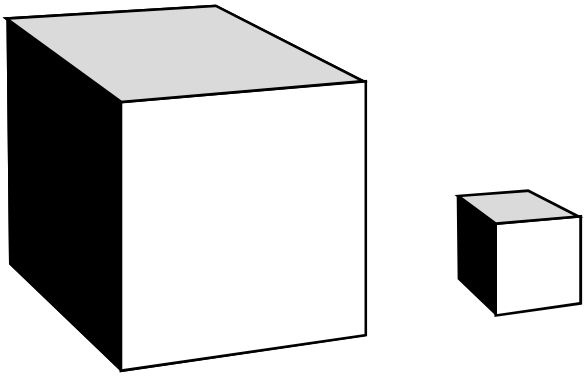
Comparing Cubes



Sofia has two solid cubes made of the same material. One cube is very large, and the other cube is very small. Put an X next to all the statements you think are true about the two cubes.

___ **A** The larger cube has more mass than the smaller cube.

___ **B** The larger cube has less mass than the smaller cube.

___ **C** The larger cube melts at a higher temperature than the smaller cube.

___ **D** The larger cube melts at a lower temperature than the smaller cube.

___ **E** The density of the larger cube is greater than the smaller cube.

___ **F** The density of the larger cube is less than the smaller cube.

___ **G** The larger cube is more likely to float in water than the smaller cube.

___ **H** The larger cube is more likely to sink in water than the smaller cube.

___ **I** The larger cube is made up of larger atoms than the smaller cube.

___ **J** The larger cube is made up of smaller atoms than the smaller cube.

Explain your thinking. Describe the "rule" or reasoning you used to compare the cubes.

_____

_____

_____

_____

_____

Lab Handout

Lab 3. Physical Properties of Matter: What are the identities of the unknown substances?

Introduction

Matter, the "stuff" of which the universe is composed, is all around us. Anything that we can touch, feel, or see is an example of matter. Matter can be defined as something that has mass and takes up space. All matter is composed of submicroscopic particles called atoms. A substance is a sample of matter that has a constant composition. Examples of substances include water, iron, plastic and glass. On earth, substances are found in one of three different states (i.e., solid, liquid, gas) and it is common to see a substance change from one state to another. The types of atoms, the interactions that occur between atoms, and how the atoms are moving within a substance determine its state and its behavior under different conditions.

Scientists use atomic composition and specific chemical or physical properties to distinguish between different substances (see Figure 1). The atomic composition of a substance refers to the different types of atoms found in it and the relative proportion of each type of atom. Water, for example, is composed of hydrogen atoms and oxygen atoms in a ratio of two hydrogen atoms for every one oxygen atom. The chemical and physical properties of a substance refer to measurable or observable qualities or attributes that are used to distinguish between different substances. Chemical properties describe how a substance interacts with other matter. Sodium and potassium, for example, react with water but aluminum and gold do not. Physical properties are descriptive characteristics of matter. Examples of physical properties include color, density, conductivity, and malleability. All substances will have a unique set of chemical and physical properties that can be used to identify it because every type of substance has a unique atomic composition.

