

Diffusion of gases – a safer alternative to bromine

Equipment

Apparatus

- Eye protection
- Gloves
- Measuring cylinder, 250 ml
- Retort stand
- Boss and clamp
- Gas jar x 3
- Gas jar lid
- Fume cupboard

Chemicals

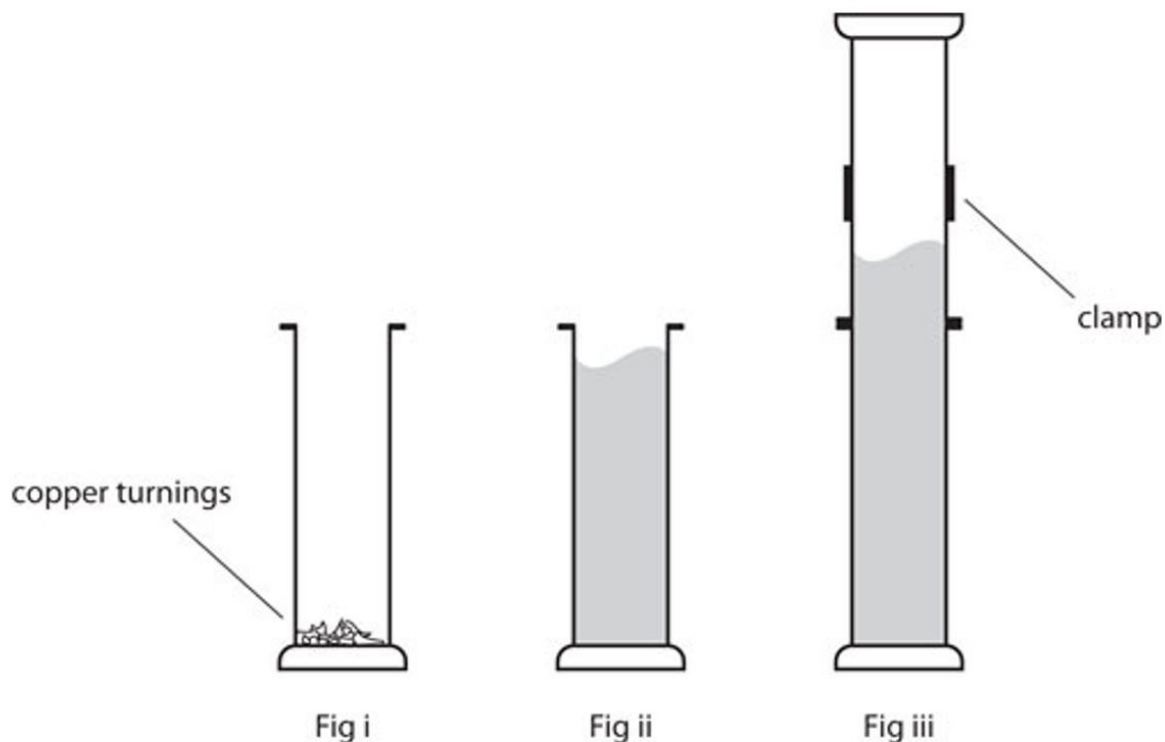
- Bromine
- Nitrogen dioxide
- Nitric acid
- Water
- Copper turnings, 2 g

Health, safety and technical notes

- Read our standard health and safety guidance here <https://rsc.li/3zUpwhV>
- Always wear eye protection
- Wear gloves.
- Bromine is toxic and corrosive (see CLEAPSS Hazcard [HC015b](#)).
- Nitrogen dioxide is toxic and corrosive (see CLEAPSS Hazcard [HC068b](#)).
- Nitric acid is corrosive (see CLEAPSS Hazcard [HC067](#)).
- Copper turnings are of low hazard (see CLEAPSS Hazcard [HC062](#)).

Procedure

1. Using water and a 250 ml measuring cylinder, establish the volume of the gas jar. Do not use this wet gas jar for the following demonstration.
2. Using a retort stand, boss and clamp, adjust the fitting of a dry inverted gas jar over another dry gas jar of the same size and set it to one side.
3. In a fume cupboard, place at least 1 g, but no more than 2 g, of copper turnings in the gas jar (fig i).
4. Knowing that 8 ml of concentrated nitric acid produces 1000 cm³ of nitrogen dioxide at room temperature and pressure, estimate the volume of acid needed to just fill the gas jar with gas.
5. Wearing eye protection and suitable gloves, place 1 ml less than the estimated volume of nitric acid in a 10 ml measuring cylinder. Empty the contents of the measuring cylinder into the gas jar with copper and watch the brown gas rise (fig ii).
6. Once the reaction stops, it is possible to place a lid on the gas jar and carry out the rest of the demonstration in the open laboratory.
7. Invert the second jar over the jar containing the gas and remove the lid from the lower jar (containing the nitrogen dioxide)
8. Clamp this jar into position with care (fig iii).
9. Diffusion takes place in 20 minutes.



Notes

- Wear goggles (EN 166 3) when handling concentrated nitric acid. Gloves are not required when an automatic pipettor is used.
- If possible, move the gas jars to a fume cupboard. Add water to each gas jar and pour the contents down a foul-water drain, adding more water. Unreacted copper turnings can be dried and reused. If there is no fume cupboard in the room, carefully insert gas-jar lids to cover both jars. Seal with sellotape and remove to a fume cupboard.
- The demonstration can be performed along with a similar set-up using bromine to show that gases diffuse at different rates. To fill a 1 litre gas jar, use no more than 2 ml of liquid bromine. Adjust the volume of bromine liquid to the capacity of the gas jar that is available. It takes time for bromine to vaporise. Use a fume cupboard, wear goggles or a face shield and nitrile or latex chemical-resistant gloves. A bucket of 1 M sodium thiosulfate solution should be available in case bromine splashes onto the skin or is spilled.