

Lab: Complete and Incomplete Combustion of Hydrocarbons

Many steps in today's lab require precise timing. For each step, read it over completely before attempting any part of it.

Part 1: Complete combustion

1. Get a 250 mL Erlenmeyer flask, a #6 rubber stopper, a lit candle, and a 50 mL beaker with limewater.
2. To cool the Erlenmeyer flask do this: a) stopper the flask, b) run it under cold water for 30 seconds, c) dry it well, d) remove the stopper, e) dry off any remaining water from around the mouth of the flask.
3. Place the cold flask over the lit candle so that the flame goes into the flask. If water is produced during combustion, you will see a thin film condensing on the inside of the flask. As soon as the candle goes out, quickly stopper the flask. Is water a product of the combustion of paraffin wax?
4. Remove the stopper from the flask just long enough to quickly add half of your limewater. Shake the flask for 30 seconds. If CO₂ is present the limewater will turn white & cloudy.
5. Based on the products you have just seen formed, write a balanced chemical equation for the complete combustion of paraffin wax (C₂₅H₅₂): C₂₅H₅₂ + _____ → _____ + _____



Part 2: Incomplete combustion

In Part 1 you observed what happens when a hydrocarbon is burned with a sufficient amount of oxygen. In this part of the lab, you will examine what happens when a hydrocarbon burns without sufficient oxygen. You will be producing, and then combusting, the hydrocarbon acetylene (C₂H₂). Acetylene can be prepared from calcium carbide (CaC₂) & water according to the reaction: CaC₂(s) + 2H₂O(l) → C₂H₂(g) + Ca(OH)₂(aq).

1. Set up your fume hood. Obtain: three test tubes (clean them with a test-tube brush & cleaning solution if necessary, then rinse them well), a pneumatic trough, a glass plate, two #3 rubber stoppers, and a 400 mL beaker. Place a piece of tape around two of the tubes – label them “1” and “1/10”. When they are not in use, rest the test tubes in the 400 mL beaker.
2. Fill the “1” tube to the top with tap water and the “1/10” tube 1/10 full of water (see right).
3. Get a balloon from the front of the room. Your teacher will place some CaC₂ into the balloon for you.
4. Fill the remaining test tube to the top with water. Squeeze the air out of the balloon, pinch the neck, & stretch the tip around the top of the tube (be careful not to get the CaC₂ in the balloon wet). Dry the tip of the balloon and tape it tightly in place. Mix the water and CaC₂ by inverting the tube several times (CaC₂ will be washed into the tube). C₂H₂ gas will fill the balloon. Do this under the fume hood to catch any gas that escapes.
5. Place the hose from the pneumatic trough into the sink and then fill the trough with water. Cover the “1” tube with a glass plate to seal in the water. Turn the tube (with glass plate in place) upside down. Place the glass plate & the mouth of the tube under the level of water in the trough and then remove the glass plate. If you've done this correctly you will have a test tube full of water standing up in the trough.
6. Pinch the tip of the balloon and remove it from its tube (try not to lose any gas). Place the opening of the balloon under the mouth of the tube in the trough. Release gas slowly into the tube until all of the water is displaced (don't let any gas bubble over). Stopper the tube without allowing any gas to escape.
7. Repeat step 6 for the 1/10 tube (i.e. displace the water in the 1/10 tube with C₂H₂ gas). If there is any gas remaining in your balloon, tie the end and return the partially inflated balloon to the front of the room.
8. Write a balanced equation for the complete combustion of C₂H₂: C₂H₂ + _____ → _____ + _____
9. In which tube are you most likely to see complete combustion (i.e. in which tube will there be enough O₂ to react with the C₂H₂)? _____ In which tube are you most likely to see incomplete combustion? _____
10. **Put on safety goggles.** Get a lit candle and a splint. With a flaming splint ready, remove the stopper from the 1/10 tube and quickly place the burning splint in the mouth of the tube (keep a firm grip on the tube). Replace the stopper immediately after the reaction in order to catch the products of combustion.
11. Repeat step 10 for the “1” tube (**do this under the fume hood**). What do you observe? _____
12. Remove the stopper from the 1/10 tube just long enough to quickly add some limewater (to about 1-2 cm high in the tube). Shake the tube for 30 seconds. Is CO₂ present? _____
13. Wash all glassware using a test tube brush & the cleaning solution provided. Rinse & return equipment.



Questions: Read “Incomplete Combustion of Hydrocarbons” on pages 526 and 527.

1. A complete combustion always produces which two compounds?
2. What are the 4 possible products of an incomplete combustion? Which one of these is always produced?
3. What was the black substance produced during the combustion of the gas in tube “1”?
4. What would happen if hydrogen gas (H₂) were combusted with an insufficient amount of oxygen (O₂)? How is this different from the incomplete combustion of a hydrocarbon?
5. Write the balanced equation for the complete combustion of propane (C₃H₈).
6. Write two possible balanced equations for the incomplete combustion of propane (C₃H₈).