

Matter Lesson Plan

Name	Mary-Kate Perrone
Your Science Course or Class	6 th Grade Science: Section 602
School Name	MaST Community Charter School
Planned Teaching Dates and Times	

1. GUIDING INFORMATION:

a. Student and Classroom Characteristics

This science class consists of 27 students who are engaged in science learning for approximately 65 minutes a day. The time frame for this class is 11:25 a.m. to 12:30 p.m., which is right before their lunch period. Students are seated at tables. There are six groups of four students at each table and one table of three students. During science, students are expected to work collaboratively on hands-on or inquiry based projects/ assignments. Throughout various science lessons, students are expected to use observational skills as well as they are required to utilize the steps to the scientific method. When students are engaged in the science lesson, they make observations, inferences, and record data in either their copybooks or lab sheets. At times, students may lose focus of the objective and have to be redirected to the task at hand. In the classroom, students work well together to discuss the activity and the concepts behind it.

b. Prior Knowledge

Currently, my students have many misconceptions about specific concepts in matter, such as density, mass, and volume. There is a notion that children develop ideas about science from their everyday experiences and those ideas are adapted and expanded upon throughout formal science education. When asked about the particulate nature of matter, elementary level children respond more descriptively rather than explanatory. In other words, students describe states of matter and phase changes using descriptive words by means of the senses. They do not, however, explain the states and changes with a deep understanding of how matter interacts in the natural world. According to a research study done by Nakleh et al (2005), these students operate through “macroparticulate frameworks,” which is that they believe that matter can be broken down into tiny pieces by physical means. This study was also conducted with secondary students who additionally conveyed their knowledge through the macroparticulate frameworks. They described observable properties of matter and the behavior of various substances. It is noted, though, that children of all levels have difficulty restructuring their preconceived notions about matter in nature from macroscopic to microscopic, also known as the atomic and molecular basis of matter (Nakleh, Samarapungavan, and Saglam 2005).

The data I gathered to assess my own students’ prior knowledge was based on their responses to two questions pertaining to the characteristic properties of matter, specifically density, mass, and volume. Some students used explanative terms such as using words like “larger, bigger, heavier, and lighter” when answering the questions, while others responded in complete sentences without supporting details as to the reasoning behind their thoughts. My students associated a brick’s weight or heaviness with having more matter and mass than a dry sponge. Some students were confused and responded with “matter is what space it takes up” and “volume and mass are almost the same thing,” even though it was stated in the question that both the dry sponge and the brick took up the same amount of space.

Based on the pre-assessment questions, these students explained density and mass based on the visible, tactile objects mentioned in the pre-assessment question. In other words, some of the students envisioned an actual brick and a dry sponge sitting on their desk. Using their senses, these children adapted their knowledge of matter, mass, density, and volume and applied it to what they previously knew from either their own experiences or what they had learned in past years through science education. Therefore, the lessons set forth in this plan are designed to teach my students the relationships between density, mass, and volume so that they may progress towards and understanding about matter in nature from macroscopic to microscopic.

2. PURPOSES:

a. Major Concepts

Molecules that make up matter have an attraction among them and are constantly in motion. In a solid, a strong attraction holds the particles close together. Instead of moving, each particle vibrates. In a liquid, the particles are not held together as tightly; therefore, the particles are able to move past one another so the liquid can flow into different shapes. In a gas, there is a very weak attraction among particles. The particles move quickly and freely in all directions leaving a lot of empty space between them. The movement and closeness of molecules determines the density of that type of matter. In other words, density is “the amount of matter in a given space, or volume” (Cuevas, et al. 2005). Therefore, if there is more matter (closer molecules) than it is said to be denser, while if there is less matter (farther apart molecules) than the object is less dense.

To determine the density of an object, one must first identify the mass and volume of that item. Mass can be defined as the “measurement of the amount of matter in an object” (Cuevas, et al. 2005). Mass remains constant from one location to another. In fact, the mass of an object is the same no matter where it is located within the entire universe. Altering the amount of matter, or the number of molecules, that make up the object is the only way to change the mass of the object.

