Combustion & Burning | A Lab Investigation

Summary

In this investigation, students are challenged to make careful observations about a burning candle to discover the chemical and physical changes that make it work.

Objective

Students will desribe their observations about a burning candle to discover the chemical and physical changes that make it work.

Safety

- Be sure to wear safety goggles while making close observations, tie your hair back if you have long hair, and always be aware of where the flame is with respect to your clothing —do not lean over the flame.
- Burning candles are open flames that can cause burns. Liquid wax is hot and can cause burns to the skin.

Materials for Each Group

- Tea light candle
- Matches
- Small beaker or evaporating dish (such as 50 mL or 100 mL)
- Balance
- Ruler or meter stick
- String (for measuring circumference)
- Stopwatch

Time Required

One class period, approximately 45–50 minutes.

Lab Tips

Tea candles can be purchased in large quantities, as can tapered candles from hardware stores. Candles of different colors, sizes, and shapes can enrich the observations made by the class.

Integrating into the Curriculum

This investigation could fit into a unit on chemical reactions.

TEACHER'S KEY

Reflecting on the Investigation

1. What phase (solid, liquid, or gas) is the wax in when it mixes with oxygen in the air and undergoes a chemical change?

   Gas

2. Based on your observations, in which phase (solid, liquid, or gas) is the wax most likely to undergo a chemical change?

   In the gas phase surrounding the wick.

3. Explain why this is the case based on your sketches of wax in solid, liquid, and gas phases.

   In the gaseous phase the wax molecules have more freedom to mix and collide with oxygen molecules in the air, and react with them to produce water and carbon dioxide.

4. How might this (your answer to question 3 above) explain a sign that says NO SMOKING near the pumps at a gas station?

   Gasoline that has vaporized near the pumps may react with oxygen if exposed to an open flame or a lit cigarette.

5. Look back at your diagrams of the candle flame. Can you identify the region where the wick itself is undergoing combustion? Where is this region?

   At the very tip of the wick, where it is glowing orange, the wick itself is burning, or reacting with oxygen in the air. Melted wax (in the process of changing into gaseous wax) coats the rest of the wick.

6. What is fire? Is it matter or is it energy? Explain your answer.

   Both. What we call fire is what we see and feel when the gaseous reactants and products of combustion release energy in the form of light and thermal energy that heats the surroundings.

Extension

Further analysis problem using stoichiometry:

Given the reaction that we are using for the combustion of wax:

$$2\ C_{18}H_{38}\ (s) + 55\ O_2\ (g) \longrightarrow 36\ CO_2 + 38\ H_2O$$

Use stoichiometry relationships to calculate:

1. The volume of oxygen gas needed at STP to burn 37.5 g of wax.

   90.8 L O_2

2. The mass of carbon dioxide released when 37.5 g of wax burns.

   117 g CO_2

If less oxygen is available, one possible outcome in the combustion of wax is

$$2\ C_{18}H_{38}\ (s) + 37\ O_2\ (g) \longrightarrow 18\ C\ (s) + 18\ CO_2\ (g) + 38\ H_2O\ (g)$$

If this were to happen, what mass of soot (carbon) is produced for every 1.0 g of wax that burns?

0.42 g C

Can you think of another gas that could be produced when there is insufficient oxygen to produce CO_2?

CO