# Lab 2

## Pendulum Lab-

In this lab, you will be determining which of three factors determines the speed at which a pendulum swings. The three factors, or variables, that you will be testing are the mass at the end of the pendulum, the angle from which the pendulum is dropped, and the length of the pendulum. You need to follow the rules of a good experiment (i.e. changing only one variable at a time).

Procedure:
This procedure will mainly be determined by you, but these are some tips:

1) Do not swing the pendulum from high angles (greater than 35 degrees) or it will not swing smoothly.
2) It will be nearly impossible to measure one swing of the pendulum, you will want to let it swing 10 times and then divide the total time by 10.
3) If one or more of the factors does affect the speed of the pendulum, it will affect it greatly. Do not let a difference between 1.21 and 1.23 seconds make you think that there was a change. The difference will be more like 1.21 and 4.33 seconds.
4) You don't have to measure the exact masses, angles and lengths of the pendulum. You can use low, medium, and high or one washer, two washers, and three washers instead.

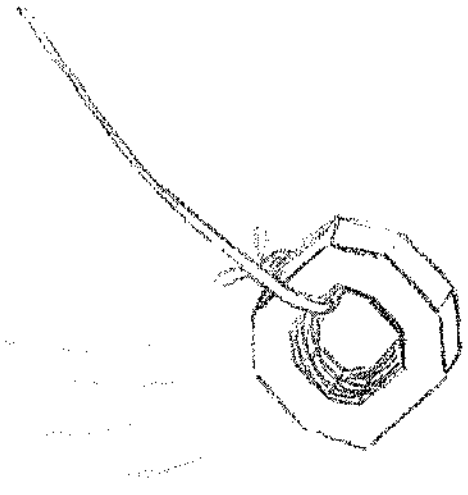
Data:
Since you will be determining the procedure, you will also be determining the data charts. Keep in mind that you should test each variable for at least three different levels (low, medium, high).

Post-Lab Questions:

1) Which variable or variables had the biggest effect on the speed of the pendulum?

2) Can you relate this information to your experiences on or around playground swings?

3) Be sure to draw three graphs. Each should have the variable being tested on the y-axis and the time for a swing on the x-axis. Start the y-axis at 0 to avoid amplifying small changes.



# Lab 3

## Thickness of Paper Lab-

It would be impossible to measure the thickness of one sheet of paper with a ruler. In this lab, you will be measuring a stack of paper and mathematically determining the thickness of one sheet of paper.
This is very similar to calculations in chemistry. It would be impossible for us to find the mass of one atom of carbon. We can, however, find the mass of a large number of carbon atoms and then figure out the mass of a single atom. The quantity of atoms that we use is the "mol". The mol is the number of atoms that have a mass (in grams) equal to the atomic mass found on the periodic table. For example, an atom of carbon has a mass of 12.011 atomic mass units (amu). A mol of carbon has a mass of 12.011 grams.

Procedure:
Take a large number of papers (100, 250, 500) preferably new papers that haven't yet been bent or crinkled and measure how thick they are. Be sure to measure in centimeters. Even though most rulers say "mm" on the side of the ruler that goes from 1-30, those are actually the centimeters that are numbered.
Then divide the thickness of the stack by the number of pages.

Data:
Number of sheets _____

Thickness of sheets _____ cm

Thickness of one sheet _____ cm

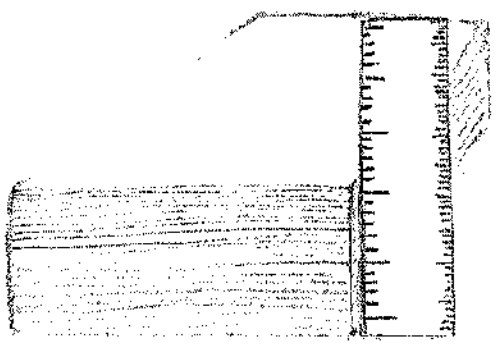
Post lab questions:

1. What were some sources of error in this lab?

2. How tall would 1,000,000 sheets of paper stand?

3. How many sheets of paper would it take to stand as tall as a basketball rim (10 feet)? One inch is 2.54 cm.

4. Your teacher will use a device called a micrometer to actually measure a piece of paper. Calculate the percent error from the following equation: % = (difference/real)(100)



# Lab 5

## Are You Getting Shorter?-

In this lab, you will be investigating what may possibly be an urban legend. It is said that when you wake up in the morning, you are taller than later in the day. You will be testing this by measuring your height as soon as you get up in the morning and then again at the end of the day.

