PHY132 Practicals Day 1 Student Guide

Summer 2009

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 Tuesday and Thursday in room MP125A, B or C. 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 PHY132.

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. We will be very stingy in awarding marks of 4.

Here are the components and their weights:

1. **Notebook Mark 1 (0 Weights)**. After the first Practical the lab books will be collected and marked. However, this mark will not count towards your Practical mark. Instead it is intended to make our standards and requirements clear to you.
2. **Notebook Mark 2 (6 Weights)**. After the last Practical before Test, a selection of Activities from Practical sessions completed so far will be chosen to be marked. The decision of which Activities will be marked will be chosen more-or-less randomly after the books have been collected. All Teams will have the same Activities marked.
3. **Notebook Mark 3 (6 Weights).** At the end of the term a selection of the Mechanics, Oscillations and Fluids Activities you have done since the Test will be chosen to be marked. The decision of which Activities will be marked will be chosen more or less randomly after the books have been collected. All Teams will have the same Activities marked.
4. **Measurement Project (3 Weights).** Due on July 28, this is a 2-page report on a Measurement Project done by individual students outside of class time.
5. **Individual Assessment (5 weights).** Throughout the semester your two TAs will be observing how you, as an individual, perform in the practicals on an ongoing basis. In arriving at this mark, your TAs will take into account your preparedness, the way you approach and organize experimentation and record-keeping, and your ability to work effectively with your team members. Also considered will be your ability to estimate errors (rather than calculating each one exactly), your ability to distinguish the essential from the inessential, your willingness to try something, to make a mistake, and to learn from it, and how often you seek advice and ask questions. If an individual is often late or absent this may also affect the Individual Assessment mark. At the end of the course, the in-lab mark will first be computed on the integer 4-point scale by both of your TAs independently. Then, in consultation with the practicals coordinator, half-integer marks will be allowed as the results from both TAs are combined into a single mark for each student. Therefore, the Individual Assessment mark can have a value of 0, 0.5, 1, 1.5, 2, 2.5, 3, 3.5 or 4. As usual, 3.0 is the "standard mark" which, by course policy, most students will receive.

- All teams should stay for the entire 110 minutes during each week of Practicals. If a student arrives more than 20 minutes late (ie later than 30 minutes past the hour), then he or she is counted as absent for that day. If a student leaves more than 10 minutes early, he or she is counted as absent for that day.

- *Cube of Absences Rule*: Attendance at the Practical is vital for your learning. If you do not attend, you will be letting down your team-mates. The Practicals mark (worth 20% of the course mark) will be converted to a mark out of 100. The number of absences each student has will be cubed and deducted from this total out of 100. Effectively, this means that one absence generates a 1% penalty in Practicals mark. Two absences generates an 8% penalty. Three absences generates a 27% penalty, etc.

- *If You Have Time Activities* (IYHT): IYHT Activities should not be attempted by any teams until they have spoken to a TA and obtained permission. For each Notebook Mark which counts, one IYHT activity will be randomly selected along with the regular activities. Teams that did well on the chosen IYHT get a 0.5-point bonus, while teams that didn't do it or tried but didn't do well on it get no bonus points.

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.

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.

Measurement Project, due July 28

I would like you to answer ONE of the following five general questions:

1. What is the height of the Burton Tower, which is part of McLennan Physical Laboratories?
2. What is the volume of the water in the fountain pool in the courtyard between McLennan Physical Laboratories and Lash Miller Chemical Labs?
3. What is the average mass per unit length of the typical blade of grass from the courtyard between McLennan Physical Laboratories and Lash Miller Chemical Labs?
4. How fast do your own fingernails grow? [Please convert into some useful unit, such as mm/month.]
5. What is the average maximum temperature of the hot water coming out of the taps in the bathrooms in McLennan Physical Laboratories?

You should re-state the question so that it is more specific. Make sure that your final answer matches the question *you* are asking. If you would like to answer a question that is very different from any of the above five, please first obtain permission from Jason Harlow, the Practicals Coordinator. The Measurement Project will, in part, be marked on writing style and on the organization and presentation of the material. Good English structure, spelling and grammar are expected, and graphs and diagrams should be clearly labelled.

