Virginia Instructors of Physics

Winter edition Jan '00

VIP's mission is to foster communication among teachers of physics and physical science as well as to provide unique learning experiences for teachers and their students.

Next Meeting March 25 at UVA's Physics Building

A note from the President

Hi! I hope this newsletter finds you in good health and good spirits. For many of you this may be the first time you have received a mailing from VIP. If this is the case let me take a little of your time to introduce myself and the organization. My name is Andy Jackson and I teach Physics and Astronomy(new class-First year!) at Harrisonburg High School. I have a BS in Physics from James Madison University and have been teaching for 13 years now. VIP has been instrumental in providing me with excitement and growth opportunities in Physics education. VIP is a (very!) loosely organized group of teachers, professors, and educational staff who are interested in physics and the teaching of physics. This letter has come to you because someone in your schools central office identified you as a physics teacher or you have at some past time put your name on our mailing list.

This organization was created about 13 or 14 years ago as a means for physics educators to get together to share ideas about teaching physics. We meet twice a year to share labs, demos, concerns and questions about teaching physics. This newsletter is an additional means for trading labs and demos. Our last meeting was held in conjunction with the Fall VAST meeting that was held in Richmond. Our session was well attended and I got to meet a lot of physics teachers from around the state and beyond for the first time. I hope if you were one of those I had the privilege of meeting, you will consider attending our spring meeting at UVA Saturday March 25. If you're a VIP veteran than you know what it's all about and I hope to see you again in Charlottesville in the spring!

Looking forward to seeing you at UVA on March 25!

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If you ever find yourself in Harrisonburg I'd love to see you. If you'd like to visit my classroom, you are certainly welcome.

MARCH 25, 2000, AT UVA'S PHYSICS BUILDING
SPRING MEETING SCHEDULE

9:00 - 9:30 Hello's
9:30 - 10:30 VIP Business, Election of officers,
10:30 - 11:30 General demonstrations and lesson plans to share
12:00 - 1:30 Lunch (You are on your own).
1:30 - 3:30 General demonstrations and lesson plans to share

If you will be attending please contact me. If you'd like to present please let me know how much time you would like. My e-mail, phone & school address on previous page.
There is no fee and there are no dues, just come and enjoy! Please bring an idea, lesson plan, demo or experiment to share (~50 copies). Also, consider bringing another teacher who might benefit.
Have a piece of equipment you don't know how to use (or what it is)?
BRING IT !!! See if you can stump the experts (whoever they are) or get some help.

The three labs that follow are my adaptations of labs that are in PysicaAL: An Activity Approach to Physics by Martin Spronk published by LeBel. I use these three labs very early in the course. In fact, Aristotle's law we do on day 1. Hope you can use them.
Andy Jackson

Aristotle's Law of Falling Bodies

The Greek philosophers are generally given credit for being the fist people to attempt to develop science. One of the most famous of these philosophers was Aristotle. He lived in the century of 300 B.C. and did a lot of thinking about what we today call physics. One of the subjects that he contemplated was the nature of falling objects. He formulated a description of the way objects fell that became Known as Aristotle's law of falling bodies. This law states that the rate of the fall of a body is proportional to its weight: the heavier the body the faster it falls.

One of the main differences between the science of the ancient Greeks and science today is that today we use experimentation to test our ideas. Today you will conduct an experiment to test Aristotle's law.

MATERIALS- Pennies, tape, and meter stick

PURPOSE- To test Aristotle's law of falling bodies.

PRELAB- Write out the...

SIMPLE PROBLEM- This is a question that will be answered by the experiment.

MANIPULATED VARIABLES or INDEPENDENT VARIABLES- This is a list of the variables that you will change in a methodical way to see how they affect the outcome of the

experiment. Remember that in a good experiment that you only want to change one variable at a time.

CONTROLLED VARIABLES- This is a list of the things that you must keep constant so they won't confuse your conclusions.

DEPENDENT VARIABLE- The thing that will be looked at to see how it changes with response to changes in the independent variable.

TENTATIVE ANSWER- This is your best answer to the simple problem that you posed earlier based on the knowledge you have prior to doing the experiment. Remember that it is perfectly OK. to be wrong here !

PROCEDURE- Write out what you are going to do. Make sure you pay attention to what you have chosen to be your manipulated variable and your controlled variables. It is good procedure to do several trials for every change you make.