Procedure:

1) Be sure that your shoes are off and you're standing on level ground. Have someone mark your height with a small mark on a wall or doorway making sure that the pen or pencil is completely level. This is easier if the other person is taller than you.
2) Use your ruler to measure the height of the mark from the floor carefully.
3) Repeat this procedure again at the end of the day, but before you spend a significant amount of time laying down or resting.

Data:

Height in the morning: _____ cm

Height in the evening: _____ cm

Post-Lab Questions:

1) Is it true that you get shorter later in the day?
2) How would you explain this phenomenon?
3) Devices to hang upside down from your ankles used to be popular for relieving pressure in your spine. Could this possibly work? Will it make you taller in the long run? Explain.

# Lab 8

## Probability of Finding an Electron-

It is known that electrons don't actually fly around in fixed orbits like planets. When you see textbook drawings of electrons in orbits, the orbits only represent where it is the most probable that the electron may be found at any moment. You will be simulating this probability analysis by dropping a pen at a target and counting how many times the pen marks in each area.

Procedure:
Take the target paper and put it on the floor. Holding the pen at arm-length, drop it 50 times tip first such that it will make a mark on the paper.
Count how many times the pen struck each of the areas on the target. If it is on the line, try to determine which side it is closer to. Fill in the chart and then graph your results with a smooth curve.

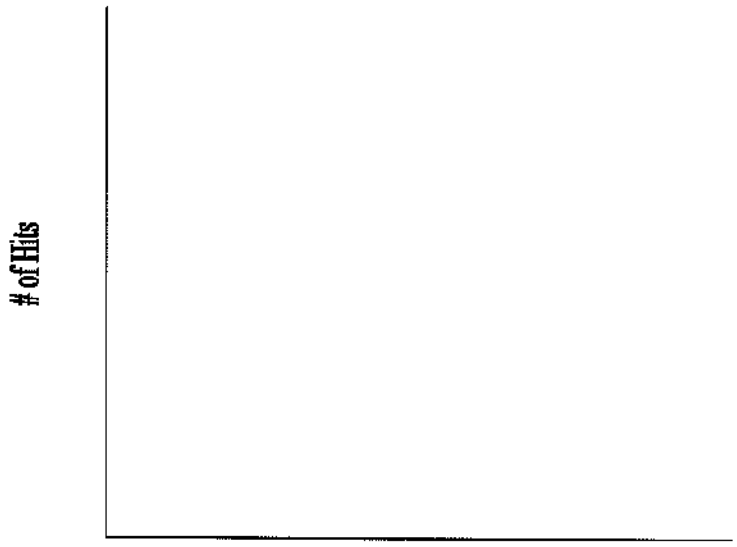
Data:
Area 1 _____ hits
Area 2 _____ hits
Area 3 _____ hits
Area 4 _____ hits
Area 5 _____ hits
Area 5 _____ hits