Resources: The technologists for PHY132 are Larry Avramidis, Lilian Leung, Phil Scolieri and Rob Smidrovskis. They all share an office in MP127. With their permission you may borrow metre sticks, stopwatches, measuring tape, Vernier callipers, thermometers, and the like from the Resource Centre in MP126. They can also make a digital scale available to you. If MP126 is not open you can knock on the door of MP127 during regular business hours M-F 9-12, 1-5.

The Measurement Project in electronic format is due to www.turnitin.com by 11:59 PM on Tuesday, July 28, 2009. Late Measurement Projects will be penalized at the rate of 10% per day of lateness. An identical paper copy must also be submitted to your demonstrator either during your 8th Practical session July 28. To submit your assignment electronically you should follow these steps:

Log on to www.turnitin.com . If you don't already have a user profile, set one up:

- Click *Create a user profile*.
- Enter a valid utoronto.ca email address, password and your name. Please enter the same name that is on your University of Toronto I.D. so we can easily tell who you are.

Enroll in this class

From your turnitin homepage click the *Enroll in a class* button.

For this class the *Turnitin class I.D.* is **2619965** and the *Turnitin enrollment password* is **sunshine** . The name of the class should be "PHY132 Summer 2009".

Submitting a paper.

From your Turnitin homepage select this class

Click on the Submit button and select *File Upload* from the pulldown menu.

Enter a submission title for your paper, which should include your name. You may use spaces in the title, but not commas or other special characters. Use the *Browse* button to select the file that you would like to submit. Click *Submit*.

If you prefer, you may choose to submit only a hard-copy of your project, but in this case you must also provide a photocopy of the relevant notes you took while performing your measurements with dates and times, with numbered references linking the text in your formal report to the original measurement notes. Please speak with the lab coordinator at least one week before the project deadline if you prefer to submit a hard-copy only.

Length Limit: The typed report should be 2 pages long, including figures, tables, etc. If the report spills onto 3 pages this is acceptable, but 3 is the limit. It should contain no more than 800 words (including title, table captions, figure captions). Marks will be deducted if either of these length limits is exceeded. Note that www.turnitin.com sometimes overcounts the number of words, mostly depending on how you submitted your tables; in any case the turnitin.com word count should not exceed 1000 words.

Poster Option: You may submit your Measurement Project as a poster. The poster should be 28" tall and 36" wide, and should not have any text on it smaller than 24-pt. You should make a PDF of your poster and submit it to turnitin.com following the instructions above. You should NOT submit a poster in paper format. Instead, please attach the PDF file in an email to Jason Harlow by the electronic deadline. The very best posters submitted will be printed by the graphics department in Physics, and, with the author's permission, posted in the hall on the first floor of the North Wing of McLennan. Posters should include all the necessary information about your measurements and analysis, but should also be eye-catching, colourful and succinct.

Note on "Originality": While your Procedure may include work you do with your friends (who should be listed as collaborators in your report), your Measurement Project should be primarily your individual work. You must perform the analysis and write the entire report yourself. For information on "how not to plagiarize", please see http://www.utoronto.ca/writing/plagsep.html.

The turnitin.com version will be treated as your official submission, and the marker may download your report from the turnitin.com web site. The marker will also have access to an "originality report", which is a comparison of the text-portion of your report to millions of other documents, including all the online material for this course, all the other reports submitted to turnitin.com, and many documents which were available at some time on the world-wide-web. The originality report will probably not be used in the marking unless there is some evidence that an unusually large amount of your unquoted text is identical to some other source. If you do wish to quote a source, be careful to reference it and include the copied words in quotation marks, so it is clear to the reader that you did not write them.

