

SCIENCE 8 Candle Inquiry Lab

Science 8

Block: _____

Physical and Chemical Changes

first and last Name: _____

Partner's names: _____

Date of lab experiment: _____

PURPOSE: (also called an Objective)

In this lab you will light a candle and perform various tests to discover some things about burning and about candles. You will learn the practice of scientific observation.

Observation is not the same as seeing. If five people see the same movie and then are each asked to tell about it you will hear five different stories. Some of the people are more observant than others or have better memories. You can make your memory better by carefully writing down your observations and you can become more observant by practicing. In fact, start by watching this video together as a class: https://www.youtube.com/watch?v=IGQmdoK_ZfY.

When you complete your work on this lab you will be able to answer the following questions based on your observations:

1. What happens to the candle when you light it?
2. Can you prove that the candle needs oxygen in order to burn?
3. Can you prove that the candle produces carbon dioxide when it burns?
4. Can you prove that the candle produces water when it burns?
5. What happens when you hold a piece of glass in different parts of the flame? What do these results say about the process of burning wax in a candle?
6. Is it possible to light a candle without touching the flame directly to the wick? Why or why not?

Materials

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|---|------------------|
| candle | watch glass |
| matches | beakers |
| safety goggles | ruler |
| lab experiment handout | pens and pencils |
| digital balance or triple / four beam balance | |

Safety

Tie back loose hair and clothing. When doing lab experiments, you should wear long pants without holes and closed-toe, closed-heel shoes. Wear safety goggles throughout the activity. Conduct yourself in a professional manner, in order to demonstrate that you are capable of behaving safely in a laboratory setting. Follow the procedure carefully in order to be allowed to continue to take part in future lab experiments.

Background – The Relevant Theory of this Lab Experiment

You will be observing a candle and what happens when you light one. To understand what you are observing a little background would help. When you light a candle, you initiate a type of chemical reaction called a **combustion reaction**.

This reaction can be written in chemical shorthand as:

hydrocarbons + oxygen (O_2) \longrightarrow carbon dioxide (CO_2) + water (H_2O) + heat/light

or

$C_nH_{2n+2} + O_2 \longrightarrow CO_2 + H_2O + \text{heat/light}$

You can tell that a chemical reaction is occurring because of the heat and light: a sure sign of a chemical change. Combustion reactions require three things: fuel (hydrocarbons), oxygen, and a source of ignition. Hydrocarbons are molecules made up of hydrogen and carbon and are in fact what make up such things as gasoline, fuel oil and propane. Candles are made of hydrocarbon wax. Oxygen is supplied by the atmosphere and you supply the ignition (a match). One point of some importance is that different phases of matter burn at different rates. Solids burn more slowly than liquids and liquids burn more slowly than gases.

Combustion can be an imperfect process. That is, some of the hydrocarbons may not burn completely. When that happens several carbon-containing products can form besides carbon dioxide. First, carbon monoxide (a highly toxic gas) can form. This is only dangerous in cases of burning charcoal indoors or using a gas-powered generator in a closed space. Second, incomplete combustion can result in pure carbon: the hydrogen is burned away (it combines with oxygen to become water) and the carbon stays behind unburnt.

It may seem odd to think that burning the candle produces water but it is a fact even so. Water is a compound of hydrogen and oxygen and when those two elements combine the most common compound is H_2O . It is hard to see the water that results from burning the candle because it is a gas (steam) and it is invisible.

Carbon dioxide is a colorless, odorless gas. As it forms in a combustion reaction it is very hot and therefore has a lower density than air. This causes it to rise. When water containing calcium hydroxide ($Ca(OH)_2$) is exposed to CO_2 the carbon dioxide reacts with the $Ca(OH)_2$ to form insoluble calcium carbonate ($CaCO_3$, also called limestone). This substance is white and when the reaction occurs it makes the water turn cloudy. Water with $Ca(OH)_2$ dissolved in it is called limewater.

In this lab you will make a series of observations. The purpose of doing so is to hone your observation skills for the labs you will do in the future and to learn something about an object you may have taken for granted.

Objective One

Making Scientific Observations

DATA TABLE

Record some quantitative observations (**quantities!**) about the candle before you light it. Consider the following question before you start: does the candle's mass change over time?

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Observations of the Candle

Record some qualitative observations (**qualities!**) about the candle before you light it.

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Finally, record the sequence of events that occurs as you light the candle.
Try to be as detailed as possible.
These observations will be qualitative and should be as organized as possible.
Check in with your teacher to be sure you have not missed any important observations.

Reminder: each lab group member should write their own observations!

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Objective Two

Candles Use Oxygen as They Burn

In order to undergo the chemical change called combustion, candles require oxygen. Oxygen is a gas that makes up about 20% of the Earth's atmosphere (by volume).

**Can you prove that oxygen from the air is required for the candle to burn?
Devise and carry out an experiment.**

Write down the steps of your experiment.

