Ghost Particles

Science Notebook

NAME

SANFORD UNDERGROUND RESEARCH FACILITY

Sample Science Notebook Entry

Symbols for Entry Type

Investigation =  Notes =  Reflection = 

Heading Template

Entry Symbol	Lesson Title	Name	Date	Entry Symbol

Heading Examples

 Observation: Footprints Molly F 9/15/13 

Sections for Investigation
Focus Question
Prediction
Plan
Observation
Claims and Evidence

You will make an *investigation* entry when you are recording experiments, sketching, observing, etc. You may include all or some of the **Sections for Investigation**, and the order of these is flexible.

 Observation vs Inference Diali B-R 9/12/13 

You will make a *notes* entry when you are taking notes.

 Observation Reflection Kira M 9/20/13 

You will make a *reflection* entry when you are reflecting about your learning. Generally, you will be given a prompt or questions to respond to.

GHOST PARTICLES
TABLE OF CONTENTS

NORMS FOR DISCUSSION

NORMS FOR GROUPWORK

LESSON 1 – LAUNCH

What are properties of objects?

THINK. In science, what do we mean by the **properties** of an object? Write down a definition in your own words.

OBSERVE. Your teacher will show you an object. Draw a picture of it:

Write down four properties of that object.

THINK. Looking at the list of all the properties your class thought of,

1. name two or more properties of the object that are **measurable**:

_____

2. name two or more properties of the object that are **observable:**

_____

LESSON 1 – EXPLORATION

When we mix salt and water, how do the properties change?

NOTICE. Your teacher will show you two substances. Write three properties of each substance in the table.

	SUBSTANCE 1 	**SUBSTANCE 2** 
1.		
2.		
3.		

OBSERVE. Write down 3 things you noticed when the salt was added to the water and stirred.

1. _____

2. _____

3. _____

What are three properties of the combined system?

LESSON 1 – SUMMARY

What is happening when the salt is mixed with the water?

THINK. What do you think is happening when the salt is mixed in with the water? Write down one or more ideas.

_____

_____

_____

PAIR. Share your ideas with a partner and listen to their ideas. Put a check by any ideas, above, that your partner also wrote down. Then, write down ideas your partner had that you did not have:

_____

_____

_____

SHARE. Review all of your ideas and circle the one you and your partner want to share with the rest of the class. One of you will share this idea with the whole group.

As you listen to the ideas of the whole group, write down three more ideas you like:

1. _____
2. _____
3. _____

LESSON 1 – SUMMARY

Can I draw a model for the combined salt+water system? What questions do I still have?

MODEL. After you listen to everyone's ideas, make a drawing of the combined salt + water system. Label everything.

QUESTION. What questions do you still have about what happened when the two substances were mixed?

1. _____

2. _____

3. _____

LESSON 2 - EXPLORATION

How can we use the property of size to categorize objects we can see?

UNIT	How many in a meter?	How many meters in 1 ___(unit)?	What do you see in the room that is about this length?
1 meter	1	1	
1 decimeter (dm)	10	1/10 (0.1)	
1 centimeter (cm)			
1 millimeter (mm)			
0.1 mm			
0.01 mm			

1. My hair has a thickness closest to: □ 10 mm □ 1 mm □ 0.1 mm □ 0.01 mm
2. Write the thickness of your hair in meters: _____ m.
3. How many powers of 10 are there between 1 meter and 0.01 mm? _____

LESSON 2 - Summary

[This page is for extra notes, drawings, reflections etc.]

LESSON 3 – LAUNCH

What is matter?

THINK. How do scientists define matter?

Matter is anything that has _____ and takes up _____ . If something takes up space, it has _____ .

Look at the object you drew on your exit card from Lesson 2. Does it fit the definition of matter? Why or why not?

QUESTION: Write down two things you wonder about matter?

LESSON 3 –EXPLORATION A

How do the properties of salt change with size?

OBSERVE. Using your scale plate and a spoon to crush the salt, observe what happens as you crush them very small.