Create a data table to record your observations.

EVALUATION- Discuss whether your tentative answer to the simple problem was supported or refuted. Back up your "yes, I was right" or "No, I was wrong" with evidence offered by the data you collected. Write down a few questions about the nature of falling objects that still remain.

QUESTIONS

1. If you found that Aristotle's law was not correct state what you now believe is the correct law for falling bodies.

2. Aristotle's law was taught as "truth" for many centuries in Europe's leading universities. Why was it believed for so long?

3. Does this experiment shed any light on why rocks fall faster than feathers? Why or why not?

Notes to the teacher

What I like about this lab is, right off the bat, the students are talking, discussing and thinking Physics! Enjoy watching the students. Some still believe Aristotle's law to be true. I find this in Honors as well as general Physics. I use this as a platform to talk about experimental design as well as a vocabulary builder. At the end of the class I conduct experiments in front of the class so everyone leaves with the "right" data. Some groups will have data that supports Aristotle's law due to strongly held notions of falling bodies. Andy Jackson

Notes to the teacher

This next lab is also my adaptation of PhysicAL's version of an oldie but a goody. The results are reliable and it uses pretty standard equipment. The quote by Galileo at the top of the lab is something I try to incorporate into all my labs. A famous quote that has some pertinence to the question at hand. I have students keep a Physics Journal, and as a small grade assignment, I have them write about the meanings of these quotes. What was Galileo talking about? Is it possible for people to see "beauty" in facts? Do you agree or disagree with what the quote is saying? As I read the students responses I often get some neat insights into their thinking.

This lab is also a beginning point in the class for presenting and interpreting graphs. At this point in the course, we have already completed a measurement & sig. fig. lab. The students are expected to be able to measure carefully and correctly at this point. In addition to the uniform acceleration topic being introduced here, I take the opportunity to introduce the concepts of random and systematic error as well as the difference between errors and mistakes.

Motion of a falling body

Facts which at first seem improbable will, even on scant explanation, drop the cloak which has hidden them and stand forth in naked and simple beauty.

Galileo Galilei

Objective- to apply measuring skills and graphing skills to the analysis of a ticker tape created by a falling body.

- to determine the manner in which a falling body's displacement changes over time.

Materials

-ticker timer
-mass
-meter stick
-masking tape
-newspapers

Procedure

1- Attach a ticker timer to the top of a support stand and place the set up on the counter top.
2- Tear off a piece of ticker timer tape that is just a little shorter than the height of the timer from the floor. Ticker tape is expensive use it intelligently.
3- Feed one end through the timer and tape it to the mass.
4- Place newspapers on the floor to cushion the fall.
5- Spread the tape out so that it does not tangle as the mass falls.
6- Hold the mass very still , turn on the timer, release the mass.
7- Turn off the timer and check to see that you have a good record.
8- Create a tape for each member of your group.
9- Keep your tape until this and the next lab are graded & returned to you. I may ask to see it.

Analysis

1- Identify the dot that was made when the mass was released. Mark this on the tape as t=0.

2- Your timer makes 10 dots each second. Mark each dot after the t= 0 dot as 0.10 s, 0.20 s etc.

3- Measure the **total distance** the mass has fallen for every tenth of a second. This means that you will measure the distance to each marked dot starting from the **zero** dot.

4- Make a table of the data. Remember to measure carefully and use proper significant figures. The table should have time and distance in it.

5- Construct a distance vs time graph for the motion. Make a smooth curve through the distribution of data points that is representative of the motion.

Questions

1- What does the increasing slope of the graph indicate about the nature of a falling object?

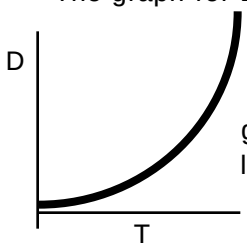
2-If a serious error or mistake occurred in the measuring of a single data point, would it be more easily spotted in the table or on the graph? Why?

3- When two or more trials of a measurement differ slightly from each other the cause of the difference is a random error. Random errors can be due to errors in judgment by the reader, fluctuating conditions, small disturbances in the environment or equipment, or irregularity of the object being measured. When all of the measurements deviate from the known value by the same amount then this is most likely a systematic error.These can be due to errors in calibration of the instrument, constant experimental conditions different from those assumed, or consistently imperfect technique.

