Name Helen

Date

2 Physical States of Matter

Goals

- Review the kinetic theory of matter and the phase changes of matter.
- Demonstrate sublimation, evaporation, and condensation.

Prelab

Concepts

The kinetic theory states that all matter is composed of particles that are in constant motion. Although the particles are in motion, there are attractive forces that exist between the particles. If the attractive forces are sufficiently strong, the particles will be held close together with a fixed distance between them. The resulting substance exhibits a definite shape and volume. This state of matter is called the **solid** state. If energy is applied to the substance, the particles begin to vibrate more vigorously, overcoming some of the attractive forces between the particles. If sufficient energy is applied, the distances between the particles are no longer fixed. Although the substance no longer has a definite shape, it still has a definite volume. The substance is now in the **liquid** state. As more energy is applied to the substance, the particles vibrate so vigorously that the attractive forces between them are completely overcome. The loss of the attractive forces allows the particles to move about randomly and expand indefinitely unless limited by a container. This state is known as the **gas** state. Substances attain the **plasma** state when even more energy is applied to the substance, causing the particles to move at speeds high enough to allow the collisions between the particles to result in the removal of electrons from the particles. Thus, plasma is highly ionized gas. On the other hand, if energy is removed from a substance, the motion of the particles slows down, and the attractive forces between the particles begin to bring the particles closer together. As the substance approaches absolute zero and the motion decreases (theoretically, all particle motion would stop at absolute zero), a new state of matter is predicted to exist—the **Bose-Einstein condensate.**

The change of a substance from a solid to a liquid is called **melting,** and the change from liquid to gas is termed **evaporation.** Conversely, **condensation** is the phase change from gas to liquid, and **freezing** is the change from liquid to solid. Most of the time, a substance goes through all three stages as it changes from solid to gas. However, some solids change directly from a solid to a gas without passing through the liquid state. This direct transformation from solid to gas is called **sublimation.** The same term is used for the change from a gas directly to a solid.

In this laboratory exercise you will observe the processes of sublimation, evaporation, and condensation and the effect of adding thermal energy to each process.

Checkup

1. Define *sublimation.*

   Solids change to gas without passing the liquid state

2. What is the theoretical state of matter that is predicted to exist at absolute zero?

   It is called Bose - Einstein condensate.

3. Where do you think the *para*-dichlorobenzene crystals would form if you did not use ice and if the jar were placed in a sunny windowsill? Explain your answer.

The side that is farther from the sun will evaporate as fast as the jar that is placed in the sunny windowsill.

Materials

bowls, shallow, 2
*cap, bottle
*jars, glass, with tight-fitting lids, 4
spoon
food coloring
ice
para-dichlorobenzene, $p\text{-}C_6H_4Cl_2$
water, distilled

Do not inhale fumes from *para*-dichlorobenzene crystals.

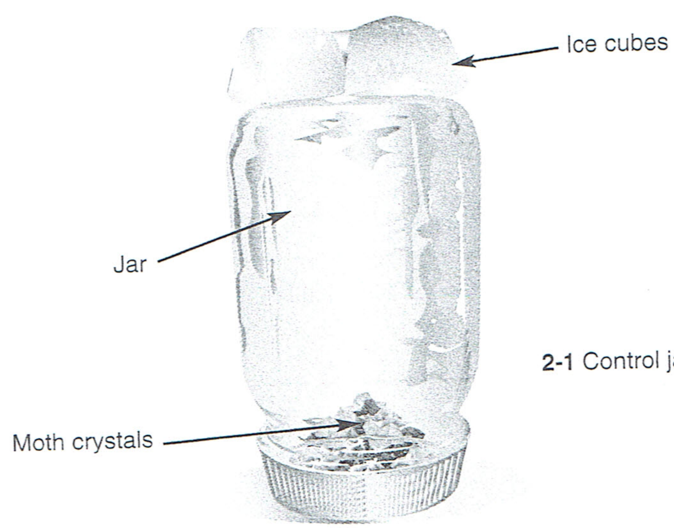
*Substitutions

1. A bottle cap from a soft drink bottle will work, or a smaller lid that will fit inside the rim of the jar lid and still allow the jar to be sealed.
2. Any small jar will work—pickle, mayonnaise, olive, baby food, or jelly jar—as long as it can be sealed.
3. Some moth killers contain *para*-dichlorobenzene as the active ingredient. Those that do are often called moth *crystals*. Others contain naphthalene, and they are often called moth*balls*. Be sure to check the label. This exercise requires moth crystals that contain *para*-dichlorobenzene.

