

Name:

16.1

Classifying Matter



Question: How can a homogeneous mixture be separated?

1 What is paper chromatography?

2 Preparing the samples

3 Setting up the experiment

There are no questions to answer in parts 1 through 3.

4 Recording your results

Record your data in the table.

Ink color	Dye colors present	Distance traveled by dye color (D_c)	Distance traveled by water (D_w)	Retention factor ($D_c \div D_w$)
black				
blue				
green				

5**Analyzing your data**

a. Which ink contained the greatest number of dye colors? Which colors did it contain?

b. Did the manufacturer use the same dye color in more than one marker? How do you know?

c. Compare your chart for the green ink with one other group's chart. Did you see the same separation of colors? Did your dye colors travel the same distance? Did your dye colors have similar retention factors?

d. If you repeated the procedure using a 20 centimeter paper strip, would your retention factors change? Why or why not?

16.2

Measuring Matter



Question: How is matter measured?

1

Measuring mass

Your materials for this part of the Investigation include a large solid object, a collection of identical small objects, and a container of liquid. Develop a technique for measuring the mass of each object. Record your results in the Table 1.

Table 1: Measuring mass

Object (s)	Description of material	Mass (g)	Description of technique used to find mass
<i>example</i>	<i>stick of chewing gum</i>	<i>3.3 g</i>	<i>placed directly on balance</i>
solid object			
collection			
liquid			

2

Measuring volume

You have liquid in a container, a solid object with a regular shape, and an irregular solid. Develop a technique for measuring the volume of each object. Record your results in the Table 2.

Table 2: Measuring volume.

Object	Description of material	Volume in mL or cm ³	Description of technique used to find volume
<i>example</i>	<i>cereal box</i>	<i>4680 cm³</i>	<i>used formula: length × width × height</i>
liquid			
regular solid			
irregular solid			



Question: How fast can you melt an ice cube?

1 Procedure

There are no questions to answer in part 1.

2 Analyzing your results

a. List at least three techniques used in your group to melt the ice cube.

b. Which technique was most effective? Why?

c. Using what you know about potential and kinetic energy, describe the transfer of energy which occurred as your group's best technique was executed.

3 A closer look at the melting process

Read the passage in your Investigation book.

