Physics 1402

TA Manual

2013 Revision

Preface

As always, rule #1 is to do all of the labs well before your students have to do them. There are some subtle points in these labs, particularly some of the later ones.

For 2013, I have added the torque and precession section (Problem 5) to the magnetostatics lab. Exactly how this gets handled is up to the instructor, but we found that students were finishing Problem 4 fairly quickly.

These notes replace a previous version which was all PDF and hence not editable. Going forward, instructors can make their own edits.

Paul Crowell
November 2012

Laboratory 1

Your instructor will probably choose Problem 2 (first week) and Problem 4 (second week). Make sure you are prepared. **The tubes for the standing wave lab need to be filled each year**. Fill the nitrogen and argon at the beginning of the week. **Helium tubes need to be filled every day** Make sure that the tubes are purged and filled properly. Make sure the students analyze the data while in lab.

Make sure that you have all of the correct slit assemblies for Problem 4.

I am inserting here notes about all of the problems, although in recent years we have just used Problems 2 and 4.

Problem 1: Standing Waves on a String

Background

The setup for this lab is quite simple, and much of what you find here may be repetition from what you will find in the student manual. We already know that the velocity of a wave can be described in two ways. Of course, one way to calculate the velocity of the wave is with its frequency and wavelength. The easiest method to make these measurements is with standing waves. The objective for the students is to verify that equation 1.2 by plotting the velocity of the waves on the string against the tension or the linear mass density.

Materials

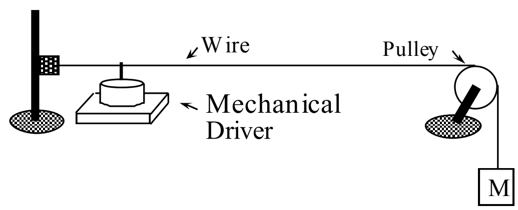
Your students will need:

1) a Pasco® mechanical driver,
2) wires of various sizes (different linear mass densities),
3) a hanging mass set,
4) a pulley,
5) a function generator,
6) a meter stick, and
7) a mass balance.

It would be best to find various wires that are loose and flexible. In the past, we have used some stiffer wires, which skew results, as you will see in the *Analysis* section for this problem. Effectively, stiffer wire will decrease the velocity of the wave that traverses the wire.

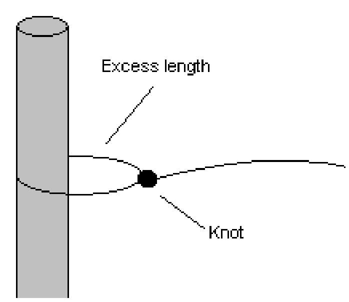
Procedure

Using the materials listed above, set up an experiment to observe standing waves on a wire. A diagram is shown on the next page that will help guide your setup.



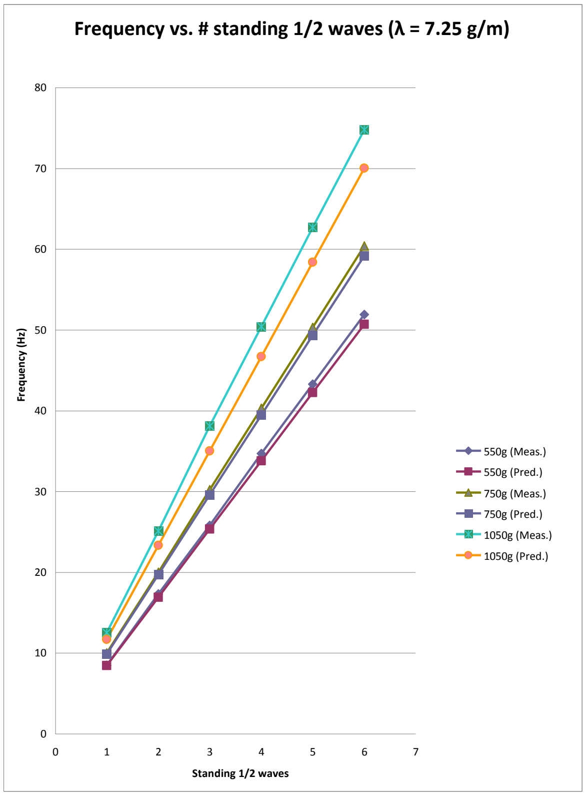
The placement of the mechanical driver is important, and you should try to let the students figure this out at the beginning of the lab. The amplitude that the driver makes must match the amplitude of the string where the driver is attached. If these two do not match, you will find that the wire will wobble or you will get uneven standing waves. You may need to adjust the placement of the driver as you change the frequency.

We had also noticed that errors arise from how the wire is tied to the post in the diagram above. In our measurements for the wavelengths of the standing waves, we had assumed that the waves traveled between the top of the pulley to the knot holding the wire to the post. However, our wire was loosely tied, and there was some excess length that was not initially accounted for, as shown in the figure to the right. What seemed to happen was standing waves would be established between the knot and the bar, or even the driver and the knot that had different lengths than the rest of the standing waves along the wire. In short, try to minimize this excess length as much as possible, or one could try stabilizing the knot by clamping the wire directly to the post.



For a given linear mass density for the wire, students should try 4 to 6 different tensions. For each of these tensions, have them measure the frequency and wavelength of the first 5 or 6 standing wave modes. For any of the modes, you may need to wait about 30 seconds for the standing wave to stabilize.