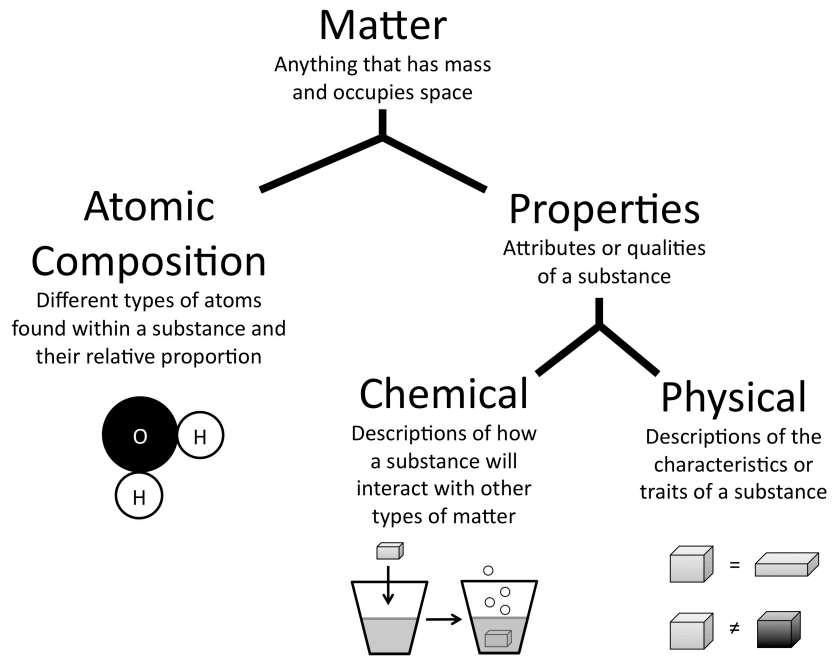


Figure 1. How scientists distinguish between different substances

It is often challenging to determine the identity of an unknown substance based on its chemical and physical properties. A scientist, for example, may only have a small amount of a substance. As a result, a scientist may not be able to conduct all the different types of tests that he or she wants to because some tests may change the characteristics of the sample during the process (such as when a metal is mixed with an acid). It is also difficult to determine many of the physical properties of the sample, such as its density or its malleability, when there is only a small amount of the substance because taking measurements is harder. To complicate matters further, an unknown substance may have an irregular shape, which can make it difficult to accurately measure its volume. Without knowing the mass and the volume of a substance, it is impossible to calculate its density. In this investigation you will have an opportunity to learn about some of the challenges scientists face when they need to identify an unknown substance based on its physical properties and why it is important to make accurate measurements inside the laboratory.

The Task

You will be given a set of known substances. You will then document, measure or calculate at least three different physical properties for each substance. From there, you will return the known substances to your teacher. He or she will then give you a set of unknown substances. The unknown substances will consist of one or more of the known substances. Your goal is to use what you know about the physical properties of matter, proportional relationships, and patterns to design and carry out an investigation that will enable you to collect the data you need to determine the identity of the unknown substances.

The guiding question of this investigation is, ***What are the identities of the unknown substances?***

Materials

You may use any of the following materials during you investigation:

Consumables

- Water (in squirt bottles)
- Set of known substances
- Set of unknown substances

Equipment

- Electronic (or triple-beam) balance
- 50 ml beaker
- 250 ml beaker
- 400 ml beaker
- 10 ml graduated cylinder
- 25 ml graduated cylinder
- 100 ml graduated cylinder
- Pipettes
- Ruler
- Wire
- D Battery
- Mini Light Bulb
- Mini Light Bulb Holder

Safety Precautions

Follow all normal lab safety rules. In addition, take the following safety precautions:

- Wear sanitized indirectly vented chemical-splash goggles and chemical-resistant gloves and aprons when collecting your data.
- Handle all glassware with care.
- Wash your hands with soap and water when you are done collecting the data.

Investigation Proposal Required? ☐ Yes ☐ No

Getting Started

In order to answer the guiding question you will need to make several systematic observations of the

known and unknown substances. To accomplish this task, you must determine what type of data you will need to collect, how you will collect it, and how will you analyze it before you begin.

To determine ***what type of data you need to collect*** think about the following questions:

- Which three physical properties (e.g., color, density, conductivity, malleability, luster) will you focus on as you make your systematic observations?
- What information do you need in order to determine or calculate each of the physical properties?

To determine ***how you will collect your data***, think about the following questions:

- What equipment will you need to collect the data you need?
- How will you make sure that your data is of high quality (i.e., how will you reduce error)?
- How will you keep track of the data you collect?
- How will you organize your data?

In order to determine ***how you will analyze your data*** think about the following questions:

- What type of calculations will you need to make?
- What patterns do you need to look for in your data?
- What type of table or graph could you create to help make sense of your data?
- How will you determine if the physical properties of the various objects are the same or different?