We know there is a certain amount of friction between the tape and the timer. Does this introduce a random error or systematic error? Defend your answer. When you are measuring the distance from one dot to the next, how far off from the "correct" value can you expect to be? In other words what is the uncertainty in your measurements? Is this + or - value systematic or random error? Defend your answer.

Expected Lab Answers for Motion of a Falling Body

The graph for D vs T for this experiment should look something like this



The increasing slope is indicating the object is falling a greater distance in each 1/10 th of a second. Many students will correctly go the next step and identify this as the object is falling faster the longer it falls.

#2- I expect most students to respond that it is easier to see on the graph since the point in question won't line up with the rest on the curve. Some students can convince me otherwise with a well explained explanation for their answer.

#3 - Friction between the tape and timer is a systematic error. It affects every trial and every dot made. The uncertainty in each measurement is indicative of random error. Someone might measure slightly "long" while the next person might measure slightly "short'.

Speed of a falling body

Name_____

Period_____

Simple Problem- How does the speed of a falling body change over time?

Materials- ticker tape from the previous lab
- ruler

Procedure-

1-Measure the distance the mass fell **between** each time interval. This is called the interval distance.

2- Fill in the data table below.

interval distance	interval time		change in time	average speed	mid-interval time
$\Delta d_{interval}$	$t_{initial}$	t_{final}	Δt	V_{av}	t_{mid}
(m)	(s)	(s)	(s)	(m/s)	(s)

Speed of a falling body

1-You'll notice that the distance for each interval is getting bigger and bigger. Since each interval corresponds to 1/10 of a second what does this mean about the speed of the falling body?

2-At what point in time will the instantaneous speed of the mass be equal to the average speed of the mass during a particular time interval? Consider the beginning, middle, and end times. Defend your answer.

3-Use graphical analysis to construct a graph of speed vs time.

4-What does the shape of this graph tell you about the manner in which a falling object gains speed?

5- What is the equation for the "Best fit" line or curve. Write this equation including the correct units.

6-If you used a ticker timer that had more friction in what ways would the graph be different? [HINT write about the way the line on the graph would change]

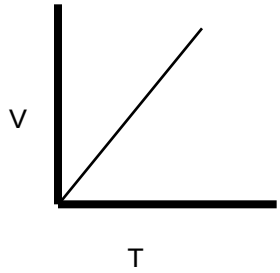
Notes to the teacher

Yet one more adapted from the same source Spronk's PhysicAL.

To complete this last of the falling body labs, the student needs to be comfortable with the concepts of average speed and instantaneous speed. Between the Motion of a Falling Body and the Speed of a Falling Body labs, I spend a class period with some reading, lecture, and "group" labs calculating speeds for walking, running and other motions.

#1 The speed is increasing.

#2 The average speed equals the instantaneous speed at the middle time. At the start it is going slower than average and at the end it is going faster than the average since it is picking up speed the whole time.



#3 This should be a straight line graph passing through the origin.

#4 The speed increases in direct proportion to time. The object gains speed at a steady rate.

#5 Something like $V=9.80\ m/s^2\ T$

#6 The object would gain speed at a lesser rate so the slope would be less. The line would lay closer to the x-axis.

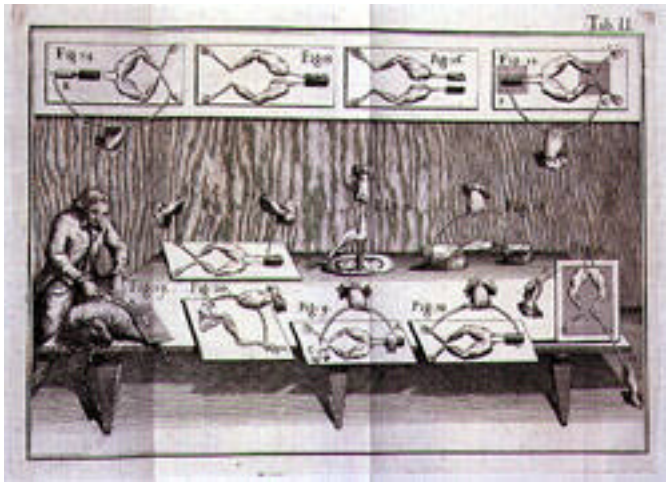
Here is an item that definitely departs from the VIP status quo. This is not a lab or demo but notes for a lecture that I have found to be very interesting to myself and to my students- especially those more inclined to the humanities than the sciences. This lecture concerns the interesting and famous conflict between Galvani and Volta that eventually led to Volta's creation of the precursors to our modern batteries. Also included in the lecture is some conjecturing about links between Galvani, Volta and the famous novel by Mary Shelley, Frankenstein. I've cited my sources and I'm sure you can gain much more from them than from my notes. I've found it to be a great point to do some interdisciplinary teaching. Andy Jackson