Procedure

Moth Crystal Sublimation

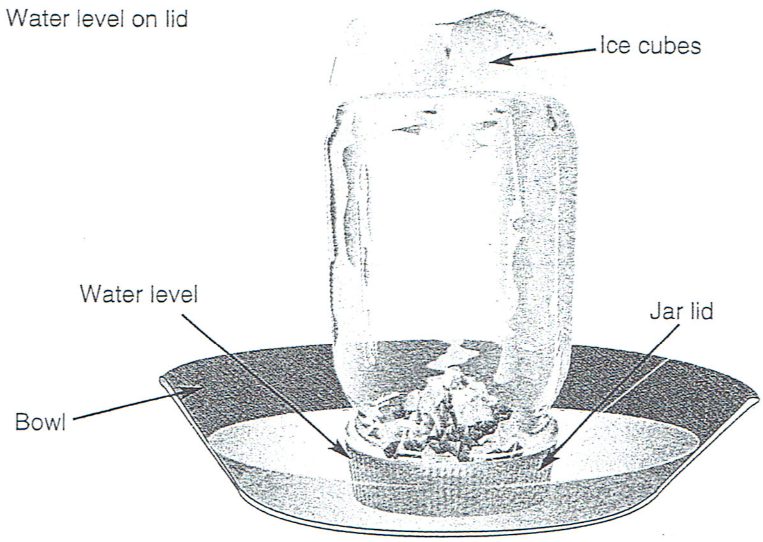
1. Using a spoon, place several moth crystals in a clean, dry glass jar. Tightly seal the jar with the lid. Invert the jar so that the moth crystals are positioned on the inside of the lid. Do not inhale the fumes.
2. Place some ice cubes on the inverted bottom of the jar (see Figure 2-1). Record the time when you placed the ice on the inverted the jar. (Record: 1.) Let the jar stand undisturbed. As the ice melts, replace it. Check the jar about every 10 minutes and record the time when you first see *para*-dichlorobenzene crystals forming on the inside of the top of the jar. (Record: 2.) This will be your control.



2-1 Control jar

3. Prepare a second jar with several moth crystals. Place this inverted jar into the shallow bowl and add only enough hot tap water to the bowl to come to a level just below the rim of the jar lid (see Figure 2-2). Record the time when you first place the jar in the hot water and when you first see crystals forming on the top of the jar. (Record: 3-4.)

2-2 Water level on lid



Water Evaporation and Condensation

4. Fill a bottle cap half full with distilled water and add 1 drop of food coloring. Finish filling the cap with distilled water. Set the cap on the inside surface of a jar lid, invert the jar, and tightly seal it. Place ice cubes on the top of the jar and record the time. (Record: 5.) Check the jar about every 10 minutes and record the time when you first see water condensing on the inside bottom of the jar. (Record: 6.) This is your control.
5. Repeat step 4 with the addition of placing the jar into the bowl and adding hot tap water. Record the time when the jar is first placed in the hot water and when you first see water condensing on the inside of the bottom of the jar. (Record: 7-8.)

Data

Moth Crystal Sublimation

1. Start time for control jar 12:22 pm
2. Time crystals first seen in control jar 12:29 pm
3. Start time for jar using hot water 12:30 pm
4. Time crystals first seen in jar using hot water 12:34 pm

Water Evaporation and Condensation

5. Start time for control jar 12:44
6. Time condensate first seen in control jar 12:52
7. Start time for jar using hot water 12:54
8. Time condensate first seen in jar using hot water 1:07

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Analysis

1. What effect did placing the jars in the hot water have on each of the processes?

   It from the crystals faster and the processes go faster too

2. Why do you think that ice was placed on top of the jars? What do you think would have happened if the ice had not been placed on the jars?

   The Ice is helping the crystals to transefre the heat. If the Ice have not been placed on the jars it will take forevery to from those crystals.

3. What color was the condensate inside the jar with the water? Based on this observation, if salt had been dissolved in the water, do you think that the condensate would taste salty?