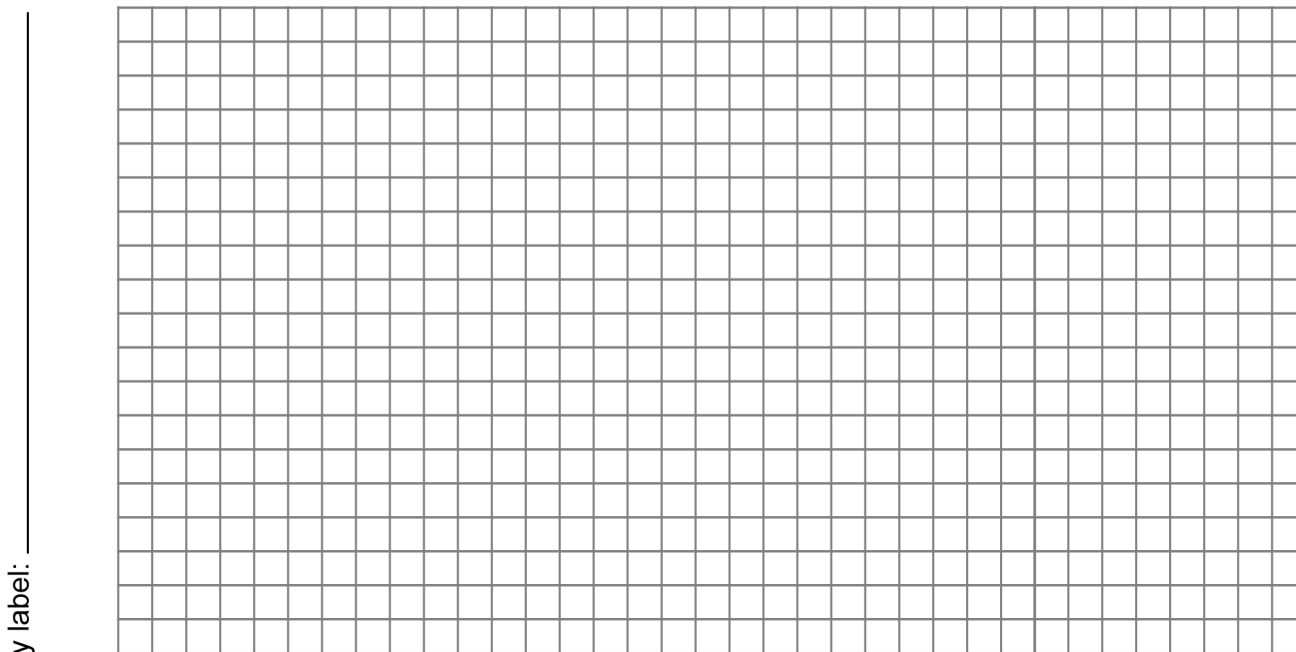
4 Procedure

Follow the steps in your Investigation book.

5**What did you learn?**

- a. Graph the data you collected during this procedure.

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- b. Where did the energy that was added to the cup of ice come from?

- c. Did the kinetic energy of the water molecules increase at a constant rate throughout the experiment? Use your data as evidence to support your answer.

- d. What force had to be overcome in order to change the solid to a liquid?

- e. What happened to the energy that was added to the system while the ice was melting?

f. In the space below, draw a sketch of the graph you would expect to see as liquid water changes to gas.



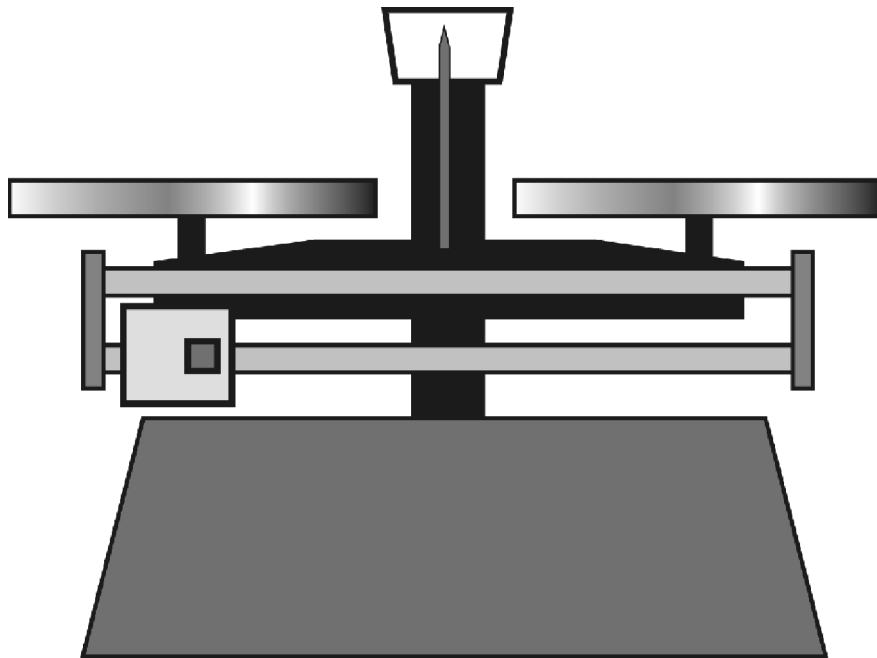
Write two or three sentences describing the energy changes that occur during this process.

Extra space for notes:



Question: How can you find the density of a solid?

On the right side of the balance below, sketch a rectangular shape to represent the size of a pound of bricks. Then, on the left side, draw a second rectangle to represent the space taken up by a pound of feathers.

**1****Setting up**

There are no questions to answer in part 1.