As mentioned in above paragraphs, molecules are attracted to one another. Depending upon the mass of the object, the force of the attraction may be tiny for normal matter, such as a paper clip, or stronger for larger matter, such as a truck. This strong attraction is known as the force of gravity (*Matter* 2005). This attraction of gravity is felt as “weight” on earth. Weight is not the same as mass; rather, it is the measurement of the gravitational force exerted on an object (Cuevas, et al. 2005). The value of weight is dependent upon the location of the object and it’s relation to the center of the earth’s gravitational force. Therefore, a person would weigh less on the moon because the moon is farther away from the center of the earth’s gravitational force; yet, the same person would still have the same mass on the moon as they would have on the earth (the number of molecules would not change).

In correlation to mass and density, all matter takes up space. The space that a certain amount of matter takes up is known as the object’s volume. Typically, volume is the measurement of an object in a three dimensional space and is usually measured in cubic centimeters or cubic inches (Cuevas, et al. 2005). Characteristically, volume is not altered in a specific type of matter. For instance, if one were to take a ball of clay, at a certain volume, and change it into a flat object or a cube it would not lose its volume. In other words, it is still taking up the same amount of space. This is because no two types of matter can be in the same place at the same time. An observable example of this is when an empty glass is filled with water. One would notice that bubbles are created when the water is forced into the solid object, the glass. Scientifically, the water molecules have now filled in the space where air molecules once were; hence, the air molecules were pushed out of the glass creating the bubbles escaping at the top.

In conclusion, matter can be found everywhere in the universe. Any object, whether it is a solid, liquid, or gas, can be identified having properties such as mass, weight, density, and volume. The molecules that make up matter are held together by an attraction and are constantly in motion. This summary has outlined some of the types, characteristics, and properties of matter.

The major concepts for these lessons pertain to the concept of matter. More specifically, students will need to be able to differentiate between density, mass, and volume.

- Density: the quantity of something per unit measure, especially per unit length, area, or volume; the mass per unit volume of a substance under specified conditions of pressure and temperature
- Mass: a unified body of matter with no specific shape
- Volume: the amount of space occupied by a three-dimensional object or region of space, expressed in cubic units; the capacity of such a region or of a specified container, expressed in cubic units.

Students will also need to be able to define matter and apply the concepts listed above to the overall topic of matter.

- Matter: something that occupies space and can be perceived by one or more senses; a physical body, a physical substance, or the universe as a whole; something that has mass and exists as a solid, liquid, gas, or plasma.
- Information for the above definitions were taken from:

b. Learning Goals

Throughout these lessons, students will learn that everything in this universe is made up of matter, including living organisms. They will be able to identify and describe what matter is and how it can be classified. They will investigate with different types of matter that have unique physical properties/ characteristics. Students will learn that matter is anything that has volume and mass. They will explore how the volume of solids, gases, and liquids are measured. An understanding of volume can help students decipher a simple task such as which books will fit into their schoolbags. Additionally, they will learn the difference between mass and weight. This concept will help students understand how the gravitational force of the Earth pulls on all matter; therefore, giving everything weight and that the more mass an object has the greater the force will be and the object will have more weight. This concept helps students to comprehend why objects such as elephants weigh more than themselves.

As well, students will study about the physical changes that matter can undergo in the everyday world. With this knowledge, the students will be able to understand how all matter changes state. For example, students will know how puddles left from rain evaporate into earth's atmosphere, as well as how snow seems to disappear as the temperature outside rises above freezing; hence, they will correlate matter as being conserved and not lost or destroyed.

Through inquiry, students will gain knowledge of how density is used to identify and describe various substances. Students will understand where the best place to stay cool in the house in the hot summer months. They will conceptualize the density of air and how temperature affects the moving gas molecules (i.e.: hot air rises and cool air sinks).