   No, we would not teste the Saltyness

4. What other examples can you think of that show evaporation or condensation? Sublimation?

   You can put a ice in a cooking pan to show the evapordtion. The rian in the sky.

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3B Measurement of Matter

Goals

- Practice the techniques of measuring length, volume, and mass.
- Determine the densities of regular and irregular solids.
- Determine the percent error of an experiment.

Prelab

Concepts

The physical property of density is frequently used to help identify substances. **Density** is defined as the mass per unit of volume $(d = m/V)$. In the metric system, the units for density are g/mL or g/cm^3 for liquids and solids, and g/L for gases.

You can determine the density of regular objects (those with exact shapes) by dividing the mass of the object by a volume calculated from measurements of the object. You can determine the density of both regular and irregular objects by dividing the mass of the object by the amount of water it displaces (which is its volume). For example, if you want to find the density of an irregular object such as a rock, determine its mass first. Then determine its volume by filling a graduated cylinder to a known level and placing the rock in the cylinder. The difference between the new level of the water and the original level is the volume displaced by the rock. In this experiment you will determine the density of a regular object by both methods, and the density of an irregular substance (BBs or lead fishing sinkers) by the water-displacement method.

Checkup

1. Name several items that are considered regular objects.

   Rectangle, trangles, cron, are the regular objects

2. Name several items that are considered irregular objects.

   rock, water bottle, they are irregular objects.

3. How do you determine the density of a regular object?

   Need to dividing the mass of the object, by a volume by calculated the measurements of the objects

4. How do you determine the density of an irregular object?

   Dividing the mass of the object of the amount of water volume.

5. If you need to use both methods to determine the density of an object, will the object you use be regular or irregular?

   It will be the irregular

Materials

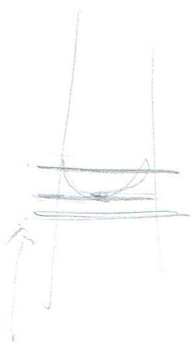
balance
*cylinder or bar, metal
fishing sinkers, lead
graduated cylinder, 10 mL
ruler, metric

*Substitution

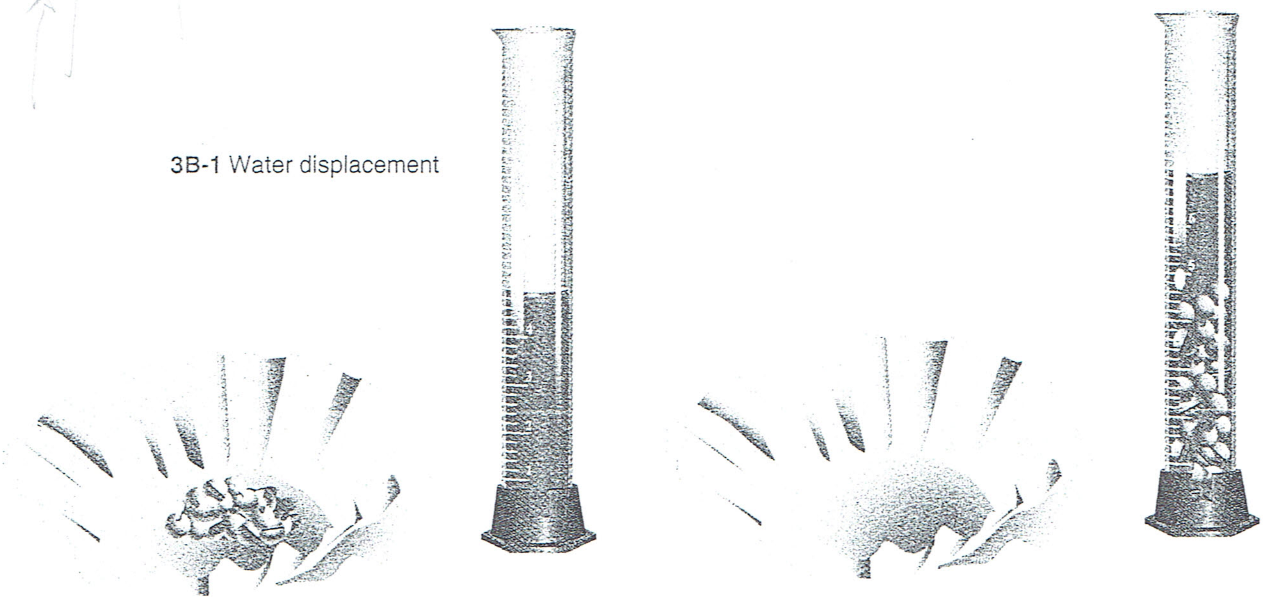
- A nail from which the head and point have been removed, or a segment of a metal rod can be used to replace the metal cylinder.

