PHY132 Practicals Week 1 Student Guide

Welcome to the Physics Practicals! We have devised a number of Activities and Projects which will help you to learn a lot of Physics. They will also help you to do well on the tests and exam of the course. We are very excited about this new way of helping you to learn Physics, and hope you find your time in the Practicals to be fun and productive.

How the Practicals Work

You will be meeting for 2 hours every week in room MP125A or B. Each Group will have a maximum of 36 students. You will be working in a Team with up to three of your classmates. There will be two Teaching Assistant Instructors present for each Practical.

Your Team will keep a single lab book, which is to be a complete record of everything you did, what you and your teammates thought it meant, and what conclusions you have drawn from your work.

Each Practical session will include time for student questions and discussion. However the "heart" of the Practicals will be a series of Activities.

Every week you will be doing Activities based on the material currently being discussed in class. Often the Activities will be based on material that has already been discussed in class, but sometimes the Activities may be used to introduce material that has not yet been talking about in class.

For each Practical session two members of each Team will serve the following roles:
>   **Facilitator:** This person, a different individual each week, is responsible for keeping the Team on track with the Activities. When the entire Practical group discusses some topic, the Facilitator will be the Team's primary spokesperson.
>   **Recorder:** This person, also a different individual each week, takes primary responsibility for recording all work, speculations, conclusions etc. in the lab notebook.

Evaluation and Marks

The Practicals will count for 20% of your mark in PHY131.

All marks will be given on an integer scale from 0 to 4:
0. Missing work.
1. Seriously deficient.
2. Requires improvement.
3. The standard mark indicating good work which meets all expectations
4. Exceptional. Work which goes well beyond the expectations in the write-up.

Attendance at the Practical is vital for your learning. We will deduct the *cube* of the number of un-excused absences from the final Practical mark.

Computers and Networks

The Practical server is: feynman.physics.utoronto.ca. You will access the server using your UTORid and password. You will have access to three folders on this server:

Your home directory. You have read and write privileges for this directory.
Your team directory. All members of your team have read and write privileges here.
public. This is an area of the server containing documents, computer programs, etc.
Everyone has read privileges for this directory.

Note: you should never save work on the local PC. These discs will be ruthlessly purged on a regular basis.

Remote Access

You may access the server at: https://feynman.physics.utoronto.ca. You may upload and download files from your computer to the server.

Printing

There is a colour printer in the Practical Room. You may choose to print either in colour or black and white by choosing the appropriate printer in the print dialog. We charge for printing using your **TCard**. We charge:

10 cents per page for black and white printing.
15 cents per page of colour printing.

We do not (yet) have facilities in the building to add dollar values to your card. The locations of cash-to-card locations is at:
http://content.library.utoronto.ca/finance-admin/photo/cash-to-card
At present the nearest location is the Main Floor of the Earth Science building, just across Huron Street.

Concepts of this week's Module

- Traveling waves
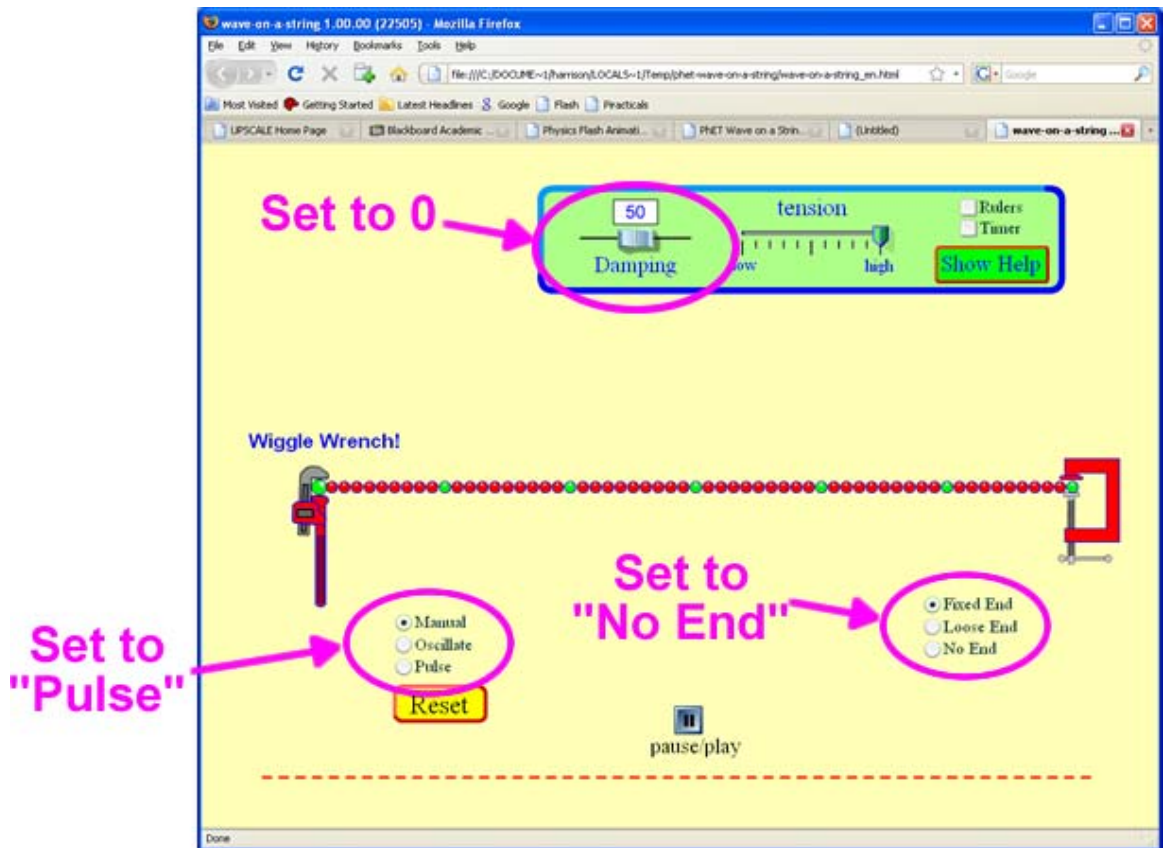- Longitudinal sinusoidal waves