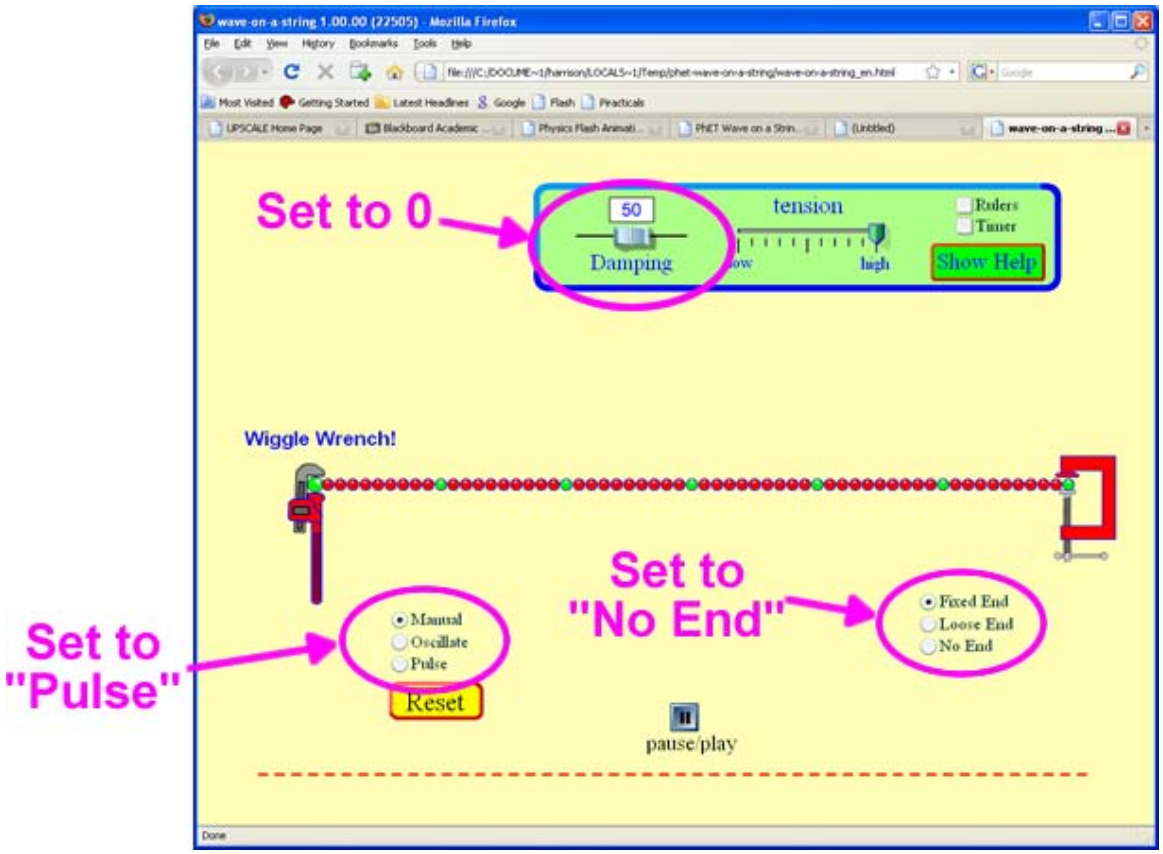
Students agree that by taking this course your measurement project may be subject to submission for textual similarity review to Turnitin.com for the detection of plagiarism. All submitted papers will be included as source documents in the Turnitin.com reference database solely for the purpose of detecting plagiarism of such papers. The terms that apply to the University's use of the Turnitin.com service are described on the Turnitin.com web site.

Concepts of this week's Module

- Traveling waves
- Reflection

Waves Module 1, Activity 1

A. Open the Java applet `wave-on-a-string.jar` which is at: `Feynman:Public/Modules/Waves`.



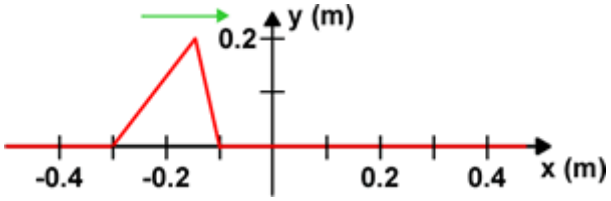
- Set the Damping to 0
- Set the wave type to “Pulse”
- Set the end to “No End” which will replace the vise on the right side with an open window for the waves to go through.

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.

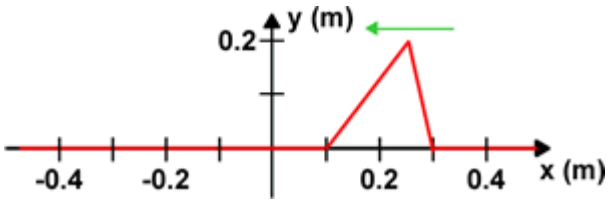
B. Click on the *Rulers* control in the upper-right corner of the simulation. The rulers that appear can be moved with the mouse. Estimate the speed, width and amplitude of the wave pulse. Add labeled tick marks on the axes of the sketch of Part A.