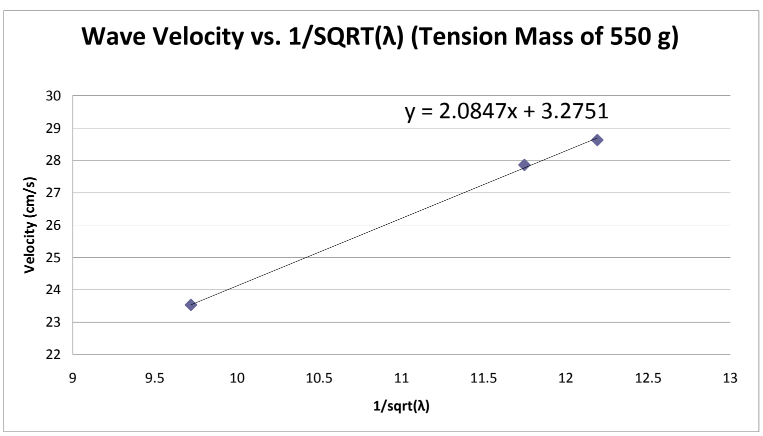
The measured frequency of the first mode is generally not very precise – you could easily be off by 0.5 Hz. The second, third and fourth modes will be the best data points you will get from this experiment. The fifth and higher modes become increasingly more difficult to zone in on because they are more sensitive to the small errors in the setup, such as the placement of the driver or ambiguity in the wavelength caused by the knot.



Analysis

For the most part, the analysis is quite simple. Show the relationship between the wavelength and frequencies of the waves for a given linear mass density and tension. An example of this is shown in the graph to the left. Along the horizontal axis, we have plotted the number of standing ½ waves between the two fixed ends of the wire, which is proportional to the inverse of the wavelength. Predictions are plotted with the measured results.

Note that the measured velocities are consistently lower than what was predicted. Our uncertainties in the measured frequencies were on the order of 0.5 to 1 Hz. As you can see, errors are much more significant for higher tensions.



Finally, we want to show the relationship between the wave velocity, tension and the linear mass density of the wire. Above, we have plotted the wave velocity (computed from the wavelength and frequency) against one over the square root of the linear mass density, λ, for the fixed tension of 5.39 Newtons. Ideally, the slope of the line should have been 2.3 ± 1.0 $N^{1/2}$. We are certainly within that margin of error, though we would like to make this even closer.

Problem 2: Standing Waves of Sound

Background

This problem is meant to be completed immediately after Problem 1, though the two problems may not necessarily be completed the same week. The principle to this problem is similar to that of the prior one, except we now ask the students to identify the medium through which the waves propagate. The velocity, v, of the waves through a gas can still be calculated by the usual, $\lambda \cdot f$, but we can also use the equation

$$v = \sqrt{\gamma \cdot P/\rho},$$

where γ is a constant (5/3 for a monatomic gas, and 7/5 for a diatomic gas), P is the pressure of the gas, and ρ is the density of the gas. Note the similarity of this equation to that from Problem 1. We can refer to the ideal gas law,

$$PV = NRT,$$

where V is the volume, T is the temperature, N is the number of moles of the gas, and R is the universal gas constant. Using this to eliminate P and ρ from the above equation, we find that the velocity of the gas can be written in terms of γ, T, and the molar mass, M:

$$v = \sqrt{\gamma RT/M}\ .$$

If we can measure v, then we can calculate the molar mass, M, of the gas.

Materials

- 3 gas tubes with piezoelectric transducers on both ends,
- Helium, Nitrogen, and Argon gases (to fill the tubes the week of lab),
- a function generator,
- an oscilloscope, and
- BNC cables.

Procedure

Each tube needs to be filled with one of the three gases the first day of lab: Helium, Nitrogen, or Argon. You should be able to find some supply of these in the physics building. The Machine Shop should have a supply of Argon that you can use to fill one of the tubes. Professor Crowell, or other professors, should have some tanks of Helium and Nitrogen in their labs. To fill the tubes, connect one of the valves to the gas supply while holding the valve on the other end open. We want the gas pressure to be close to 1 atm, though it is not entirely important. Most importantly, you need to have the tube filled with only one gas, so all of the air already inside the tube needs to be expelled.

The Helium gas leaks much faster than the nitrogen or argon. This tube may need to be replenished every 2 or 3 days. The measurements of the velocity through the gas will change from day to day due to this leak, but as long as you are within that 3-day window, the results should be fine.

Pick one of the tubes. Connect one of the piezoelectric transducers to a function generator with the BNC cable. This will drive the waves in the tube. Also connect the output of the function generator to a channel of the oscilloscope. The other channel on the scope should be connected to the other end of the tube – the receiver transducer.

Sweep through the frequencies on the function generator and look for resonant frequencies for the gas in the tube. The fundamental frequency is generally not as precisely measured as the 2nd through the 6th

standing wave modes. You may even run into one or two resonances with the tube itself, rather than with the gas in the tube, but these are fairly easy to identify.

Analysis

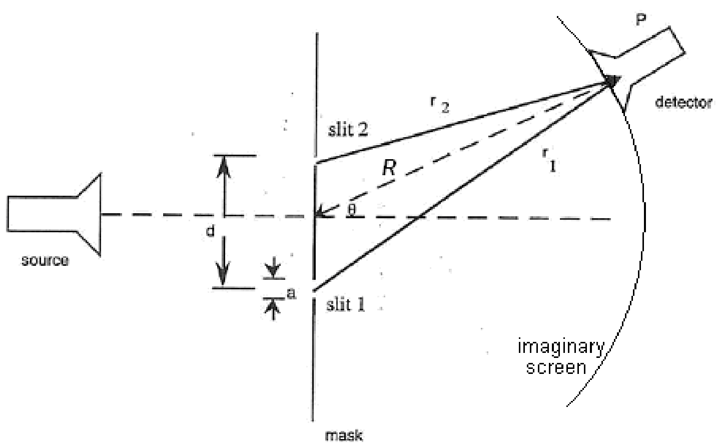
The analysis of the data is pretty straight forward, and you should be able to identify the gases to within 2 to 4 g/mol. For this reason, many students will mistake the nitrogen gas for oxygen. There is some guess-work as to which γ to use in the calculations, but the students should be able to figure it out based on which gets them closer to a reasonable answer. Argon and Helium seem to be the easiest to identify.