- Of Frogs and Frankenstein

- (Notes for Literature and Physics cross curricular lesson by Andrew S. Jackson)

• Franklin publishes book on electricity in mid 1700s that was later translated into Italian.

• Luigi Galvani is professor of Anatomy & surgery at Bologna.
Galvani's particular interest is animal senses. He believed Franklin's description of Leyden jars to be most important. He noticed that frog muscle twitched when subjected to a spark. It was already known that living muscles spasm but now he saw dead muscle react! He knew (by Franklin) that lightning was electricity set out to see if lightning would make dead muscle twitch. Galvani hung frogs legs on brass hooks so they rested against iron window lattice. The muscles twitched in thunderstorm and in clear weather. Galvani thought muscles acted like leyden jar where the nerve and the muscle acted as the two surfaces. He concluded that the electricity was in the muscle and called it "animal electricity".



(a print from *Immortals of Science - Alessandro Volta and the Electric Battery* by Bern Dibner showing Galvani at work)

• Galvani published his ideas in "Proceedings of the Bologna academy of Science" in 1791. He printed a small number of pamphlets for friends. He sent one to Alessandro Volta, Professor of Physics at University of Pavia.

• Volta repeated the experiments but suspected Galvani's hypothesis was incorrect. Volta decided the electricity was created by the two metals & the muscle was just an indicator of its presence.

• Volta published "Account of some discoveries made by Mr. Galvani" in 1793. He praised the discovery and tentatively suggested his ideas. In 1794 he published stronger arguments against Galvani's hypothesis.

http://www.ideafinder.com/facts/inventors/volta.htm

• Galvani was shy and steered away from argument and controversy & was silent on the matter. Galvani's supporters argued on his behalf. Particularly vocal was Giovanni Aldini (Galvani's nephew) Professor of Physics at Bologna.

- The two cities which were about 100 miles apart took sides as did the rest of the scientific world.
- Aldini was more of a showman than scientist and did public demonstrations with slaughtered animals and severed heads, and limbs of executed criminals.
- In 1797 Galvani still believed his ideas were valid and went to the Mediterranean to study the torpedo(an electric eel of sorts) He was requested by the invading French to sign an oath of loyalty to the new republic. He refused.
- Galvani suffered academic and political setbacks and died in 1798 sad and disillusioned.

http://www.desert-fairy.com/maryshel.shtml

Mary Wollstonecraft Shelley

- Marry Wollstonecraft born 1797 in England.
- At the age of 17 in 1814 She eloped with Percy Byshe Shelley to Europe.
- While visiting Germany they may have visited the Castle Frankenstein.
- One June 16 1816 Mary and Percy stayed at Lord Byron's place on lake Geneva with Lord Byron and Polidori, Byron's personal physician. One discussion that took place concerned the "Nature of the principle of life" (intro to 3rd edition Frankenstein) They spoke of some recent experiments conducted by Dr. Darwin (Charles Darwin's father) and Mary remembers thinking "Not thus, after all, would life be given. Perhaps a corpse would be re-animated; galvanism had given token of such things: perhaps the component parts of a creature might be manufactured, brought together, and endued with vital warmth."
- A ghost story contest was proposed and a short story version of "Frankenstein" was Mary Shelley's contribution. (Incidentally the first version of the modern vampire story was written by Polidori the same night!)
- Mary Shelley Published "Frankenstein" in 1818.
- In the book Victor Frankenstein says

  "One of the phenomena which had particularly attracted my attention was the structure of the human frame and indeed, any animal with life. Whence, I often asked myself, did the principle of life proceed" Chapter 4

  and

  "I collected the instruments of life around me, that I might infuse a spark of being into the lifeless being that lay at my feet." Chapter 5

