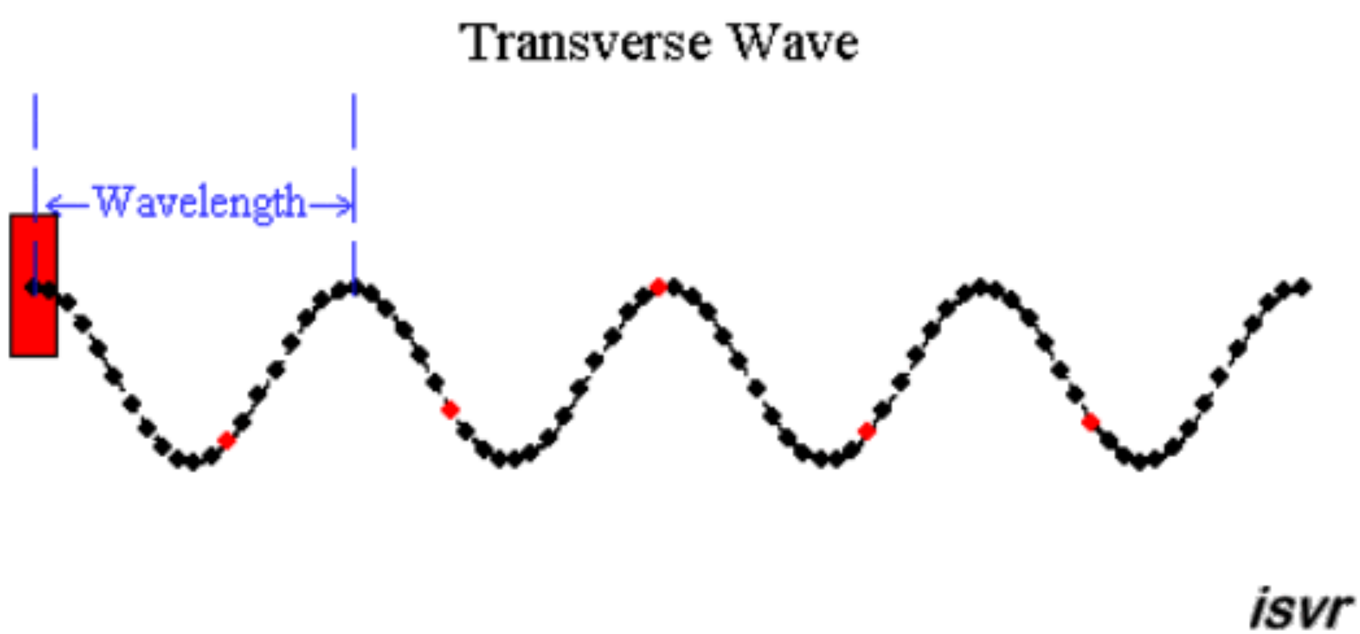


Frequency f = # of full cycles per second

Period $T = 1/f$

Frequency: Two Ways

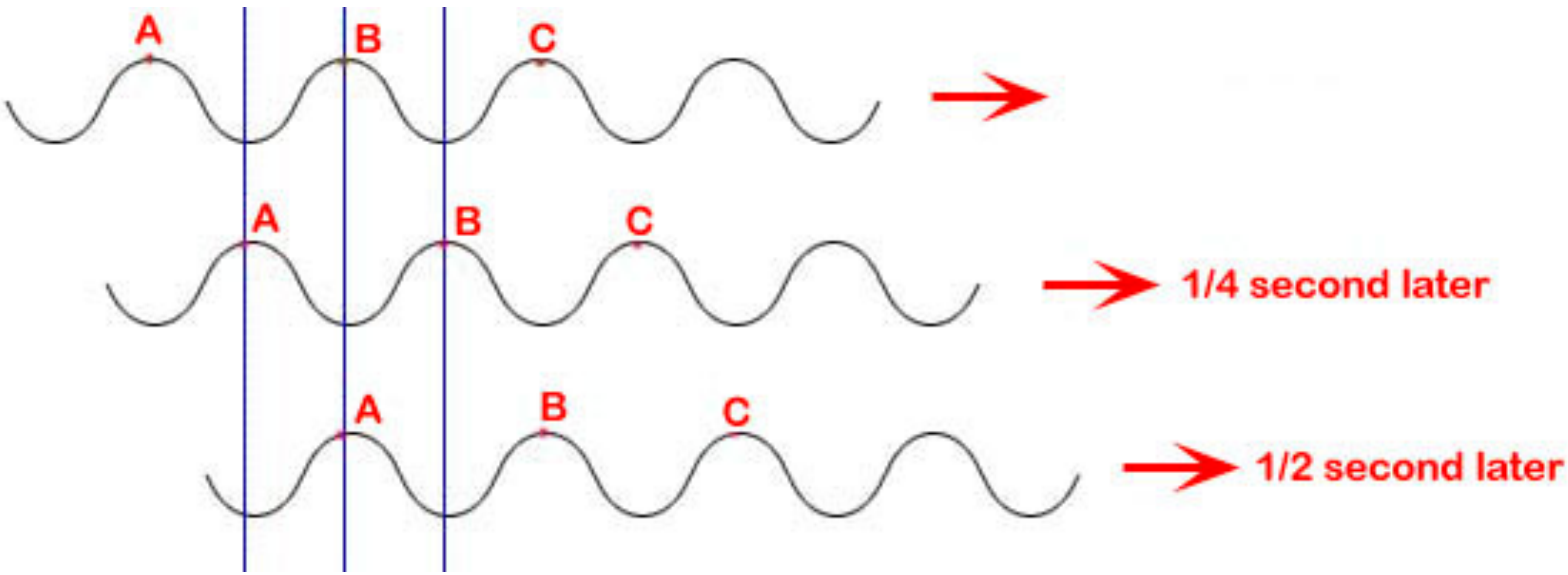
- The frequency with which a single part of the wave oscillates is the same frequency with which the wave structure passes a given point