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.

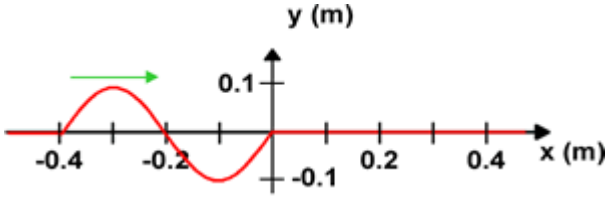
C. The triangular pulse of Parts A and B was symmetric. Here is a plot of an asymmetric triangular pulse traveling from left to right. At the moment shown the time $t = 0$. The wave is traveling with a speed of 0.5 m/s. Sketch the amplitude of the pulse at $x = 0$ as a function of time t as the pulse 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.

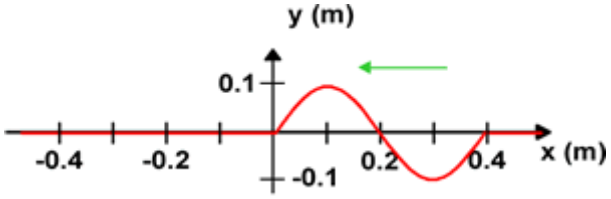


E. Here is a sinusoidal wave pulse traveling from left to right at $v = 0.5$ m/s. At the moment shown $t = 0$. Sketch the amplitude of the pulse at $x = 0$ as a function of time t

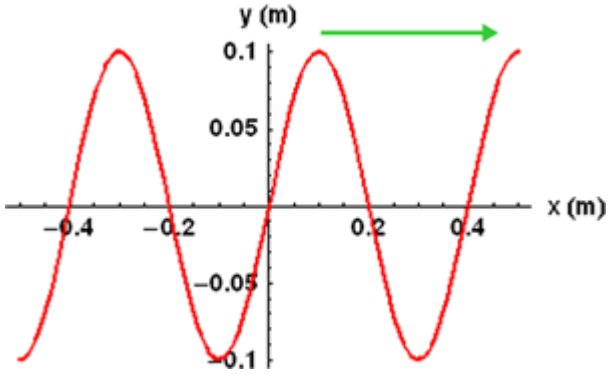


as the pulse goes by. Include labeled tick marks on both the *y* and *t* axes. What is the wavelength λ of the pulse? From your sketch what is the period *T*, frequency *f*, and angular frequency ω of the sinusoidal pulse? What is the relation between λ, *f* and *v*?

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 $\Psi(x=0,t) = 0.1\sin(2\pi\frac{t}{T})$ or as $\Psi(x=0,t) = 0.1\sin(-2\pi\frac{t}{T})$. 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 *Waves Module 1, Activity 4*

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?

If you have time: Waves Module 1,Activity 5

[***STOP!*** Please go back and take a second look at what you have recorded in your notebook for the mandatory activities. Is there anything missing? Can anything be improved? Does your TA have advice on what you might be able to do better? Please do not attempt this "If you have time" activity until you feel confident that the other activities are completed to the best of your ability, and you have obtained permission from one of your TAs.]

A. Open the Java applet `wave-on-a-string.jar` which is at: `Feynman:Public/Modules/Waves`. Part A of Activity 1 shows a screen shot of the applet.

   - Set the Damping to 0
   - Set the wave type to "Oscillate"
   - 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.

   How does the amplitude of the wave change as it propagates down the string? Is this a one dimensional, two dimensional, or three dimensional wave? You may wish to look over Parts B and C before answering this question.

B. A two dimensional wave, such as a water wave, is propagating away from its source equally in all directions. Assume damping is negligible. How does the amplitude of the wave change with distance from the source?
C. A three dimensional wave, such as a sound wave, is propagating away from its source equally in all directions. Assume damping is negligible. How does the amplitude of the wave change with distance from the source?
D. What physical principle or conservation law gives the answers to Parts A – C? Explain

Last revision to this write-up: June 26, 2009 by Jason Harlow.

This Waves Module 1 Student Guide was written by David M. Harrison, Dept. of Physics, Univ. of Toronto in the Fall of 2008.

The Java applet used in Activities 1, 5 and 6 was written by the Physics Education Technology (PhET) group at the University of Colorado, http://phet.colorado.edu/index.php. Retrieved November 9, 2008.