Connections to Crosscutting Concepts and the Nature of Science and the Nature of Scientific Inquiry

As you work through your investigation, be sure to think about:

- How scientists need to be able to recognize proportional relationships between categories, groups, or quantities;
- How scientists use patterns a basis for classification systems;
- The difference between data and evidence in science; and
- How scientists use different types of methods to answer different types of questions.

Initial Argument

Once your group has finished collecting and analyzing your data, your group will need to develop an initial argument. Your initial argument needs to include a claim, evidence to support your claim, and a justification of the evidence. The claim is your groups' answer the guiding question. The evidence is an analysis and interpretation of your data. Finally, the justification of the evidence is why you group thinks the evidence matters. The justification of the evidence is important because scientists can use different kinds of evidence to support their claims. You group will create your initial argument on a whiteboard. Your whiteboard should include all the information shown in Figure 2.

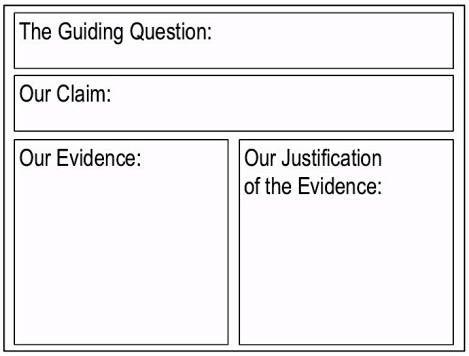


Figure 2. Argument Presentation on a Whiteboard

Argumentation Session

The argumentation session allows all of the groups to share their arguments. One member of each group will stay at the lab station to share that group's argument, while the other members of the group go to the other lab stations to listen to and critique the other arguments. This is similar to how scientists present their arguments to other scientists at conferences. If you are responsible for critiquing your classmates' arguments, your goal is to look for mistakes so these mistakes can be fixed and they can make their argument better. The argumentation session is also a good time to think about ways you can make your initial argument better. Scientists must share and critique arguments like this in order to develop new ideas.

In order to critique an argument, you might need more information than what is included on the whiteboard. You will therefore need to ask the present lots of questions. Some good questions to ask might be:

- What did your group do to collect these data? Why do you think that way is the best way to do it?
- How did your group analyze your data? Why did your group decide to analyze it that way?
- What other ways of analyzing and interpreting the data did your group talk about?
- What did your group do to make sure that these calculations are correct?
- Why did your group decide to present your evidence in that way?
- What other claims did your group discuss before you decided on that one? Why did your group abandon those other ideas?
- How sure are you that your group's claim is accurate? What could you do to be more certain?

Once the argumentation session is complete, you will have a chance to meet with your group and revise your initial argument. Your group might need to gather more data as part of this process. Remember, your goal at this stage of the investigation is to develop the best argument possible.

Report

Once you have completed your research, you will need to prepare an ***investigation report*** that consists of three sections. Each section should provide an answer for the following questions:

1. What question were you trying to answer and why?
2. What did you do to answer your question and why?
3. What is your argument?

Your report should answer these questions in 2 pages or less. This report must be typed and any diagrams, figures, or tables should be embedded into the document. Be sure to write in a persuasive style; you are trying to convince others that your claim is acceptable or valid!

ADI Laboratory Investigation Proposal A: Descriptive Studies

The Guiding Question…

↓

What data will you collect?

↓

How will you collect your data?

Your Procedure

What safety precaution will you follow?

↓

How will you analyze your data?