Bibliography

Immortals of Science - Alessandro Volta and the Electric Battery by Bern Dibner

The 1995 Grolier Multimedia Encyclopedia

Frankenstein or The Modern Prometheus - by Mary Shelley

The History of Physics - by Isaac Asimov

The Real Frankenstein and Untold Story -(video) by Truusje Kushner produced by Nicholas Stein. ABC Video Publishing P.O Box 3815, Stamford CT 06905

This next lab is sent in by Thomas O'Neill (VIP vice president). It's a great experiment that can be quite fascinating. (And who can resist the smell of Play Doh?) There can be some additional but puzzling extensions to this experiment as sometimes the play doh's resistivity doesn't always behave the way you think it should. You might even see if resistivity is color dependent. Thanks Thomas

The Play Doh™ Resistor

by Thomas O'Neill

Objectives:

The student will demonstrate knowledge of the relationship between length of a wire and resistance of a wire by experimental determining that relationship using a Volt-Ohm meter.

The student will demonstrate knowledge of the relationship between cross-sectional area of a wire and resistance of a wire by experimental determining that relationship using a Volt-Ohm meter.

VA SOL - 3rd 3.3, 3.4, 3.5 4th 4.4, 4.7 6th 6.2 8th 8.1, 8.4, 8.9, 8.11
12th 12.1, 12.3, 12.11, 12.16

Equipment and Materials

Play-Doh™ modeling compound, Volt meter, ammeter
or alternately
Play Doh™ modeling compound, Volt-Ohm Meter(VOM)

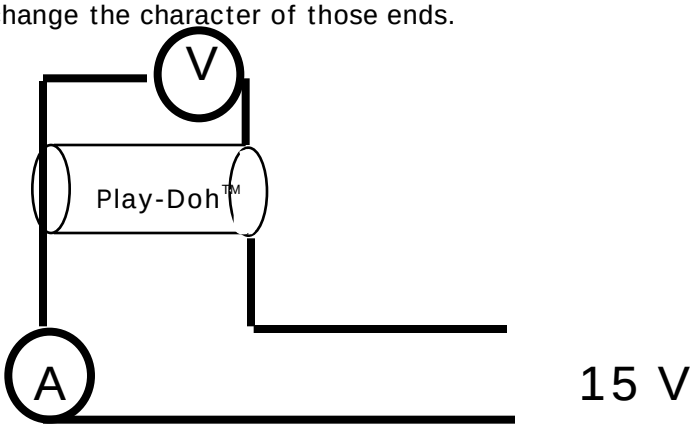
References

Carpenter, Rae and Minnix, Richard. The Dick and Rae Physics Demo Notebook. Dick and Rae, Inc. 1993 pg E-380

Jones, Brian. "resistance Measurements in Play-Doh™". The Physics Teacher 31:1 (Jan 1993) pp. 48-49

Construction of equipment:

The Play Doh™ should be fresh and not dried out. Shape the material into a cylinder. Set up the Volt meter and ammeter as diagramed below: The power should be supplied by a 0-15 V lab DC source. The Volt meter should be connected across the ends of the Play Doh™ and not the leads of the power supply as chemical reactions at the interface of electrode and Play Doh™ will rapidly change the character of those ends.



Alternatively, with a good VOM it is possible to measure the resistance directly although the numbers will vary considerably and will not be consistent with the Volt/ammeter method. Small fissures in the Play-Doh™ will have large effects on the internal resistance of the cylinder. It is usually best to plot only the results from one run (constantly increasing the length) as the resistance of the cylinder seems to depend on the presence or absence of cracks in the Play-Doh™ as it is rolled out.

Suggested activities:

1) Measure the resistance of the Play-Doh™ for various lengths using the same amount of compound each time.

The general equation for resistance of a wire is $R = \frac{\rho \text{ length}}{\text{Area}}$ where R is the resistance, ρ is the resistivity and is characteristic of a given material (usually in Ohm-cm), length is the length of the wire in cm and area is the cross sectional area of the wire in square cm. Since the volume of the cylinder in question is constant and V = Area* Length then substituting in the above equation we get

$R = \frac{\rho \text{ length}^2}{\text{volume}}$ where both ρ and V are constants. This means that a plot of resistance versus length^2 should be a straight line.