2**Finding the relationship between the mass and volume of a substance**

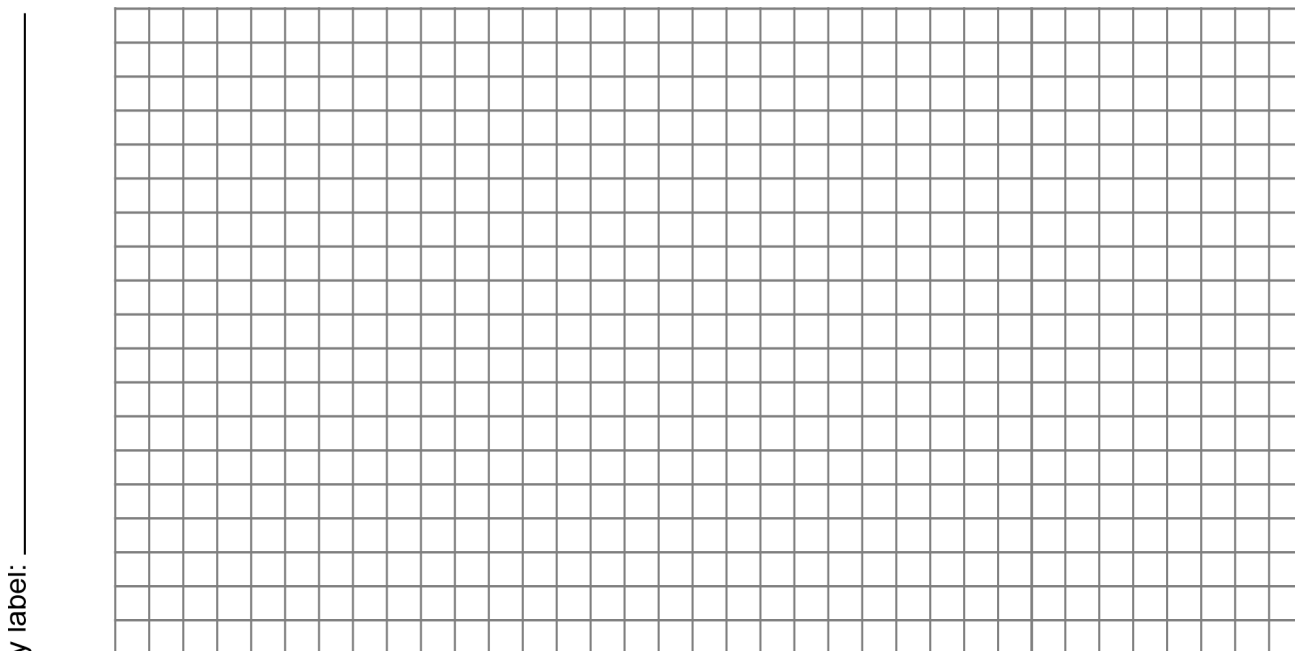
1. Record your data in Table 1.

Table 1: Mass and volume data

	one object	two objects	three objects	four objects	five objects
mass in grams (g)					
volume in milliliters (mL)					

2. Plot your data on graph paper. Label the x -axis “volume” and the y -axis “mass.” Be sure to use the entire space on your graph paper for making your graph.

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x label: _____

3**Analyzing your results**

- a. Is there any pattern to the data points on your graph? For example, the points might form a smooth curve, a straight line, a random scattering, or a cluster in a certain region. If you detect a pattern, describe it.

- b. Take your ruler and move it along the points of the graph in order to find the line on the paper that is as close as possible to all of the dots. This line is called the “line of best fit.” Draw the line.

Now find the slope of this line.

- c. Compare your slope with the result obtained by other groups. Are your slopes similar or different?

- d. The relationship between a substance’s mass and volume is called its density. What is the density of the material you tested?

4**Using your knowledge**

- a. Your graph includes data for five objects. Now, use your graph to predict the mass of *six* objects.

- b. Next, use the balance to find the mass of six of these objects.

- c. How does your value from your graph compare to the mass obtained using the balance?

- d. Use the mass value that you found in step 4 (b). Find that number on the *y*-axis of your graph. Now find the point on the line which crosses that *y*-value. What is the *x*-value of that point?

e. What does the x -value found in step 4 (d) predict about the volume of the six objects?

f. Now, find the volume of six objects experimentally.

g. How does the x -value from the graph compare with the volume you obtained experimentally?

5

Compare class data

Collect data from each group in the class to fill in Table 2.

Table 2: Class data for density of objects

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
size of one object (mL)						
type of material						
density						

Using the data above, answer the following questions in your lab notebook:

a. Does density depend on the size of the material? Give evidence to support your answer.

b. Does density depend on the type of material? Give evidence to support your answer.

- c. Using what you have observed in this lab, do you suppose that density depends on the shape of the material? Why or why not?

6 Using density to solve a mystery

There are no questions to answer in part 6.

7 Procedure

- a. Each lab group has been given a stack of approximately 100 pennies. Sort them into two stacks: pre-1982 and post-1982 pennies. If you find any 1982 pennies, set them aside.
- b. Find the mass of your collection of pre-1982 pennies. Use the displacement tank to find the volume of the pre-1982 pennies. Repeat the procedure for your collection of post-1982 pennies. Record your results in Table 3.

