

Knowledge Domain: Mechanical
Unit: Calibration
Skill: Oxygen Concentration Measurement

Tools and Parts Required:

1. **Wide basin or pan**
2. **Water**
3. **Adhesive substance** eg. putty, chewing gum or gluestick
4. **Glass Bottle** 90-220ml, eg. food jar, beaker (must be glass).
5. **Aluminum foil** Enough to cover mouth of bottle
6. **Small candles** ~75% bottle height, much narrower than mouth of bottle
7. **Lighter or matches**
8. **Electrical tape**
9. **Wooden stick** <4cm, narrower than mouth of bottle
10. **Volume measurer** eg. graduated cylinder, syringe, or measuring cups
11. **Dishwashing soap**
12. **Spreading utensil** eg. butter knife
13. **Marker**
14. **Pencil**
15. **Paper**
16. **Safety goggles (optional)**
17. **Heat-resistant gloves (optional)**
18. **O₂ Concentrator or O₂ Cylinder with tubing**

Introduction

This test measures the concentration of oxygen in a sample of air. This test can be used to measure the output oxygen concentration of an oxygen concentrator. Oxygen concentrators must be tested to insure that they are functioning properly.

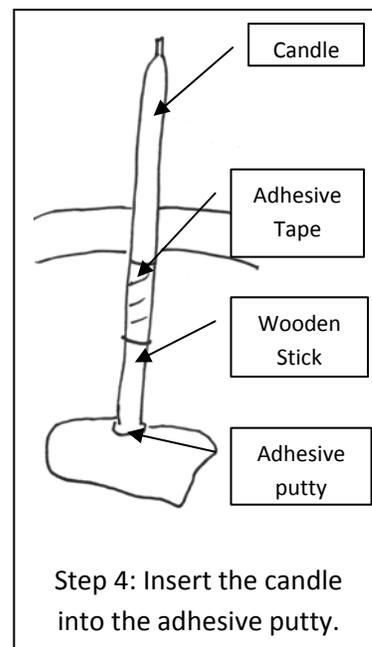
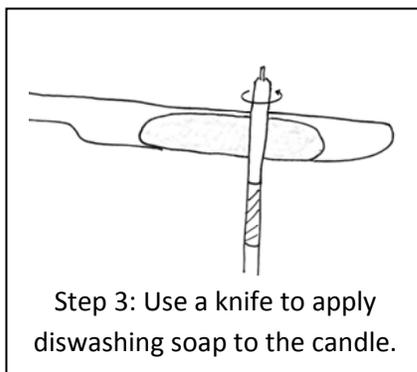
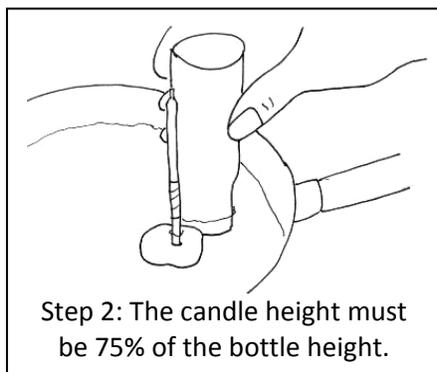
Identification and Diagnosis

An oxygen concentrator device provides concentrated oxygen to the patient. It is important to know that the device can deliver concentrated oxygen. Use this method to measure the concentration of oxygen provided by the oxygen concentrator. The measurement is based on a change in the volume of gas that occurs during a combustion reaction. Record the measurements on a piece of paper. You may want an assistant for help.

Procedure

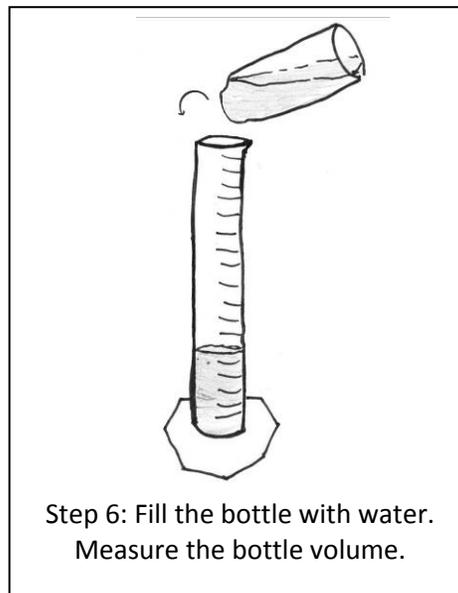
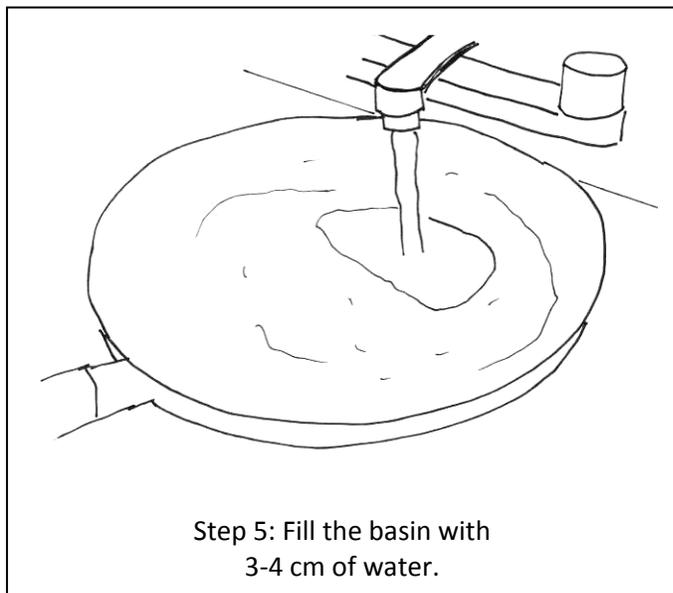
Preparation