Size:	**Number of grains with size*:**	
	Before crushing (pick out 10 grains to measure)	**After crushing 1 grain (pick out 10 bits to measure)**
1 mm		
0.1 mm		
Less than 0.1 mm		
Draw some typical shapes		

1) I crushed one grain of salt to make _____ grains (estimate to the nearest power of 10).

2) If I crushed 10 grains of salt, I would have approximately _____ smaller grains of salt.

3) What did you notice about the shapes of the salt grains before and after crushing?

   _____

4) What do you think would happen to the salt grains if you crushed them even smaller?

   _____

   _____

LESSON 3 – SUMMARY A

How do the properties of salt change with size?

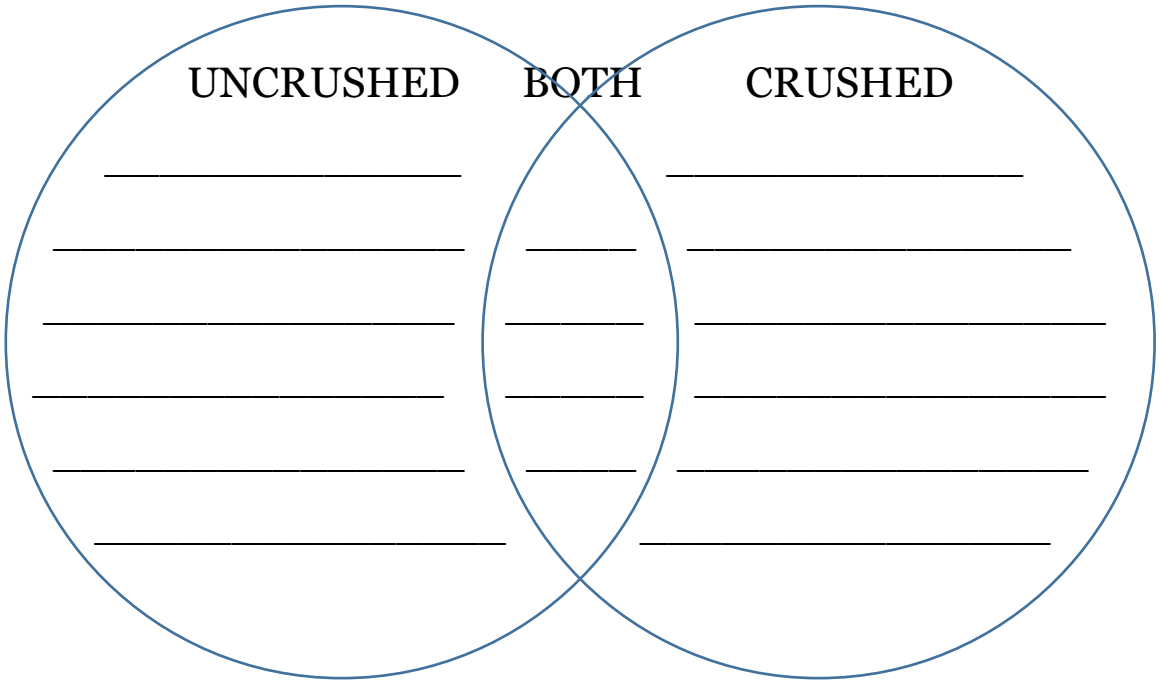
With a partner, think about the properties of the uncrushed and crushed salt and where they would fit on the Venn Diagram shown below:

Properties of salt: _____

_____

_____

ADD THE PROPERTIES TO THE VENN DIAGRAM:



LESSON 3 – EXPLORATION B

Does the weight of salt change when it is crushed into smaller pieces?

MAKE A PREDICTION. Is the weight of the crushed salt more, less or equal to that of the uncrushed salt?

I think the crushed salt weighs 1) More □ 2) Less □ 3) the Same □ as the uncrushed salt because

_____

_____

_____

_____

INVESTIGATE. Read the task card and make sure you understand your group role. Follow the procedure on the task card *(Investigation B)* and record your data in the data table (don't forget units):

DATA TABLE:

Empty Boat	**Boat with Salt (uncrushed)**	**Boat with Salt (crushed)**
Subtract the weight of the empty boat to get the weight of the salt:		

1) The investigation showed that the crushed salt weighed more/less (circle one) than the uncrushed salt. The difference was _____ gm.