Problem 3: Interference of Microwaves

Background

This lab is actually a bit interesting because it can yield some slightly unexpected results. The problem can also be approached in two ways (they are very similar). One way is to treat the problem like the classic double slit experiment where there is some imaginary, flat screen some perpendicular distance, *L*, away from the slits. The interference pattern is "projected" onto this imaginary plane, so you can move the microwave detector along it to "visualize" the pattern. However, this is the very same problem that will be covered in Problem 4, so we will direct you to that section to work out the math.

The second approach is to prediction maximums and minimums of the interference pattern if our screen formed an arc with a radius, *R*, centered on the two slits, as shown below. In this case, you will only change the angular position, θ, of the detector, keeping its radial position along the rotating arm fixed.



The two slits act as spherical wave sources, with the same wavelength, frequency and phase. The path that the waves travel from slit 1 to the point *P* (the detector) is r_1, and r_2 is the path from slit 2 to *P*. From the law of cosines and a little trigonometry, we find that r_1 and r_2 are given by

$$r_1 = \sqrt{R^2 + \left(\frac{d}{2}\right)^2 + Rd \cdot Sin(\theta)}$$, and

$$r_2 = \sqrt{R^2 + \left(\frac{d}{2}\right)^2 - Rd \cdot Sin(\theta)} .$$

The path difference between the two is just the difference between r_1 and r_2. The condition for constructive interference is:

$$\delta = |r_1 - r_2| = n\lambda ,$$

where n is an integer. Now we have a way to determine what angle, θ, the maximum will be in our interference pattern. In a similar way, you can predict the intensity of the waves at some angle, θ.

For this apparatus, the wavelength is approximately 3.15 cm, and d is on that order as well, so you should be able to find about 2 maximums other than that at θ = 0 radians.

One of the unexpected results is that you may only find 1 maximum in your pattern. This is due to the diffraction from the two slits. The slit width, a, is approximately 3cm, and it just so happens that the diffraction pattern interferes with the other pattern you are trying to measure. It will be best if you could make you own slits out of aluminum foil and some cardboard. Making narrower slits will widen the diffraction pattern from each slit. You should be able to make them thin enough that you should not see any unexpected interference between the two patterns at all.

Materials

For this problem, you will be using a Cenco® microwave apparatus, which is in the boxes in room 245. From these you will need the following:

- an emitter,
- a detector,
- a set of rotatable arms,
- a magnetic card stand, and
- a double-slit card.

The microwaves that are emitted from the apparatus are fairly low in intensity. The only way they would be harmful is if you have a body part set directly in the beam for some extended period of time.

The detector has a gain setting that amplifies the readings so that they can be detected and read. **DO NOT** let the gauge on the detector max-out! The gauge is delicate, and exceeding this limit could damage the detector. You should find a setting that will give you a recordable answer when you reach a maximum in the interference pattern.

Procedure

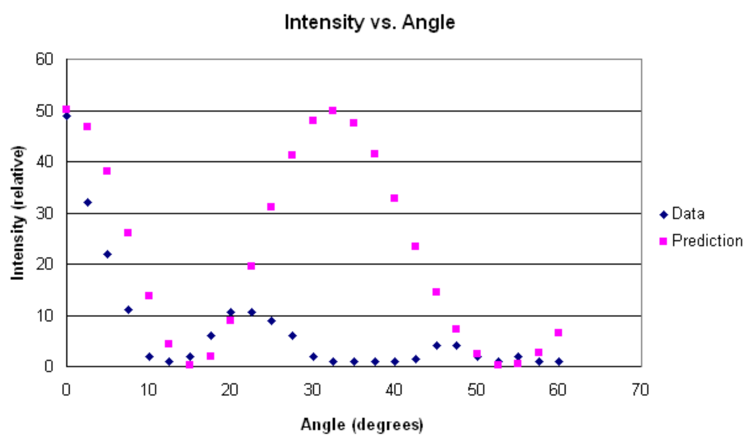
We suggest playing around with the emitter and detector on the rotating arms first. Place them on directly opposite each other on the rotating arms. If you move the detector radially along the arm, you should see the gauge on the detector rise and fall periodically. This is simply due to the standing waves that are established between the emitter and detector. You can try measuring the wavelength of the microwaves with this setup.

Place the double slit mask on the center of the rotating arms. Starting with the arm at θ = 0 radians, record the intensity, as measured on the detector, as you change the angle, θ. The maximums should occur roughly at 20° and 60°.

Make another set of slits with aluminum foil and cardboard, but make the slits a bit thinner. This should reduce errors from the diffraction of the waves from the individual slits.

Analysis

The data that is shown below. The screen is about 20 cm from the slits, and the slits are separated by 5.6 cm. From our predictions, we believed that there would be maximums around 0°, 33° and 70°. However, as you can see in the graph below, the next maximum does not occur at 33°, but there are smaller local maximums at 21° and 47°.



The minimum that occurs at 33° is due to the diffraction of the microwaves from the individual slits, since they are 3cm wide (the same size as the wavelength. This minimum could be eliminated if the slits are narrowed a bit, which will widen the diffraction pattern out of the scope of what we are really interested in.