Overall, students will gain a core understanding of the properties of matter. They will be able to describe, identify and classify matter using the concepts of mass, weight, volume, and density.

c. Objectives

1. Students will be able to describe properties of all matter and identify the units used to measure volume and mass. (Day 1)
2. Students will be able to compare mass and weight and explain the relationship between them. (Day 1-2)
3. Students will be able to mathematically calculate the volume, mass, weight, and density of various objects. (Day 2)
3. Students will be able to identify and list six examples of physical properties of matter (Day 3).
4. Students will be able to describe how density is used to identify substances (Day 2-3).
5. Students will be able to explain what happens to matter during a physical change (Day3).

d. State Standards

National Science Education Standards Covered:

- **ST 1:** Abilities of Technological Design
- **ST 2:** Understandings about Science and Technology
- **SPSP 1:** Personal Health
- **SPSP 5:** Science and Technology in Society
- **SAI 1:** Abilities necessary to do scientific inquiry
- **PS 1a:** A substance has characteristic properties, such as density, a boiling point, and solubility, all of which are independent of the amount of the sample. A mixture of substances often can be separated into the original substances using one or more of the characteristic properties.
- **PS 1c:** Chemical elements do not break down during normal laboratory reactions involving such treatments as heating, exposure to electric current, or reaction with acids. There are more than 100 known elements that combine in a multitude of ways to produce compounds, which account for the living and nonliving substances that we encounter.

3. RATIONALE:

The approach to the following lessons was developed to incorporate a variety of learners. Students learn in various ways; therefore, I integrated many different teaching strategies to accommodate all my learners and create a classroom environment that is conducive to learning scientific concepts. In my lessons, I included hands-on activities for students who are concrete learners. In addition, the lessons feature visual aids with the use of graphic organizers, charts, transparencies, and tactile visible objects to adapt to my visual learners. Also, for contextual learners, I developed plans based on the text. Auditory learners learn through the integration of a listening center as well as through many oral discussions. The rationale for the content of lesson stems from my initial pre-assessment of my students' knowledge about mass, volume, and density. My students have much confusion about these specific concepts; therefore, I wanted to devise a lesson plan that addressed their misconceptions as well met each of their individual needs.

4. CLASSROOM PREPARATION:

a. Instructional Materials

Day One

- A rock, a paper clip, a book, a pencil, a glass of water and a large cardboard box
- Students' notebooks, textbooks, and pencils (27)

- Guided reading packets A (general) and B (special needs): section 1

Day Two

- Jars (7), bottles (7), cans (7), and cartons (7)
- Graduated cylinders and measuring cups
- Students' notebooks, textbooks, and pencils (27)
- Various classroom objects
- Centimeter rulers (27)
- Water

Day Three

- Density column (corn oil, water, shampoo, dish detergent, and maple syrup)
- Students' notebooks, textbooks, and pencils (27)
- Audio center and CD of text
- Guided reading packets A (general) and B (special needs): section 2
- Metric balance, graduated cylinder (100 ml), 8-10 marbles, graph paper, paper towels, water (enough materials must be in place for 7 groups)
- Lab sheets (27)

b. Management and grouping patterns

Students will continue to sit at tables with their assigned groups. Students will discuss with peers when the lesson requires discussion. Independent work will be done at the same location; however, students will not be permitted to talk to one another. During labs, one student from each group gathers materials, so as not to have chaos with students walking freely around the room. All handouts are distributed by the teacher or classroom assistant. During clean up, groups are called individually to clean up their materials and return them to the proper place.

c. Safety

Day One: Students should use caution when working with water to avoid spills. If a spill occurs, students will retrieve paper towels to soak up wet surfaces. In addition, they should notify the teacher of the spill.

Day Two: Students should use caution when working with water to avoid spills as well as glass containers such as jars and cylinders. Any broken glass should result in immediate clean up by the adult supervisor. If glass is cracked or broken, students should notify the teacher and move to safe area of the room. No student will be permitted to touch shattered glassware.

Day Three: Same precautions as previous lessons.

