Required Training

UC Lab Safety Fundamentals

Required PPE

Flame-resistant lab coat, safety glasses/goggles, hearing protection, nitrile gloves

Performers Required: 2

Equipment

Steel can with metal lid (shipping/1 gallon paint can)

Chemicals

Hydrogen (H₂), with regulator and tubing installed

Drill/punch and pliers for preparing can

BBQ-style butane lighter (≥ 6” long)

Procedure:

1. To prepare the can, first punch or drill a small (1/8-1/4”) hole in the center of the bottom of the can; this will act as the gas outlet and pilot light. Then cut/drill one medium (1/2”) hole in the side of the can, roughly 1” from the rim of the opening and opposite each other; this act as an air-intake vent. Use pliers to compress the press-fit ring around the circumference of lid, such that it fits very loosely on the can – the lid should fall off when the can is inverted.

2. When filling the can the goal is to replace all of the air inside of the can with hydrogen gas, then seal both holes to prevent H₂ from escaping. It is critical when filling the can to have both holes open to allow air to escape. Left over air will cause a premature explosion, endangering the performers. To fill the can with H₂, first ensure that both holes are unobstructed then hold the lid slightly offset from the can and insert the hose barb or the end of the tube attached to the regulator on a cylinder or other supply of flammable gas (H₂). Alternatively, insert the hose barb directly into the air vent on the side of the can. Proceed to fill the can (~30 seconds with a 5 psi regulator). Remove the hose barb or tube, press the lid loosely onto the can, and cover both holes with gloved finger to trap the gass.

3. Immediately place the can on a table (20 feet or in a different room from the gas cylinder) with the bottom of the can and pilot hole facing up. The lid should be skewed, not in any way fit onto the can. Ensure you are wearing hearing protection and that the audience has been warned to cover their ears before proceeding. Remove fingers from the pilot and vent holes, at this moment another performer should use the lighter to ignite the gas escaping from the pilot hole, both volunteers stepping back once it is lit. There will be a small, difficult to see flame visible from the pilot hole (dimming the lights will increase the visibility of the pilot flame). Once the upper explosive limit is reached (~ 1 min), the mixture of gases in the can will ignite with a loud bang, sending the can flying upwards (~10-30 feet).

Clean-up: None required.

Hazards: The explosion in the can produces heat, fire, and a loud noise, and the can is launched upwards with
considerable force. Hazards include thermal burns from the fire or the can immediately after the explosion, hearing damage from the explosion, or physical injury from being hit with the can.

**Principle:** The H\(_2\) gas in the can is lighter than air and escapes from the hole in the top of the inverted can. Air from the surrounding is pulled into the can through the hole in the side to equalize the pressure. Lighting the stream of gas through the top creates a pilot light that remains lit until the mixture inside reaches a concentration known as the upper explosive limit, which is roughly 75% H\(_2\) by volume. At this point, the flame will flash back through the hole and ignite the entire mixture at once, forming hot gaseous H\(_2\)O that forces the can upwards.

**Notes:** It may take up to 1-2 minutes for the mixture to ignite, depending on the fuel gas and the size of the holes. If the ignition does not occur, do not place your hand over the can if you attempt to relight the pilot, as the flame may still be lit and the mixture may ignite at any moment. In the event of a failed ignition, leave the can undisturbed for at least 5 minutes before using a long stick to topple over the can, allowing any remaining hydrogen to escape. Methane is not recommended for this demo.