Table 3: Penny data

	Pre-1982 pennies	Post-1982 pennies
mass		
volume		
density		

- c. Calculate the density of each type of penny. Record your results in the third row of the table.

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Density of Fluids



Question: Can you create a stack of liquids?

1 Measuring the density of various liquids

Record your results in the table below.

Substance	Mass in grams	Volume in mL	Density in g/mL
molasses			
water			
vegetable oil			
light corn syrup			
glycerin			

2 Deciding how to stack your liquids

List the order of your liquids below.

Liquid 5 (top)	
Liquid 4	
Liquid 3	
Liquid 2	
Liquid 1 (bottom)	

5**Using the density column to predict the density of the rubber stopper**

- a. Based on your results from above, predict the density of the rubber stopper. Use the following sentence format: The density of the rubber stopper is between __ g/mL and __ g/mL.

- b. Pour the materials out of the graduated cylinder. All of the liquids may be disposed of in a sink. Clean and dry the graduated cylinder and the three objects.

- c. Calculate the actual density of the rubber stopper by obtaining its mass and volume.

- d. Does your calculated density match your predicted density based on the density column results? Explain why or why not.

Extra space for notes:

17.3**Buoyancy of Fluids**

Question: *Can you make a clay boat float?*

1**Finding the density of your stick of clay**

1. Before molding your stick of clay, find its density. Use the formula method (length \times width \times height) to calculate its volume.

2. Predict: Will your stick of clay sink or float? Why?

2**Testing your prediction**

Did your stick of clay sink or float?

3**Finding the mass and volume of the displaced water**

1. Measure the mass of the beaker + displaced water from 2.1 above.

2. Pour the water into a 100-milliliter graduated cylinder. Record the volume.

3. Dry the beaker, then measure its mass.

4. Now, calculate the mass of the displaced water.

4**Calculating the weight of the displaced water**

Mass and weight measure two different properties of matter. Mass refers to how much matter the object contains. Weight measures the gravitational pull between the object and (in our case) Earth. The gravitational force between a 1-kilogram object and Earth is 9.8 newtons, and a 1-gram object's weight on Earth is 0.0098 newtons. You can use this information to calculate the weight of your displaced water from the mass which you found in step 3.4.

Calculate the weight of the displaced water. Use the formula: $\text{grams} \times (0.0098\text{N/gram}) = \text{newtons}$.

5**Calculating the weight of your clay**

From the mass of your clay (found in step 1), calculate its weight.

Again, use the formula: $\text{grams} \times (0.0098 \text{ N/grams}) = \text{newtons}$.

6**Challenge: Can you mold your clay into a shape that floats?**

1. You know that steel can be fashioned into a shape that floats. Can you do the same thing with clay? For this part of the Investigation, you must use ALL of your clay. Mold it into a shape that you believe will float.
2. When you are ready to test a shape, lower it into a container of water approximately three-quarters full. If the clay sinks, retrieve it immediately and dry it with a paper towel. Avoid mixing water into your clay, or it will get very slimy. When your clay is dry, modify your "boat" and try again.
3. When you have successfully molded a boat that floats, take it out of the water and dry it with a paper towel. Then, prepare your displacement tank just as you did in step 2. Carefully place your boat into the displacement tank. Avoid making waves. When the water stops flowing, move the beaker away from the displacement tank spout. Retrieve your boat and set it aside to dry.
4. Find the mass of the beaker + displaced water. Subtract the mass of the beaker, which you found in step 3.3. Record the mass of the displaced water.

5. Calculate the weight of the displaced water from its mass. Use the formula given in step 4.1.

6. Pour the displaced water into a graduated cylinder. Record its volume.

7. When your boat is dry, first measure its mass, then calculate its weight.

7 Analyzing your data

Enter your data from this Investigation in the table below:

	weight (N) of clay	volume (mL) of displaced water	weight (N) of displaced water
stick of clay	(step 5.1):	(step 3.2):	(step 4.1):
clay boat	(step 6.7):	(step 6.6):	(step 6.5):

a. Did the weight of the clay change during the Investigation? Give a reason for your answer.

b. Which displaced more water, the stick of clay or the clay boat?

c. Which weighed more, the stick of clay or the water it displaced?

d. Which weighed more, the clay boat or the water it displaced?