- 1) Find a glass bottle that holds 90 to 220 ml of liquid. You can use a lab beaker, or any food jar, such as pickle, jam, peanut butter jars.
 - The bottle must be glass. Plastic will melt and change shape with the candle flame. The oxygen measurement will not be accurate with a plastic bottle.
 - The bottle must be between 90-220 ml. This volume range has been tested for accuracy. If your bottle is larger or smaller, the oxygen measurement will not be accurate.
- 2) Find a candle of appropriate height and thickness.
 - The candle height must be 75% of the bottle height. If the candle is too short, extend the candle by taping a wooden stick to the candle. If the candle is too long, cut off the top end with a heated butter knife or scissors.
 - The candle should fit into the mouth of the bottle. If the candle is too thick, use the butter knife to scrape the candle in a rotating motion until it is the correct size.
- 3) Using a knife or other spreading utensil, apply dishwashing soap to the candle. The soap protects the wax from burning too quickly. If you do not soap the candle, it will flame too quickly. **Do not soap the wick of the candle.**
- 4) Insert the candle into the adhesive putty (or gum or gluestick). The adhesive putty should hold the candle upright. Insure that the bottle can be lowered over the candle. Stick the adhesive putty and the attached candle to the bottom of the basin. Insure that the apparatus is secure.



- 5) Fill the basin with 3-4 cm of water.

- 6) Fill the bottle with water. Measure the bottle volume by pouring this water into a volume measuring device (graduated cylinder, syringe, or measuring cups). Record the **bottle volume**.

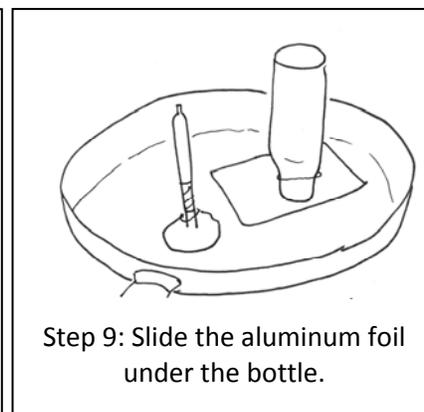
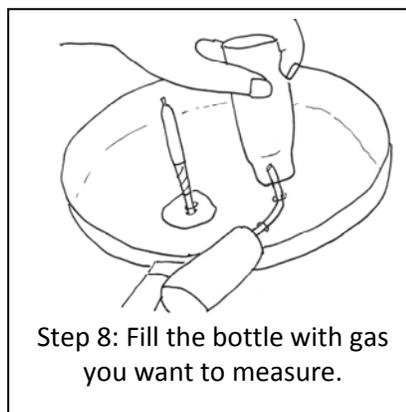
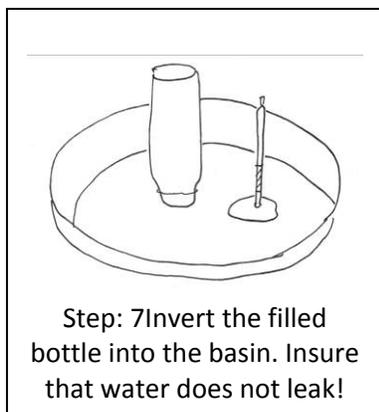


Fill the bottle with gas to be measured

(Find a partner to assist you with the remaining steps. Follow the appropriate steps for filling the bottle with oxygen, room air, or a mixture of both.)

