CO_2 and Mass

Chemistry

Background: Many students believe that gases like carbon dioxide (CO_2) do not have mass. The fact is that atmospheric gases like CO_2 and methane (CH_4) have a tremendous amount of mass if you consider how much there is of them in our atmosphere.

Goal: Students will determine if CO_2 and CH_4 have mass.

Objectives: Students will …

- Identify that CO_2 and CH_4 have mass
- Use chemistry to determine the mass of CO_2 and CH_4
- Learn about the density of CH_4(g)

Materials (per lab group):

- 1 - 125ml flask
- 1 large 12 inch balloon
- 1 pin (or scissors)
- 1 microspoon spatula
- 30g of baking soda
- 60ml of vinegar
- 50ml beaker
- Triple beam balance or similar scale
- Metal pie tin
- Safety glasses for each student
- CO_2 and Mass – Data Sheet and Lab Procedure for each student
- CO_2 and mass – CH_4 Lab Procedure and Student Sheet for each student
- 60ml syringe of CH_4 from Trapping CO_2 lab
- Large bulb polyethylene transfer pipette
- Scissors
- Candle in holder
- Matches or lighter
- 3% dish soap solution
- Safety glasses for each student
- 2cm length latex tubing

Time Required: Two, 45-60 minute periods

Standards Met: S1, S2, S3, S6, S7

Procedure:

PREP

- Gather all of the necessary lab materials and run a test lab to be certain of safety procedures.
- Give each group one lab set-up.
- Explain that they will be creating CO_2 and CH_4 in class and using these gases to examine mass and density.

DAY ONE

- Review safety procedures with the students.
- Divide students into groups of 4.
- Hand out the CO_2 and Mass – Lab Procedure and CO_2 and Mass – Data Sheets and review.
- Allow students to complete the lab as they follow steps on their procedure sheets.
- Remind students to fill in Table 1 on the CO_2 and Mass – Data Sheet.
- Review clean up procedures with students and give them time to complete a thorough clean-up of their lab stations.
- Allow time to complete the CO_2 and Mass – Data Sheet and review together if time allows.

DAY TWO

- Review safety procedures with the students.
- Divide students into groups of 4.
- CO_2 and Mass-CH_4 Lab Procedure and review with the students.
- Allow students time to complete lab as they follow the steps on their CO_2 and Mass-CH_4 Lab Procedure.
- Review clean up procedures with students and give them time to complete a thorough clean up of their lab stations.
- Hand out CO_2 and Mass-CH_4 Student Sheet
- If time allows, review the answers together.

Assessment:

- Completed lab procedures
- Completed CO_2 and Mass – Data Sheet

CO_2 and Mass – Teacher Answer Key

Name: ______________________________ Date: ____________________

Hypothesis: If I attach a balloon to the mouth of a flask and inside the flask mix 30g of baking soda with 60ml of vinegar, then the balloon will___________________________.

TABLE 1

Mass of flask and balloon before reaction (grams)	Mass of flask and balloon after reaction (grams)	Mass of flask and balloon after gas has escaped (grams)	Mass of gas (CO_2) (grams)

Respond to the following:

1. Does the gas carbon dioxide have mass? Give proof for your answer.

   Yes, carbon dioxide does have mass. When the balloon was popped, and the gas escaped, the mass decreased.

2. During the reaction between the baking soda and vinegar, was any mass lost? Explain your answer.

   There was no mass lost during the reaction between the baking soda and vinegar, but the mass of the flask and its contents did slightly decrease. In order to determine the mass of a gas in a flexible container, the buoyant force of air needs to be considered. The scale is not really measuring the mass of the flask and its contents. The scale measures the force of the flask and its contents that are pressing down on it. The mass of the flask is the downward force of gravity. The mass of the flask and its contents has not changed. The chemical reaction between the vinegar and baking soda produced carbon dioxide. The atoms of the carbon dioxide gas were originally in the vinegar and baking soda. The upward buoyant force of the air on the flask has increased because its volume enlarged. The increase in the buoyant force is the reason the scale decreases.