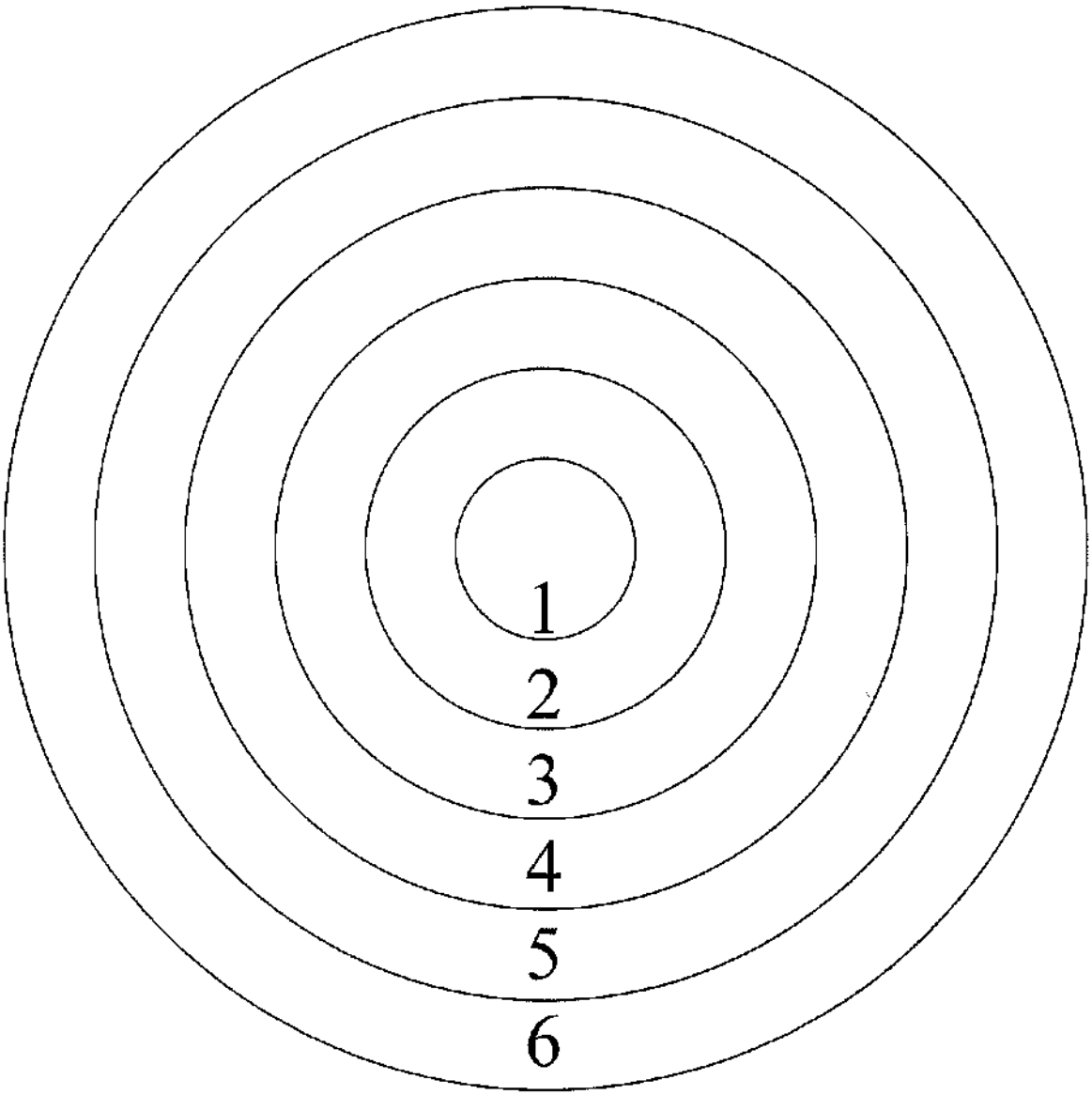
Post-Lab Questions:

1. In which area is the highest probability of finding an electron?

2. Describe the pattern that you saw in your data.

3. Compare your graph to a graph of electron probabilities.



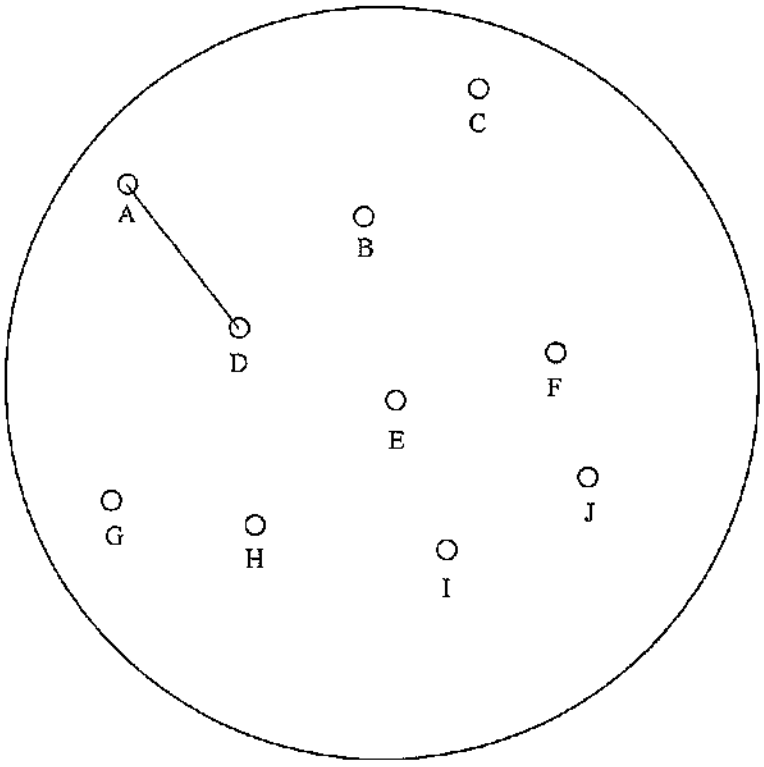

1
2
3
4
5
6

# Lab 11

## Mean Free Path Activity-

Mean free path is the average distance between molecules or atoms. It is usually used when dealing with gases and plasmas. Remember that the word "mean" used in this context means the same thing as "average". Mean free path is important when analyzing chemical reactions that involve gases, calculating the conductivity or density of a gas, and working with plasmas such as in a fluorescent light bulb or a fusion reactor.

Procedure:
Consider the diagram below in which there are many circles representing atoms or molecules of a gas or plasma. Measure the distance between 10 of the atoms and one of its neighbors. Average the distances to find the mean free path. Measure in centimeters from the centers of the atoms. One has already been marked for you.




Data:

| 1st atom | 2nd atom | distance |
|---|---|---|
| A | D | |

Post-Lab Questions:

1. If two of these atoms were very close together, would it have changed your answer very much? Explain
2. If you were to increase the number of atoms or molecules in this container, how would it change the mean free path? Explain
3. If you were to increase the size of the container, how would it change the mean free path? Explain.

# Lab 13

## Surface Tension Lab-

In this lab, you will be testing surface tension by counting how many drops of water you can put on a penny. Dishwashing liquid breaks up surface tension, so you will repeat it again after putting a little dishwashing liquid in the water.

Procedure:
First, predict how many drops of water you think you'll be able to put on the penny. Lay a penny on a flat surface with the tails side facing up. Using your syringe, carefully count drops until the water overflows. Now add a couple drops of dishwashing liquid to the water and repeat.

Predicted number of drops _____ drops

Drops of tap water _____ drops

Drops of soapy water _____ drops

Post-Lab Questions:

1. Which of the types of water enabled you to put more drops of water on the penny? Why?
2. If there was a chemical that could increase surface tension, do you think it would allow more drops or few drops?
3. Were you able to put more or fewer drops than you predicted?

# Lab 18

## Intensive and Extensive Properties-

Intensive properties do not depend on the size of a sample. Since the texture of a sample doesn't depend on how big it is, texture is an intensive property. Extensive properties depend on the size of the sample. Since the weight or mass of an object depends on how much you have, mass is an extensive property. In this lab, you will be taking a simple substance and performing some simple actions on it to shed some light on intensive and extensive properties.

Procedure:

1) In a large cup, put some water and a couple of drops of food coloring.
2) Write down 10 properties of this substance. If the property is a measured property (like temperature), you can estimate if a measuring device isn't available.
3) Now pour that liquid solution into three smaller cups. Write down 5 properties of the smaller cups.

Post-Lab Questions:

1) Name three properties that changed during this activity. Are these intensive or extensive properties?
2) Name three properties that didn't change during this activity. Are these intensive or extensive properties?
3) For a certain extensive property, show that the particular property before the change is equal to the sum of the property in the smaller cups after the change.

# Lab 22

## Lifting an Ice Cube with a String

In this lab, you will be shown a discrepant event (an action that doesn't make much sense). Then you will be asked to try to figure out how it worked. You may use your book, information given in class, and the internet to figure out your answer. Remember that the internet has a lot of very elementary and incorrect information on it. If you use the internet, be careful to analyze what you read and only depend on high-school level and large websites. If the website is the California State College website, it's probably trustworthy. If it's John John's 3rd grade science fair project website, it's probably not.

Procedure:

1) Put one large ice cube in an almost full cup of water so that it is near the top of the cup.
2) Lay a string across the top of the ice cube. Coil it in circles if possible.
3) Sprinkle salt on the string and ice cube and wait 10 seconds.
4) Now lift the ice cube out of the water.

Wrap-up:

Write a 3 paragraph explanation for how this event works. Try to use some of the following terms in your explanation: freezing point depression, temperature, heat, fusion, heat of fusion, melting, freezing, and reversible. As with everything in life, spelling, grammar, and punctuation do count.