8 Drawing conclusions

a. When you changed the shape of your clay, what happened to the amount of water it displaced?

b. Is there a relationship between the weight of a sunken object and the weight of water it displaces?

c. Is there a relationship between the weight of a floating object and the weight of water it displaces?

d. If you had a clay boat that weighed 100 newtons, how many newtons of water would it displace?

17.4

Viscosity of Fluids



Question: How can viscosity be measured?

1 Measuring viscosity

2 Setting up your viscometer

There are no questions to answer in parts 1 and 2.

3 Using your viscometer

Follow the procedures and record your data in Table 1.

Table 1: Average velocity of marble in liquid.

Type of liquid	Distance traveled	Time required	Average velocity of marble
Trial 1			
Trial 2			
Trial 3			
Find the average of your three values for velocity and record it here:			

4 Comparing class data

Each lab group found the data for a different substance. Record the data for each substance in Table 2.

Table 2: Class data for average velocity of marble in liquids of different viscosities

Substance	Avg. velocity of marble in substance at 20°C
group 1:	
group 2:	
group 3:	
group 4:	
group 5:	

5**Analyzing class data**

- a. Rewrite Table 2, listing the liquids from **least** viscous to **most** viscous.

Substance	Average velocity of marble

- b. Compare this data with the data from the density column (Investigation 17.2). Does there seem to be a relationship between density and viscosity at room temperature? In other words, if liquids have low density, do they also have low viscosity? Provide an example to justify your answer.

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Atomic Structure



Question: How was the size of an atom's nucleus determined?

1 Using indirect measurement to determine the radius of a circle

Follow the steps in your Investigation book.

2 Recording the data

Record your result from the experiment in the table below.

number of marks on paper	number of marks in circles	area of paper in mm^2	total area of circles in mm^2

3 Analyzing your results

- a. Divide the total area of the circles by the number of circles on your paper. This will tell you the area of one circle by *indirect measurement*.

- b. Now, calculate the area of one circle by *direct measurement*. First, use your ruler to find the radius of one circle in millimeters. Use this formula to determine the area of one circle: $A_c = \pi r^2$ where A_c , the area of a circle, is equal to pi (3.14) times the radius squared.

- c. Compare this value with the radius found by the indirect method. Calculate the percent error of your results:

4**Drawing conclusions**

- a. Write a paragraph to explain how this activity is like the gold foil experiment. Be sure to comment on **each** piece of equipment used. For example, what does the marble represent?

- b. Could Rutherford and his colleagues calculate percent error in the same manner that you did? Why or why not?