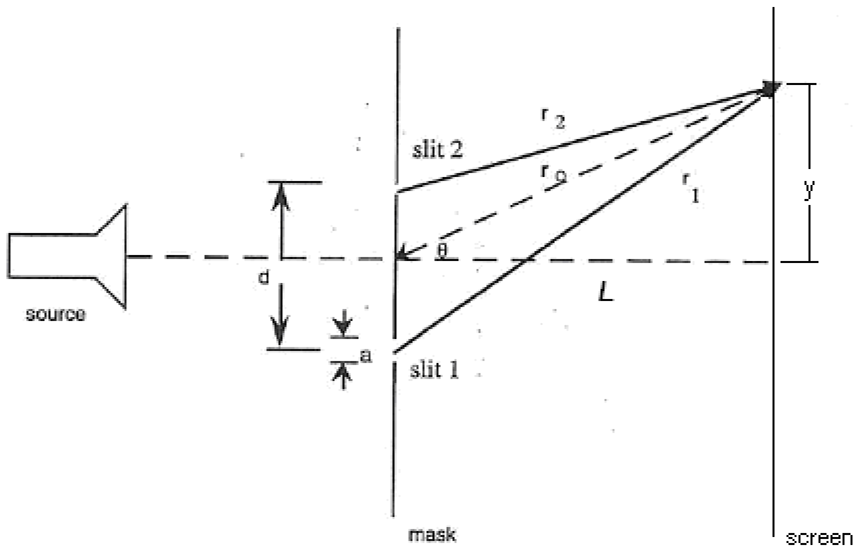
NOTE: In 2009 we reduced the width of the slits and increased their separation This moved the first diffraction minimum out beyond the second interference maximum – a significant improvement. There is less signal, but it still works. This needs to be made permanent.

Problem 4: Interference of Visible Light

Background

This problem is very similar to Problem 3, and we suggest that the student only complete one of these two so that the problems they complete are not repetitive.

For this problem, the objective is for the students to determine the wavelength of the light emitted by the laser beam. They will do this by measuring the positions of the maximums and minimums on their interference patterns for a couple of different double slits.



Because of the dimensions of the apparatus and the wavelength of light, we can max some very simple approximations. Refer to the diagram above. Very close the slits, the two emerging beams are almost parallel. For some position, *y*, along the screen, the path difference, *δ*, between the two beams is

$$\delta = d \cdot Sin(\theta),$$

where *d* is the slit separation, and *θ* is the angle from the center of the slits to the point on the screen. The condition for constructive interference is

$$\delta = \left(\tfrac{1}{2} + n\right)\lambda,$$

where *n* is an integer, and λ is the wavelength of the light. Likewise, the condition for destructive interference is

$$\delta = (n)\lambda.$$

Using a little trigonometry, we can approximate the sine of the angle, *θ*:

$$\sin(\theta) = {}^{y}\!\big/\!_{\sqrt{y^2 + L^2}}.$$

Substituting this into *δ* and then rearranging the equation for constructive interference we find that:

$$\sqrt{1 + {}^{L^2}\!\big/\!_{y^2}} = {}^{d}\!\big/\!_{n\lambda}.$$

Now if one should plot the left side with 1/*n*, the slope of the line should resolve the wavelength of the beam.

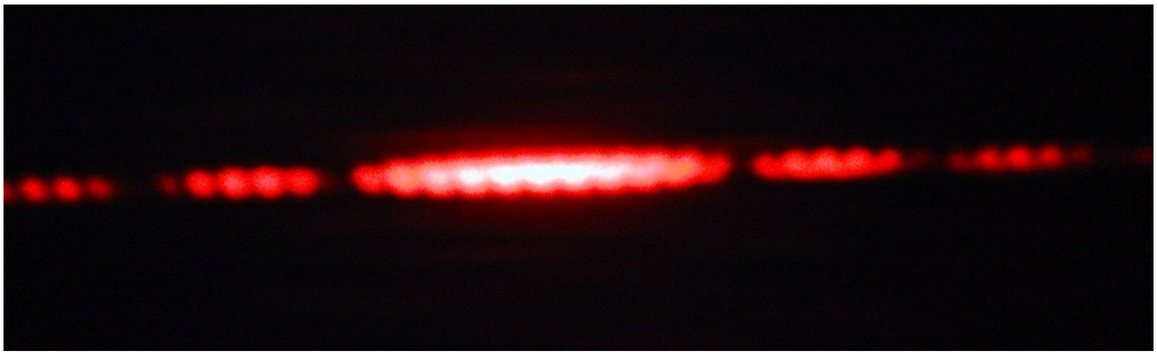
Materials

For this lab, you wll need:
- a 2 meter aluminum track or a black optical track
- a Laser (~650 nm wavelength)
- a set of masks with double-slits
- a magnetic stand for the masks,
- a sheet of cardboard, poster board or something to tape and write on,
- a couple sheets of plain, white paper.

Remind your students about safety with lasers. Though these are low-power lasers, they can still do a lot of damage to one's eye. They should never look directly into the beam, nor should they stare too long at the pattern. Students will have to put their faces fairly close to the screen to make accurate markings for their data.

Procedure

Place the track on a table so that it runs perpendicular to a wall in the room. Place your cardboard or poster on the wall – this will act as your screen. To see a good number of maximums and minimum in the pattern on the screen, you should place the slits on the track about 1.5 to 2 meters from the screen. Place the laser directly behind the slits, and turn it on. You should see a pattern like the one shown below on the screen. You may need to turn off the lights in the room to see the pattern.



Note that the pattern with the short period is the interference pattern between the two slits. The overall envelope is from the diffraction of the light from the individual slits.

Tape a piece of plain white paper onto the cardboard against the wall. Clearly mark the center of the first peak (the center of the interference pattern). All of your measurements will be made from this location. Next, mark the minimums and maximums of the pattern on the sheet of paper. It might be a good idea to make distinguishing marks for the two. The data you will record will be the distances from the center that the peaks and minimums occur. Repeat this process for a few different slit separations.

Analysis

Make a plot of $\sqrt{1+L^2/y^2}$ against $1/n$ for the constructive interferences ($1/[\frac{1}{2}+n]$ for the destructive interferences). The slope of the line should be proportional to the wavelength, λ. We were able to resolve the wavelength to within 30 nm of the actual wavelength (650 nm). Many students tended to be off by up to 100 nm or so, though this seems to be reasonable.

Laboratory 2

Read the relevant sections of the 1302 TA manual. Note that this lab uses the old CRT's.