5. TEACHING METHOD(S), INSTRUCTIONAL PROCEDURES, AND LEARNING ACTIVITIES:

Day 1

a. Phase of Inquiry:

Engage: Students will be engaged in hands-on activities to assist in motivating students to learn about physical properties of matter, specifically mass, weight and volume. In addition, students will be able to apply contextual definitions to tactile learning activities. Students will actively describe, identify and classify various substances by their physical properties.

Explore: Students will explore the concepts of physical properties of matter by partaking in a concrete learning activity. Students will experiment with different substances with which they will describe and identify the physical properties of each and classify them according to those properties.

b. Content

Students will be defining important terms such as matter, mass, volume, and weight. By defining these terms, students will be able to correlate them to the various physical properties of matter. Students will identify basic properties of a liquid (water) and a gas (air). They will study how liquid volume can be measured as well as investigate how to measure the volume of a gas. In addition, students will become familiar with measuring the volume of regular and irregular shaped solid objects. This lesson also encourages students to compare and contrast the similarities and differences between weight and mass. They will use graphic organizers to illustrate these. Additionally, students will investigate measuring mass and weight of various substances and apply correct units of measure to the data calculations.

c. Motivational opening

In groups, students will examine a “secret sack” that contains an object. Students will need to use their senses and observational skills to identify characteristics and properties of the object. Students will then discuss their findings and record their observations in a “T-Chart” in order to make lists of identifiable and non-identifiable characteristics and properties of the object. Students will make inferences based on what they know from their observations and draw conclusions as to the actual object inside the sack. After students have shared their predictions, they will open the sack and properly identify the object.

d. Core Learning Activities

1. As a whole group, we will discuss the results of the “secret sack” activity. I will record descriptive words that students use to identify the objects. I will then pose the question: “How are you like those objects, what do you have in common with other objects such as a rock, a paper clip, a steaming bowl of soup, or the air we breathe?” (Students will write their own thoughts and share them with the group).
2. Each group will observe several different items, such as a book, a pencil, a large cardboard box, and a glass of water (1/2 full). Students will speculate how they are all alike (responses should render that they all take up space) and how they are different (comparison of size and weight).
3. In groups, students will then be given the task of developing a plan to investigate the differences and similarities among the substances.
 - Students’ plans should include an investigation where they need to measure the volume, weight, and mass of the substances.
 - At this stage, students should be writing up their experiment following the 6 steps to the scientific method, including a list of all the needed materials and a basis for researching more information (i.e.: research and define volume, weight, and mass).
 - Each student in the group will be responsible for maintaining a role in this investigation.
 - Teacher will monitor groups and provide feedback based on student designs.
 - Students will submit a complete list of materials needed for the experiment by the end of the period.

4. Students will read section 1 of the text for homework and complete the guided reading sheet that correlates to this section.

e. Critical Questions

1. How can a regular and an irregular shaped solid object's volume be measured? Which units would you apply to your measurements?
2. How can matter, mass, and volume be related?

f. Closure

To each group, I will ask the review questions of the students. As a whole group, I will review the main points of the lesson and redefine the important terms discussed earlier. I then will discuss the following day's activities, which will be reinforcing the concept of how volume is measured, so that they will be prepared for the upcoming lessons where students will carry out their investigations.

Day 2

a. Phase of Inquiry

Explore: Students will investigate the measurement of volume, mass, and weight using a hands on approach in which they designed. As well, students' investigations should include a form of mathematical equations that demonstrate their understanding of volume, mass, and weight both scientifically and mathematically. Students will conduct their own experiments on how various objects are alike and share common properties. They will measure the volume of several objects and use containers, water, and graduated cylinders as well as using a centimeter ruler.