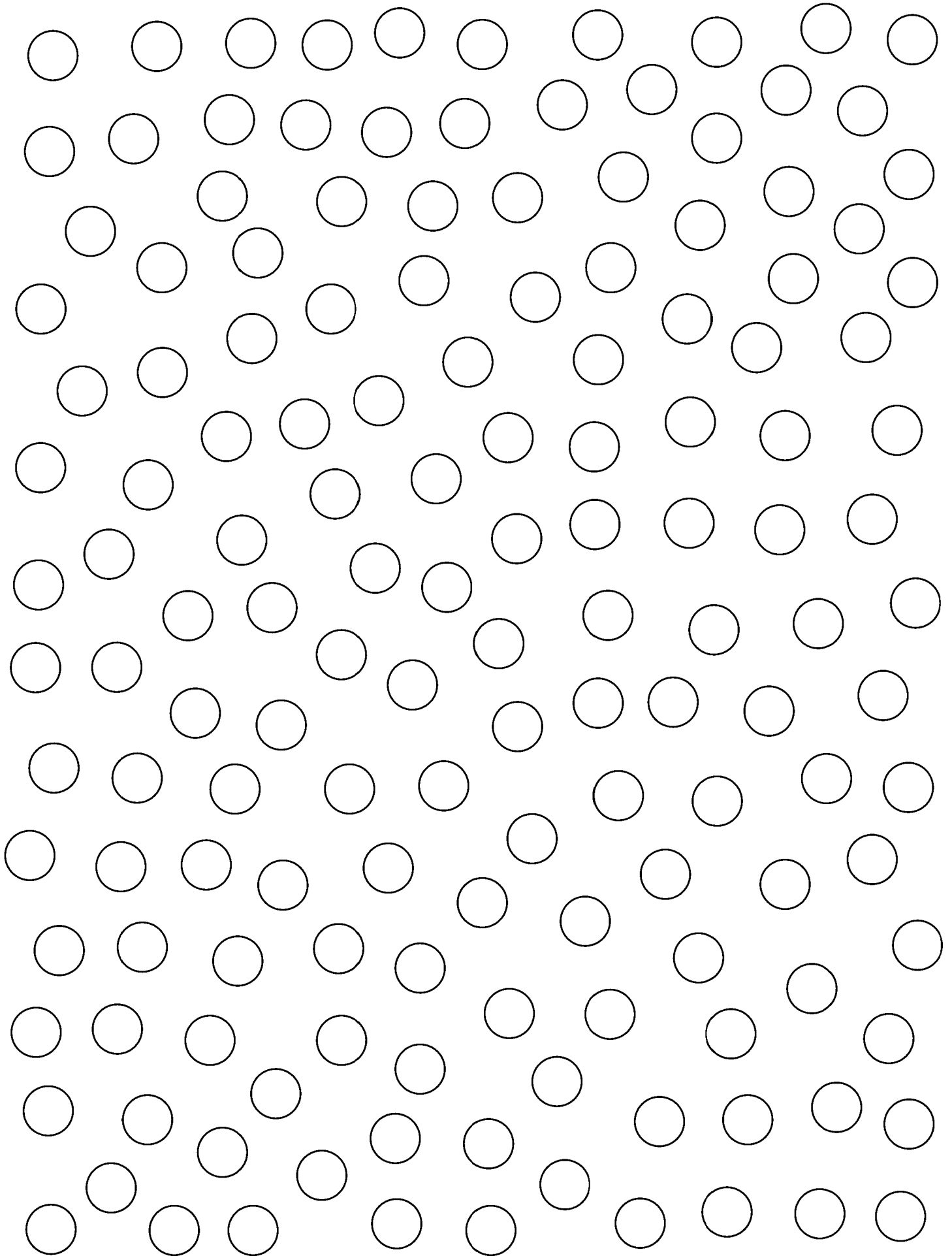
- c. What might Rutherford and his colleagues have done to confirm the accuracy of his findings?

- d. Would your percent error have decreased if the marble were