I approve of this investigation. _____ _____

Instructor's Signature Date

ADI Investigation Report Peer Review Guide – Middle School Version

Report By: _____ (ID Number) **Author:** Did the reviewers do a good job? 1 2 3 4 5 (Rate the overall quality of the peer review)

Reviewed By: _____ (ID Number) _____ (ID Number) _____ (ID Number) _____ (ID Number)

Section 1: Introduction and Guiding Question	Reviewer Rating			Instructor Score
1. Did the author provide enough ***background information***?	☐ No	☐ Partially	☐ Yes	0 1 2
2. Is the background information ***correct***?	☐ No	☐ Partially	☐ Yes	0 1 2
3. Did the author make the ***goal of the investigation*** clear?	☐ No	☐ Partially	☐ Yes	0 1 2
4. Did the author make the ***guiding question*** clear?	☐ No	☐ Partially	☐ Yes	0 1 2

Reviewers: If your group made any "No" or "Partially" marks in this section, please **explain how the author could improve** this part of his or her report.	**Author:** What revisions did you make in your report? Is there anything you decided to keep the same even though the reviewers suggested otherwise? Be sure to explain why.

Section 2: Method	Reviewer Rating			Instructor Score
1. Did the author provide a clear description of what he or she did during the investigation in order to ***collect data*** (the method)?	☐ No	☐ Partially	☐ Yes	0 1 2
2. Did the author describe ***how*** he/she ***analyzed*** the data?	☐ No	☐ Partially	☐ Yes	0 1 2
3. Did the author use the ***correct term*** to describe his/her investigation (e.g., experiment, observations, interpretation of a data set)?	☐ No	☐ Partially	☐ Yes	0 1 2

Reviewers: If your group made any "No" or "Partially" marks in this section, please **explain how the author could improve** this part of his or her report.	**Author:** What revisions did you make in your report? Is there anything you decided to keep the same even though the reviewers suggested otherwise? Be sure to explain why.

Section 3: The Argument	Reviewer Rating			Instructor Score
1. Did the author provide a ***clear and complete claim*** that answers the guiding question?	☐ No	☐ Partially	☐ Yes	0 1 2
2. Did the author use **evidence** to support his or her claim? Evidence is an analysis of data and an explanation of what the analysis means.	☐ No	☐ Partially	☐ Yes	0 1 2
3. Did the author ***present the evidence*** in an appropriate manner by ▪ including a correctly formatted and labeled graph (or table); ▪ using correct metric units (e.g., m/s, g, ml); and ▪ referencing the graph or table in the body of the text?	☐ No ☐ No ☐ No	☐ Partially ☐ Partially ☐ Partially	☐ Yes ☐ Yes ☐ Yes	0 1 2 0 1 2 0 1 2
4. Does the ***evidence support the author's claim***?	☐ No	☐ Partially	☐ Yes	0 1 2
5. Did the author use a scientific concept to ***justify the evidence***? The justification of the evidence explains why the evidence matters.	☐ No	☐ Partially	☐ Yes	0 1 2
6. Is the ***justification of the evidence*** acceptable?	☐ No	☐ Partially	☐ Yes	0 1 2
7. Did the author **use scientific terms correctly** (e.g., *hypothesis* vs. *prediction, data* vs. *evidence*) and **reference the evidence in an appropriate manner** (e.g., *supports* or *suggests* vs. *proves*)?	☐ No	☐ Partially	☐ Yes	0 1 2

Reviewers: If your group made any "No" or "Partially" marks in this section, please **explain how the author could improve** this part of his or her report.	**Author:** What revisions did you make in your report? Is there anything you decided to keep the same even though the reviewers suggested otherwise? Be sure to explain why.

Mechanics	Reviewer Rating			Instructor Score
1. ***Organization:*** Is each section easy to follow? Do paragraphs include multiple sentences? Do paragraphs begin with a topic sentence?	☐ No	☐ Partially	☐ Yes	0 1 2
2. ***Grammar:*** Are the sentences complete? Is there proper subject-verb agreement in each sentence? No run-on sentences.	☐ No	☐ Partially	☐ Yes	0 1 2
3. ***Conventions:*** Did the author use appropriate spelling, punctuation, and capitalization?	☐ No	☐ Partially	☐ Yes	0 1 2
4. ***Word Choice:*** Did the author use the appropriate word (e.g., there vs. their, to vs. too, then vs. than)?	☐ No	☐ Partially	☐ Yes	0 1 2

Instructor Comments:

Total: _____/40

ADI Investigation Report Peer Review Guide - High School Version

Report By: _____ (ID Number) **Author:** Did the reviewers do a good job? 1 2 3 4 5 (Rate the overall quality of the peer review)

Reviewed By: _____ (ID Number) _____ (ID Number) _____ (ID Number) _____ (ID Number)

Section 1: Introduction and Guiding Question	Reviewer Rating			Instructor Score
1. Did the author provide enough ***background information***?	☐ No	☐ Partially	☐ Yes	0 1 2
2. Is the background information ***accurate***?	☐ No	☐ Partially	☐ Yes	0 1 2
3. Did the author ***describe the goal*** of the study?	☐ No	☐ Partially	☐ Yes	0 1 2
4. Did the author make the ***guiding question*** explicit and explain how the guiding question is related to the background information?	☐ No	☐ Partially	☐ Yes	0 1 2

Reviewers: If your group made any "No" or "Partially" marks in this section, please **explain how the author could improve** this part of his or her report.

Author: What revisions did you make in your report? Is there anything you decided to keep the same even though the reviewers suggested otherwise? Be sure to explain why.

Section 2: Method	Reviewer Rating			Instructor Score
1. Did the author describe ***the procedure*** he/she used to gather data and then explain why he/she used this procedure?	☐ No	☐ Partially	☐ Yes	0 1 2
2. Did the author explain ***what data*** were collected (or used) during the investigation and why they were collected (or used)?	☐ No	☐ Partially	☐ Yes	0 1 2
3. Did the author describe ***how he/she analyzed the data*** and explain why the analysis helped him/her answer the guiding question?	☐ No	☐ Partially	☐ Yes	0 1 2
4. Did the author use the ***correct term*** to describe his/her investigation (e.g., experiment, observations, interpretation of a data set)?	☐ No	☐ Partially	☐ Yes	0 1 2

Reviewers: If your group made any "No" or "Partially" marks in this section, please **explain how the author could improve** this part of his or her report.

Author: What revisions did you make in your report? Is there anything you decided to keep the same even though the reviewers suggested otherwise? Be sure to explain why.

Section 3: The Argument	Reviewer Rating			Instructor Score
1. Did the author provide a ***claim*** that answers the guiding question?	☐ No	☐ Partially	☐ Yes	0 1 2
2. Did the author include ***high quality evidence*** in his/her argument? ▪ Were the data collected in an appropriate manner? ▪ Is the analysis of the data appropriate and free from errors? ▪ Is the author's interpretation of the analysis (what it means) valid?	☐ No ☐ No ☐ No	☐ Partially ☐ Partially ☐ Partially	☐ Yes ☐ Yes ☐ Yes	0 1 2 0 1 2 0 1 2
3. Did the author ***present the evidence*** in an appropriate manner by***:*** ▪ using a correctly formatted and labeled graph (or table); ▪ including correct metric units (e.g., m/s, g, ml, etc.); and, ▪ referencing the graph or table in the body of the text?	☐ No ☐ No ☐ No	☐ Partially ☐ Partially ☐ Partially	☐ Yes ☐ Yes ☐ Yes	0 1 2 0 1 2 0 1 2
4. Is the claim ***consistent with the evidence***?	☐ No	☐ Partially	☐ Yes	0 1 2
5. Did the author include a ***justification of the evidence*** that: ▪ explains why the evidence is important (why it matters) and ▪ defends the inclusion of the evidence with a specific science concept or by discussing his/her underlying assumptions?	☐ No ☐ No	☐ Partially ☐ Partially	☐ Yes ☐ Yes	0 1 2 0 1 2
6. Is the ***justification of the evidence*** acceptable?	☐ No	☐ Partially	☐ Yes	0 1 2
7. Did the author discuss ***how well his/her claim agrees with the claims made by other groups*** and explain any disagreements?	☐ No	☐ Partially	☐ Yes	0 1 2
8. Did the author **use scientific terms correctly** (e.g., *hypothesis* vs. *prediction, data* vs. *evidence*) and **reference the evidence in an appropriate manner** (e.g., *supports* or *suggests* vs. *proves*)?	☐ No	☐ Partially	☐ Yes	0 1 2

Reviewers: If your group made any "No" or "Partially" marks in this section, please **explain how the author could improve** this part of his or her report.	**Author:** What revisions did you make in your report? Is there anything you decided to keep the same even though the reviewers suggested otherwise? Be sure to explain why.