Measuring an oxygen concentrator/cylinder:

- 7) Fill the bottle completely with water. Cover the bottle mouth with the palm of your hand and turn the bottle upside-down. Keep your hand over the bottle mouth to prevent leakage. Place your hand and the bottle into the water-filled basin. When the mouth of the bottle is underwater, remove your hand. **Insure that water does not leak out of the bottle.** The bottle should now be full of water and upside down.
- 8) Bring the oxygen concentrator close to the basin. Insert the oxygen concentrator tube under the bottle mouth. Turn on the concentrator. The oxygen will displace the water in the bottle. You should see gas bubbles entering the bottle. Fill the entire bottle with gas. The bottle mouth must remain underwater.
- 9) After the entire bottle is full of gas, remove the tube. Immediately slide the aluminum foil under the bottle mouth. Fasten the aluminum foil around the bottle mouth. Insure that the bottle remains underwater. Do not allow the oxygen to leak out.
- 10) Light the candle.



Measuring room air:

- 11) Light the candle.
- 12) Skip straight to step 16. You will not need the aluminum foil.

Measuring a mix of room air and oxygen:

- 13) Follow the steps 6, except fill the bottle only partially with water.
- 14) Follow steps 7 – 9.

Burn away the oxygen

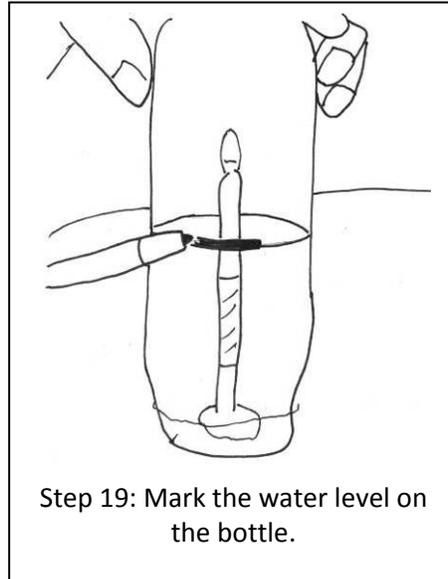
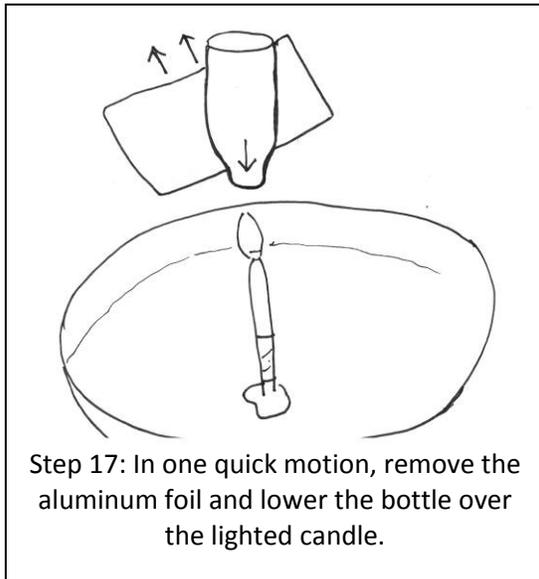
- 15) Carefully lift the bottle from the water along with the aluminum foil. Let any water on the aluminum foil drip out. Insure that the aluminum foil maintains a tight seal around the mouth of the bottle. **Do not allow the gas inside the bottle to leak out.**
- 16) Place the bottle above the flame. The bottle should be upside down and the aluminum foil-covered mouth of the bottle should be above the candle flame. **Do not allow the gas inside the bottle to leak out.**

***Note: Be careful in the next step. If you have a high concentration of oxygen, the candle flame will suddenly flare. The flame should be very big. There may be a hissing sound. Do not be frightened. The bottle will not explode.*

- 17) In one, quick motion, remove the aluminum foil from the mouth of the bottle and lower the bottle over the lighted candle. Hold the bottle down perpendicular to the basin with the bottle mouth underwater. As the flame burns oxygen, water will enter the bottle from the water basin. Insure that the mouth of the bottle remains underwater.
- 18) Wait for the flame to die out and let the water level rise in the bottle.
 - If bubbles pop around the bottle mouth, repeat the procedure. Insure that the bottle remains perpendicular to the basin.

- If the water reaches the flame before the flame dies, repeat the procedure. Make sure to re-soap the candle.

19) After the water stops entering the bottle, mark the water level on the bottle.