Frequency vs. Amplitude

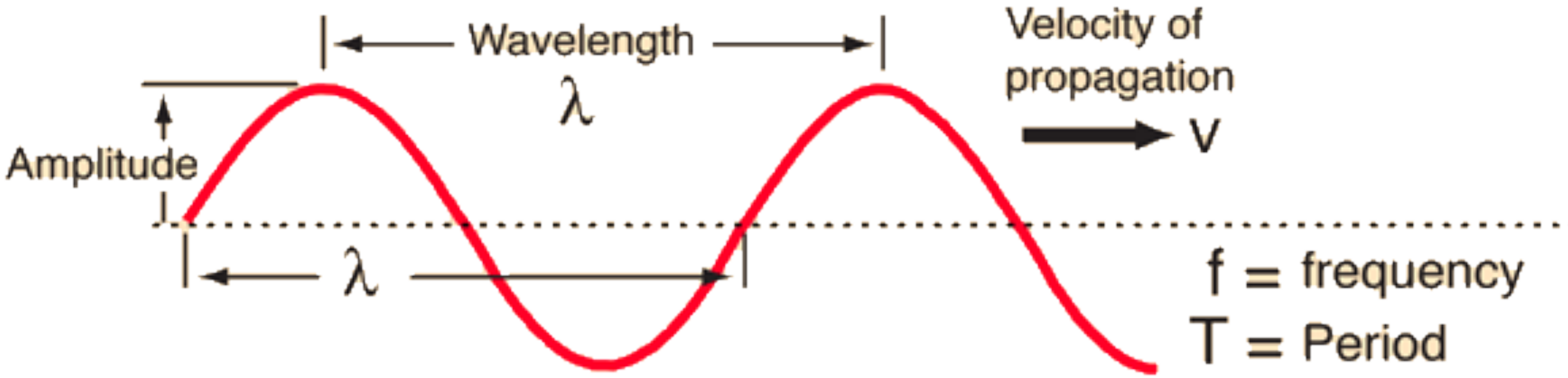
- Each portion of a wave (part of a string, particle in atmosphere, etc.) can be thought of as a little harmonic oscillator
- Just like a harmonic oscillator, the amplitude of a linear wave is independent of the frequency