Procedure

1. Using a metric ruler (with centimeter markings), measure the length and diameter of a cylindrical object to 0.1 cm. If it is a bar, measure its length, width, and height. (Record: 1-2.)
2. Determine the mass of the regular object to 0.01 g. (Record: 3.)
3. Fill your 10 mL graduated cylinder to the 5 mL mark. Always read it to the nearest 0.1 mL. (Record: 4.)
4. Holding your graduated cylinder at a 45° angle, carefully slide the regular object down the side of the cylinder and measure the volume to 0.1 mL. (Record: 5.) Be sure the object is completely submerged.



3B-1 Water displacement



5. Determine the mass of a small container to 0.01 g. (Record: 6.)
6. Add 25 to 30 g of fishing sinkers to the small container and find the total mass. (Record: 7.)
7. Repeat steps 3-4, using the fishing sinkers in place of the regular object. (Record: 8-9.)

Data

1.	Length of object	3.7 cm
2a.	Diameter (or width) of object	0.7 cm
2b.	Height of object (bar only)	______ cm
3.	Mass of regular object	14.6 g
4.	Original volume of water in the graduated cylinder	8.0 mL
5.	Final volume of water and object	9.89 mL 1.89
6.	Mass of small container	1.6 g
7.	Mass of small container and fishing sinkers	31.0 g
8.	Original volume of water in the graduated cylinder	5.08 mL
9.	Final volume of water and fishing sinkers	7.92 mL

Analysis

1. What is the radius of the regular object (cylinder only)? 0.35 cm

   $r = d/2$

2. What is the calculated volume of the object? 1.4 cm^3

   $V = \pi r^2 h$ (cylinder) or $V = lwh$ (bar)

3. What is the density of the object? 10 g/mL

   $d = m/V$

4. What is the volume of the regular object according to water displacement? 1.89 mL

5. What is the density of the regular object? 7.72 g/mL

   $d = m/V$

6. What is the percent difference of the two densities? 25.7 %

7. What is the volume of the fishing sinkers according to water displacement? 2.83 mL

8. What is the density of the fishing sinkers? 2.94 g/mL

   $d = m/V$

9. What is your percent error?
   (Your teacher will give you the actual density of the lead sinkers.) ________ %

10. Which method do you think is more accurate for the regular object? Explain.

    Useing the density of the regular objea. It gave you more accuratce

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Lab 4: Mixtures of Isotopes

Concepts:

Isotopes are two or more atoms of the same element that have the same number of protons (atomic number) but different numbers of neutrons. Naturally occuring elements are usually mixtures of isotopes. This is the reason that the atomic masses listed on the periodic table are not whole numbers. Instead, they are the weighted averages of the various isotopes of each element.

You can calculate atomic mass by using the following formula:

$$\text{weighted average} = \frac{\text{total mass of atoms}}{\text{total number of atoms}}$$

To determine the total mass, you must first determine the amount of mass each kind of atom (isotope) contributes. The formula for this calculation is:

$$m_{total} = (m_1 \times n_1) + (m_2 \times n_2)$$

where m_{total} is the total mass of the isotopes of the element, m_1 is the mass of one isotope, n_1 is the number of atoms of that isotope, m_2 is the mass of the second isotope, and n_2 is the number of atoms of that isotope.

In this experiment you will use a mixture of two varieties of candy-covered chocolates to represent two different isotopes in a sample of the "element" *ememium.*

Checkup:

1. Define isotopes: ~~more then 2~~ atoms of same element has same protons, different numbers of neutrons.

2. How many "isotopes" will your "isotopic" mixture have in this experiment? 2

3. Why are most of the atomic masses on the periodic table not whole numbers?

1. The mass of a proton or neutron is not a whole number.
2. Is the average of the isotopes.

4. An imaginary element candium contains two isotopes. In the naturally occuring mixture, 70.00% of the atoms are Cn-286 and 30.00% are Cn-288. Calculate the atomic mass of naturally occurring candium. Express your answers to the tenths place.