Explain: Students will work cooperatively to define physical properties of matter based on their observations, experiences, and prior knowledge. Students will share their ideas and we will discuss them as a whole class. They will construct meaning of these concepts based on the activity and the discussion. For reinforcement, students will read through sections in the text at home so that they can relate contextual information to concrete learning activities.

b. Content

Students will study how liquid, solid, and gas volume can be measured. In addition, students will become familiar with measuring the volume of regular and irregular shaped solid objects. Students will also learn the mathematical equation for determining volume using a centimeter ruler, which is that it is equal to the length of the object multiplied by the width and the height of the object. In addition, students will calculate the mass and weight of the objects chosen and calculate and record their own data.

c. Motivational opening

To demonstrate that air (gas) has volume, students will work in pairs to complete a lab, "space case." They will crumple paper and stick into a cup and submerge the cup upside down in water. They will observe how air filled the space in the cup and did not allow water to flow inside. They will repeat the experiment again, yet this time the cup will have a hole in it. Students will observe that the water pushed the air out of the space and filled the cup. As a class, we will discuss and correlate measuring the volume of liquids, solids, and gases.

d. Core Learning Activities

1. Students will work together in groups to test their hypotheses from previous lesson. Students will measure different objects' volumes using a variety of containers (of their own accord). They will also use balances and scales to measure the mass and weight of the objects as well. Students will record their findings in a group data chart.
 - Students should analyze their data and write their conclusions based on their findings.
 - As a whole class, we will discuss the measurements of the various groups' data. During the sharing of data, I will assess prior knowledge of individual students through inquiry of terms and concepts learned from the previous lesson.
2. To reinforce the concept of volume, students will work individually on mathematical equations to determine the volume of solids:
 - A book has a length of 25cm, a width of 18cm, and a height of 4cm. What is its volume? ($V=l*w*h$)
 - What is the volume of a suitcase that has a length of 95cm, a width of 50cm, and a height of 20cm?
 - A CD case is 14.2cm long, 12.4cm wide and 1cm deep. What its volume?
3. Once students have solved the equations, they will then pick three small/ medium sized objects from the classroom and measure their volume using a centimeter ruler. They will share their results with the group.
5. To review the main concepts in this section, students will complete the section review for homework.

e. Critical Questions

1. What are two units used to measure volume?
2. Explain how you would measure the volume of an apple.

f. Closure

To end the lesson, I will ask the review questions of the students. I will review the main points of the lesson and redefine the important terms learned earlier. I then will discuss the following day's activities, which will be about identifying the physical properties of an object and in particular density, so that they will be prepared for the upcoming lessons.

Day 3 (*This lesson will be used for the remainder of the week, so that all students may cycle through 4 learning centers*).

a. Phase of Inquiry

Elaborate: Students will further their understanding of matter by identifying specific physical properties of substances, such as density. They will elaborate on previously learned concepts about matter, mass, and volume and use the information gained through those lessons and investigations and apply it to describing, identifying and classifying the six physical properties of matter and the changes that matter goes through. Specifically, students will focus primarily on the property of density.

Evaluate: Students will conduct a hands-on investigation on determining density, while applying concepts of mass and volume and the mathematical value given to each. Students will be evaluated based on their performance in the lab activity as well as evaluated by their peers during the learning center activities.

b. Content

In this lesson, students will learn about the six main examples of the physical properties of an object, which are thermal conductivity, state, density, solubility, ductility and malleability. Students will define important terms such as physical property, density, and physical change. Furthermore, they will apply these terms and concepts to hands-on learning activities on determining the densities of various objects while incorporating previously gained knowledge of mass and volume.

c. Motivational opening

At the front of the room, students will observe a density column filled with corn oil, water, shampoo, dish detergent, and maple syrup. Students will need to respond to the question: “What do you think causes the liquid in this container to look the way it does?”