3. What is the term for the affect that the combined weight of all the gases in our atmosphere has on us?

   The term that is used is atmospheric pressure.

4. What other type of chemical reactions produce CO_2 (give at least four)?

   Four other types of reactions that produce carbon dioxide are; cellular respiration, fermentation of ethanol, the manufacture of ammonia, and the burning of fossil fuels, such as coal, gas and oil.

CO_2 and Mass-CH_4 Teacher Answer Key

Name____ Date__________________

1. How would you describe the density of methane?

   Methane is not very heavy in comparison to other types of gases. It is lighter than air. Methane does tend to collect near the ceiling and will layer itself downward, becoming quite dense and in an enclosed space will be lethal.

2. How does the density of methane affect our climate?

   As more and more methane is generated in our atmosphere, large pools collect and even greater quantities of methane will eventually accumulate in the atmosphere that will reflect heat back on the earth. Methane is a very effective green house gas and in combination with CO_2 the effect can raise the temperature of the earth significantly.

3. What is the purpose of the soap in this lab?

   Soap helps to trap the methane in a "bubble". Methane trapped in this way can demonstrate the mass of the gas in comparison to air. Soap material helps to contain the methane and is an effective means of observing this experiment's results. The soap bubble also helps to slow the ascent of the gas.

4. Describe what happened to your bubbles when you flicked them off of your pipette and give an explanation to their behavior.

   The bubble tends to drop at first than begins to go upward. Methane is lighter than air and will float. If the bubble is not full of methane you will get a varying degree of floatation from the bubble. Either it drops to the floor, not enough methane; hovers and floats, only enough methane to counter the mass/density of the bubble; and finally if it floats, the bubble is full of methane and should be lighter than the surrounding air.

CO_2 and Mass – Lab Procedure

Materials:

- 1 - 125ml flask
- 1 large 12 inch balloon
- 1 pin (or scissors)
- 1 microspoon spatula
- 30g of baking soda
- 60ml of vinegar
- 50ml beaker
- Triple beam balance or similar scale
- Metal pie tin
- Safety glasses

Procedure:

- Be sure to wear your safety glasses!
- Double check that you have the correct materials at your lab station.
- Place the 50ml beaker on the pie tin and place it on the scale. Zero the scale by holding down the on button.
- Use the scale to measure 30g of baking soda in the 50ml beaker.
- Place the 30g of baking soda into the balloon using the microspoon spatula.
- Use the beaker to measure 60ml of vinegar, and then pour the vinegar into the 125ml flask.
- Carefully attach the balloon to the mouth of the flask keeping the balloon containing the baking soda to the side of the flask (be careful not to mix the baking soda with the vinegar).
- Place only the pie tin on the scale and zero the scale by holding down the on button.
- Place the 125ml flask and balloon setup on the pie tin that is on the scale. Find its mass and record this mass in Table 1 on the CO_2 and Mass – Data Sheet.
- Hold on tight to the balloon and lift it up, mixing the baking soda and vinegar together allowing the two materials to mix and inflate the balloon.
- Find the mass of the inflated balloon and the beaker and record in the second column in Table 1 on the CO_2 and Mass – Data Sheet.
- Puncture the balloon and let the gas escape.
- Find the mass of the deflated balloon and beaker and record in the third column in Table 1 on the CO_2 and Mass – Data Sheet.
- Determine the mass of the gas and record in the last column in Table 1 on the CO_2 and Mass – Data Sheet.
- Clean up your lab station according to your instructor's directions and answer the questions on the CO_2 and Mass – Data Sheet.

CO_2 and Mass – Data Sheet

Name: ______________________________________ Date: _____________________

Hypothesis: If I attach a balloon to the mouth of a flask and inside the flask mix 30g of baking soda with 60ml of vinegar, then the balloon will______________________________.