286 x 0.7 = 200.2
+ 288 x 0.3 = 86.4
286.6

286 x 0.7 = 200.2
+ 288 x 0.3 = 86.4
286.6

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Procedure:

1. Obtain your mixture of candies.
2. Find the mass of five large candies (Record: 1.) and five small candies. (Record: 2.)
3. Divide each mass by 5 to get an average mass for each type of candy. (Record: 3-4.)
4. Count the total number of large candies (Record: 5.) and the total number of small candies in your mixture. (Record: 6.)

Data:

1. Mass of five large candies 9.7 g
2. Mass of five small candies 4.3 g
3. Average mass of one large candy (m_1) 1.94 g
4. Average mass of one small candy (m_2) 0.86 g
5. Number of large candies in mixture (n_1) 32 candies
6. Number of small candies in mixture (n_2) 71 candies

Analysis:

1. Calculate the weighted average o the masses of candies in the mixture. Be sure to follow the significant digit rules. Show your work in the margin.
   a. Calculate the total mass of your sample of candies using the formula on page 1.

      (32 x 1.94) + (71 x 0.86)
      62.08 + 61.06 = 123.14 123.14 g

   b. Calculate the weighted average of one candy using the formula on page 1.

      123.14 / 103 1.195 g

2. Calculate the percentage of "isotopes" in the candy mixture.
   a. Solve for the percentage of each type of candy according to the following equation. Use your calculated values for weighted average and the masses. x represents the fraction of large candies and (1-x) represents the fraction of small candies.

$$\text{weighted average} = (x \times m_1) + [(1-x) \times m_2]$$

large 31 %
small 69 %

1.195 = (x · 1.94) + [(1 - x) x 0.86]
100 - 31 = 69

1.94x + (1-x) x 0.86

1.195 - 0.86 = 0.335

1.195 = 1.94x + 0.86 - .86x
1.195 = 1.08x + 0.86

31. = x

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b. Verify your calculations using the formulas below.

$$\% \text{ large} = \frac{n_1}{\text{total number of "isotopes"}} \qquad \% \text{ small} = \frac{n_2}{\text{total number of "isotopes"}}$$

$$\frac{32}{103} = 0.310$$

$$\frac{71}{103}$$

large 31 %

small 69 %

c. Account for any difference between the values obtained in 2a and 2b.

____

____

____

____

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5 Periodic Trends

Goals

- Demonstrate periodic patterns by graphing several atomic radii versus their atomic numbers.
- Predict other atomic radii based on the periodic patterns graphed.

Prelab

Concepts

The **periodic law** states that many properties of the elements are periodic functions of an element's atomic number. A **periodic function** is one that goes through cycles with high and low values at regular intervals. Your text discusses periodic properties such as atomic radii, ionic radii, ionization energies, electron affinities, and electronegativities.

The periodic table is arranged so that all of the elements that appear in similar positions in the cycle of properties are in the same vertical column in the table. For example, since Li, Na, K, Rb, and Cs appear at the maximum points in the cycle for atomic radii, they are placed in the same vertical column. Vertical columns are called **groups** or **families,** and horizontal rows are called **periods.** Properties vary according to a pattern as you move across a period or down a group.

In this laboratory exercise, you will graph the atomic radii of elements from several periods and one group from the periodic table. You will then use these graphs to predict the atomic radii of other elements. In the first graph, you will find a decrease in the atom's size as you move across a period. This decrease is caused by the increasing attraction between the opposite charges of the nucleus (+) and the valence electrons (–) as electrons and protons are added. The decrease in size continues until the noble gas of that period is reached, and then the atom's size suddenly increases. This increase probably occurs because the eight valence electrons of the noble gases have more repulsion for one another than attraction to the protons. The size increases again as you proceed from one period to the next. This time the increase is the result of adding an energy level. In the second graph, you will find an increase in size as you proceed down a group. This increase is also the result of additional energy levels.