Mechanics	Reviewer Rating			Instructor Score
1. ***Organization:*** Is each section easy to follow? Do paragraphs include multiple sentences? Do paragraphs begin with a topic sentence?	☐ No	☐ Partially	☐ Yes	0 1 2
2. ***Grammar:*** Are the sentences complete? Is there proper subject-verb agreement in each sentence? No run-on sentences.	☐ No	☐ Partially	☐ Yes	0 1 2
3. ***Conventions:*** Did the author use appropriate spelling, punctuation, paragraphing and capitalization?	☐ No	☐ Partially	☐ Yes	0 1 2
4. ***Word Choice:*** Did the author use the appropriate word (e.g., there vs. their, to vs. too, than vs. then, etc.)?	☐ No	☐ Partially	☐ Yes	0 1 2

Instructor Comments:

Total: _____/50

ADI Investigation Report Peer Review Guide - Undergraduate Version

Report By: _____ (ID Number) **Author:** Did the reviewers do a good job? 1 2 3 4 5 (Rate the overall quality of the peer review)

Reviewed By: _____ (ID Number) _____ (ID Number) _____ (ID Number) _____ (ID Number)

Section 1: Introduction and Guiding Question	Reviewer Rating			Instructor Score
1. Did the author provide enough ***background information***?	☐ No	☐ Partially	☐ Yes	0 1 2
2. Is the background information ***accurate***?	☐ No	☐ Partially	☐ Yes	0 1 2
3. Did the author ***describe the goal*** of the study?	☐ No	☐ Partially	☐ Yes	0 1 2
4. Did the author make the ***guiding question*** explicit and explain how the guiding question is related to the background information?	☐ No	☐ Partially	☐ Yes	0 1 2

Reviewers: If your group made any "No" or "Partially" marks in this section, please **explain how the author could improve** this part of his or her report.

Author: What revisions did you make in your report? Is there anything you decided to keep the same even though the reviewers suggested otherwise? Be sure to explain why.

Section 2: Method	Reviewer Rating			Instructor Score
1. Did the author describe ***the procedure*** he/she used to gather data and then explain why he/she used this procedure?	☐ No	☐ Partially	☐ Yes	0 1 2
2. Did the author explain ***what data*** were collected (or used) during the investigation and why they were collected (or used)?	☐ No	☐ Partially	☐ Yes	0 1 2
3. Did the author describe ***how he/she analyzed the data*** and explain why the analysis helped him/her answer the guiding question?	☐ No	☐ Partially	☐ Yes	0 1 2
4. Did the author use the ***correct term*** to describe his/her investigation (e.g., experiment, observations, interpretation of a data set)?	☐ No	☐ Partially	☐ Yes	0 1 2

Reviewers: If your group made any "No" or "Partially" marks in this section, please **explain how the author could improve** this part of his or her report.

Author: What revisions did you make in your report? Is there anything you decided to keep the same even though the reviewers suggested otherwise? Be sure to explain why.