TABLE 1

Mass of flask and balloon before reaction (grams)	Mass of flask and balloon after reaction (grams)	Mass of flask and balloon after gas has escaped (grams)	Mass of gas (CO_2) (grams)

Respond to the following:

1. Does the gas carbon dioxide have mass? Give proof for your answer.

2. During the reaction between the baking soda and vinegar, was any mass lost? Explain your answer.

3. What is the term for the affect that the combined weight of all the gases in our atmosphere has on us?

4. What other type of chemical reactions produce CO_2 (give at least four)?

CO_2 and Mass-CH_4 Lab Procedure

Materials:

- Large bulb polyethylene transfer pipette
- Scissors
- Candle in holder
- Matches or lighter
- CH_4 (g), 60ml syringe from It's a Gas! lab
- 3% dish soap solution
- 2cm length latex tubing

Methane is 45% lighter than air, so bubbles of the gas rise. Single bubbles of suitable size are easily generated by the device shown in Figure 2. A large bulb polyethylene transfer pipette is connected to a methane-filled syringe with a 2-cm length of latex tubing. The bulb of the pipette is cut off with a scissors.

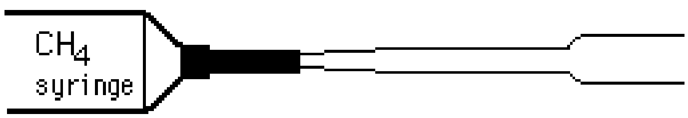


Figure 2

Procedure:

- Be sure to wear your safety goggles!
- Dip the mouth of the pipette into a 3% dish soap solution. A film of soap will cover the opening.
- Start forming the bubble while directing the pipette's mouth downward (Figure 2, rotated right) so the bubble forms below the device. This allows extra soap solution to gather at the bottom of the bubble as it is forming. While the bubble is still small, a slight shake will dislodge the extra drop which otherwise could make the bubble heavier-than-air. Quickly fill the bubble with the 60ml gas while tilting the device to a horizontal position (Figure 2).
- Dislodge the bubble with an abrupt downward flick of the pipette. The bubble may rise, stay suspended in air or slowly drop depending on the amount of methane compared to the mass of the soap film. Bubbles containing 60ml methane usually rise.
- Optional (but fun)-- The bubbles can be ignited with a candle. They will produce a fireball about 20-cm in diameter and represent about 2 kJ of heat. USE CAUTION!
- Clean up according to your instructor's directions and answer the questions on CO_2 and Mass-CH_4 Student Sheet.

CO_2 and Mass-CH_4 Student Sheet

Name____ Date____________________

1. How would you describe the density of methane?

2. How does the density of methane affect our climate?

3. What is the purpose of the soap in this lab?

4. Describe what happened to your bubbles when you flicked them off of your pipette and give an explanation to their behavior.

CO_2 and Mass – Lab Procedure

Materials:

- 1 - 125ml flask
- 1 large 12 inch balloon
- 1 pin (or scissors)
- 1 microspoon spatula
- 30g of baking soda
- 60ml of vinegar
- 50ml beaker
- Triple beam balance or similar scale
- Metal pie tin
- Safety glasses

Procedure:

- Be sure to wear your safety glasses!
- Double check that you have the correct materials at your lab station.
- Place the 50ml beaker on the pie tin and place it on the scale. Zero the scale by holding down the on button.
- Use the scale to measure 30g of baking soda in the 50ml beaker.
- Place the 30g of baking soda into the balloon using the microspoon spatula.
- Use the beaker to measure 60ml of vinegar, and then pour the vinegar into the 125ml flask.
- Carefully attach the balloon to the mouth of the flask keeping the balloon containing the baking soda to the side of the flask (be careful not to mix the baking soda with the vinegar).
- Place only the pie tin on the scale and zero the scale by holding down the on button.
- Place the 125ml flask and balloon setup on the pie tin that is on the scale. Find its mass and record this mass in Table 1 on the CO_2 and Mass – Data Sheet.
- Hold on tight to the balloon up and lift it up, mixing the baking soda and vinegar together allowing the two materials to mix and inflate the balloon.
- Find the mass of the inflated balloon and the beaker and record in the second column in Table 1 on the CO_2 and Mass – Data Sheet.
- Puncture the balloon and let the gas escape.
- Find the mass of the deflated balloon and beaker and record in the third column in Table 1 on the CO_2 and Mass – Data Sheet.
- Determine the mass of the gas and record in the last column in Table 1 on the CO_2 and Mass – Data Sheet.
- Clean up your lab station according to your instructor's directions and answer the questions on the CO_2 and Mass – Data Sheet.

