Experiment 1: OPERATION OF THE BUNSEN BURNER

INTRODUCTION:

The chemical reaction in burning natural gas is the reaction of methane (CH$_4$) with oxygen (O$_2$) in the air. If excess oxygen is used, the products would be gaseous carbon dioxide (CO$_2$) and gaseous water (H$_2$O). This is referred to as complete combustion.

\[
\text{CH}_4 (g) + 2 \text{O}_2 (g) \rightarrow \text{CO}_2 (g) + 2 \text{H}_2\text{O} (g) + \text{heat}
\]

If insufficient oxygen is available, we would have an incomplete combustion, producing poisonous carbon monoxide (CO) and soot (C), which would be undesirable. It is important to learn how to control the type of flame you get in order to avoid producing carbon monoxide and soot, as well as being able to adjust for the temperature of the flame.

Insufficient oxygen would also result in a cooler, yellow flame, called a luminous flame. The yellow color is due to small particles of soot being burned to incandescence. If we need a hotter flame, which is usually the case, we would need to introduce more oxygen, by mixing more air with the methane gas before combustion. The hotter the flame, the bluer it gets. The hottest part of the flame would be the tip of the inner blue cone of the flame.

In the diagram below, you can see there are three ways to control the flame:

(Note: This is NOT the procedure but a description of the parts of a Bunsen burner.)

- The Gas Valve (1) controls how much natural gas (methane) is piped to the Bunsen burner. When the handle is pointed straight at you, the valve is fully opened. You close the valve by turning the handle either left or right. The gas goes to the Gas Inlet through a piece of rubber tubing.
- The Needle Valve (2) at the bottom of the burner controls how much methane goes from the Gas Inlet into the Barrel (4).
- The Air Vents (3) control how much oxygen from the air is mixed with the methane. You adjust it by holding the Barrel (before it gets hot) and turning it either direction, to open or close the air vents. If you want a very hot flame, you would open the air vents to allow a maximum amount of oxygen to mix with the methane. You might have to also use the Needle Valve to allow less methane in so that there is a higher ratio of O$_2$ to CH$_4$. 

![Diagram of Bunsen burner parts](image)
Procedure: Work individually.

1. SAFETY FIRST: Remember that if your hair is longer than shoulder-length, you MUST tie it back. Move any flammable material, such as books and paper towels away from your work area.

2. First practice getting a spark out of the striker (also called a gas lighter). You need only one spark to light the flame. It is not how quickly or how many times you squeeze the handles of the striker. To create a spark you need to press the flint down on the serrated surface inside the cup while you squeeze the handle. Do NOT go on to the next step until you have mastered getting sparks out of the striker.

3. Close the Needle Valve (2) at the bottom of the burner then open it one full turn (360°).

4. Rotate the Barrel (4) until all of the Air Vents (3) are totally closed.

5. Turn the gas on full with the Gas Valve (1) and light the burner with the striker.

   **Question 1:** What is the color of the flame? *Answer this and all subsequent questions in full sentences in your lab notebook. Reading the Introduction section will be helpful!*

6. Rotate the Barrel until the Air Vents are fully open. If the flame goes out, turn down the gas slightly with the Gas Valve and relight the flame.

   **Question 2:** What is the color and appearance of the flame now? Is it what we consider a luminous flame or a hot blue flame?

7. Turn the Needle Valve at the bottom of the burner first one way and then the other way to see what effect your action has on the color and appearance of the flame. Do not turn it so far that the flame goes out.

   **Question 3:** Explain why closing (tightening) the Needle Valve would give a smaller but more intense blue, roaring flame. *Hint: Reread the Introduction section.*

8. In this next step you need to be very observant as you cannot repeat it. Take a 400-mL beaker from your drawer. Hold it by the rim, and while keeping your eyes on the surface of the beaker, pass the bottom of the beaker quickly through the flame once.

   **Question 4:** Did you see anything happen to the surface of the beaker? If you didn’t see anything, do it again, with a different beaker. Provide a reason for what you saw.

   *Hint: Examine the chemical equation in the Introduction section of this experiment.*