Section 3: The Argument	Reviewer Rating			Instructor Score
1. Did the author provide a ***claim*** that answers the guiding question?	☐ No	☐ Partially	☐ Yes	0 1 2
2. Did the author include ***high quality evidence*** in his/her argument?				
▪ Were the data collected in an appropriate manner?	☐ No	☐ Partially	☐ Yes	0 1 2
▪ Is the analysis of the data appropriate and free from errors?	☐ No	☐ Partially	☐ Yes	0 1 2
▪ Is the author's interpretation of the analysis (what it means) valid?	☐ No	☐ Partially	☐ Yes	0 1 2
3. Did the author ***present the evidence*** in an appropriate manner by*:*				
▪ using a correctly formatted and labeled graph (or table);	☐ No	☐ Partially	☐ Yes	0 1 2
▪ including correct metric units (e.g., m/s, g, ml, etc.); and,	☐ No	☐ Partially	☐ Yes	0 1 2
▪ referencing the graph or table in the body of the text?	☐ No	☐ Partially	☐ Yes	0 1 2

Section 3: The Argument (continued)	Reviewer Rating			Instructor Score
4. Is the claim ***consistent with the evidence***?	☐ No	☐ Partially	☐ Yes	0 1 2
5. Did the author include a ***justification of the evidence*** that: ▪ explains why the evidence is important (why it matters) and ▪ defends the inclusion of the evidence with a specific science concept or by discussing his/her underlying assumptions?	☐ No ☐ No	☐ Partially ☐ Partially	☐ Yes ☐ Yes	0 1 2 0 1 2
6. Is the ***justification of the evidence*** acceptable?	☐ No	☐ Partially	☐ Yes	0 1 2
7. Did the author discuss ***how well his/her claim agrees with the claims made by other groups*** and explain any disagreements?	☐ No	☐ Partially	☐ Yes	0 1 2
8. Did the author **use scientific terms correctly** (e.g., *hypothesis* vs. *prediction, data* vs. *evidence*) and **reference the evidence in an appropriate manner** (e.g., *supports* or *suggests* vs. *proves*)?	☐ No	☐ Partially	☐ Yes	0 1 2

Reviewers: If your group made any "No" or "Partially" marks in this section, please **explain how the author could improve** this part of his or her report.	**Author:** What revisions did you make in your report? Is there anything you decided to keep the same even though the reviewers suggested otherwise? Be sure to explain why.

Section 4: Limitations	Reviewer Rating			Instructor Score
1. Did the author discuss the ***limitations of the procedure*** that he/she used to collect the data during the investigation?	☐ No	☐ Partially	☐ Yes	0 1 2
2. Did the author discuss ***sources of error*** that were unavoidable in the collection of the data?	☐ No	☐ Partially	☐ Yes	0 1 2
3. Did the author discuss what he or she should have done differently in order to ***increase the rigor*** of the investigation?	☐ No	☐ Partially	☐ Yes	0 1 2

Reviewers: If your group made any "No" or "Partially" marks in this section, please **explain how the author could improve** this part of his or her report.	**Author:** What revisions did you make in your report? Is there anything you decided to keep the same even though the reviewers suggested otherwise? Be sure to explain why.

Mechanics	Reviewer Rating			Instructor Score
1. ***Organization:*** Is each section easy to follow? Do paragraphs include multiple sentences? Do paragraphs begin with a topic sentence?	☐ No	☐ Partially	☐ Yes	0 1 2
2. ***Grammar:*** Are the sentences complete? Is there proper subject-verb agreement in each sentence? No run-on sentences.	☐ No	☐ Partially	☐ Yes	0 1 2
3. ***Conventions:*** Did the author use appropriate spelling, punctuation, paragraphing and capitalization?	☐ No	☐ Partially	☐ Yes	0 1 2
4. ***Word Choice:*** Did the author use the appropriate word (e.g., there vs. their, to vs. too, than vs. then, etc.)?	☐ No	☐ Partially	☐ Yes	0 1 2

Total: _____/56

Sample B

Section 1: The question we were trying to answer and why.
Scientists can use atomic composition and specific chemical or physical properties to identify different substances. Scientists can first identify certain properties of known substances to compare to unknown substances. By using several different physical properties, scientists can collect enough data to identify unknown substances. Our question for this investigation was, what are the identities of the unknown substance.