2) Why is it important to subtract the weight of the boat and only compare the weight of the salt?

LESSON 3 – SUMMARY B

What have we learned so far about salt that could help explain what happens when salt is mixed into water?

REFLECT:

1) Did the results of the experiment fit your prediction? _____ What wonder(s) do you have that could help explain why or why not?

2) Do you think salt is matter? Why or why not?

Based on our exploration of the properties of salt, do you have any new ideas about what happens to the salt is stirred into water?

Lesson 4 - LAUNCH

What investigations could give us new evidence about what happens when salt is added to water?

My ideas for a possible investigation that could give evidence for what happens when salt is added to water are:

A. MY IDEAS	**What question would I ask?**
B. OUR GROUPS IDEA	**What question would we ask?**
C. AFTER TWO GROUPS MEET	**What question would we ask?**
D. AFTER THE CLASS MEETS	**What question will we ask?**

Lesson 4 – Exploration

How will we carry out our planned investigation to learn more about the salt + water system?

Procedure:

Data Table:

Data Analysis:

Lesson 4 - SUMMARY

How does the data we collected and analyzed help explain what happens when the salt is stirred into the water?

MY CLAIM	I think the salt:
MY EVIDENCE	The evidence I use to support my claim is:
MY REASONING	I think the evidence supports my claim because:

MODEL. Make a new drawing of the combined salt + water system. Label everything.

My new model of the salt+water system is improved over my old model (page 8) because

_____

_____

_____

Lesson 4 – SUMMARY

Are there similarities with a simple model of dots printed on a piece of paper?

REFLECT. After examining both sides of the dot lamination,

I noticed:

I also noticed:

Could the dot lamination have similarities to the salt mixed with water?

I wonder:

I think:

[This page is for extra notes, drawings, reflections etc.]

Lesson 5 – LAUNCH

What happens when heat is added to water?

OBSERVE. Your teacher will show you a video with a new phenomenon about water. The video is filmed from the side of a container and in slow-motion. Observe what happens to the water as you watch and make some notes about what you observed:

Your teacher will show you another video with the same phenomenon about water. This time the video is filmed from the top and at normal speed. Observe what happens to the water as you watch and make some notes about what new things you observed:

Lesson 5 – LAUNCH

What happens when heat is added to water?

THINK. What are three wonderments you have about the phenomenon in the video?

1. _____
   _____
2. _____
   _____
3. _____
   _____

PAIR. Discuss your observations, ideas and wonderments with a partner, and be sure to listen to theirs. Decide on a wonderment you both have about the phenomenon to share with the class.

Our wonderment is

_____
_____
_____

SHARE. After listening to your classmates' wonderments, write down three that you are interested in exploring further.

1. _____
2. _____
3. _____

MAKE A CONNECTION TO THE UNIT PHENOMENON:

- When we mix together salt and water, _____ seems to disappear into _____ .
- When we heat up water, _____ seems to disappear into _____ .

Lesson 5 – LAUNCH

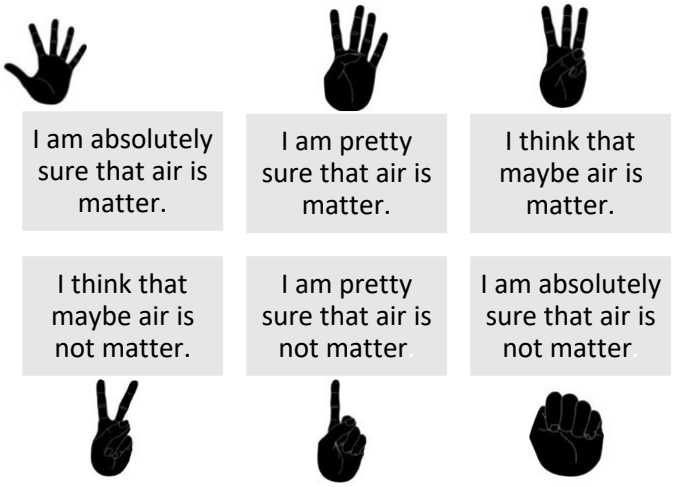
What happens when heat is added to water?