Laboratory 3

Problems 1 and 2

We are now using 1 microF **polypropylene capacitors**, and so measurements of the time constant with the Vernier box and the *differential probe* **will work perfectly** if you select components so that time constants are a few tenths of second or longer. Make sure the students learn how to plot data on a logarithmic scale and fit it properly.

Do not use the double-layer or electrolytic capacitors. Nor should you attempt to do anything quantitative with light bulbs as resistors. The double-layer capacitors are a pedagogical disaster, because they do not produce exponential decays and the time scale is not RC. The resistance of of a light bulb is a function of the current (because the filament temperature changes), which is also a recipe for confusion.

The "force on capacitor plates" lab (Problem works very well. Read the notes in this manual. This is a lab that rewards careful experimental technique.

Problem 5

You must make sure that the students understand about grounds and that the proper placement of the scope in the circuit matters.

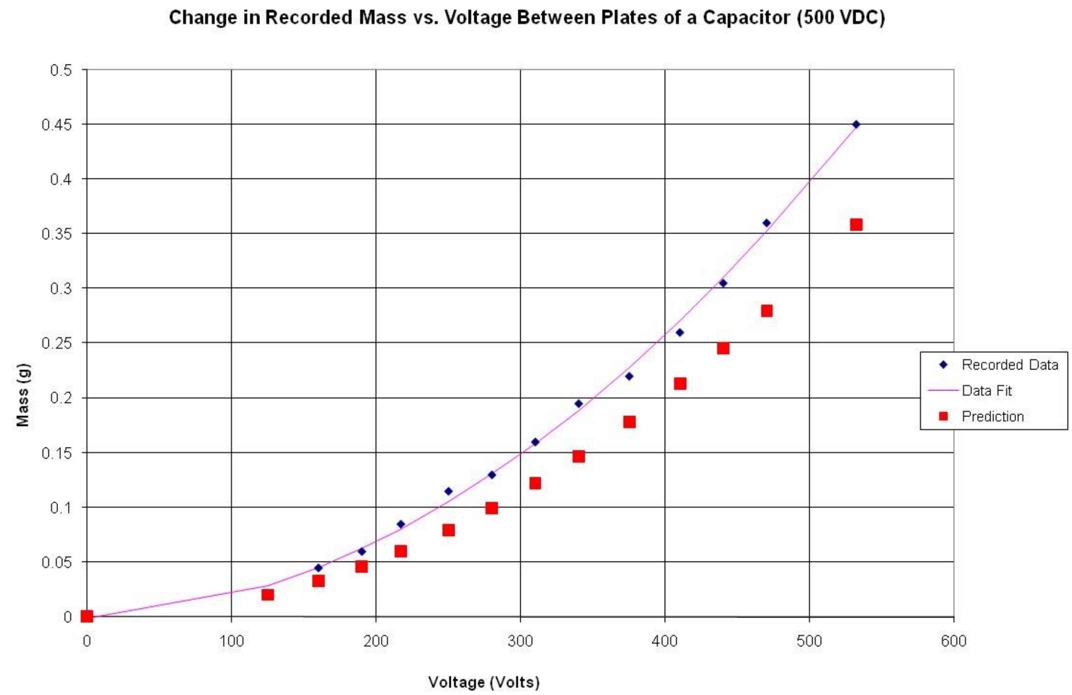
Problem 3

Use the plates provided. The plate with a plastic post is attached to a micrometer stage that is mounted to ringstand hardware. Use the ringstand hardware to level the upper plate. The lower plate can go directly on the balance, since the weighing pan already floats. Use adhesive copper tape to attach flimsy wires to each plate. Tape down the wires so they do not pull on the lower plate when taking data. Make sure that no forces are exerted on the balance by the wires!

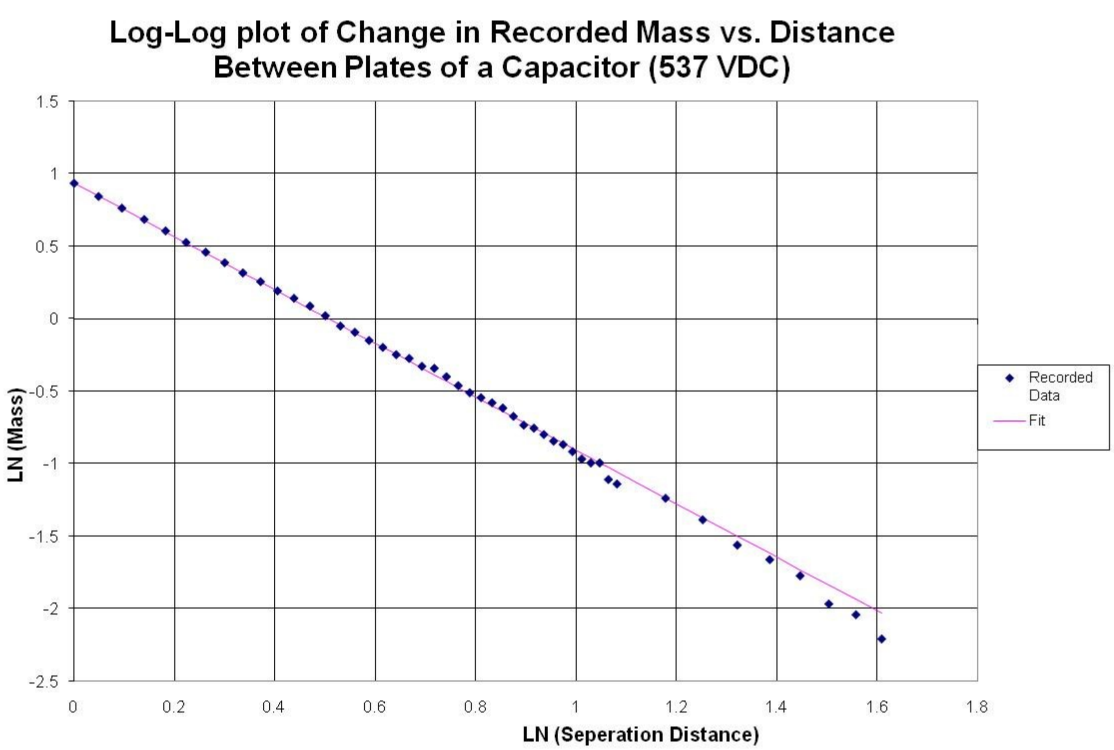
Use a translation stage to adjust the height of the plate on the ringstand. The gap can then be varied by adjusting the translation stage. You should be able to go down to one mm without difficulty. Take data up to 1000V. **Make sure you are reading the voltage correctly.**

It is probably best to analyze the Force vs. voltage data by plotting F vs. V^2. On the other hand, the Force vs. distance data do not come out exactly as $1/d^2$. Try a log-log plot.