CO_2 and Mass – Data Sheet

Name: ____ Date: ______________________

Hypothesis: If I attach a balloon to the mouth of a flask and inside the flask mix 30g of baking soda with 60ml of vinegar, then the balloon will__________________________________.

TABLE 1

Mass of flask and balloon before reaction (grams)	Mass of flask and balloon after reaction (grams)	Mass of flask and balloon after gas has escaped (grams)	Mass of gas (CO_2) (grams)

Respond to the following:

1. Does the gas carbon dioxide have mass? Give proof for your answer.

2. During the reaction between the baking soda and vinegar, was any mass lost? Explain your answer.

3. What is the term for the affect that the combined weight of all the gases in our atmosphere has on us?

4. What other type of chemical reactions produce CO_2 (give at least four)?

CO_2 and Mass-Methane Extension Activities

Chemistry

The experiments below all involve the combustion of methane. Be sure to review all safety notes prior to doing any of the experiments in the classroom. Specific procedures have been omitted to allow for easy modification.

The reaction is:

$$CH_4(g) + 2\ O_2(g)\ \text{----->}\ CO_2(g) + 2\ H_2O(g)\ \ \Delta H = -802.3\ kJ$$

Experiment 1. Products of Combustion.

Equipment:

- Length of latex tubing
- Glass pipette (the tubing fits snugly inside the pipette)
- Screw clamp
- 125ml flask
- Matches or a lighter

Chemicals:

- CH_4(g), 60ml
- Limewater (See: How to prepare and dispense limewater)

Generate a syringe full of methane. Equip the syringe with a length of latex tubing, a glass pipette (the tubing fits snugly inside the pipette), and the screw clamp. Tighten the screw clamp to completely seal the tubing. Using a ring stand and a suitable clamp, clamp the glass pipette in the approximate position shown in Figure 3. Two people are needed for the next part of this experiment. One person should apply continuous, gentle positive pressure on the plunger so that the methane is always under pressure. The second person should open the screw clamp just enough to allow a steady but small flow of methane. Ignite the gas issuing from the pipette. The flame should be no more than 1-cm in height. The screw clamp controls the flow of the gas and should be adjusted as necessary. Position an inverted 125ml flask over the pipette so that flame is centered inside the flask. Water condensation on the glass will be noted and the flame will go out within seconds due to deprivation of oxygen. Remove the pipette from the flask and close the screw clamp. Test the contents of the flask for CO_2 (g) by adding 10ml limewater to the flask and shaking the flask for a few seconds. A cloudy solution indicates the presence of CO2 as a result of the reaction:

$$Ca(OH)2(aq) + CO_2(g) \longrightarrow CaCO_3(s) + H_2O(l)$$

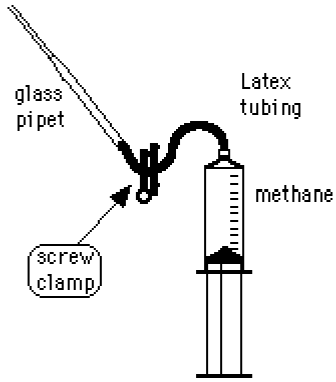


Figure 3. Screw clamp controls gas flow rate.

Experiment 2. How a Bunsen Burner Works.