DEVELOP A MODEL. Draw a model of what happens to the water when heat is added to a pot of water. Label all parts.

Lesson 5 – EXPLORATION

What is air? Is air matter?

Make a prediction. Is air matter? Does it have mass and take up space? Circle the box that is closest to what you think now.



When your teacher asks you to share your prediction with the rest of the class, use the 'Fist-to-Five' symbol above or below your prediction and raise that number of fingers.

Observe. Does breathing give evidence that air is matter? If so, how?

Write 3 things you <u>noticed</u> when you took deep breathes that may give evidence that air is matter:

I noticed _____ .

I noticed _____ .

I noticed _____ .

Write 2 things you <u>think</u> about the air you are breathing:

I think

_____.

I think

_____.

Write 1 thing you <u>wonder</u> about the air you are breathing:

I wonder _____

_____.

Lesson 5. Exploration

What is air? Is air matter?

THINK. When we breathe, we can feel our lungs expand. Is this evidence that air takes up space? Why?

From things you know about the world, write or draw three other pieces of evidence that air does or does not takes up space.

If air is matter, then it also has weight. From things you know about the world, write or draw one or more piece of evidence that air does or does not have weight.

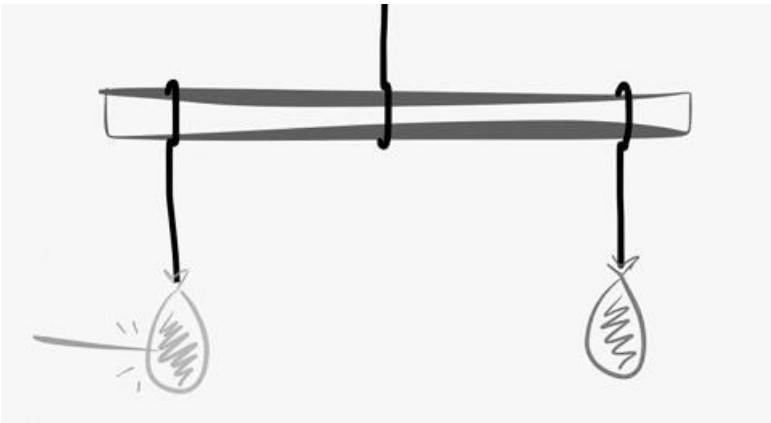
Lesson 5. Exploration

What is air? Is air matter?

PREDICT: What will happen to the balloon balance when your teacher pricks one balloon with a pin?

Circle what you think will happen to the side with the pricked balloon:

- It will go up.
- It will go down.
- It will stay the same.



Draw what actually happened when your teacher tried it!

Lesson 5. Exploration

What is air? Is air matter?

PLAN AN INVESTIGATION. Can a balloon be used to give evidence whether or not air is matter, that is, does it take up space and have weight? Working with your group, plan an investigation using a balloon to answer the question.

Our independent variable is _____ .

Our dependent variable for volume is _____ .

Our dependent variable for weight is _____ .

Our procedure is:

CHECKLIST: Our procedure includes:

- ☐ how we will change the independent variable systematically in order to take at least three data points
- ☐ how the dependent variable for volume is measured
- ☐ how the dependent variable for weight is measured
- ☐ how we will use a control

Lesson 5. Exploration

What is air? Is air matter?

CONDUCT AN INVESTIGATION.