Wave Speed



Wave propagation speed measures how fast it takes a given part of a wave to propagate past a fixed point

Wavelength/Frequency Relation



$$v = f\lambda \qquad f = \frac{v}{\lambda} \qquad \lambda = \frac{v}{f}$$

Speed of Wave on a String

- Wave Speed (m/s)

  Ft- tension force (N)

  m- mass (kg)

  L-length (m)

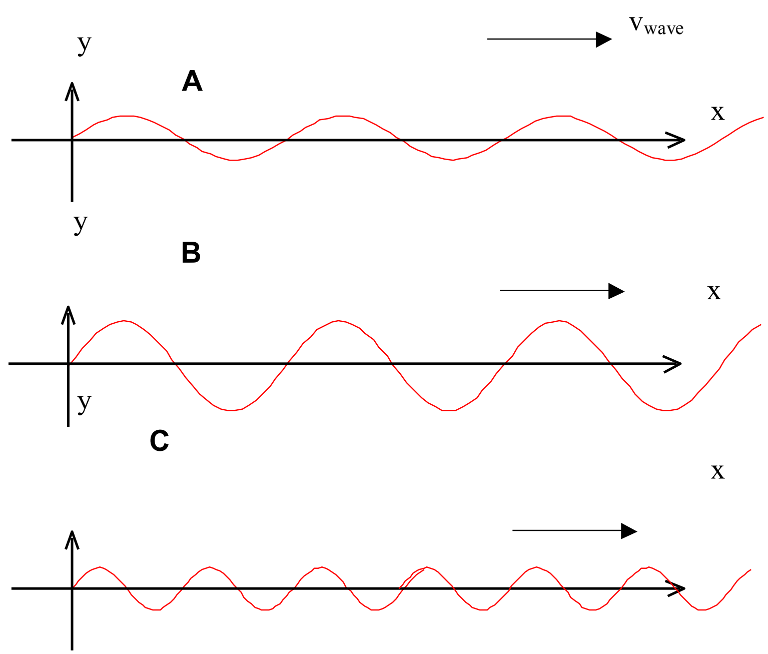
  μ- linear mass density (kg/m)

$$V = \sqrt{\frac{F_T}{\left(\frac{m}{L}\right)}} \rightarrow v = \sqrt{\frac{F}{\mu}}$$

Concept Check

- Three waves are traveling along identical strings. Wave B has twice the amplitude of the other two. Wave C has a smaller amplitude and 1/2 the wavelength than A or B. Which wave goes fastest?

- 1) A
- 2) B
- 3) C
- 4) All have same v



Speed of Sound in a Gas

- You might guess that the speed of sound is related to the thermal velocity of the particles in the gas, and you would be right
  - The average kinetic energy in a gas is $\langle KE \rangle = \langle 1/2\ mv^2 \rangle = 3/2\ kT$
    - So, $v_{rms} = \sqrt{(3kT/m)}$
  - The speed of sound is close to this, but with a slightly different numerical factor

Speed of Sound in a Gas

$$c_s = \sqrt{\frac{\gamma RT}{M}} = \sqrt{\frac{\gamma k_B T}{m}}$$

$\gamma = C_P/C_V =$
5/3 if monatomic

Changing the temperature of a gas changes the speed of sound in it!

So does changing anything else that affects the temperature, like pressure or volume.

So does changing the mass of the molecules in the gas…

Concept Check

- If you double the pressure in a fixed sample of an ideal gas, while maintaining the same volume, what happens to the speed of sound in the gas?