Checkup

1. Define *atomic radius.*
   From the N to the most outer layer

2. The sizes of atoms and ions and the forces between the nucleus and electrons are direct offshoots of electron configurations. Would you say that the electron configurations are periodic? Why?
   Yes; because the radius of the atoms grow across the periodic table.

3. State the periodic law.
   Alot of properties of the element function, is the atomic number.

4. What is a periodic function?
   Is the one that goes through cycles with high and values at regular intervals.

5. What periodic property will you be graphing?

The metals, Halogen and non Metals.

Materials

periodic table
ruler, metric

Procedure

1. Using the data in Table 5-1, plot the atomic radii of the elements in Periods 1-4 on Graph 5-1. (Rb and Sr are the first two elements in Period 5.) Plot the atomic radii on the y-axis and the atomic number on the x-axis. Connect each consecutive point with a straight line and label the peaks on the graph with the symbol of the appropriate element.

Table 5-1

Atomic Radii of the Elements

Element	Atomic Number	Atomic Radius (nm)	Element	Atomic Number	Atomic Radius (nm)
H	1	0.03	Ca	20	0.197
He	2	0.093	Sc	21	0.160
Li	3	0.152	Ti	22	0.146
Be	4	0.111	V	23	0.131
B	5	0.088	Cr	24	0.125
C	6	0.077	Mn	25	0.129
N	7	0.070	Co	27	0.126
O	8	0.066	Ni	28	0.124
F	9	0.064	Cu	29	0.128
Ne	10	0.112	Zn	30	0.133
Na	11	0.186	Ga	31	0.122
Al	13	0.143	Ge	32	0.122
Si	14	0.117	As	33	0.121
P	15	0.110	Se	34	0.117
S	16	0.104	Br	35	0.114
Cl	17	0.099	Kr	36	0.169
Ar	18	0.154	Rb	37	0.244
K	19	0.231	Sr	38	0.215

2. Using the data in Table 5-2, plot the atomic radii of the Group I elements on Graph 5-2. Plot the atomic number on the x-axis and the atomic radii on the y-axis. Connect the data points.