Data Table:

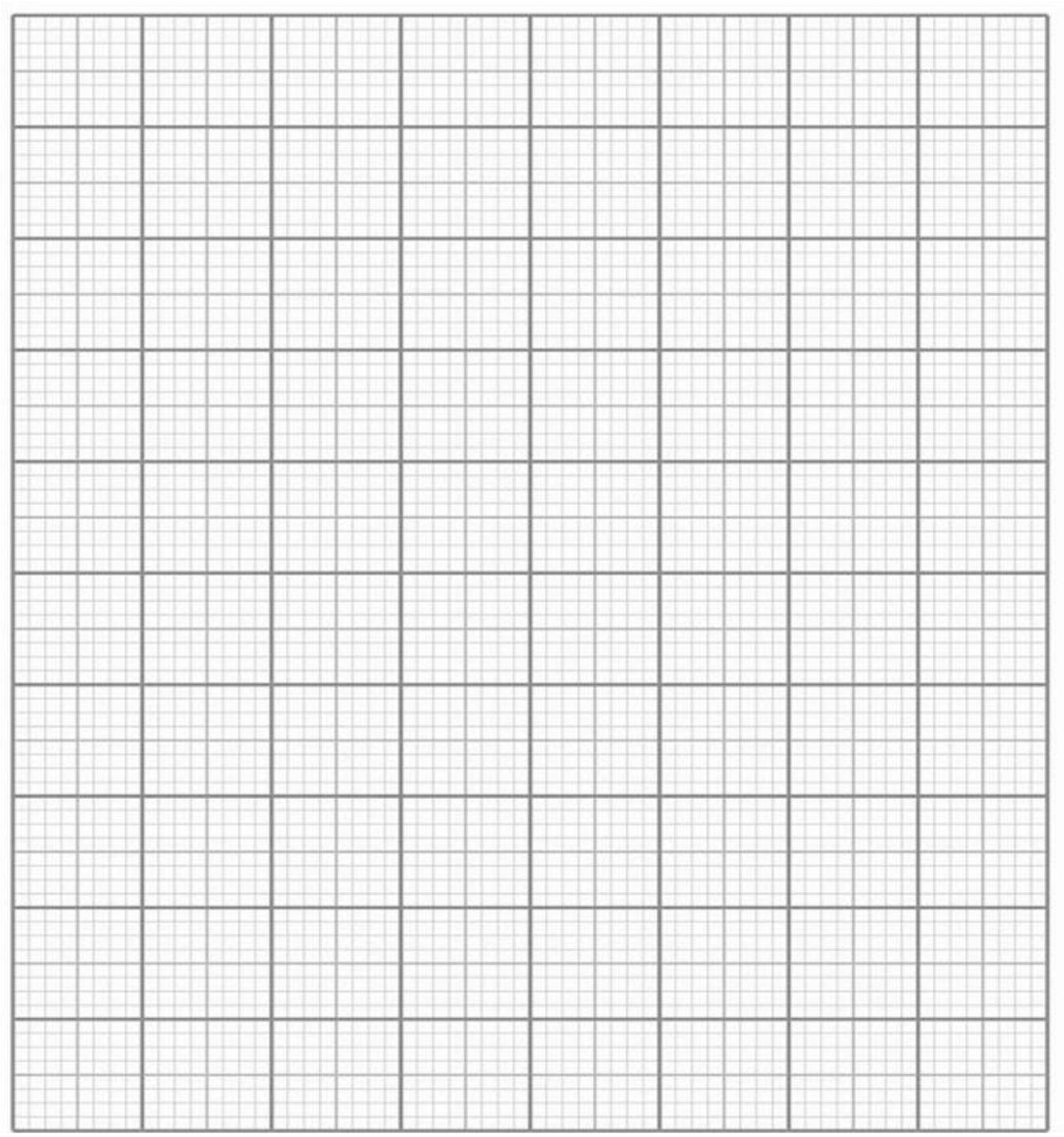
Data Point	Independent Variable	Dependent Variable for Volume	Dependent Variable for Volume
What we are measuring			
Measurement Unit			
Data point 1			
Data point 2			
Data point 3			
4 (optional))			
5 (optional)			

Notes (record anything that was unexpected or didn't go according to the procedure here):

Lesson 5. Exploration

What is air? Is air matter?