We have several sheets of dielectric material in the cabinets. You can look up dielectric constants on the web. I would lay the sheet down on the bottom plate (thus changing the tare weight). They will have to do the analysis as two capacitors in series, but they can try to make the gap between the dielectric and the top plate as small as possible (without touching).



Sample Data: Note that it would be easier to have them plot as a function of V^2.



Sample data vs. distance; Use a log-log plot. The exponent is not exactly -2.00.

The deviation from the expected $1/d^2$ behavior is probably due to edge effects. A sophisticated student could try fitting to the expression based on the capacitance of a finite plate capacitor:

Problem #4 (not currently used):

To solve the ladder, note that adding the three resistors in the circle to the resistance R_n of the ladder with n rungs, gives a ladder of resistance

$R_{n+1} = 2R + \dfrac{R_n R}{R_n + R}$. By setting $R_n = R_{n+1}$ and solving, you find a limiting resistance of $(1+\sqrt{3})R$.

We have some good variable resistors for this lab. Note that for the Wheatstone bridge they can use either a voltmeter or an ammeter in the central arm of the bridge, but I would get it balanced with a voltmeter first, and then show how an ammeter can be a much more sensitive detector.

RC circuits:

Part 1 is pretty straightforward. The biggest challenge is probably use of the oscilloscope. Note that shorting out circuit components with the outer terminal of the scope input (which is at ground) is going to be a common mistake.

For part 2: when the lamp is off, it is just an RC circuit with a time constant given by the chosen R and C (start with 500 kOhm or so and a 1 microFarad capacitor. If using an electrolytic, make sure that the polarity is correct). Once the lamp is on, the capacitor charges up through R and discharges through the effective resistance R_{eff} of the lamp, which is actually quite voltage dependent, but let's say 10 kOhm – 100 kohm. If $R >> R_{eff}$, then the discharge time constant is just $R_{eff}C$. If they really analyze it right, the discharge time constant should be $\dfrac{R_{eff} RC}{R - R_{eff}}$ (I think). It is not worth analyzing the "on" time too much, because the lamp is quite non-linear.

Essentially the voltage across the lamp will oscillate back and forth between 65 and 90 V, with an off time set by RC (the time for C to recharge) and an on time set by R_{eff}. They can try to vary t_{On} by putting a resistance in series with the lamp. This should be in the 10 kOhm range. If it gets too big, the lamp will just stay on all the time.

To measure the IV curve of the lamp, use a variable voltage source, put a 10 kohm resistor in series and measure the voltage across the lamp. They can either use an ammeter or just measure the voltage drop across the 10 kohm resistor to measure the current. Remind them to measure the IV curve for both increasing and decreasing voltages. They should increase and decrease the voltage monotonically.

Laboratory 4

Problems 1 and 2: Read the relevant sections of the 1302 lab manual. Make sure they do not saturate the field sensors.

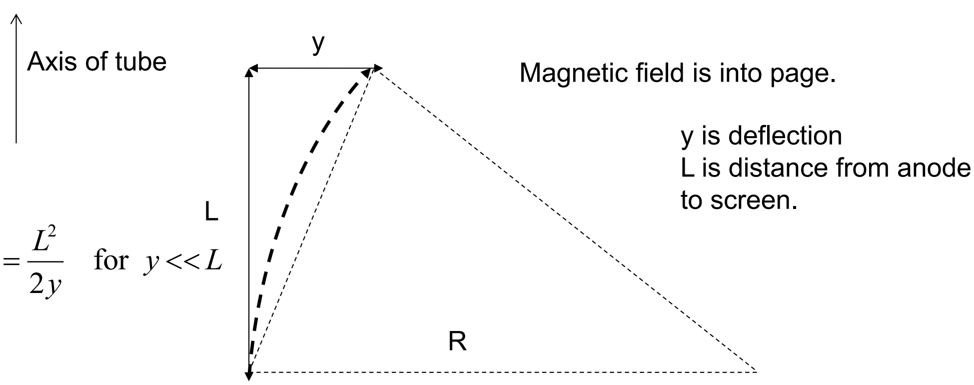
Problem 3:

The CRT will be positioned so that the axis of the tube is perpendicular to the field of the Helmholtz coils. There are two (distinct) strategies for minimizing the effects of the Earth's field. You can set things up so that the axis of the CRT is perpendicular to the Earth's field; or you can set things up so that the axis of the coils is parallel to the Earth's field. If doing the latter, you MUST take data for both positive and negative currents in the coils and remove the offset due to the Earth's field. Although more complicated, this does allow the careful student to use the apparatus to estimate the value of the Earth's magnetic field.

In all honesty, the systematic errors are large enough that they should not worry too much about the Earth's field.