Table 5-2

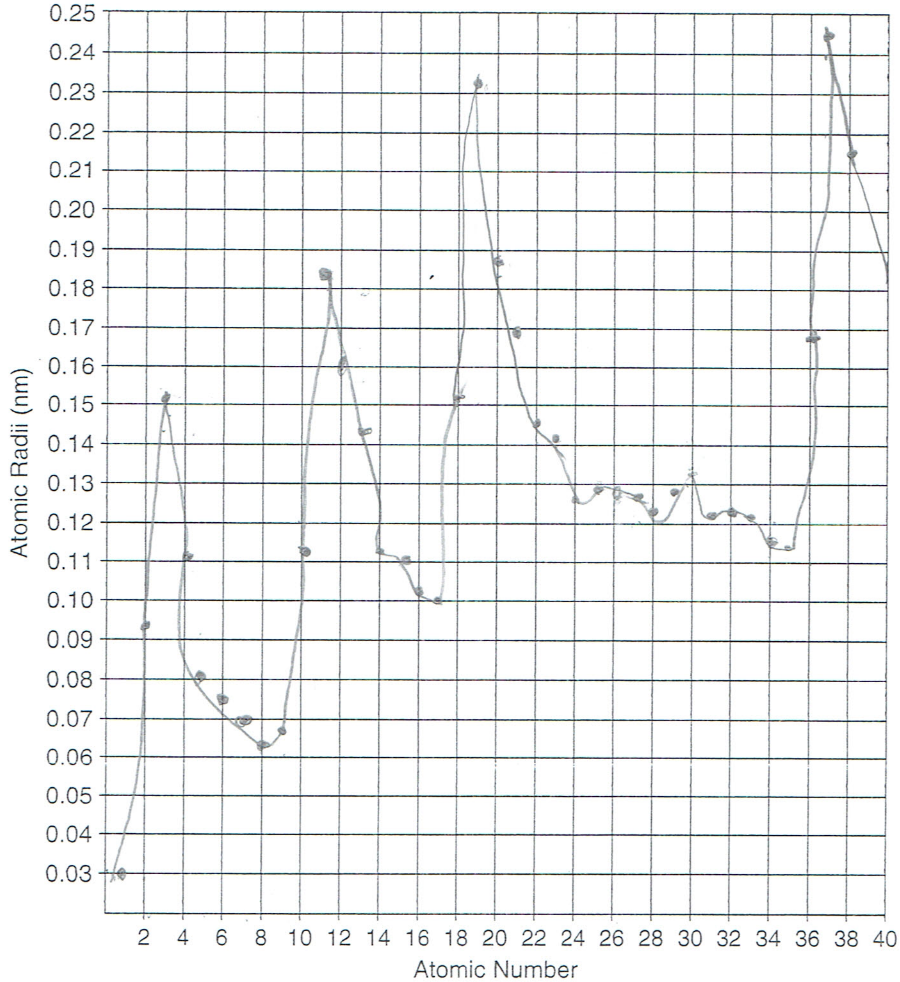
Atomic Radii of the Group I Elements

Element	Atomic Number	Atomic Radius (nm)
H	1	0.03
Li	3	0.152
K	19	0.231
Rb	37	0.244
Fr	87	0.27

Data

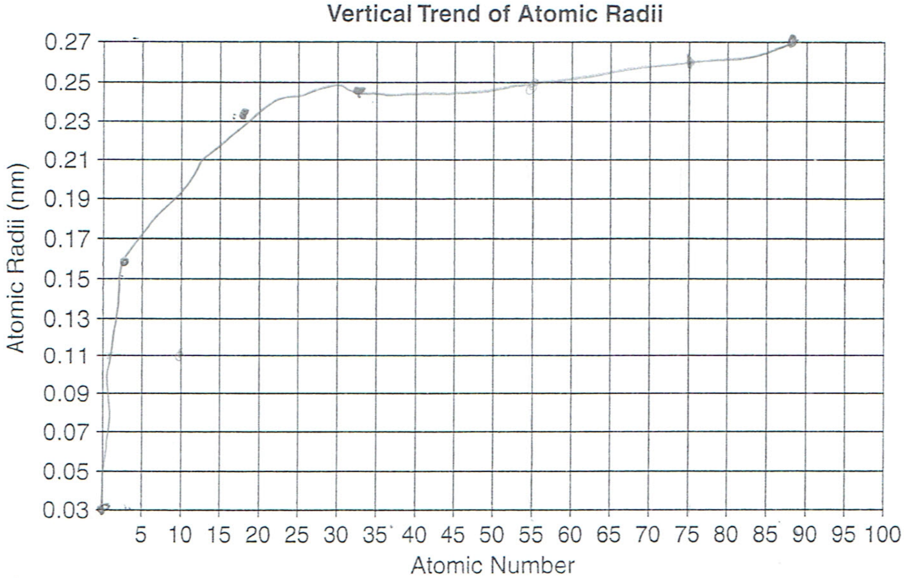
Graph 5-1

Horizontal Trend of Atomic Radii



Graph 5-2

Vertical Trend of Atomic Radii



Analysis

Horizontal Trend of Atomic Radii

1. Which elements occupy the peaks in the cycles on Graph 5-1?

   The elements are Li,

2. Are the periods, or cycles, the same length on Graph 5-1?

   No, they starte out the same, but the last peaks is larder

3. Using Graph 5-1, predict the radii of Mg and Fe.

   Mg is 0.156, Fe is .130

4. Compare your atomic radii values for Mg and Fe to the actual values obtained from your teacher. What is your percent error?

   0.130 − 0.156 = 0.026 / 0.156 − 0.16

   Mg 8 %

   Fe 17 %

   (0.156 − 0.145) / 0.145 × 100%

   $$\text{percent error} = \frac{\text{observed} - \text{actual}}{\text{actual}} \times 100\%$$

Vertical Trend of Atomic Radii

5. Look at the curve obtained in Graph 5-2. Is it in a form you would expect for elements within a group?

   The radii is geting biger

6. Using Graph 5-2, predict the atomic radii of Na and Cs.

   Cs: 0.25. Na 0.11

7. Compare your atomic radii values for Na and Cs to the actual values obtained from your teacher. What is your percent error?

   Na 42 %

   Cs 16 %

   (0.11 − 0.190) / 0.19

   (0.25 − 0.298) / 0.298