dropped 200 times? Or 1000 times?

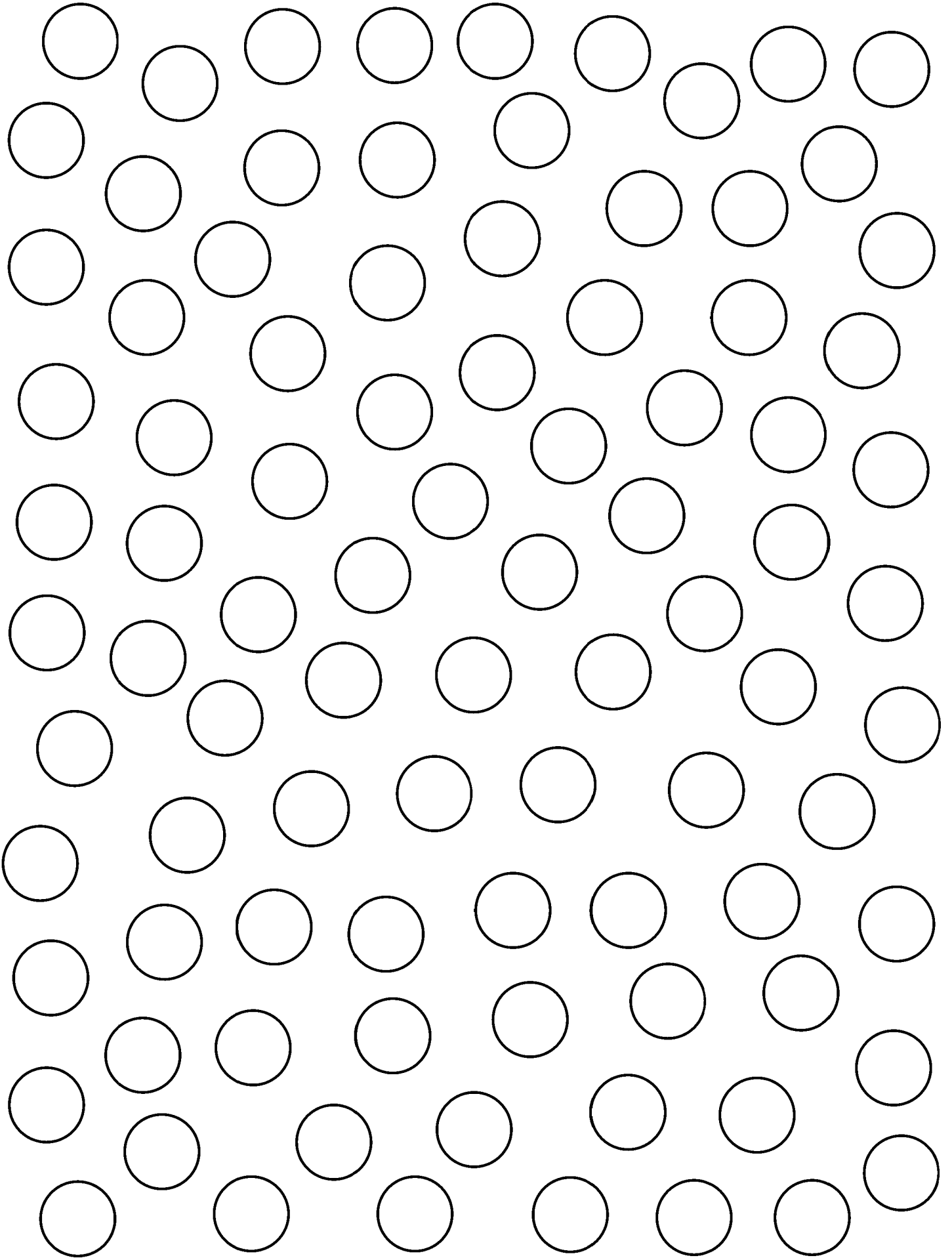
- e. Name two potential sources of error in your experiment. How could you change the procedure to minimize these errors?