Activity 1

Course Concepts

[based on Activity 1 of "Waves Module"]

A. Open the Java applet `wave-on-a-string` which is at: My Computer →
   `public on 'feynman' (P:)` → Modules → Waves

- Set the Damping to 0
- Set the wave type to "Pulse"
- Set the end to "No End" which will replace the vise on the right side with
  an open window for the waves to go through.

Click on the *Pulse* button that will appear. Imagine you are standing right beside
the window as the pulse goes out of it, measuring the amplitude as a function of
time as it goes by you. Sketch the amplitude as a function of time.

B. Click on the *Rulers* control in the upper-right corner of the simulation. The rulers that appear can be moved with the mouse. Estimate the speed, width and amplitude of the wave pulse. Add labeled tick marks on the axes of the sketch of Part A.

This is a good time to experiment with different values of the Damping and tension. What happens as the Damping is increased? What happens as the tension in the string is decreased? You may wish to explore some of the other settings of the simulation too. As usual, record all of your observations in your notebook.

C. The triangular pulse of Parts A and B was symmetric. Here is a plot of an asymmetric triangular pulse traveling from left to right. At the moment shown the time $t = 0$. The wave is traveling with a speed of 0.5 m/s. Sketch the amplitude of the pulse at $x = 0$ as a function of time t as the pulse goes by. Include labeled tick marks on both the y and t axes.
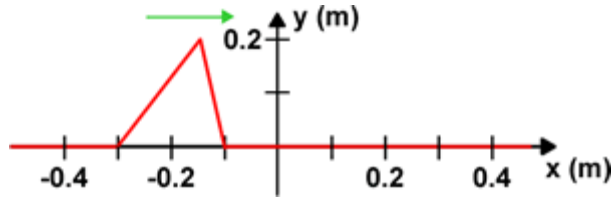
D. Here is the same triangular pulse as Part B, but it is traveling from right to left at 0.5 m/s. At the moment shown the time $t = 0$. Sketch the amplitude of the pulse at $x = 0$ as a function of time t as the pulse goes by. Include labeled tick marks on both the y and t axes. Compare to the sketch from Part B.
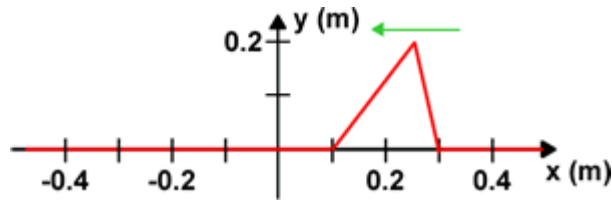
E. Here is a sinusoidal wave pulse traveling from left to right at $v = 0.5$ m/s. At the moment shown $t = 0$. Sketch the amplitude of the pulse at $x = 0$ as a function of time t as the pulse goes by. Include labeled tick marks on both the y and t axes. What is the wavelength λ of the pulse? From your sketch what is the period T, frequency f, and angular frequency ω of the sinusoidal pulse? What is the relation between λ, f and v?
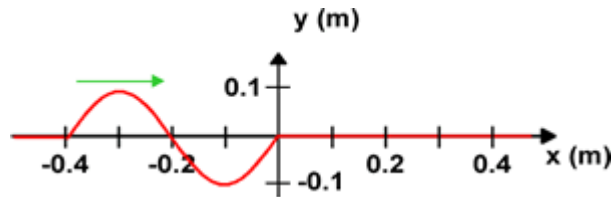
F. Here is a sinusoidal wave pulse traveling from right to left at $v = 0.5$ m/s. At the moment shown $t = 0$. Sketch the amplitude of the pulse at $x = 0$ as a function of time t
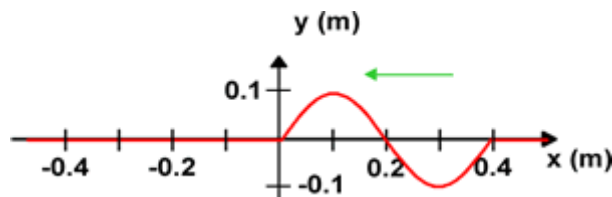
as the pulse goes by. Include labeled tick marks on both the *y* and *t* axes. What is the wavelength λ of the pulse? From your sketch what is the period *T*, frequency *f*, and angular frequency ω of the sinusoidal pulse? What is the relation between λ, *f* and *v*?

