The Candle Lab Name _____

(rev 2019-11-1)

Introduction

Fire has long fascinated the human spirit. Even today people enjoy sitting around a campfire or a fireplace and watching the activity of the flames. The references to fire and flames in art and literature throughout the ages are too numerous to mention. Scientists have also been intrigued by the process of burning. Have you ever thought about what happens when something burns?

Materials

ruler
timing device (stopwatch, watch, smartphone)
plumber's candle
matches
600 mL (or 1000 mL) beaker
cobalt(II) chloride test paper
1000 mL Erlenmeyer flask
500 mL Erlenmeyer flask
bromothymol blue indicator
glass tubing
test tube holder
crucible
copper wire (bent into a spiral)
metal spoon
candle wicking

Determining how a candle burns

You will conduct a series of tests to elucidate how a candle burns (that is how the wax, wick, flame, and surroundings) come into play to produce a continually burning flame.

Safety precautions:

- Wear protective eyewear at all times.
- Do not touch any hot materials or surfaces without using appropriate protection, *i.e.* hot hands.

Hypothesis

A hypothesis is a testable statement that is based on observation. Watch a candle burn. Based on this observation, write down your hypothesis that explains how the wax, wick, flame, and surroundings contribute to candle burning. **Your hypothesis needs to be written at the top of your notes before the start of laboratory experimentation**.

Procedure

Record (using the two-column format) all steps and observations in your work to elucidate how a candle burns. Note there are guiding questions after each test. Leave space in your notes after each test so that you can go back and try to answer them. When you go back and try to

answer the guiding questions, you will no longer be making observations but you will be making inferences. You should clearly indicate (in your notes) that what you are providing is an inference. Your ability to argue that changes have occurred will be strengthened if you have observations before, during and after the change to support any claims.

1. Before doing any of the following tests, write a description of the candle and measure the candle's mass and length
2. Light the candle (and note the time that you first light the candle). Carefully note the appearance of the burning candle and include a labeled diagram.

Test 1

1. Light the candle
2. Invert a large beaker (600 mL or 1000 mL) over the lit candle (*make sure the beaker is room temp before starting*). Hold the beaker at a slight angle above the flame (the opening of the beaker should be at roughly flame height).
3. Note any changes to the beaker. If any substance forms, test it with the cobalt(II) chloride test paper (**note: what does the cobalt(II) chloride test paper test for? you will need to find this out**)

Guiding questions: Think about what the results of this test will tell you about the burning process? Where did the elements that make up the substance formed come from?

Test 2

1. Light the candle
2. Invert a 1000 mL Erlenmeyer over the burning candle (holding the opening of the Erlenmeyer flask right at the top of the wax) and record how long it takes the flame to extinguish.
3. Repeat step 2. with a 500 mL Erlenmeyer

Guiding questions: What do the results tell you about the burning process? What can you infer from any differences you observe? What can you not say about the burning process based on this test?

Test 3

1. Light the candle
2. Obtain approximately 10 mL bromothymol blue solution.
3. Invert a 500 mL Erlenmeyer over the top of the candle and wait for the flame to extinguish.
4. Immediately turn the Erlenmeyer right side up and add bromothymol blue solution. Cover the flask with your hand and swirl. What observations do you observe?

Guiding questions: You may have used bromothymol blue as an indicator before. What do the results of this test tell you about the burning process?

Test 4

1. Light the candle
2. Obtain a piece of glass tubing with a test tube holder

3. Using the test tube holder, hold the glass tube upwards at a 45° angle and move it into the flame. What comes out of the glass tube? Can you ignite the material coming out of the tube?
4. Move the glass tube closer to the center of the flame (by the wick). What comes out of the tube? Can you ignite the material coming out of the tube?

Guiding questions: Did you observe any differences when the glass tube was held in different parts of the flame? What do the results of this test tell you about the burning process?

Test 5

1. Put a small amount of wax into a crucible and try to ignite the solid wax.
2. Light the candle
3. Using the candle, heat up the wax in the crucible (using forceps to hold the crucible) until it is a liquid. Can you ignite the liquid wax?

Guiding questions: What do your results indicate about the state of the wax in burning and the role of the flame (vis-a-vis the wax)?

Test 6

1. Light the candle and let it burn until you have a large pool of wax
2. Crush a small piece of a burnt match between your fingers and let some of the fine particles fall into the liquid wax. What do you observe about the motion of the candle particles? Include a diagram in your observations.

Guiding questions: What do the results of this experiment tell you about the behavior of the wax during the burning process?

Test 7

1. Light the candle
2. Obtain a piece of copper wire that is wound into a spiral.
3. Lower the spiral around the wick. What happens to the flame?
4. Remove the spiral. What happens to the flame?