Equipment:

- Length of latex tubing
- Glass pipette (the tubing fits snugly inside the pipette)
- Screw clamp
- Matches or a lighter
- Glass tubing (approx. 10 mm inside diameter and 20 cm length)
- Aquarium air pump or a second syringe filled with air
- Ring stand and clamp

Chemicals:

- CH_4(g), 60ml

The Bunsen burner works by mixing a hydrocarbon fuel such as methane with air. The principle is simple and can be demonstrated with a simple length of glass or plastic tubing. The same device shown in Figure 3 will be used in this experiment.

Clamp a piece of glass tubing in a vertical position as shown in Figure 4. A source of forced air, such as an aquarium air pump or a second syringe filled with air is optional and is used to create a hotter flame. Generate a syringe full of methane. Open the screw clamp and start the flow of methane through the 'Bunsen burner' tube by applying a continual positive pressure on the syringe plunger. Light the gas at the top of the tube. The flame will be gentle. Start the flow of air. This may blow out the flame if its flow rate is too great. Use a screw clamp on the air delivery tube to reduce the flow of air. When the methane-air mixture is optimal, the flame will be small and sharp and there will be an audible noise. Interestingly, methane prepared as described above will burn with an orange-yellow flame due to trace levels of suspended sodium salts in the gas. These can be removed by washing the methane (suction 5ml distilled water into methane-filled syringe and shake) after which the methane burns with its characteristic blue flame.

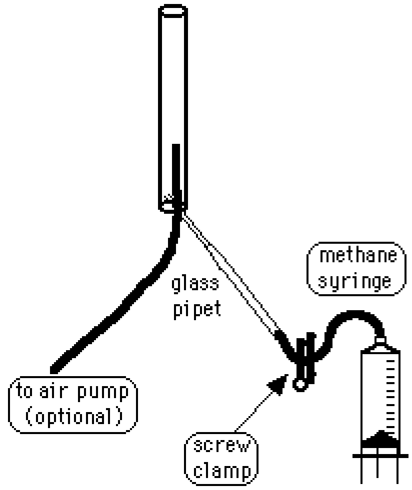


Figure 4. A glass tube Bunsen burner

Experiment 3. Flame Chemistry

Equipment:

- Length of latex tubing
- Glass pipette (the tubing fits snugly inside the pipette)
- Screw clamp
- Matches or a lighter
- Glass tubing (approx. 10 mm inside diameter and 20 cm length)
- Piece of glass tubing (5 mm ID x 8 cm length)
- Ring stand and clamp

Chemicals:

- CH_4(g), 60ml

Most chemistry textbooks describe the chemistry of the flame, a fascinating subject that was first investigated by Michael Faraday and described in his "The Chemical History of the Candle" lectures which he gave at the Royal Institution during the early and mid-19th century (**see info at end of this experiment**). Faraday demonstrated that ". . . there are clearly two different kinds of action — one of the production of the vapor, and the other the combustion of it — both of which take place in particular parts of the candle." The former is now called the pyrolysis zone, where the fuel is broken into radicals (such as H atoms and CH_3 groups) and smaller molecules including H_2(g). The outer region contains air and is called the combustion zone. In this experiment we will repeat this experiment of Michael Faraday's using methane rather than a candle flame. The general set up uses the Bunsen burner shown in Figure 4. The air pump is not used for this experiment. A smaller piece of glass tubing (5 mm ID x 8 cm length) should be held by a clamp in a 45^o position about 2 - 3 cm above the opening of the "Bunsen" burner as shown in Figure 5.

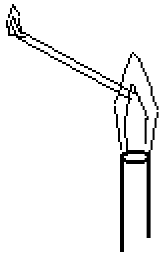


Figure 5. Siphoning off the pyrolysis zone

Prepare several syringes full of methane. Two people are required to perform this experiment. One person delivers the methane through the main burner in a continuous, steady stream and ignites the gas issuing from the top. The flame should be large enough that the small tube is positioned towards the top of the flame. Gases diverted into the tube are incompletely combusted and can be ignited by the second person as they issue from the opening.

