The Chemical History of a Candle

**Background:** Modern Chemistry involves the use of many sophisticated instruments for the collection of the data that will be used to discover new things about our physical and biological worlds. However, all of chemistry is based on relatively simple observations of the various phenomena that surround us. Probably one of the most significant advances in the development of the human race was the study and ultimate control of fire. A wide variety of chemical and physical properties and phenomena can be observed with a system as seemingly simple as a burning candle. In December 1860, the English chemist, Michael Faraday, presented his now famous series of Christmas lectures for young people, entitled “The Chemical History of a Candle,” in which a large number of experiments, observations of chemical facts, and the development of chemical thinking were based on a candle.

**Prelab:**
Using this excerpt from “The Chemical History of a Candle”, answer the pre-lab questions in complete sentences.

*Now the only reason why the candle does not burn all down the side of the wick is that the melted wax extinguishes the flame. You know that a candle, if turned upside down, so as to allow the fuel to run upon the wick, will be put out. The reason is, that the flame has not had time to make the fuel hot enough to burn, as it does above, where it is carried in small quantities into the wick, and has all the effect of the heat exercised upon it.*

1. When you light a candle, what is actually burning (hint: it’s not the cotton on the wick).
2. What physical changes occur when a candle burns?
3. What chemical changes occur when a candle burns?

I. **Purpose**
What are the physical and chemical properties of a candle?

II. **Materials**
Candle, matches, 250 mL beaker, baking soda, vinegar, ice

III. **Procedure**
1. Describe the candle in as much detail as possible. Be sure to include physical properties such as color, texture, shape, dimensions, weight, volume, density, etc. To estimate the volume of your candle, use the volume of a cylinder ($\pi r^2 h$).
2. Candle wax is typically composed of long-chain hydrocarbons (containing only hydrogen and carbon), such as $C_{27}H_{56}$. When Hydrocarbons are burned in an excess of oxygen, carbon dioxide and water are the products. This is a combustion reaction.

$$C_{27}H_{56} + 41 O_2 \rightarrow 27 CO_2 + 28 H_2O$$

Light the candle and note the pool of liquid which forms. Record your observations.
3. Light a match. Blow out the candle, then quickly bring the lighted match slightly above, but not touching the wick. Describe what happens.
4. Hold your hand several inches above the candle flame (not too close). What do you observe?
5. Mass 30 g of baking soda into a weigh boat. Pour 20 mL of vinegar into a 250 mL beaker. Light the candle. Add the baking soda to the vinegar. As soon as the bubbling stops, pour the gas from the beaker onto the lit candle by holding the beaker sideways above the candle. NOTE: Do not pour any liquid out of the beaker onto the candle. What happens to the candle; record your observations in the data chart. Pour the contents of the beaker down the drain, rinse and dry the beaker.
6. Place 3 pieces of ice in a 250 mL beaker and hold the beaker several inches over the flame until you see a slight change on the bottom of the beaker. Be careful not to let the glass get so hot that it is burns you. Record what happens to the bottom of the beaker. Empty and dry the beaker.
7. Invert and lower the empty and dry 250 mL beaker over the lit candle and describe what happens to the flame. Record your observation in your data chart.
8. Allow the extinguished candle to cool. Again describe its physical properties as you did in step 1.
IV. Data Table: Allow 3 lines for every observation.

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<th>Procedure #</th>
<th>Observations</th>
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V. Calculations None for this lab.

VI. Questions
1. Is the formation of the liquid in procedure # 2 a physical or chemical change? Is the formation of the gas in procedure # 2 a physical or a chemical change? How can you tell?
2. Based on your results in procedure # 3, what state (solid, liquid or gas) is the candle wax in as it is being burned?
3. Based on your results in procedure # 4, why is the match needed to start the candle burning?
4. Based on your results in procedure #5, what must be one of the products of the reaction of baking soda and vinegar?
5. Based on your results from procedure #6, what must be one of the products of the combustion reaction of burning candle wax?
6. Based on your results from procedure #7 what component of air is necessary for combustion?
7. Now that you have observed your candle before and after the experiment, list the physical properties that are truly characteristic of the candle that you used and which are dependent on the chemical history of the candle?
8. Explain why the mass and volume of your candle changed but the density did not.

VII. Discussion of Error
Describe an errors made in this experiment. Briefly discuss how these errors could be corrected.

VIII. Conclusion
a. Claim and evidence: Summarize the results of your experiment in no more than 3 sentences.
b. Reasoning: How does your data support the scientific principle explored in this lab? This is a research section. Use your text or an outside reference.
c. Connections to the Real World: How are combustion reactions contributing to global warming?
d. Further Experiment: Give an idea for an experiment that tests the concept of combustion (burning) using fuel sources other than a candle. You may not describe the same experiment with different materials.