The one subtle point is that they cannot measure the orbit radius R directly, and so the geometry below is essential:

The quadratic dependence on *y* and quartic dependence on *L* are killers. They cannot measure *y* very well and they must take someone's word for *L,* given in the manual. It is reasonable to expect *e/m* to come out within a factor of two or so.



$$R = \frac{L^2}{2y} \quad \text{for } y << L$$

$$evB = m\frac{v^2}{R}$$

$$\frac{1}{2}mv^2 = qV_{acc}$$

$$\frac{e}{m} = \frac{8y^2 V_{acc}}{B^2 L^4}$$

To eliminate error due to offset from Earth's field: take data for positive and negative B.
From the slope of the curve get dy/dB. 10% error would be very good.

Problem 4:

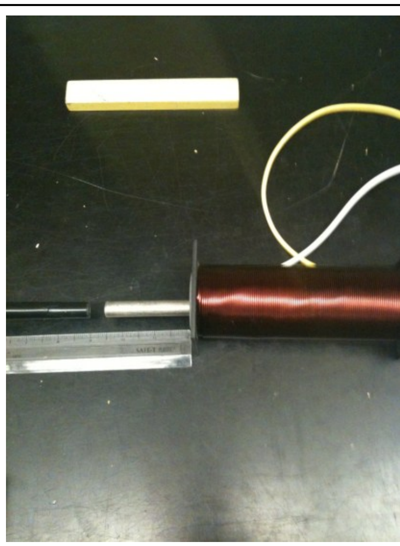
New for 2013: I have moved the "magnetic" part of the gyroscope lab to this lab as Problem 5. In 2012, the TA's found that the students finished the hysteresis problem very quickly. Exactly what you do is up to the instructor. Note that the hysteresis problem includes three parts:

1. Measurement of field inside solenoid.
2. Measurement of nickel, which has hysteresis
3. Measurement of soft iron, which has a high permeability but negligible hysteresis

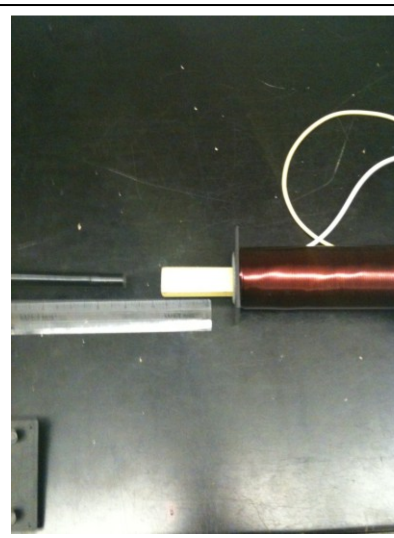
If I (Crowell) were teaching the course, I would skip the soft iron, which is relatively boring, and then have students spend the second half of the lab doing the torque/precession problem. Note that if you skip the soft iron, then you should also eliminate or modify some of the questions they are supposed to answer.

There is one major hint for the hysteresis problem: **Avoid saturating the field sensors! Make sure the sensor is on the least sensitive setting (largest range) and that there is a gap of about ½ inch between the sensor and the end of the rod.**

Note that it is fine for the students to measure B (the field with the rod present) and plot it versus the solenoid current (I). They do not know about H yet. They should be able to pick up on the fact that the magnetization of the rod is proportional to the difference of B (measured with the rod) and H (essentially the field measured without the rod), but this is all a bit subtle.



For Ni, rod should stick out about 2 inches, and field sensor (set to 6.5 mT) should be about ½ inch from end of rod

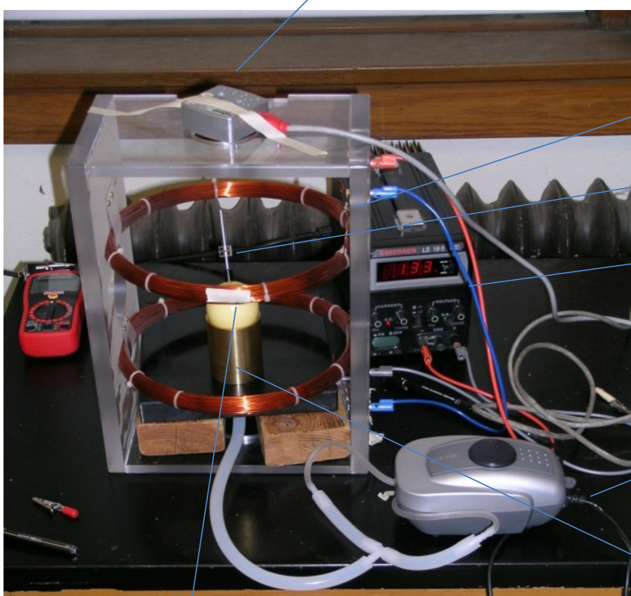


For soft Fe, the rod should stick out about 2 inches, and field sensor should be about 1 inch from the end

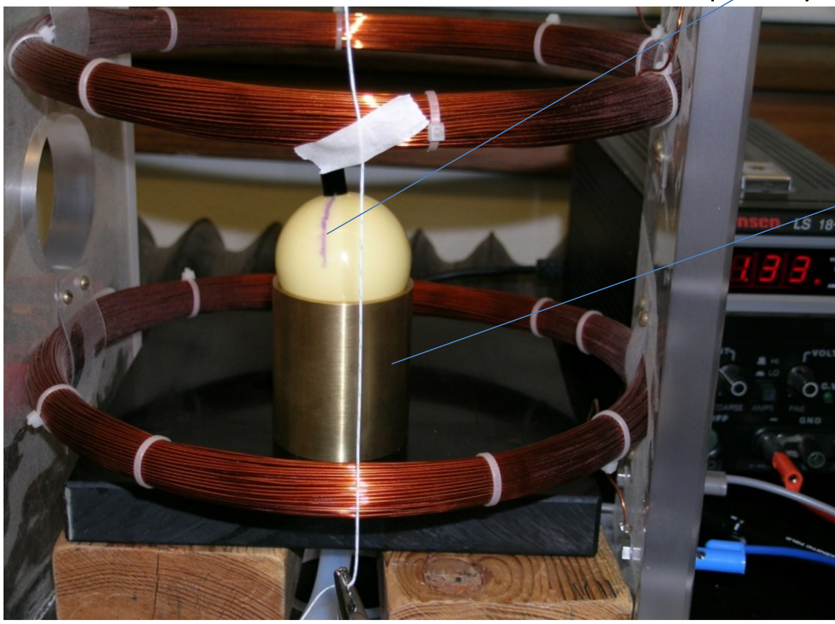
Problem 5, Torque and Precession:

This works about as well as any freshman experiment can work. Note the simplified write-up. All they are asked to do is verify that the torque (as determined from the precession period) is proportional to the field. They can also compare the measured moment with the value stated in the lab manual.