# Lab 25

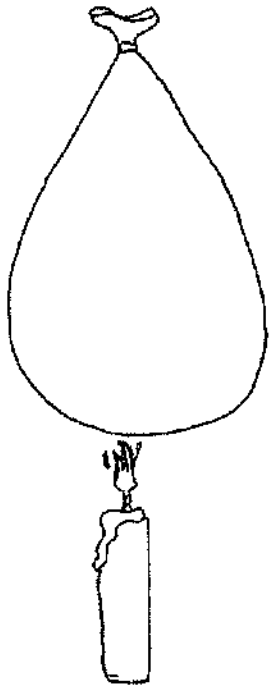
## Specific Heat Lab-

In this lab, you will not be calculating specific heat, but observing an effect of specific heat. The specific heat of a substance is how much energy it takes to raise the temperature of that substance. If a substance has a high specific heat, it will be difficult to raise its temperature and it will be able to store a lot of energy. A substance with a high specific heat also gives off a lot of heat when it cools down. Water is such a chemical. We sometimes think that water is easy to heat up, but that's only because we just have to put it in the microwave and press a few buttons and it starts to boil. Microwave ovens are very powerful appliances that can deliver large amounts of heat in just a short time. Some microwaves take as much electricity as 15 or 20 100-watt lightbulbs. You will be observing the heat-absorbing capabilities of water in this lab.

Procedure:
Stabilize a candle on a saucer or plate so that it cannot fall over and put it in the sink. Fill up the water balloon, but not too tight and blow up the regular balloon. Light the candle. Hold the regular balloon over the candle for several seconds, but do not let the rubber light on fire. If it lights on fire, run water over it immediately. Hold the water balloon over the candle for several seconds and notice what happens. Record your observations in your lab notebook.

Post-lab Questions-

1. Which balloon popped and which didn't?
2. How did the water keep the balloon from popping?
3. Use this property to explain why cities like San Diego that are near the beach have much more stable climates than cities away from water like Palm Springs.



# Lab 26

## Identifying Types of Streetlight Labs-

In this lab, you will be using a diffraction grating to determine what type of light bulbs are used in a nearby parking lot. You will either be provided with a card, given access to a card, or directed to a website that has the different spectra for the different types of lights used in outdoor lighting (high-pressure sodium, fluorescent, etc.)

Constructing the spectroscope-
You will be using a CD as the diffraction grating in your spectroscope. It doesn't matter what type of CD you use, computer, music, AOL, etc. If you have one of the clear CDs that come as spacers when you buy a lot of recordable CDs, read the alternate directions below (the clear CD must show a rainbow when you look at it in the light).
In one end of a shoe box or similar container, poke a hole about the size of a penny. At the other end, use tape to put the CD inside the box at an angle and cut a slit in the box above the CD. Tape the lid on so that light cannot get in from the sides.

Alternate construction with clear, blank CD-
If you have one of the clear CDs that actually has scratches in it or if you can peel the silver layer off of a recordable CD, you can simply put a slit in one end of the box and a hole in the other end. Cut or break off a small piece of the clear CD and cover the hole with it. That's it, just point it directly at the light.

Procedure:
Now take your spectroscope to the parking lot that your teacher tells you and look at the lights through it. Make sure to be as far as possible from any other sources of light such as head lights and neon signs. Draw a sketch of the brightly colored lines that you see and label the colors of the lines. Now repeat this with another type of lights on the street or in another parking lot. You will be told where to find the information to tell what kinds of lights they are.

Post-Lab Questions:

1. What was the most difficult part about determining what type of light you used?
2. How sure were you that you got the right one?
3. Why did you have to put a slit in the box instead of just leaving the top off?

# Lab 28

## Conservation of Mass Lab-

The Law of Conservation of Mass says that mass is conserved during a chemical reaction. In this lab, you will be performing a chemical reaction; burning a candle. By putting another candle on the other end of the balance, you can see if mass is conserved in this reaction.

Procedure:
Using some play-doh, clay, or wax, stick a candle to each end of your balance and adjust the material until it balances. Now light one of the candles and observe the experiment for a couple of minutes.

