Qualitative tests for organic functional groups

Plan a sequence of tests to identify a set of unlabelled compounds. Watch a video of the investigation, plus find technician notes and more resources, at rsc.li/38KQFpE

Equipment (per group)

- 22 x test tubes and spares
- 6 x bungs for test tubes (minimum)
- 1 x test tube rack (minimum)
- 12 x dropper pipettes
- 2 x well plates or spotting tiles
- 2 x beakers, 400 cm^3 (for water baths)
- 1 x kettle to boil water for water bath

- Sample A (DANGER: flammable, harmful if swallowed, irritant, toxic to the aquatic environment)
- Sample B (DANGER: flammable, harmful if swallowed, may cause damage to organs, irritant, corrosive)
- Sample C (DANGER: flammable, irritant, health hazard)
- Sample D (DANGER: flammable, irritant)
- Sample E (DANGER: flammable, irritant, health hazard, toxic to the aquatic environment)
- Sample F
- Potassium dichromate solution 0.1 mol dm^{-3} (DANGER: corrosive, harmful, irritant, health hazard)
- Silver nitrate solution, 0.1 mol dm^{-3} (WARNING: irritant)
- Sodium hydroxide solution, 0.4 mol dm^{-3} (WARNING: irritant)
- Ammonia solution 1.00 mol dm^{-3} (WARNING: irritant)
- Brady's reagent (DANGER: flammable, corrosive)
- Sodium or potassium hydrogen carbonate solution, 0.4 mol dm^{-3}
- Ethanol (DANGER: flammable, harmful if swallowed, may cause damage to organs)
- Bromine water, 0.2 mol dm^{-3} (DANGER: corrosive, irritant)

- Safety equipment: safety glasses

Safety

Wear eye protection throughout.

Avoid skin contact and wear chemical resistant gloves if you have any open wounds or skin conditions.

Avoid breathing chemicals, keep bottles closed and bungs on test tubes as much as possible. Dispose of the reaction products after each step if possible.

Silver nitrate solution stains clothing and surfaces.

Method

Plan the order to do the tests listed. Start with testing the least hazardous reagents.

Test for alcohols

1. Add 3–4 drops of acidified potassium dichromate to a well in a spotting tile. Take care to avoid skin contact and wipe any spills immediately with a damp cloth/paper towel.
2. Add a drop of the sample to the same well.
3. Repeat steps 1 and 2 for the remaining samples.

4. Observe and record any colour changes.
5. If only one sample gives a colour change from orange to green, remove this from further testing.

Test for aldehydes

1. Add 2.5 cm^3 of silver nitrate solution to a clean, dry test tube. Take care to avoid spilling silver nitrate solution as it stains clothing and surfaces.
2. Add 1 drop of sodium hydroxide to the test tube.
3. Add ammonia dropwise with agitation until the precipitate just dissolves. This is Tollens' reagent.
4. Heat the Tollens' reagent in a water bath to 60–70°C.
5. Add 2 cm^3 of the sample identified as an aldehyde to the test tube and give it a little shake.
6. Leave the test tube in the water bath for around 15 minutes.
7. A silver mirror will from in the presence of an aldehyde.
8. Dispose of the reaction mixture immediately down a foul-water drain.

Test for carbonyl groups

1. Add 3–4 drops of Brady's reagent to a well in a spotting tile. Take care to avoid skin contact.
2. Add 3–4 drops of the sample to the same well.
3. Repeat steps 1 and 2 for the remaining samples.
4. Observe and record your results.
5. If only one sample gives a positive result of an orange precipitate, remove this from further testing.

Test for carboxylic acids

1. Add 2 cm^3 of the sample to a labelled test tube and place a bung on top.
2. Remove the bung and add 3–4 drops of sodium hydrogen carbonate solution to the test tube.
3. Observe and record your results in a table.
4. Repeat steps 1–3 for the other remaining samples.
5. If only one sample gives a positive result of effervescence, remove this from further testing.

Test for haloalkanes

1. Add 2 cm^3 of ethanol to a labelled test tube.
2. Add 10 drops of the appropriate sample to the test tube.
3. Add 2.5 cm^3 silver nitrate solution to a second labelled test tube. Take care to avoid spilling silver nitrate solution as it stains clothing and surfaces.

4. Repeat steps 1–3 for the other remaining samples.
5. Set up two water baths, with 100 cm^3 just boiled water and 100 cm^3 cold tap water.
6. Place the test tubes with the sample and ethanol into one of the water baths. Place the test tubes with the silver nitrate solution into the second water bath.
7. Warm the solutions for five minutes.
8. Remove the silver nitrate solution test tubes from the water bath.
9. Pour the first sample into the appropriately labelled silver nitrate solution test tube.
10. Observe and record your results.
11. Repeat steps 9 and 10 for the remaining samples.
12. If only one sample gives a positive result of a precipitate, remove this from further testing.

Test for unsaturated hydrocarbons

1. Add a few drops of the sample to a labelled test tube.
2. Add 1 cm^3 of bromine water to the sample. Shake the test tube vigorously from side to side.
3. Observe and record your result in a table.
4. Repeat steps 1 and 2 for the remaining samples.
6. If only one sample gives a positive result of turning the bromine water colourless, remove this from further testing.

Disposal

- Always dispose of chemicals carefully following your teacher's instructions.
- Empty your test tubes after testing for carboxylic acids, haloalkanes and unsaturated hydrocarbons into the labelled waste container.
- Rinse the spotting tiles used for testing alcohol and carbonyl groups.
- Dispose of the aldehyde test's reaction mixture immediately down a foul-water drain.