Section 2. What we did to answer the question and why
During the course of this investigation, data was collected about the density, conductivity and luster of the samples. This data was seen as the easiest way to determine the make up between the known and unknown substances. Through the creation of a data table, we were able to compare all the substances based on three identified physical properties. We also needed to determine the mass and volume of each object to determine the density of an object. The objects are irregular shaped so displacement was used to determine volume. A circuit was created between battery and light bulb to determine the conductivity of each substance. Finally, the luster of the object was determined based on observing the substances.

Section 3. Our Argument
Unknown A is PVC, unknown B and D is aluminum, and unknown C is steel. According to the tables below, the densities, conductivity, and luster of the 4 unknown objects are the same as three of the known objects. These are physical properties and because they physical properties are the same they must be the same objects.

Known Substances

	Density (g/cm^3)	Conductivity	Luster
Brass	10	yes	yes
Lead	9.1	yes	yes
Steel	7.9	yes	yes
Nylon	1.2	no	no
PVC	.96	no	no
HDPE	.97	no	no
Copper	9.9	yes	yes
Aluminum	3	yes	yes

Unknown Substances

	Density (g/cm^3)	Conductivity	Luster
A	0.83	No	No
B	2.7	Yes	Yes
C	7.6	Yes	Yes
D	2.9	Yes	Yes

Sample C

Section 1: Introduction
Physical properties are descriptive characteristics of matter such as color, density, luster, and conductivity. Unfortunately, it is not always easy to identify an unknown substance based on its physical properties because the sample might be small or have a weird shape. This makes it hared to take good measurements. Our goal was to identify a set of unknown substances based on their physical properties. The question we were trying to answer was, what are the identities of the unknown substances?

Section 2: Method
We were given a set of 8 known substances. We determined the mass of each one using a balance. We then determined the volume of each one by adding it a graduated cylinder filled with water and then measuring how much the water went up. We then calculated the density of the substance by dividing the mass by the volume (m/v). We also used a battery, bulb and wire to determine if the substance conducts electricity or not. Finally, we recorded the luster and color of each object. We keep track of all this information in a table.

Once we had the physical properties of the known substances, we tested the 4 unknowns. We determined the mass and volume of each one like we did for the known. We then calculated the density of each one. We then determined if the unknown object conducted electricity or not. Finally, we recorded the color and luster of all 4 unknown substances. We keep track of all this information in another table. We then compared the physical properties of known objects to the unknown ones. To analyze our data, we compared the density, conductivity and luster of the known substance to unknown substances.

Section 3: Argument
Unknown A is PVC. Unknowns B and D are aluminum, and unknown C is steel. The density, conductivity, and luster of all 8 known substance are provided in Table 1. Table 2 has the density, conductivity, and luster of the 4 unknown substances. The

density of unknown A is closest to the density of PVC. It also lacks luster and does not conduct electricity like PVC. The densities of unknown B and D are almost identical to aluminum. B and D also conduct electricity and are shiny like aluminum. Finally, unknown C has almost the same density as steel. It also conducts electricity and is shiny like steel. Since the properties of the unknowns match the properties of the knows, they are therefore the same substances.

Table 1. Physical Properties of the Known Substances

	Mass (g)	Volume (mL)	Density (g/mL)	Conductivity	Luster
Brass	15	1.5	10	+	+
Lead	9.1	1	9.13	+	+
Steel	7.9	1	7.9	+	+
Nylon	15.1	13	1.2	-	-
PVC	15	15.7	0.96	-	-
HDPE	15	15.5	0.97	-	-
Copper	8.9	0.9	9.9	-	-
Aluminum	15	5	3	+	+

Table 2. Physical Properties of the Unknown Substances

	Mass (g)	Volume (mL)	Density (g/ml)	Conductivity	Luster
A	1	1.2	0.83	-	-
B	2.7	1	2.7	+	+
C	3.8	0.5	7.6	+	+
D	11	4	2.9	+	+

This evidence is important because scientists can use physical properties, such as color, density, luster, and conductivity to distinguish between different substances. Scientists can us use physical properties to identify a substance because every substance has a unique set of physical properties. Each substance has a unique set of physical properties because every type of substance has a unique atomic composition.