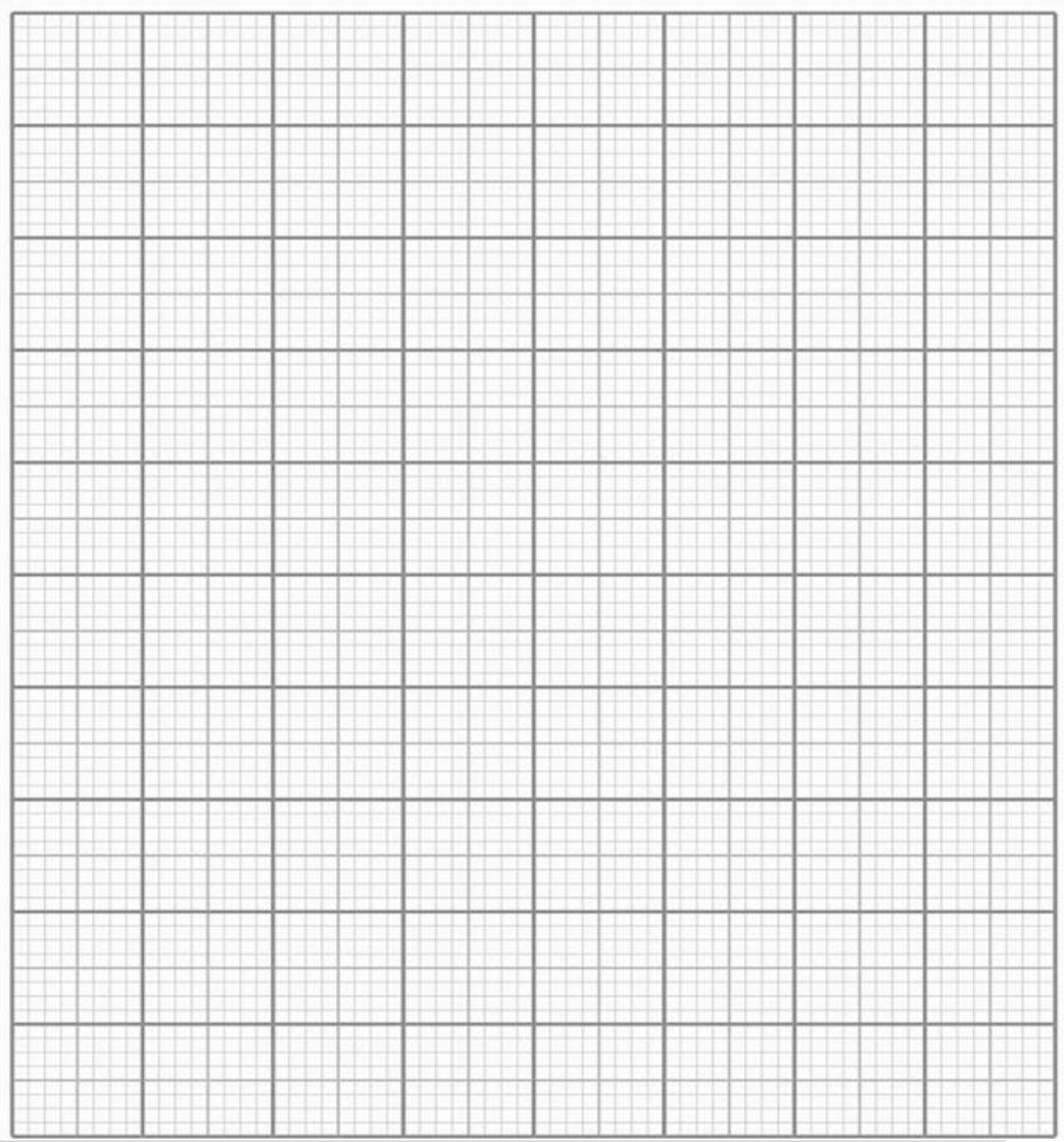
GRAPH YOUR VOLUME DATA. The independent variable data goes on the x-axis and the dependent variable for volume on the y-axis.



Lesson 5. Exploration

What is air? Is air matter?

GRAPH YOUR WEIGHT DATA. The independent variable data goes on the x-axis and the dependent variable for weight on the y-axis.



Lesson 5. Exploration

What is air? Is air matter?

REASON. After the investigation and data analysis, circle your claims and give your evidence and your reasoning:

<table>
<tr><td>MY CLAIM (circle your claim)</td><td colspan="2">Air is matter.