This great demo/lab idea was submitted by Charlene Wyrick of York PA. She says it is an adaptation from a presentation at the Central PA - AAPT workshop given in'98. Listed a "compilers" of the hand-out were Patrick Callahan and George Amann. Thanks for some great material!

Palm Pipes, A "Handy" Musical Instruments

Goal:

To show how the length of a tube is related to pitch and to make a little music.

Materials and Construction:

Cut 1/2" PVC pipe to the lengths listed in the table provided later. A complete set of 2 octaves (15 pipes) can be made from one standard 10 foot length. Use plastic pipe and tube cutter available from most Builder's supply and Do it Yourself type stores. The tube cutter costs about $15 and is well worth it if you are making several sets. Otherwise, cut the pipes a little long with a hacksaw and sand them to remove burrs. Be sure there are no rough edges on the pipes

The pipes can be marked using different color tape or paint or by the "letter" name of the note: F-G-A-Bb-C-D-E-F-etc. or by the frequency, using permanent marker. Clear spray paint or clear fingernail polish will make the marker more permanent. Or- you could leave them blank and have students identify the note!

How to Play:

It is easier for each student musician to play one pipe. Grasp the pipe firmly in one hand and quickly bring it down onto the palm of the other hand, allowing the end of the pipe to strike the palm of the other hand.

Have students practice playing the same note in unison, then try a scale involving all.

Practice playing a sort of "Chord" - two notes in unison

Play a song-The conductor points out which not to play. Since here are two octaves, there are two or three different lengths for the same note. You can play the song using melody or harmony together, or play only the melody, depending on the ability of your students.

Extensions:

Have students listen to each pipe and arrange the pipes in order form high to low pitch.

Ask the students to experiment to find other ways to make sounds with the pipes(blowing, dropping, hitting, etc)

Have students match the pitch of the pipes to other instruments in order to identify the note. (piano, xylophone, tuning forks, etc)

Have students place the pipes tightly on their palm and blow across th e top of the pipe. How does the sound differ from palming the pipes?

Hold the pipes in one hand, leaving both ends of the pipe open(not covered by hands, fingers, etc) have students blow over the top of the pipes. How does the pitch change now? What is the difference in the sound of the open and the closed-end pipe?

Note	Length (cm)	Frequency (Hz)
F	24.83	349.2
G	22.12	392
A	19.7	440
Bflat	18.6	466.2
C	16.57	523.3
D	14.76	587.3
E	13.15	659.3
F	12.41	698.5
G	11.06	784
A	9.85	880
Bflat	9.3	932.4
C	8.28	1046.5
D	7.38	1174.7
E	6.58	1318.5
F	6.21	1396.9

F Major Scale: F G A Bb C D

America

1. F F G E F G A A Bb A G G G G E F
   My coun-try 'tis of thee sweet land of lib - er- ty of the I sing!
2. C C C C Bb A Bb Bb Bb Bb A G

3. A Bb A G F A Bb C D Bb A G F

Twinkle, Twinkle, Little Star

Melody F F C C D D C Bb Bb A A G G F
Harmondy C C A A Bb Bb A G G F F E E C

Melody C C Bb Bb A A G ← Repeat this line
Harmony A A G G F F C

Rich McNamara & Ron Revere contribute a list of applets to take a look at. Believe it or not this is only a partial list! I reserved some for a future newsletter.