d. Core Learning Activities

1. Students should individually respond to the question. Once they have completed their responses, we will discuss them as a class. (Based on my research about misconceptions, student responses may state that one liquid is heavier/ lighter than another).
2. I will then lead a discussion based on the 6 properties of matter. More specifically, we will discuss the density of the various liquids and particle movement.
3. Afterwards, students will break into learning centers, where each group will be working on different activities.
 - Station1: Students will work collaboratively in groups playing the guessing game called “20 questions.” One student (leader) will think of an object and the others in the group will have to ask questions about its properties in order to figure out the object. The leader can only answer in yes/no responses. The game is generated to enable students to apply the 6 examples of physical properties: thermal, conductivity, state, density, solubility, ductility and malleability. Students will give other examples of each property.
 - Station 2: Using the listening center, students will listen to the section read aloud. While listening, they will complete the guided reading packet on section 2. Students will copy key terms and definitions. At the end of the section, students will generate 3 questions about the reading that they found difficult to comprehend. Students will share questions and help each other understand the section.
 - Station 3: Students will complete a lab activity based on determining the relationship between mass and volume of a substance. Students will apply the mathematical calculation of density which is equal to mass divided by the volume of an object to determine the density of marbles. (see appendix)
 - Station4: Students will focus on calculating densities of substances through mathematical equations and calculations. Once students have completed the math questions in the text, they will devise 5 of their own questions and pass them around the group. Students will engage in a peer assessment based on mathematical calculations of density.

e. Critical Questions

1. What physical property do the following substances have in common: water, oil, mercury, and alcohol?
2. What will happen to an object placed in water if the object’s density is less than the water’s density?

f. Closure

To end the lesson, I will ask the review questions of the students. I will review the main points of the lesson and redefine the important terms learned earlier. I then will discuss the following day's activities, which will be about reinforcing the physical properties of an object and in particular determining densities of various liquids, so that they will be prepared for the upcoming lessons.

6. EVALUATION STRATEGIES

Students will be evaluated based on teacher observations, question and answer review sessions, as well as performance based through lab activities and peer work evaluation sheets. Homework and class work will be marked as complete or incomplete. Students with an incomplete assignment will receive a five point deduction from their homework grade for each one not completed. To ensure understanding on home assignments, students will check their answers with their peers. Performance based lab activities will be evaluated based on a rubric (see appendix). Data/ Lab sheets will be collected and marked based on the *Access Excellence @ the National Health Museum* rubric for a general science lab.

7. REFLECTION:

[leave blank - to be completed after instruction. This is your reflective presentation in the final week of classes]

8. ATTACHMENTS:

- a. Handouts, scientist notebooks, journals, worksheets. You must prepare and attach all teaching materials (see appendix)
- b. Assessments, if paper-based. Rubrics for scoring assessments. (see below)
- c. References/ Bibliography

References

1. Cuevas, M., and Vonderbrink, S. (2005). *Introduction to Matter*. Holt, Rinehart, and Winston, a Harcourt Education Company: Austin, Tx.
2. *Matter*. (2005). Grolier Online. Scholastic Library Publishing, Inc. Retrieved on November 12, 2005.
3. Nakleh, M., Samarapungavan, A., and Saglam, Y. (2004). *Middle School Students' Beliefs about Matter*. *Journal of Research in Science Teaching*: Vol.42 No.5 pp. 582-612.
4. National Research Council. (2000). *Inquiry and the National Science Education Standards: A Guide for Teaching and Learning*. National Academy Press: Washington, DC.
5. *The American Heritage® Dictionary of the English Language, Fourth Edition*. Copyright © 2000 by Houghton Mifflin Company.

Peer Work Evaluation Sheets

Rating Scale:

Today, my peer demonstrated: (4) Excellent Team work (3) Good Team work (2) Satisfactory Team Work (1) Weak Team Work

Date: _____ Station # _____ Your Name _____

	<u>Name:</u>	<u>Work done today (Role):</u>	<u>Rating</u>
1.	_____	- _____	_____
2.	_____	- _____	_____
3.	_____	- _____	_____
4.	_____	- _____	_____
5.	_____	- _____	_____
6.	_____	- _____	_____
7.	_____	- _____	_____



Peer Work Evaluation Sheets

Rating Scale:

Today, my peer demonstrated: (4) Excellent Team work (3) Good Team work (2) Satisfactory Team Work (1) Weak Team Work

Date: _____ Station # _____ Your Name _____

	<u>Name:</u>	<u>Work done today (Role):</u>	<u>Rating</u>
1.	_____	- _____	_____
2.	_____	- _____	_____
3.	_____	- _____	_____
4.	_____	- _____	_____
5.	_____	- _____	_____
6.	_____	- _____	_____
7.	_____	- _____	_____

