Some reactions of nitrogen dioxide – teacher notes

Topic
Gases

Timing
20 minutes

Apparatus
- Eye protection
- Clear plastic sheet (eg OHP sheet)
- Plastic Petri dish (base + lid), 9 cm
- Plastic pipette
- Scissors

Chemicals
Solutions should be contained in plastic pipettes. See the accompanying guidance on apparatus and techniques for microscale chemistry, which includes instructions for preparing a variety of solutions here https://rsc.li/3E2J8DI

- Nitric acid (concentrated HNO_3) diluted 1:1 with water ca 5M
- Full-range indicator solution diluted 1:1 with deionised water
- Potassium iodide, 0.2 mol dm^{-3}
- Potassium iodate(V), 0.1 mol dm^{-3}
- Potassium bromide, 0.2 mol dm^{-3}
- Potassium bromate(V), 0.1 mol dm^{-3}
- Ammonia solution, 3 mol dm^{-3}
- Copper turnings

Method
Copper turnings + nitric acid generates first nitric oxide, which then reacts with air to give nitrogen dioxide:
$3Cu(s) + 8HNO_3(aq) \rightarrow 3Cu(NO_3)_2(aq) + 2NO(g) + 4H_2O(l)$
then: $2NO(g) + O_2(g) \rightarrow 2NO_2(g)$

Results
Full-range indicator turns from green to yellow-red indicating that nitrogen dioxide is an acidic gas.
The iodate/iodide solution turns black due to: $IO_3^-(aq) + 5I^-(aq) + 6H^+(aq) \rightarrow 3I_2(g) + 3H_2O(l)$ also indicating the acidic nature of the gas.
A similar reaction occurs with bromide/bromate.

Health, safety and technical notes

- Read our standard health and safety guidance here https://rsc.li/3LVOUbN

- Students must wear suitable eye protection (Splash resistant goggles to BS EN166 3).
- Nitrogen dioxide is extremely toxic and corrosive if inhaled, with sometimes delayed effects. It is important to ensure that the amount of NO_2 generated does not result in significant leakage from the Petri dish (see CLEAPSS Hazcard HC068b). No more than 2 copper turnings should be used.
- Concentrated Nitric acid, $HNO_3(aq)$, 5 mol dm^{-3}, is CORROSIVE and gives of toxic fumes (see CLEAPSS Hazcard HC067).
- Potassium iodate(V), $KIO_3(aq)$,0.1 mol dm^{-3}, Potassium bromate(V), $KBrO_3(aq)$, 0.1 mol dm^{-3} (see CLEAPSS Hazcard HC080), Potassium bromide, KBr(aq), 0.2 mol dm^{-3} and Potassium iodide, KI(aq), 0.2 mol dm^{-3} are low hazard (see CLEAPSS Hazcard HC047b).
- Ammonia solution, $NH_3(aq)$, 3 mol dm^{-3} is corrosive and a respiratory IRRITANT (see CLEAPSS Hazcard HC006).