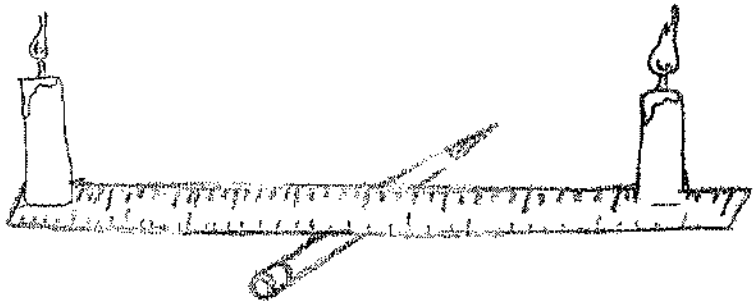
Observations:_____

_____

_____

Post-Lab Questions:

1. Was mass conserved in this experiment? Why not?
2. How could the experiment have been changed so that mass would have been conserved?
3. Where did the missing mass go?



# Lab 30

## Solubility Lab-

In this lab, you will be figuring out which solids are soluble in which liquids. For the liquids, you will be using water, rubbing alcohol, and oil. For the solids, you will be using salt, sugar, and baking soda. In the end, you will see if the liquids will mix together.

Procedure:
You will need to set out 6 small cups. Fill the first 3 cups with water. Add a small amount of sugar, salt and baking soda and record which one(s) dissolve. Allow 3-5 minutes for the dissolving to complete. Now repeat this with the rubbing alcohol and oil, using just small amounts of the liquids. Do the oil last and then clean the cups with dishwashing liquid to get all of the oil out.
Now pour two cups of water, two cups of rubbing alcohol, and two cups of oil. Pour some alcohol and some oil into the two cups of water and note if they mix or stay separate in your lab notebook. Repeat with the alcohol and oil and record the results.

Post-Lab Questions:

1. In general, polar things dissolve other polar things and non-polar things dissolve non-polar things. Water is polar. Which of the solids are polar?
2. In general, polar things mix with polar things and vice versa. Which of the liquids are polar?
3. Is antifreeze polar? Epsom salts? Car oil? Animal fat? Nutra Sweet®? Sand?

# Lab 31

## Oxidation Lab-

In this lab, you will be testing different things to see if they inhibit rust. You will be taking 2 iron nails and 2 anodized (zinc-coated) nails and putting them under different conditions and seeing how much rust forms. Keep them moist with tap water or salt water and roll them over daily.

Procedure:
Nail A-
Leave iron nail (shiny) A between two moist paper towels and don't let it dry out
Nail B-
Leave anodized nail (dull gray) B between two moist paper towels and don't let it dry out
Nail C-
Leave iron nail (shiny) C between two paper towels moistened with salt water and don't let it dry out
Nail D-
Leave anodized nail (dull gray) D between two paper towels moistened with salt water and don't let it dry out

Each day for two weeks, record observations about the nails in your notebooks. When rust begins to form, rank them from 1-4 with 1 being the least rust to 4 being the most rust.

Post-Lab Questsions:

1. Why is it that when people sell boats, they often say, "Has never been in salt water"?
2. People think that electronics are coated with gold because it's a good conductor of electricity, but that's not why. After this lab, what would your guess be?
3. In cold climates, people spread salt to melt the ice and prevent slippery roads. How could this be bad for cars?

# Lab 32

## Synthesis Reaction-

A synthesis reaction is one in which two small elements or compounds combine to form one complex compound. An example would be when carbon and oxygen combine to form carbon dioxide: $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$. In this reaction, you will be forming something called a complex containing one copper atom and four amine ions: $Cu(NH_3)_4^{+2}$. Complexes are often very colorful, as you will see.

Procedure:

1) Since you will be letting this experiment set for many days, do not use a paper cup or the liquids will soak through. Pour ammonia into the plastic cup until it is approximately 1.0 cm deep.
2) Put a clean penny in the cup and either put a lid on it or cover it with plastic wrap. Do not cover with aluminum foil or you could get some unexpected reactions between the ammonia and the aluminum.
3) Make observations of the penny and the ammonia daily for seven days.

Observations:

| Day # | Penny Observations | Ammonia Observations |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |

Post-Lab Questions:

1) Write and balance the equation for the formation of the colored complex from the information given in the introduction.
2) What color was the copper complex?
3) What happened to the penny throughout this experiment?

# Lab 33

## Single Displacement Reaction-

A single displacement reaction is when an element replaces part of another compound and releases it. When a metal reacts with an acid, that is a single displacement reaction: $Mg_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$. In this experiment, you will be using steel wool (which contains iron) and vinegar (acetic acid, $HC_2H_3O_2$). This reaction will produce iron (II) acetate: $Fe(C_2H_3O_2)_2$.