Air is not matter.</td></tr>
<tr><td>SUPPORTING EVIDENCE</td><td>Volume Data</td><td>Weight Data</td></tr>
<tr><td>MY REASONING</td><td colspan="2">I think the evidence supports my claim because:</td></tr>
</table>

Lesson 5 – SUMMARY

If air is matter, what is it, and why can't we see it?

REASON. So far in this unit, we have explored three forms of matter (solid, liquid, gas). **Can we use a model that matter is made up of atoms too small to see, to explain the following phenomena?** Fill in the table with your explanations.

Things we Observed	SOLID (SALT)	LIQUID (WATER)	GAS (AIR)
Salt is a solid that we can see. When we add it to water, it seems to disappear.			
Water is a liquid that we can see. When we heat up water, it seems to disappear.			
When we watched water boil in slow motion, it looked like gas bubbles formed.			

Lesson 5 – SUMMARY / ASSESSMENT

If air is matter, what is it, and why can't we see it?

REFLECT. What do you think happens if you heat up salt water until it boils? Draw a before and after picture and label the salt, the water and the air in each picture. Write an explanation under each picture.

BEFORE:
AFTER:

Lesson 6 – LAUNCH

How small are atoms and molecules?

MAKE A GUESS. How many atoms are in a grain of dust that is 0.01 mm across?

_____

LETS PRACTICE. Write the numbers in the table in scientific notation.

NAME	NUMBER	NUMBER IN SCIENTIFIC NOTATION*
One	1	10^0
Ten	10	10^1
Hundred	100	
Thousand	1,000	
Million	1,000,000	
Billion	1,000,000,000	
Trillion	1,000,000,000,000	
Quadrillion	1,000,000,000,000,000	
My guess for the # of atoms in a dust mote		

* HINT: Count the number of zeros!

Circle the row that is closest to the actual number of atoms in a dust mote.

Lesson 6 – LAUNCH

How small is an atom?

THINK. After observing the nanoscale video, write down 4 statements starting with the sentence frames I noticed / I learned / I wonder / I think. You can use each starter more than once if you wish:

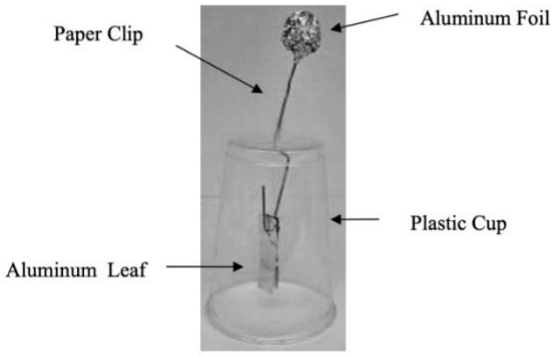
1. _____
   _____
2. _____
   _____
3. _____
   _____
4. _____
   _____

REFLECT. What are some ways we know that air is made up of atoms and molecules (matter)?

What is indirect evidence? Write a definition in your own words.

Lesson 6 - EXPLORATION

How can we use indirect evidence to show that air is made up of atoms and molecules?



BUILD. With your partner, follow the instructions on the task card to build an electroscope like the picture on the left.

TEST. What do you observe when you bring a balloon with static charge close to the electroscope?

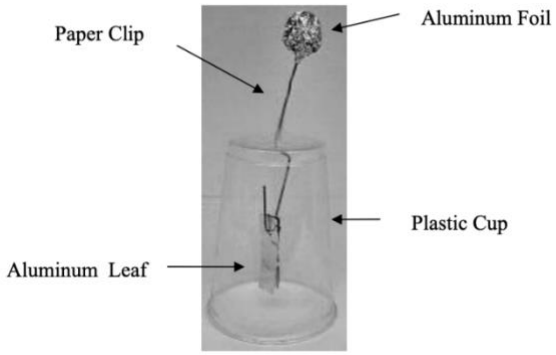
What do you observe when you bring a comb with static charge close to the electroscope?