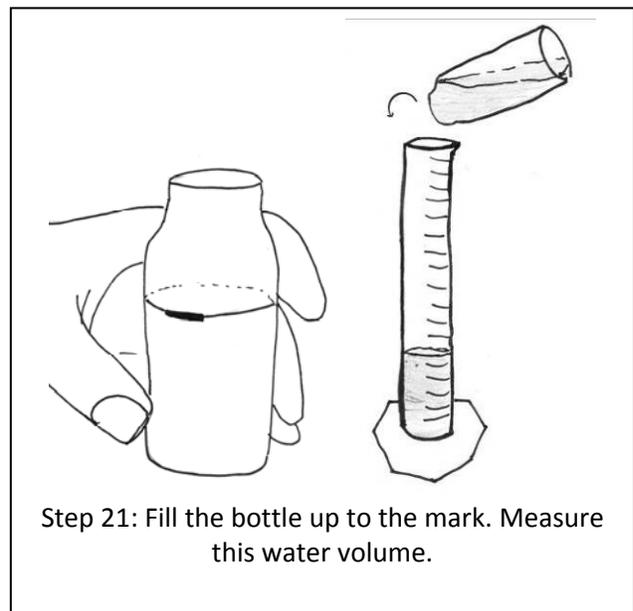
20) Remove the bottle from the basin. Fill the bottle with water to release smoke. Discard the water.

21) Fill the bottle with water up to the mark. Measure the volume of the water in mL. Record this **measured volume**.

22) Repeat the procedure with a new candle. Record the **second measured volume**.

23) Average the measured volumes obtained. Record this value as the **average volume**.

24) Refer to the chart on the following page to determine the oxygen concentration.



Exercise

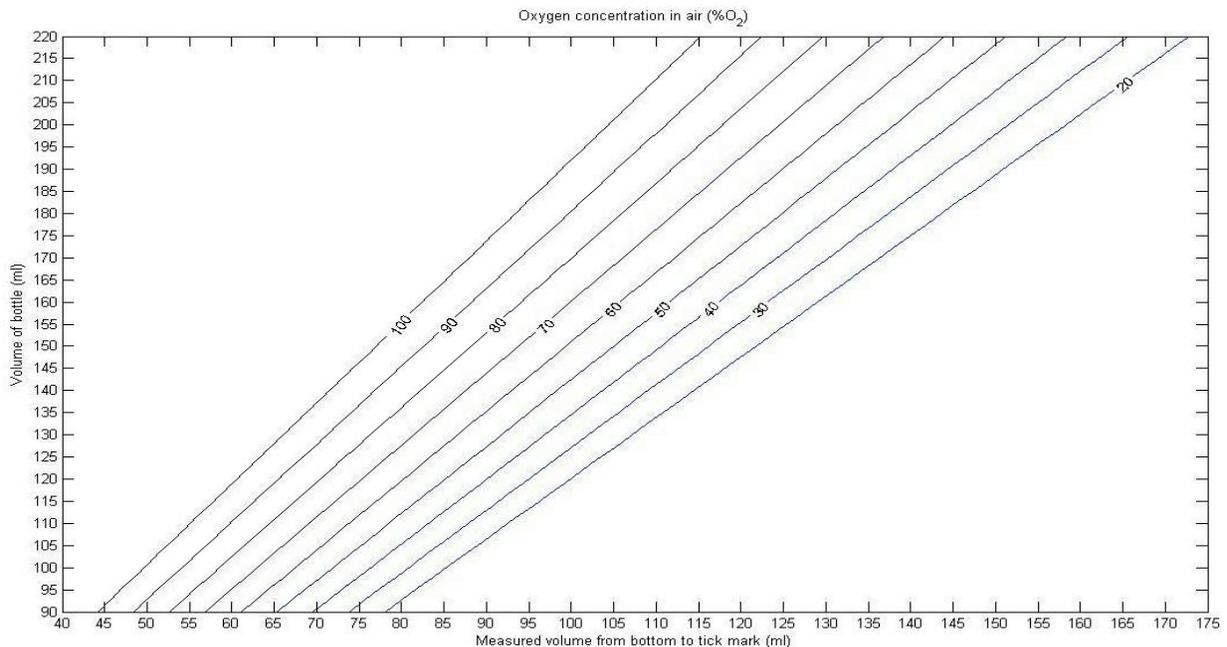
Measure the O₂ concentration with an O₂ cylinder or concentrator, room air, and a mix of the two. Follow steps 1-6 by yourself. Pair up with a partner for the remaining steps. After the first person is finished, the other partner will complete the exercise. Your instructor must verify your work before you continue.

Record your values in the following table:

	O ₂ Cylinder / O ₂ Concentrator	Room Air	Unknown Concentration
Bottle Volume			
Measured Volume #1			
Measured Volume #2			
Average Volume			
Oxygen Concentration			

To measure oxygen concentration:

1. Locate **Average measured volume** on the x-axis
2. Locate **Bottle volume** on the y-axis.
3. Locate where these two values intersect on the graph. The line closest to the intersection represents the oxygen concentration (as % O₂ in air).



Preventative Maintenance and Calibration

Insure that there are no cracks or leaks in oxygen concentrators. Check the oxygen level in the oxygen concentrators approximately every six months. Always calibrate every medical device before returning it to use.