Procedure:

1) You will be letting this experiment run for several days, so use a glass jar or a plastic cup, not a paper cup. Put approximately 2.0 centimeters of vinegar in the cup.
2) Put a wad of steel wool in the vinegar about the size of a large marble (2.0 cm diameter). It should be completely covered by the vinegar. Don't use all of the steel wool, you need more later.
3) Observe the steel wool and the vinegar for 7 days.
4) Discard the remaining steel wool from the cup and save the solution for the next experiment.

| Day # | Steel Wool Observations | Vinegar Observations |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |

Post Lab Questions:

1) Write the balanced equation for the formation of the iron (II) acetate.
2) Name 2 properties of iron (II) acetate.
3) What was the other product of this reaction? Were you able to see it?

# Lab 34

## Double Displacement Reaction: Precipitate Lab-

A double displacement reaction is one in which the ions in two compounds switch places. For example, $HCl + NaOH \rightarrow NaCl + H_2O$ is a double displacement reaction because the Na+ and the H+ ions switched places. In this lab, you will be using the solution from the last experiment to perform a double displacement reaction with ammonia. It is important to know that ammonia ($NH_3$), when added to water acts like $NH_4OH$ in the form of: ($NH_3 + H_2O \rightarrow NH_4OH$).

Procedure:

1) Take the iron (II) acetate solution from the last experiment and slowly add ammonia drop by drop until a green precipitate forms.
2) Keep adding the ammonia until no more precipitate forms.
3) Let the precipitate settle to the bottom and then carefully pour off the liquid without losing any of the precipitate. Let the precipitate dry out and then put it in a Ziploc bag to take to school and find its mass.

Post-Lab Questions:

1) If the formula of the precipitate was $Fe(OH)_2$, what was the other product in the reaction between the $Fe(C_2H_3O_2)_2$ and the $NH_4OH$?
2) Why did the precipitate stop forming after a while? Explain
3) Why do you think that this type of reaction is called a "precipitate" reaction?

# Lab 36

## Pressure Lab-

In this lab, you will be using an index card to hold a column of water in place with the help of air pressure. To do this, you will need a 3 X 5 index card and a water glass that the card will fit over. It's OK to measure things in inches for this lab only.

Procedure: Fill the cup completely with water and put the index card over the top. Holding the index card, flip the glass over (hold it over a sink just in case). Now release the index card and everything should stay right where it is.

Calculations:

2) Measure the diameter of the glass that you are using in inches. Normally, we don't use inches in science classes, but we are making an exception in this case.
3) Calculate the surface area of the glass using $A=\pi r^2$
4) Air pressure is 14.7 pounds per square inch. Use the area of the glass that you calculated in #2 to figure out how many pounds of air pressure are pushing on the card.
5) Assume that you have a half a pound of water in the glass. How many pounds per square inch are pushing down on the card due to the water?

Post-Lab Questions:

1) Which is pushing harder, the water pushing down or the air pushing up?
2) Why do the water and index card not fall down?
3) How many pounds of water could be held up with a card the size of a sheet of paper (8.5" X 11")?

# Lab 38

## Expansion and Contraction-

In this lab, you will be putting a balloon in the freezer and seeing what happens to its volume. If room temperature and the temperature of your freezer were far enough apart, you could use these to values to extrapolate what the Celsius value of absolute zero is, but they are not.

Procedure:
Fill a small water balloon about half way full of air. Fill a small bucket like the dish that butter comes in all the way to the top with water and place it inside of a larger container. Push the balloon underwater and collect all of the water that spills over. Measure it by pouring it into your syringe. Pour several times if necessary.
Now put the balloon in the freezer for about an hour and put a bucket of water in the refrigerator. Repeat the measurement process, but using the refrigerated water this time and measure the spilled water.
Now hold the balloon under a stream of hot water from the faucet for a minute or two. Have a bucket of hot water ready for the measurement. Repeat the procedure again.

Data:
Volume of balloon at room temperature _____ mL

Volume of balloon from freezer _____ mL

Volume of the hot balloon _____ mL

Post-Lab Questions:

1. Did the balloon get bigger or smaller in the freezer? By how much?
2. Say that room temperature was 22°C and the freezer was –5°C, what would be your estimate for absolute zero (the temperature at which the volume would be zero)? How close is that to the real answer? You may have to draw a graph to measure this.
3. Why was hot and cold water used to measure the balloon from the freezer and the warmed balloon?