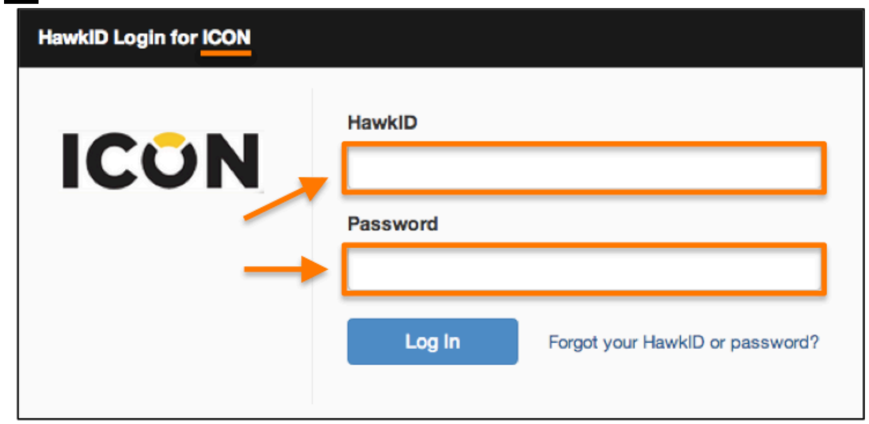
- A. The speed doubles
- B. The speed is cut in half
- C. The speed increases by sqrt(2)
- D. The speed decreases by sqrt(2)

Evaluations

- Thank you all for being such a great class!
- Please fill out a course evaluation
  - Your constructive feedback is highly appreciated, will be taken very seriously, and will be used to improve future courses
  - Input from previous students was used to improve this course

To Access Evaluations

1



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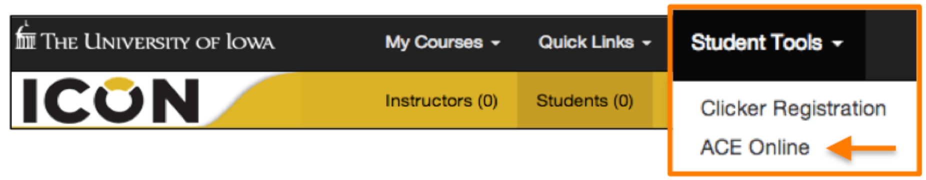

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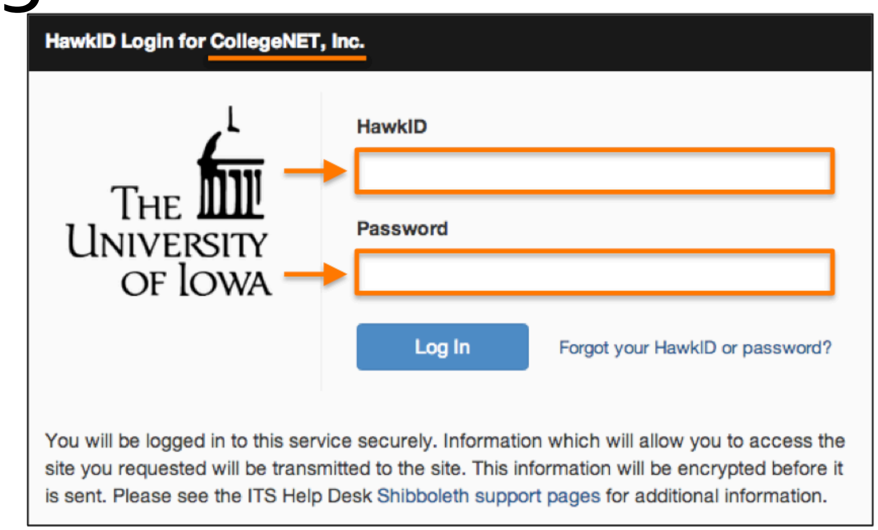

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This course is PHYS 1511

Lecture section is 0AAA