Simple Bunsen burner

Flames are yellow from traces of sodium due to reagents

Washing gas with water removes sodium and methane burns blue

"Faraday's Chemical History of the Candle. Twenty-two Experiments and Six Classic Lectures," Chicago Review Press, Distributed by Independent Publishers Group, ISBN 1-55652-035-2. Material about the life of Michael Faraday is also available at the web site of the Royal Institution of Great Britain: http://www.ri.ac.uk/History/

Experiment 4. Burned Rings in Paper.

Equipment:

- Length of latex tubing
- Glass pipette (the tubing fits snugly inside the pipette)
- Screw clamp
- Matches or a lighter
- Glass tubing (approx. 10 mm inside diameter and 20 cm length)
- Ring stand and clamp
- Heavy-stock paper such as a note card

Chemicals:

- CH_4(g), 60ml

This is another experiment described by Faraday for the candle. Here we will use methane and the burner (without the air pump) built in Experiment 2. **CAUTION!** Have a cup of water ready in case the paper used in this experiment catches on fire. While one person operates the burner and methane-filled syringe, a second person holds a piece of heavy-stock paper such as a note card positioned horizontally through the inner cone as shown in Figure 6 — approximately 2 cm above the top of the burner. Within a few seconds, the paper card will begin to burn (turn brown) in a ring. As soon as the brown ring appears, remove the card; do not allow the paper to actually ignite. This experiment reveals the fact that the pyrolysis zone is cool and the combustion zone is hot.

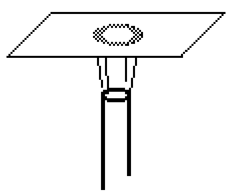


Figure 6. Paper starts to burn near the outside of the flame.

Experiment 5. Window screen provides thermal insulation.

Equipment:

- Length of latex tubing
- Glass pipette (the tubing fits snugly inside the pipette)
- Screw clamp
- Matches or a lighter
- Glass tubing (approx. 10 mm inside diameter and 20 cm length)
- Window screen, 5 cm x 5 cm, 2 pieces
- Ring stand and clamp

Chemicals:

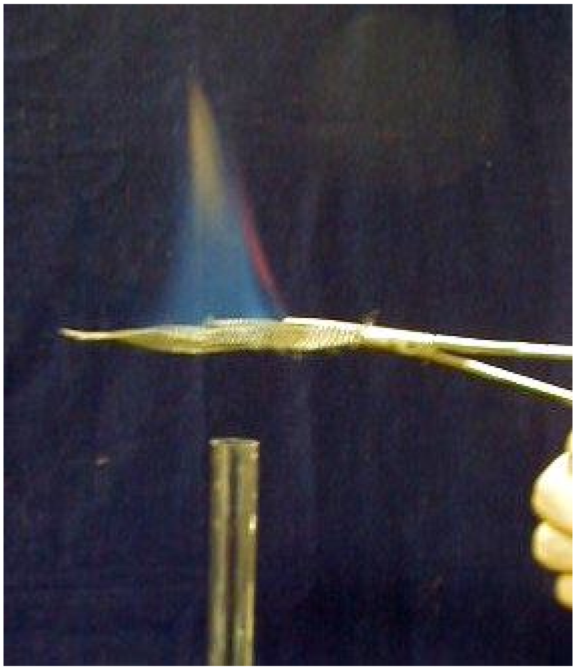
- CH_4(g), 60ml

As a final experiment from Faraday's work with candles, we will investigate how a piece of window screen will affect the flame when it is held in a position similar to that of the paper card in the previous experiment. It works best to hold the screen in position 2-cm above the burner. Do not use the air pump.