The balloon is negatively charged. The comb is positively charged:

Can you draw what is happening in each case? What repels? What attracts?

Lesson 6. Summary

How does the behavior of the electroscope give us evidence that a rod is emitting charged, unseen particles?



Predict what will happen when the teacher brings the 'magic wand' close to the top of the electroscope?

_____

_____

What do you observe happen when the wand is close to the foil? Does it act more like the balloon or the comb? Explain why you think so.

Do you think the magic wand has positive or negative charge? Why?

Lesson 7. Launch

How small is an atom, really?

LETS PRACTICE. Scientific notation for very small numbers (sizes of things). Fill in the rest of the table.

NAME	NUMBER	NUMBER IN SCIENTIFIC NOTATION
One meter	1 meter	10^0 meter
One decimeter	0.1 meter	10^{-1} meter
One centimeter	0.01 meter	10^{-2} meter
One millimeter	0.001 meter	
One micrometer		
One nanometer		
One picometer		

Circle the row that is closest to the size of an atom.

THINK. After watching the *How Small is an Atom?* video, write down 4 statements starting with the sentence frames I noticed / I learned / I wonder / I think. You can use each starter more than once if you wish:

1. _____
   _____
2. _____
   _____
3. _____
   _____
4. _____
   _____

Lesson 7. Exploration

How can we build a mental model that helps us to understand the smallness of an atom and its parts?

Scaling models of an atom:

MODEL A (video). In the video, the atom was the size of a _____ and the nucleus of the atom was the size of a _____ .

MODEL B. If we made a model of an atom that was 10 meters across, what would be the size of the nucleus? _____

What could we use to model the nucleus? _____

Would we be able to see it? _____

MODEL C. If we made a model of an atom that was 1 meter across, what would be the size of the nucleus? _____

What could we use to model the nucleus? _____

Would we be able to see it? _____

How many powers of 10 have we scaled up the atom (from a nanometer)? Use scientific notation!

In Model A	In Model B	In Model C

Lesson 7. Exploration

How can we build a mental model that helps us to understand the smallness of an atom and its parts?

Can you draw a scale model of an atom on this piece of paper?

1. How small a dot can you draw for the nucleus? (Try It!)

2. Measure the dot. How large a paper would you need to draw the whole atom?

   Since we don't have that large a piece of paper, draw an atom below that is not to scale. Include the nucleus, electrons and neutrinos. Label each particle and give its size.

Lesson 7. Summary

Are there any objects smaller than the nucleus and electron in an atom? How small is a neutrino and is it matter?

Scientists at SURF are studying the smallest particle they know, a neutrino. A neutrino has a size of approximately 10^{-24} meters. Talk it over with your partner and fill in the table (use scientific notation!)

If you need to use the number line to count powers of 10, you may!

The smallest object we can see with our eyes, the size of crushed salt, is approximately how many meters in size?	
How many powers of 10 do we have to scale up the neutrino to make it visible (the size of a crushed grain of salt)?	
What size would the electron of an atom be if we scale it up the same amount?	
What size would the nucleus of an atom be if we scale it up the same amount?	
What size would the atom be if we scale it up the same amount?	
Using the website, *Magnifying the Universe,* pick an object that would be approximately the size of the electron in this model.	
Using the website, *Magnifying the Universe, p*ick an object that would be approximately the size of the nucleus in this model.	
Using the website, *Magnifying the Universe, p*ick an object that would be approximately the size of the atom in this model.	

Ghost Particles – Final Reflection

List 3 things you learned about matter in this unit:

1. _____
   _____
2. _____
   _____
3. _____
   _____

List 3 things you learned about salt in this unit:

1. _____
   _____
2. _____
   _____
3. _____
   _____

List 3 things you learned about atoms and particles in this unit:

1. _____
   _____
2. _____
   _____
3. _____
   _____

Name 2 questions you still have:

1. _____
   _____
2. _____
   _____

Name 1 thing you are curious about after this unit:

1. _____
   _____

Ghost Particles – Final Reflection

Is a neutrino matter? Why or why not?

Draw a picture of a neutrino on the front of your Science Notebook.