G. Here is a sine wave traveling from left to right with *v* = 0.5 m/s. The wave extends to infinity in both directions along the *x* axis. At the moment shown the time *t* = 0. At the moment shown the amplitude as a function of position is:
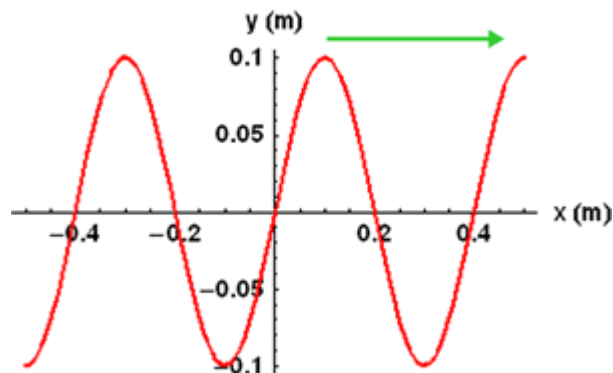
$$\Psi(x, t = 0) = 0.1\sin(2\pi\frac{x}{\lambda})$$

In your own words, explain the factor 2π in the above equation. We can describe the amplitude as the wave passes *x* = 0 either as $\Psi(x = 0, t) = 0.1\sin(2\pi\frac{x}{T})$ or as

$\Psi(x = 0, t) = 0.1\sin(-2\pi\frac{x}{T})$. Which form is correct? Explain your own words.

Write down a form of $\Psi(x, t)$ which is valid for all values of *x* and *t*. You may find the following Flash animation useful in visualizing this situation:

http://faraday.physics.utoronto.ca/PVB/Harrison/Flash/ClassMechanics/TravelWaves/TravelWaves.html

The above link is to a fixed size animation which works nicely if only one person is viewing it. If more than one person is viewing the animation, a version which can be resized is better. Here is a link to a resizable version of the same animation:

http://faraday.physics.utoronto.ca/PVB/Harrison/Flash/ClassMechanics/TravelWaves/TravelWaves.swf

Course Concepts *Activity 2*

[based on Activity 4 of "Waves Module"]

Here is a Flash animation of a molecular view of a sound wave traveling through the air:

http://faraday.physics.utoronto.ca/IYearLab/Intros/StandingWaves/Flash/long_wave.html

The above link is to a fixed size animation which works nicely if only one person is viewing it. If more than one person is viewing the animation, a version which can be

resized is better. Here is a link to a resizable version of the same animation:

http://faraday.physics.utoronto.ca/IYearLab/Intros/StandingWaves/Flash/long_wave.swf

Open one of the versions of the animation.

A. The bottom shows the motion of the air molecules. You may wish to imagine that the molecules are connected to their nearest neighbors by springs, which are not shown. There is a wave of increasing and decreasing density of the molecules. Is the wave moving to the right or to the left? Explain. Is the wave longitudinal or transverse? Explain.

B. Often instead of describing the wave as one of density we talk about a *pressure* wave. Does the higher density of molecules correspond to higher or lower pressure? Can you explain?

C. The top shows the displacement of the molecules from their equilibrium positions. It too is a wave, often called a *displacement* wave. Is the wave moving to the right or to the left? Explain. Is the wave longitudinal or transverse? Explain.

D. Use the *step* controls, pause the animation and position molecules 3 and 9 at their equilibrium position with molecule 6 at maximum displacement. The amplitude of the displacement wave is zero for molecules 3 and 9. Is the amplitude of the pressure wave at the position of molecule 3 also zero, or is it a maximum or a minimum? What about the pressure wave at the position of molecule 9?

E. Use the *step* controls to position molecules 3 and 9 at their equilibrium position with molecule 6 at minimum displacement. Is the amplitude of the pressure wave at the position of molecule 3 zero, or is it a maximum or a minimum? What about the pressure wave at the position of molecule 9?

F. From your results for Parts D and E, what is the phase angle between the pressure wave and the displacement wave?