- f. Challenge: Calculate the number of marks that should fall inside the circles on your paper if you dropped the marble 500 times.

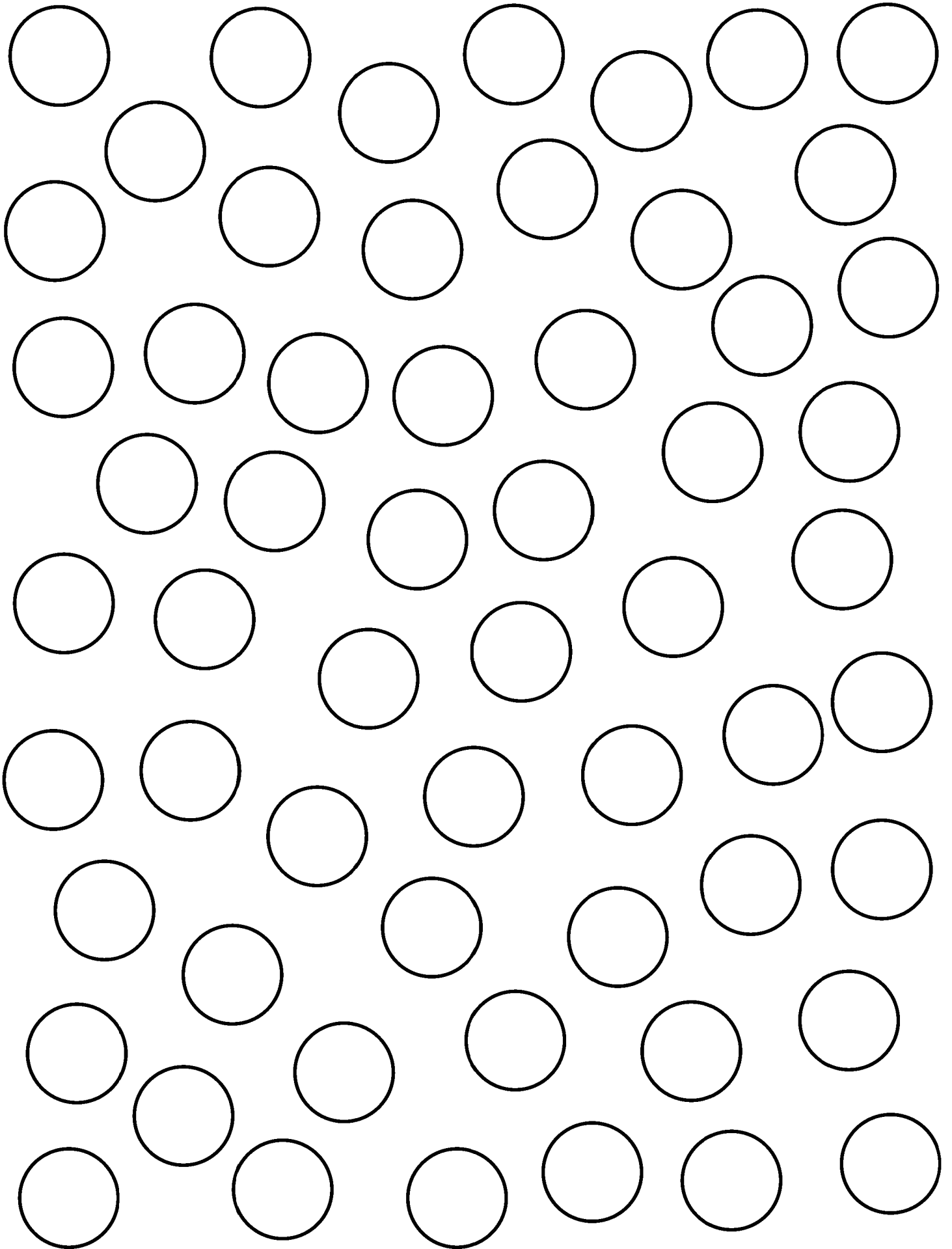
1.0 centimeter circles



1.5 centimeter circles



2.0 centimeter circles



Extra space for notes:

18.2

Comparing Atoms



Question: What are atoms and how are they put together?

1**Setting up the atom board**

Read about how you set up the atom board in your Investigation book.

2**The game of atomic challenge**

Read about how to play the game of atomic challenge in your Investigation book.

3**What did you learn?**

a. What particles are found in the nucleus of an atom? What particles are found outside the nucleus?

b. Name one element which is always radioactive and which has an atomic number less than 50.

c. What is the atomic number of sodium (Na)?

d. How many protons does Na have?

e. How many different isotopes does magnesium (Mg) have?

f. How many protons, neutrons, and electrons does Mg^{26} have?

g. If an isotope of silicon (Si) has 15 neutrons, what is its mass number?

h. What do you call an atom where the number of electrons is different from the number of protons?

i. What is the heaviest element with at least one isotope that is NOT radioactive?

j. What element has atoms with 26 protons in the nucleus?

4**What does atomic structure have to do with light and color?**

Have you ever noticed differences in the colors of light given off by different light sources in your school building or at home? With your group, discuss the differences in the light given off by the light sources listed in the table below and record your observations.


Light Source	What color(s) of light is given off by the source?
Incandescent light (a regular light bulb)	
Fluorescent light (found in your classroom)	
Mercury vapor lights (the light sources found in a gym)	
Sodium lights (street lights)	

5**Using the spectrometer**






There are no questions to answer in part 5.

6

Observing different light sources

 **Safety Tips:** Never look directly into any light source—especially the sun! Never aim the spectrometer directly at the sun. Instead, aim it at a cloud that is reflecting sunlight.

Record the results of the experiment in the table below.

Light source	Spectrometer Scale (nm)	Position of each vertical line (nm)	Elements present
Fluorescent			
			
			
			
			

Extra space for notes:

1 Introduction to Nuclear Reactions

In this Investigation, you will play the Nuclear Reactions Game. Read the introduction in your Investigation book.

2 Playing Nuclear Reactions

Read about the game in your Investigation book.

3 Scoring points

Read how points are scored in your Investigation book.

4 Miscellaneous rules

Miscellaneous rules are found in your Investigation book.

5 Applying what you learned

- a. There are two basic kinds of nuclear reactions, fission and fusion. Fission splits heavy elements up into lighter elements. Fusion combines lighter elements to make heavier elements. Both can release energy, depending on which elements are involved. What element do you get when you fuse lithium-six and boron-11 together? It is stable or radioactive?

- b. Write down a nuclear reaction using only two elements that would allow you to build fluorine-19 starting with boron-10.

- c. Suppose you split a uranium-238 atom. If you have to break it into two pieces, name two elements that could be formed. Be sure that your two elements use up all the neutrons and protons in the uranium. Are either of your two elements stable or is one (or both) radioactive?
