

Moles, formulae, gas volumes and atom economy

Chemistry grades 11-12 (A Level · IB · Class 11-12) · Lab

Name: _____ Date: _____ Class: _____

How can you weigh a gas? In this lab you collect butane from a lighter over water, measure the volume and the mass lost by the lighter, and use the ideal gas equation to find the molar mass of butane.

Level: Chemistry grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** A Level 3.1.2

Aim

To determine the molar mass of butane by collecting a known mass of gas over water and using $pV = nRT$.

Equipment

- Disposable butane lighter (not refillable)
- Balance reading to 0.01 g
- 250 cm³ measuring cylinder and a large trough or bowl of water
- Thermometer and a barometer reading (or use the local atmospheric pressure)
- Paper towel to dry the lighter
- Safety goggles

Safety

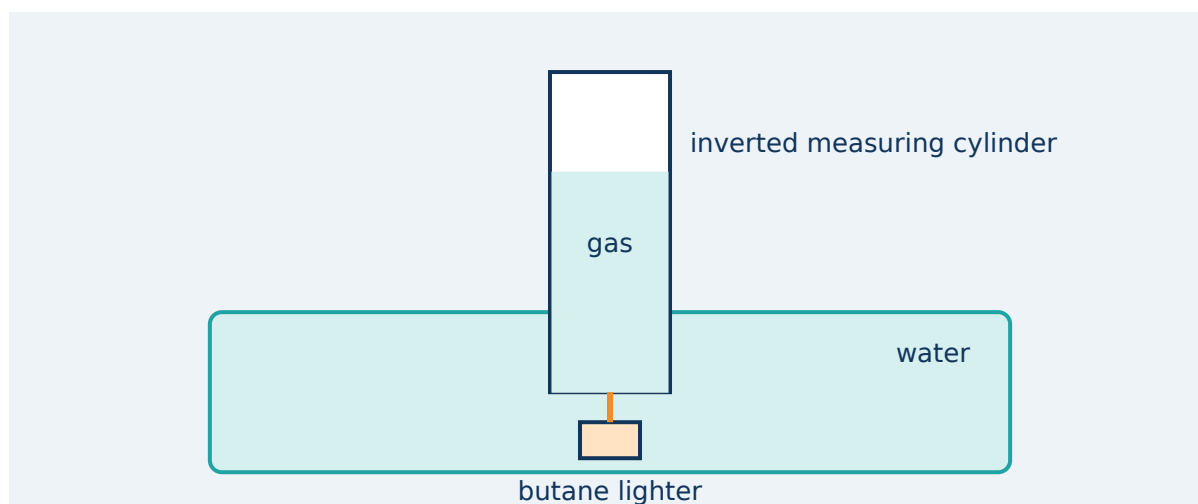
Safety

Butane is highly flammable. Work with no flame anywhere in the room, near an open window, and do not light the lighter. Wear goggles and keep the lighter away from heat.

Method

1. Fill the measuring cylinder with water, invert it in the trough and clamp it upright.
2. Dry the lighter and weigh it. Record the mass.
3. Hold the lighter nozzle just under the cylinder mouth and press the gas lever so butane bubbles in. Collect a chosen volume.
4. Level the water inside and outside the cylinder, then read the volume.
5. Dry the lighter and reweigh it. Record the mass loss.

6. Record the room temperature, then repeat for two other volumes.



Gas from a lighter is collected by displacement of water and its volume and mass loss are measured.

Results

Bilal in Lahore obtained these results. Atmospheric pressure was 101.3 kPa, the water vapour pressure at 21 °C is 2.5 kPa and $T = 294\text{ K}$.

Trial	Volume of gas / cm^3	Mass loss / g
1	80	0.19
2	100	0.24
3	120	0.28

Analysis questions

Question 1 Pressure of the butane

The gas collected is a mixture of butane and water vapour. Calculate the partial pressure of butane in Pa.

Question 2 Amount of butane in trial 2

Use $pV = nRT$ to calculate the amount of butane in trial 2.

Question 3 Molar mass from trial 2

Calculate the molar mass of butane from trial 2.

Question 4 Mean molar mass

Calculate the molar mass for trials 1 and 3, then the mean of the three trials.

Question 5 Accuracy

The formula of butane is C_4H_{10} (Ar: C 12.0, H 1.0). Calculate the percentage difference between the mean and the true value.

Question 6 Uncertainty in the mass loss

The balance has an uncertainty of ± 0.01 g on each reading. Calculate the percentage uncertainty in the mass loss of trial 2.

Question 7 Systematic error

Butane is slightly soluble in water. Explain whether this makes the calculated molar mass too high or too low.

Question 8 Improvement

Propose one change that reduces the uncertainty in the mass loss.