CHEMISTRY
THE NEXT GENERATION

7
ACTIVITY

CHEMISTRY MASTERCLASS

active compounds in commercial medicine tablets

16-17 age group

6 HRS

30 STUDENTS

6 STUDENTS PER GROUP

6 SUPERVISORS

£1440

background

This activity is designed to allow students to isolate the physiologically active organic compound in a medicine currently marketed by a pharmaceutical company.

pre-planning required

weeks before
Plan with schools how many students are coming to the session and on which days. Sessions to be held after student exams in the summer term and are run as a series of four from Tuesday to Friday inclusive.

days before
Teaching day for student demonstrators. Technicians prepare chemicals and set up the day before or the morning of the event.

facilities required

- Appropriate laboratory

general equipment

- UV lamp for visualising tlc
- bunsen burners (for melting point tubes)
- rotary evaporators
- clamp stands and rings
- NaCl plates
- Nuclear magnetic resonance (NMR) spectrometer
- melting point apparatus
- infrared (IR) spectrometers
- agate pestles and mortars
- Nujol
- NMR tubes
- d_6 Dimethyl sulfoxide (DMSO)

materials required

- four paracetamol tablets
- approximately 100 cm^3 ethyl acetate
- deionised water
- dilute HCl (approx 2 cm^3 per student)
- dilute NaOH (approx 2 cm^3 per student)
- anhydrous $MgSO_4$ (for drying)
- 100 cm^3 separating funnel
- 100 cm^3 round bottomed flask
- test-tube rack and three test-tubes
- filter funnel
- filter paper
- spatula
- melting point tube
- thin layer chromatography (tlc) plate
- jar for running tlc
- capillaries for tlc
- wash bottle of deionised water

Suggested timings for the day

9.00	Students arrive
9.30	General introduction and explanation of why the experiments in the activity are useful.
10.00	Laboratory session
14.00	Lunch break
14.15	Summary of what the students have learnt during the day. Careers talk from a university academic or an industrialist.
15.00	Finish

NOTE

The students do not know that the compound they are isolating is paracetamol. It is important that they do not know the identity of the compound before starting the experiment.

Further reading

For further information visit the RSC website at **www.chemsoc.org/networks/learnnet/paracetamol.htm**

SAFETY

A risk assessment must be done for this activity.

This resource is based on an activity run by Dr Helen Aspinall, University of Liverpool.

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CHEMISTRY MASTERCLASS

active compounds in commercial medicine tablets

aim

You are supplied with tablets that are currently being marketed by a pharmaceutical company. Your job is to isolate the physiologically active organic compound from them, to purify it, and then to work out its structure from the analytical and spectroscopic data.

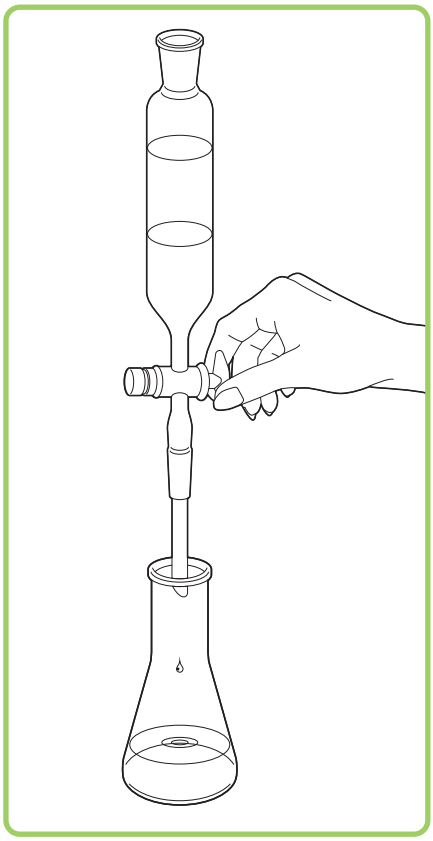
The experiment

The tablets contain one or more active ingredients combined with a water-soluble binder that holds the tablet together.

Isolation procedure

1. Weigh out four tablets and place them in a small beaker containing 20 cm^3 of distilled water. Observe what happens.

2. After the tablets have disintegrated, transfer the contents of the beaker to a separating funnel and add 20 cm^3 of ethyl ethanoate.



3. Shake the funnel vigorously until everything has dissolved. Allow the solvents to separate and run off the lower aqueous layer (including any emulsion at the interface) into the beaker. Keep this fraction.

4. Run off the remaining ethyl ethanoate layer into a dry 100 cm^3 conical flask.

5. Put the aqueous layer back into the separating funnel and extract it once more with a fresh 20 cm^3 of ethyl ethanoate. Combine this ethyl ethanoate extract with the previous one to give a combined organic extract. Keep the aqueous layer!

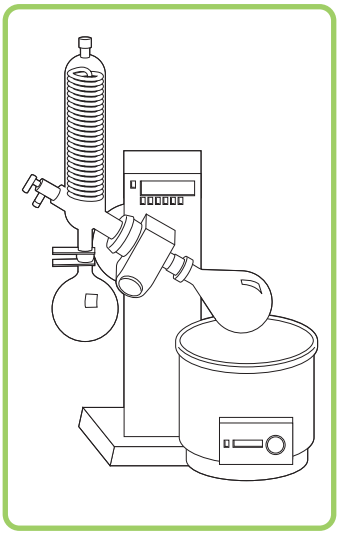
6. Dry the ethyl ethanoate solution by adding a heaped spatula of anhydrous magnesium sulfate to it and gently swirl the flask.

7. After 10-15 minutes filter off the drying agent into a round bottom flask which has been previously weighed.

8. Evaporate the solution to dryness on a rotary evaporator and weigh the flask again.

9. Record the weight of your solid on the report sheet.

10. At the end of the experiment wash the aqueous extract down the sink with plenty of tap water.



Preliminary investigation of the white solid (X)

1. Record the infrared (IR) spectrum of X, with the help of a demonstrator.

2. Run a thin layer chromatography (tlc) analysis of X using ethyl ethanoate as the eluent.

3. Measure the melting point of X and record it on the report sheet.

4. Investigate the solubility of X by adding small samples to approximately 1 cm^3 of the following solvents. Give each test about 2-3 minutes for something to happen. Record your observations on the report sheet

- cold water (Is X very, slightly or not soluble?)
- cold dilute hydrochloric acid (Is X a base?)
- cold aqueous sodium hydroxide (Is X a phenol or a carboxylic acid?)

Use the above observations, together with the following analytical and spectroscopic data, to work out the structure of X.

- Combustion analysis of compound X gave the following percentages of carbon, hydrogen and oxygen – assume the remainder is oxygen. C (63.56), H (6.00) and N (9.27). Work out an empirical formula and record this on the report sheet.
- From the mass spectrum given to you. Work out the molecular mass and hence the molecular formula of X and record this on the report sheet. Use all the facts you have gathered, together with the attached ^1H NMR spectrum and the IR spectrum you recorded, propose a structure for X.

NOTE

A compound with an odd number of nitrogen atoms has a molecular mass that is also an odd number.

Report sheet

Isolation of material X

Weight of tablets _____ g

Weight of X obtained _____ g

Melting point of X _____ °C

Structure determination of X

Tlc analysis number of components and their R_f value

Solubility in cold water

Solubility in cold dilute hydrochloric acid

Solubility in cold aqueous sodium hydroxide

Empirical formula from combustion analysis

Molecular mass

Molecular formula

Structure proposed

Structure proposed