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Perform your experiment. Be sure to record any data (quantities) and observations (qualities) you may make while carrying out your experiment.

Check in with your teacher to be sure you have not missed any important observations.

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Objective Three

Candles Produce Water as They Burn

When hydrocarbon materials such as candle wax burns, they produce water (H_2O). Burning (combustion) is a heat-releasing process and the chemical products are hot. If there is water present you will have to provide a way to cool it down in order to see it.

Can you prove that candles do make H_2O ?
Devise and carry out an experiment.

Write down the steps of your experiment.

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Perform your experiment. Be sure to record any data (quantities) and observations (qualities) you may make while carrying out your experiment.

Check in with your teacher to be sure you have not missed any important observations.

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Objective Four

Flames Can Be Surprising

Ask your teacher to do the Jumping Flame trick for you. Then try it yourself!
Then answer the questions below.

1. Describe how to perform the Jumping Flame trick in your own words, step-by-step.

2. What makes the trick possible? In other words, how is the match flame carried back to the wick?

ANALYSIS and INTERPRETATION of RESULTS:

Answer each of the following questions in full sentences. Be sure to clearly communicate your understanding by using Scientific terminology and experimental evidence to explain each answer.

1. What evidence do you have that candles require oxygen to burn?

2. What evidence do you have that candles produce water vapor while burning?

3. What part of this experiment provided clear evidence of a Physical change?
Be sure to include the definition or meaning of Physical change in your answer.

4. What part of this experiment provided clear evidence of a Chemical change?
Be sure to include the definition or meaning of Chemical change in your answer.

These questions are for those students who choose to EXTEND on CONCEPTS:

These are OPTIONAL QUESTIONS, for students who wish to examine this in more detail. Answer these questions fully on a separate piece of paper.

5. When you light a candle for the first time the flame grows, then shrinks, then grows again. Explain why this occurs.
6. What is it that is burning in a candle: the wick, the solid wax, the melted wax, or vaporized wax? Justify your answer.
7. Candles get smaller as they burn; explain why.

RUBRIC

Curricular Competency: Planning and Conducting

Objective One *Making Scientific Observations*

- Observe, measure, and record data (**qualitative and quantitative**)
- Ensure that safety and ethical guidelines are followed in their investigations

| BEGINNING | DEVELOPING | PROFICIENT | EXTENDING |
|------------------|--|--|---|
| A good start. | Could add more measurements, details, units. | Data table is comprehensive and includes units. | Went above and beyond to find values to measure, by seeking out extra equipment and steps. |
| A good start | Could add more descriptions, details . | Qualitative observations are detailed. Student recorded as many as possible. | Went above and beyond to describe aspects of the investigation that were not immediately evident. |

Objective Two *Candles Use Oxygen as They Burn*

Objective Three *Candles Produce Water as They Burn*

- Collaboratively plan a range of investigation types to answer their questions or solve problems they have identified

| BEGINNING | DEVELOPING | PROFICIENT | EXTENDING |
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| A good start | Could add more details of experimental plan or revise / improve their plan. | Descriptive details of an effectively designed experimental procedure. | Sophisticated experimental steps that were articulated very clearly. |
| A good start | Could add more descriptions, details . | Observations are detailed. Students recorded as many as possible. | Very descriptive and thorough data and observations. |

Curricular Competency: Evaluating

Objective Two *Candles Use Oxygen as They Burn*

Objective Three *Candles Produce Water as They Burn*

Analysis and Interpreting Questions and 2

- Reflect on their investigation methods and the quality of the data collected
- Demonstrate an understanding and appreciation of evidence (qualitative and quantitative)

| BEGINNING | DEVELOPING | PROFICIENT | EXTENDING |
|--------------|---|---|---|
| A good start | Needs to connect their answers more directly to data and observations, to evaluate the results. | In the answers to questions 1 and 2, student uses data and observations to explain their answers. | Answers to questions 1 and 2 elaborate on the evidence that was collected and convey deeper meaning in their responses. |

RUBRIC – PROCESSING and ANALYZING INFORMATION

Objective Four *Flames Can Be Surprising*

Analysis and Interpreting Questions 3 and 4

- Seek patterns and connections in data from their own investigations
- Use scientific understandings to identify relationships and draw conclusions

| BEGINNING | DEVELOPING | PROFICIENT | EXTENDING |
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| A good start | Answer to the <i>Flames can be surprising</i> questions need to connect more to scientific understandings to evaluate the results. | Answer to the <i>Flames can be surprising</i> questions uses scientific language to communicate relationships. | Answer to the <i>Flames can be surprising</i> questions show analysis and interpretation of evidence and the use of scientific understandings to identify relationships. |
| A good start | Needs to connect their answers to questions 3 and 4 more directly to data and observations and definitions of terms. | Answers to questions 3 and 4 elaborate on the evidence that was collected and convey the meaning of the terms. | EXTENDING questions 5, 6, 7 were completed and the student was able to elaborate on the evidence that was collected and convey the meaning of the terms in their responses. |