In context

Subject area: Organic chemistry | **Level: 14–16 years (Higher)**

Topic: Alcohols | **Source: rsc.li/3ntOcpM**

The 'whoosh' bottle experiment

This experiment shows the power of the reaction that can take place when an alcohol burns.

Source: Adrian Guy

Here is a method used by a teacher to show this experiment:

- Use an empty polycarbonate water bottle of volume 20 dm^3.
- Add approximately 10cm^3 of methanol into the bottle.
- Swirl the methanol inside the bottle.
- Then decant the excess methanol from the bottle.
- Place a rubber stopper or bung into the top of the bottle.
- Connect a wooden splint to the end of a metre rule, and light the end of the splint with a match.
- Carefully place the lighted splint (now at arm's length) above the stopper on the bottle, and remove the stopper with the other hand.
- A spectacular reaction should now take place. Watch the reaction at https://youtu.be/yl89heCsBpQ.

Answer the questions below.

1. Explain why the methanol is swirled within the bottle before it is ignited.

Answer: *To increase the surface area of the methanol so that it may form a vapour.*

2. Define the following terms used in this method:

a) Decant

Answer: *To pour off a liquid or to pour from one container to another.*

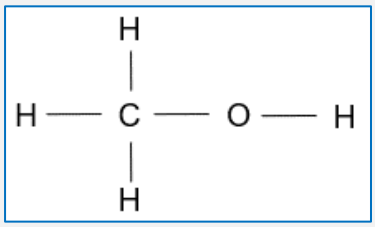
b) Excess

Answer: *More than that needed, or left over.*

3. State the molecular formula of methanol.

Answer: *CH_4O.*

4. **Draw the structure of a methanol molecule in which all bonds are shown.**



5. **In the reaction in the bottle, methanol is burning to form carbon dioxide and water.**

Write a chemical equation to show this reaction.

Answer: *$CH_3OH + {}^3/_2O_2 \rightarrow CO_2 + 2H_2O$ or $2CH_3OH + 3O_2 \rightarrow 2CO_2 + 4H_2O$*

6. **Explain why this reaction produces a 'whoosh' when it takes place within a bottle.**

Answer: *Hot gases form and are forced out of the bottle opening under high pressure.*

7. **The internal volume of the bottle was 20 dm^3.**

Write this volume in the following units:

a) cm^3.

Answer: *20,000 cm^3.*

b) m^3.

Answer: *0.020 m^3.*

8. **The mass of methanol vapour remaining in the bottle before ignition was 5.2 g.**

Calculate the concentration of the methanol vapour in:

a) g / dm^3.

Answer: $\frac{5.2\ g}{20\ dm^3}$ ***= 0.26 g / dm^3***

b) mol / dm^3, and writing this answer in standard form.

RAM data: C = 12, H = 1, O = 16.

Answer: *RFM for methanol = 32*

Moles of methanol = $\frac{0.26\ g}{32}$ = 8.125 x 10^{-3} mol / dm^3

c) Calculate the mass of carbon dioxide formed when 5.2 g of methanol vapour is ignited.

You will need to use your chemical equation from question 5 to help you.
Show your working clearly.

Answer: *$CH_3OH + {}^3/_2O_2 \rightarrow CO_2 + 2H_2O$*

Moles of methanol = $\frac{5.2\ g}{32}$ = 0.1625 mol.

Moles of carbon dioxide formed = 0.1625 mol (1 : 1 ratio from the chemical equation) .

Mass of carbon dioxide = 0.1625 × RFM of CO_2

= 0.1625 × 44 = 7.15 g

9. After the reaction in a different bottle had taken place, it was allowed to cool.

A colourless liquid, A, is observed at the base of the bottle.

a) Name liquid A.

Answer: *Water.*

b) If the volume of liquid A was 4.50 cm^3, calculate the mass of methanol that was burnt in the bottle.

Assume that the density of liquid A = 1 g / cm^3.

Answer: *$CH_3OH + {}^3/_2O_2 \rightarrow CO_2 + 2H_2O$*

As the density of water = 1 g/cm^3, the mass of water formed = 4.50 g.

Moles of water formed = $\frac{4.50\ g}{18}$ = 0.25 mol.

Moles of methanol used = $\frac{0.25}{2}$ = 0.125 mol.

Mass of methanol = 0.125 × 32 = 4.0 g

Instructions for this teacher demonstration are available at rsc.li/30q7C4S.