Teacher Observation Rubric:

Is the student:	Rating Scale + or -
• On task	_____
• Demonstrating Understanding	_____
• Following directions	_____
• Speaking scientifically	_____
• Engaged in the activity	_____

Q&A Rubric:

- Student willingly participates by raising hand _____ / 1pt
- Student answers question accurately _____ / 1pt
- Student demonstrates understanding _____ / 1pt
- Student answers in a complete sentence _____ / 1pt
- Students is confident with response _____ / 1pt
- Total _____ / 5pts

General Science Lab Rubric

	Distinguished (3)	Satisfactory (2)	Borderline (1)	Unsatisfactory (0)
FORMAT				
Title Page	Contains title, name, date, course, teacher, period.	Missing one except title or name.	Missing two except title or name.	Missing more than two, or title or name.
Sequence	Logically sequenced: Question, Hypoth., Test, Mater./Proc., Data, Anal./Conclusion. All present.	Not more than one category missing or out of sequence.	Not more than 2 categories missing or out of sequence.	More than 2 categories missing or out of sequence.
Clarity	Lab report sections clearly distinct from each other; grammatically correct English; figures/graphs correctly titled & labeled.	Sections clearly labeled but not separated; English generally correct; figures/graphs correctly labeled but not titled.	Sections labeled but not separated; frequent errors in grammar; figures/graphs labeled but contain errors in units, axes or headings.	Sections not labeled nor separated; English poor; figures/graphs not titled nor labeled.
REPRODUCIBILITY				
Hypothesis	Clear explanation of purpose; educates by providing context.	Gives a correct purpose with some framework	Declares a purpose that is correct.	Purpose is incorrect.
Design	Clear step-by-step description of experimental procedures; labeled diagrams/drawings of any apparatuses/devices used to carry out the experiment.	Step-by-step description that misses not more than one key detail; diagrams/drawings included but not labeled	Step-by-step description that misses not more than two key details; apparatuses/devices mentioned but not shown.	Description lacks more than two key details; no mention of apparatuses/devices used to carry out the experiment.
Detail	Includes formulas/calculations used to analyze data & explains their use. Records observations and explains their import. All original	Includes formulas and calculations used to analyze data. Records observations, sometimes their import. Most	Includes formulas and some calculations used to analyze data. Records some observations. Some original data	Does not include formulas nor calculations used to analyze data. No observations noted. Original data not present.

	data included.	original data included.	included.	
ACCURACY				
Units	Units are used correctly and consistently throughout the report.	Units generally used correctly in most of report	Units used only in some key parts of report.	Units are rarely used or are generally incorrect.
Data Manipulation	Calculations clearly laid out. Dimensional analysis/Math correct. Figures display data correctly, all variables labeled.	Calculations contain few errors in dimensional analysis or math. Figures correct, variables unlabeled.	Calculations contain some errors in dimensional analysis or math. Figures correct. No labels or legend.	Dimensional is analysis not used. Math not shown. Figures display data incorrectly.
CONCLUSION				
Framework	Restates the hypothesis, supports or refutes it and explains the role of the test in making the decision.	Restates the hypothesis and supports or refutes it.	Supports or refutes the hypothesis without restating it.	Does not address the hypothesis.
Evidence	Uses data powerfully as evidence to support statements.	Uses data to support statements.	Refers to data in the body of the report as support.	Does not use data to support arguments
Logic	Conclusion is logically forced from data and prior knowledge.	Conclusion is logical but not thoroughly defended.	The conclusion is logical but poorly defended	The conclusion is incorrect.
Error	Identifies sources of error and explains effect on results.	Identifies sources of error.	Suggests possibility of error but identifies no sources.	Does not address possibility of error.
Context	The expt. is made meaningful by discussion of its scientific or societal implications; proposals for further investigation are made.	An application or use of the work is provided; a proposal for further investigation is made.	The work is generally ascribed to be useful but no rationale is provided for thinking so.	No relevance is provided for the work.

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