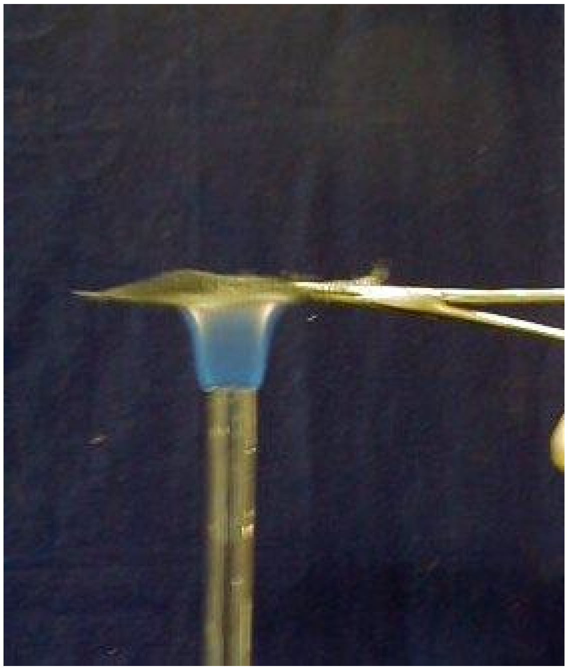
Experiment A. While one person discharges the methane-filled syringe through the burner tube, a second person holds the screen and ignites the gases above the screen. Will the flame jump through the screen and start burning below?

Experiment B. While one person discharges the methane-filled syringe through the burner tube, a second person holds the screen and ignites the gases below the screen. Will the flame jump through the screen and start burning above?

Experiment C. Holding two screens 2 and 4 cm above the burner, the gases between the screens can be ignited!



Experiment A



Experiment B

The screen's ability to dissipate heat and prevent combustion while allowing flammable mixtures of gases to pass through has been used in practical applications. Sir Humphrey Davy used this principle in his invention of the miner's safety lamp (Figure 7) in 1815. Flammable gases from the mine could pass through the screen and burn in the enclosed flame with a 'colored haze' while the screen prevented the open flame from causing a mine explosion.

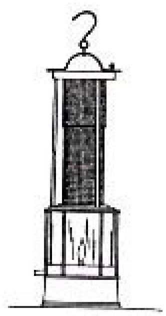


Figure 7. Sir Humphrey Davy's Miner's Safety Lamp

From the web site (History page) of the Royal Institution of Great Britain.

Experiment 6. Density of Methane: Lighter-than-Air Methane Bubbles.

(Based on "Spectacular Gas Density Demonstration Using Methane Bubbles", R. Snipp, B. Mattson, and W. Hardy, Journal of Chemical Education, 1981, 58, 354.)

Equipment:

- Large bulb polyethylene transfer pipette
- Scissors
- Candle in holder
- Matches or lighter

Chemicals:

- CH_4(g), 60ml
- 3% dish soap solution

Methane is 45% lighter than air, so bubbles of the gas rise. Single bubbles of suitable size are easily generated by the device shown in Figure 8. A large bulb polyethylene transfer pipette is connected to a methane-filled syringe with a 2-cm length of latex tubing. The bulb of the pipette is cut off with a scissors.

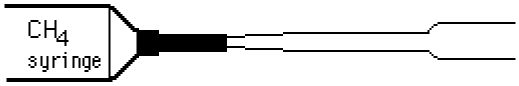


Figure 8. A pipette used as a bubble-maker

Making the bubbles: Dip the mouth of the pipette into a 3% dish soap solution 8 a film of soap will cover the opening. Start forming the bubble while directing the pipette's mouth downward (Figure 8, rotated right) so the bubble forms below the device. This allows extra soap solution to gather at the bottom of the bubble as it is forming. While the bubble is still small, a slight shake will dislodge the extra drop which otherwise could make the bubble heavier-than-air. Quickly fill the bubble with the 60ml gas while tilting the device to a horizontal position (Figure 8). Dislodge the bubble with an abrupt downward flick of the pipette. The bubble may rise, stay suspended in air or slowly drop depending on the amount of methane compared to the mass of the soap film. Bubbles containing 60ml methane usually rise. The bubbles can be ignited with a candle. They will produce a fireball about 20-cm in diameter and represent about 2 kJ of heat. **USE CAUTION!**