http://webphysics.davidson.edu/Applets/BlackBody/BlackBody.html
http://www.colorado.edu/physics/2000/
http://www.colorado.edu/physics/2000/
http://www.colorado.edu/physics/2000/
http://www.colorado.edu/physics/2000/
http://phys.educ.ksu.edu/vqm/index.html
http://www.colorado.edu/physics/2000/
http://csep10.phys.utk.edu/astr161/lect/index.html
http://csep10.phys.utk.edu/astr162/lect/index.html
http://zebu.uoregon.edu/nsf/planck.html
http://zebu.uoregon.edu/nsf/spectra.html
http://jersey.uoregon.edu/vlab/
http://www.phy.ntnu.edu.tw/~hwang/Kepler/Kepler.html
http://pao.gsfc.nasa.gov/gsfc.html
http://www.newscientist.com/student/newton/newton.htm
http://julius.ngdc.noaa.gov:8080/index.html
http://csep10.phys.utk.edu/astr161/lect/solarsys/revolution.html
http://javalab.uoregon.edu/dcaley/elements/Elements.html
http://mgw.dinet.de/physik/SunEarthApplet/sunearth.html
http://www.phy.ntnu.edu.tw/java/Kepler/Kepler.html
http://pds.jpl.nasa.gov/planets/
http://www.ngdc.noaa.gov/seg/potfld/geomag.html
http://www.colorado.edu/physics/2000/applets/forcefield.html
http://www.colorado.edu/physics/2000/applets/nforcefield.html
http://www.colorado.edu/physics/2000/applets/orbits.html
http://members.xoom.com/_XOOM/Surendranath/Kepler/Kepler.html
http://www.phy.ntnu.edu.tw/~hwang/Kepler/Kepler.html
http://csep10.phys.utk.edu/astr162/lect/binaries/visual/kepleroldframe.html
http://www.bekkoame.or.jp/~kamikawa/colors/colors_e.htm
http://wigner.byu.edu/Colors/TabbedcolorBox.html
http://javaboutique.internet.com/ColorFinder/
http://www.bekkoame.or.jp/~kamikawa/cavelens/cavele_e.htm
http://webphysics.davidson.edu/Applets/Optics/prb1.html
http://www.bekkoame.or.jp/~kamikawa/lens/lens_e.htm
http://www.phy.ntnu.edu.tw/~hwang/fishEye/fishEye.html
http://www.phy.ntnu.edu.tw/~hwang/waveInterference/waveInterference.html
http://www.phy.ntnu.edu.tw/~hwang/doubleSlit/doubleSlit.html
http://webphysics.davidson.edu/Applets/Optics/prb3.html
http://webphysics.davidson.edu/Applets/Optics/Intro.html
http://www.phy.ntnu.edu.tw/~hwang/Rainbow/rainbow.html
http://wigner.byu.edu/RefractionofLight/LightRefract.html
http://www.physics.nwu.edu/vpl/optics/diffraction.html
http://webphysics.davidson.edu/Applets/Optics/prb5.html
http://webphysics.davidson.edu/Applets/Optics/prb7.html
http://www.bekkoame.or.jp/~kamikawa/thicklens/thicl_e.htm
http://www.phy.ntnu.edu.tw/~hwang/thickLens/thickLens.html
http://wigner.byu.edu/ThinLens/lens&mirror/lensDemo.html

Ron Revere also sent in the “Best of 24 years of PHYSICS CAROLS" I picked out my favorite three. Seems like a fun and clever assignment!

#1 "GRAVITY" (sung to "Jingle Bells")

A comet hits the earth, it's made of methane ice, it makes a giant force, now isn't that so nice?
So, what made it come here? What made it hit the earth?
The answer's very clear, my friend, it fills you up with mirth!!

GRAV-I-TY, GRAV-I-TY, keeps us on the ground.
An apple fell on Newton, he said, "What goes up comes down."
GRAV-I-TY, GRAV-I-TY, mass time nine point eight.
Remember, travel very fast if earth you must escape.

Walk around the earth, keep a steady pace. If gravity twern't here. You'd float away in space.
Call it what you want, call it any name, But this force is a heavy weight, attraction is its game, OHHHHHH∑

(Alvin Lee, WHS, 1982)

#5 "NODAL LINES" (sung to "Jingle Bells)

A day or two ago, I thought I'd check out light, to see if what I'd heard was absolutely right.
I held two pencils up, and put them to my eye, and when I looked into the light I knew it was no lie!!
Ohhhhhh,
Nodal lines, nodal lines, shifting all in phase. Oh what fun it is to watch the pattern formed by rays.
Nodal lines, nodal lines, caused by bending light. Oh what fun diffraction is unless the light's too bright!!

(Frankfurt American HS, 1977)

#6 "TO THE JUDGE" (sung to "Jingle Bells)

Dashing though the snow in a four door Chevrolet, o'er the curb we go, sliding all the way.
Honking at the boy who is on the sled. Will an icy crash we see complete with flattened head? Ohhhhh,
To the judge, to the judge, to the judge we say, "Inertia is that property that kept us on our way."
To the judge, to the judge, to the judge we say, "It's not our fault, blame Newton's Laws, they made
us go that way!!"

(Cliff Hall, WHS, 1985)

Hope I hear from you soon and see you in Charlottesville on March 25!
Keep sending me these great ideas and maybe I can put out the next newsletter a little sooner!