They do not need to mess with the weighted rod in this version, nor do they need to vary the spin speed. They can spin the ball up with their fingers.

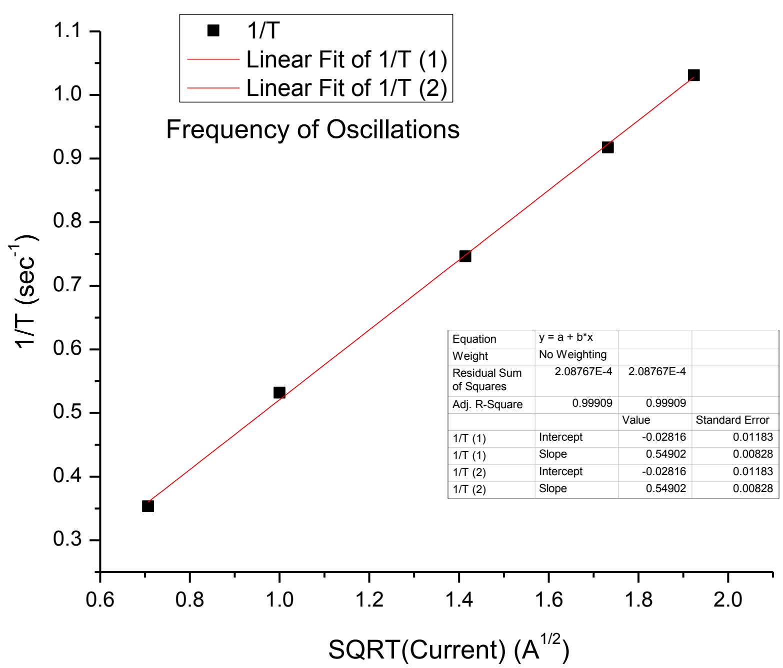


The line on the ball is used in the video to determine the spin rate of the ball. The post that you grab to spin the ball is partially obscured by the tape.



This string is helpful when timing precession cycles.

I do not have sample data for the main problem. I do have sample data for the optional part:



Equation	y = a + b*x		
Weight	No Weighting		
Residual Sum of Squares	2.08767E-4	2.08767E-4	
Adj. R-Square	0.99909	0.99909	
		Value	Standard Error
1/T (1)	Intercept	-0.02816	0.01183
1/T (1)	Slope	0.54902	0.00828
1/T (2)	Intercept	-0.02816	0.01183
1/T (2)	Slope	0.54902	0.00828

Laboratory 5

Read the relevant sections of the 1302 TA manual.

Laboratory 6

Problem 1

1. The only significant complication in the RLC lab is understanding the notion of stray capacitance. At a 1mm spacing, a parallel plate capacitor with a plate diameter of 6 inches and an air gap of 1 mm has a capacitance of 150 pf. 1 foot of coax has a capacitance of 30 pf. Two banana cables can easily provide a capacitance of a few pf. These extra capacitances are in parallel with the plate capacitor. It is easy for a small change in the parasitic capacitance (such as a cable moving) to shift the RLC circuit completely off resonance. Also, the shift in the resonant frequency when the plate separation changes will become less pronounced.

For this reason:

A. Do not use coaxial cables, except between the synch output of the generator and the triggering channel of the oscilloscope.

B. Physically separate the banana cables and tape them down so that they do not move.

C. Use the 20 pf coupling capacitor. Essentially, this isolates the RLC circuit (which the students know about) from the capacitance in the measurement circuit, which is subtle.

D. Resist the temptation to connect the lower plate of the capacitor to the function generator. This just creates more parasitic capacitance. Remember that the function generate and scope share a common ground (through the third prong).

Problem 2

Perhaps more than any other lab, it is essential for the TA's to do this first and make sure they can get it to work well.

1. We have found that the antennae must be strung out the window.

2. The ground connection must be very good. Double check it. Triple check it…..the ground braid for each table must be hard-wired to the building ground with a screw. Do not daisy chain the grounds by clipping one ground braid to the one used by the next table.

3. You must choose the appropriate taps on the coil. The goal is for the students to understand that they are using the tuned circuit to measure a very weak signal. They will find that

everything matters: exactly how the antenna is hooked up, the quality of the ground, loading by the diode, etc. Reality is complicated by stray capacitance, series inductance, etc.

4. A couple pointers: The lowest tap on the inductor is ground. Where you hook up the capacitor determines the total inductance in the tank circuit and hence the tuning range. Keep in mind that the minimum capacitance you will be able to achieve is a few picoF and careless layout can increase this substantially. Of course both the antenna and the detection diode circuit have inductance and capacitance to ground and hooking them up will change the tuning range. If you connect them to higher taps, then you will have stronger coupling (more signal) but lower Q (worse frequency resolution).

5. Common mistakes:
A. Bad ground connections and poor antenna placement.
B. Incorrect choice of taps on the inductor. Clipping the alligator lead to a tap that does not have the insulation removed!
C. Leaving the antenna coiled up so that it has a huge inductance and no reception.
D. A short in the capacitor due to the plates touching. This can happen if someone drops the capacitor. It is not easily fixed. Get a new one and tell Sean.
E. Bad connection to speakers (hopefully addressed this year by the speaker jacks on the Lucite boards).