Experiment 7. Density of Methane: Burning Methane in a Large Test Tube.
Equipment:

- Large test tube (22 x 200 mm)
- 250ml beaker or 9-ounce plastic cup
- Candle in holder
- Matches or lighter

Chemicals:

- CH_4(g), 60ml

Fill a large test tube with methane using water displacement. The volume of the test tube is 80ml so two syringes full will be necessary. Darken the room. Remove the test tube from the water and continue to hold the test tube with its mouth directed downward. Bring a burning candle up to the mouth of the test tube and the gas will begin to burn. In order to maintain the flame and burn all of the gas, the test tube must be rotated to a 45^o angle position with open end up so that the lighter-than-air methane can leave the test tube. The gas will burn down the test tube in the form of a narrow, bright blue disk that produces condensation on the glass just above the flame. It takes approximately 15 seconds for the burning disk of methane to burn to the bottom of the tube. **Caution:** The test tube will become hot, so use a test tube clamp.

Experiment 8. Explosive Mixture of Methane/Air.

Equipment:

- 20-ounce (600ml) plastic soft-drink container
- Aluminum foil, 5 cm x 5 cm
- Ring stand and clamp
- Matches or lighter

Chemicals:

- CH_4(g), 60ml

Methane forms explosive mixtures with air in the 5 - 14 % range. This can be demonstrated with the device shown in Figure 9, made from a plastic soft-drink container with the bottom half cut off. Cover the opening with a small piece of aluminum foil. With a sharp pencil, poke a hole of approximately 4-mm diameter in the center of the foil. Clamp the device in the position shown in Figure 9. Set a rubber stopper or similar object over the hole for the moment.

Generate a syringe full of methane and transfer the gas to the device from the bottom. Position the syringe or tube so that most of the gas accumulates near the top of the device. Remove the object covering the hole and immediately ignite the gas. As demonstrated in the previous two experiments, methane is lighter than air and will burn with a large flame as it passes through the hole in the foil. When much of the methane has been consumed and the methane/air mixture falls to 14%, the gas mixture will explode downward into the container. The 'explosion' is quite gentle (unlike hydrogen/air!), but demonstrates an important principle. The demonstration should be repeated in a darkened room.

Figure 9. Pop bottle used for gentle explosion

Experiment 9. Bubble Domes.

Equipment:

- 250ml beaker
- Strip of cloth
- 10-cm length of latex tubing
- Match or lighter
- Large plastic weighing boat

Chemicals:

- CH_4(g), 60ml
- 3% dish soap solution

Soap film domes can be made from 3% dish soap solution8 and a strip of cloth. Soak the cloth in the soap solution. Then starting from one side of a 250ml beaker, slowly drag the cloth across the top of the beaker forming a film of soap. Without drafts, the film will remain intact for as long as a minute. Fill a syringe with methane and equip the syringe with a 10-cm length of latex tubing. Moisten the tubing with the soap solution and insert the tubing through the soap film. When moistened, the tubing will not break the film. Quickly inject the methane; it will cause the film to mound up forming a bubble as shown in Figure 10. Remove the tubing and ignite the bubble with a candle. [Hint: Sometimes an unwanted second bubble forms at the end of the latex tubing while the methane is being injected. To prevent this, initially withdraw the plunger about 5ml in order to break the film over the end of the tubing.]

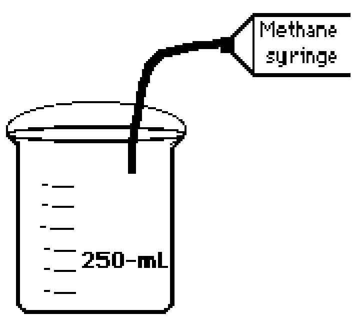


Figure 10. A partially inflated soap film dome.