Guiding questions: Copper is a metal. What are the properties of metals? What does the behavior of the flame with and without the copper tell you about the flame itself?

Test 8

1. Light the candle
2. Hold the bottom of a metal spoon 5 cm above the flame for 5 seconds. What, if any, changes do you observe to the bottom of the spoon? (compare to the block of graphite in the lab)
3. Hold the bottom of the metal spoon in the middle of the flame for 5 seconds. What, if any changes do you observe to the bottom of the spoon? (compare to the block of graphite in the lab)

Guiding questions: What differences do you observe? Given the results, can you provide an explanation for the differences in outcome?

Test 9

1. Obtain a 5 cm piece of candle wicking and hold one end with forceps (hold the wicking so that it points up not down).
2. Ignite the end of the wick and time how long it takes to burn.
3. Light the candle and let it burn for the same amount of time that the wick burnt. What length of candle burnt?

Guiding questions: How much heat and light were given off by the wicking? How much heat and light are given off by the candle? How long did it take 5 cm of wick to burn? How long did it take 5 cm of candle to burn? Can you explain the differences?

Test 10

1. Light the candle and let it burn for 30 seconds
2. Light a match in preparation for the next step
3. Gently blow out the candle and immediately bring the lit match towards the candle (go slowly and do not let the match touch the wick). What do you observe?

Guiding questions: What do the results of this test tell you about the burning process?

Wrap-up

1. Remeasure the length and mass of the candle now that all of the tests are done and note the time. Write down an estimate for how long you think your candle burnt as you conducted all the tests.

Candle lab guidelines

A complete laboratory submission will include: your laboratory notes and the write-up

Laboratory Write-up

Heading

Your Name
Lab Partner
Block
Date Submitted

Title

Your title must be original (not *Candle Lab*), specific, and descriptive (concisely convey what was done and how it was done in the experiment).

Introduction

In an introduction, you are summarizing what are the important concepts for the reader to know so that they can understand the lab. For this lab, that would include what combustion is. If you use your textbook or a website in gathering information for your write-up, you need to properly cite those sources. At the end of the introduction, you give a brief (1 sentence, maybe 2) exposition for what the purpose is for the experiment(s) being written about in this write-up. **You also need to include the hypothesis that you were testing.**

Materials and Methods

As seen previously, the materials and methods section, has two components. The first is a short paragraph that lists all of the materials used in the laboratory experiment and their origin. Writing this section will feel strange as it does not follow the rules of prescribed English writing.

The methods section is where you are reporting to the reader (assumed to be someone equally -- but not more -- educated than yourself on the topic) everything that you did in the laboratory. The goal is to convey in concise and clear language the method by which you conducted your experiment. The person reading the methods paragraph(s) should be able to go into the laboratory and redo what you did (without any other guidance). You can organize your methods by each test.

Results

A results section is where all of the data and calculations for an experiment are presented. The data is presented dispassionately and disinterestedly, which is to say that you **do not** talk about the data and especially not write your inferences in the results section.

The data should be presented in a clear and organized style. Data should be organized into tables (with appropriate titles) and/or graphs (with appropriate titles and axes labels). You should make sure to include the qualitative descriptions of the candle and the candle burning. You should then organize your results (in a combination of tables and short paragraphs) in a way that is clear (it may be best to organize your results by commonalities rather than by individual tests).

Discussion

A discussion section is where you provide your analysis of the data. It is here that you will make inferences and lead the reader to any and all conclusions from your data. Since you will be referencing your data and calculations, you will want to explicitly tell the reader where they can find the data you are discussing: "Looking at the data in **Table 1** . . .". Also, do not assume your reader will see the same patterns or relationships between the data. Explain where the data are and what you are inferring from them.

In this write-up discussion, you should discuss the result(s) of your work: specifically, you need to address how a candle burns. You need to address how the flame, the wick, the wax, and the surroundings work in concert to create a burning candle. Just like in the Unknown Metal Lab, you do not have to have the "right" answer, but your claims need to be supported by evidence and reasoning. What we will be looking for is that your conclusions are logically supported by your results. You should also address whether the results support your hypothesis or refute your hypothesis. At this stage, you should state what ideas you have that you could take to improve the laboratory or to really nail down some uncertainties that might remain.

Conclusion

This should be a single, short paragraph. You restate the main points of your experiment such that the reader can get a summary of what happened. First, state what was done in the lab. Second, state what the key results where. Third, state the key conclusion or inference that

could be drawn from the experiment(s). Fourth, if applicable, state what takeaways one could draw from having done this experiment.