

"Recycle shipwrecked cargo", demands group

An old iron cargo ship, carrying a cargo of ammonium chloride was wrecked on a sandy beach off the chalky white cliffs of Dover. The cargo was saturated with salty sea water, but subsequently dried out.

Pounded by recent storms, this mixture of 5 substances has been reduced to the sample given to you.

Local environmental groups have demanded that these five compounds should be separated and either recycled or returned to their original location.

- Your task

Separate this mixture to give a pure sample of each component of maximum yield.

- A sample of each component in its pure form is available if you wish to carry out any preliminary investigations.

Based on a suggestion by J. Crellin/V. Herbert.

Time

120 minutes.

Group size

2–3.

Equipment & materials

Eye protection.

General

Magnets, crucibles, evaporating basins, test tubes, small pyrex, or hard glass test tubes, test tube holders, filter funnels and papers, glass beakers (100 cm³ maximum), glass stirring rods, spatulas, rocksil wool. Bunsen burners, tripods, gauzes, heatproof mats, clampstands. Top pan balances.

Per group

Sodium chloride, ammonium chloride, silver sand, iron filings, calcium carbonate and a mixture containing 25 g of each of the above chemicals.

Health & Safety notes

This is an open-ended problem solving activity, so the guidance given here is necessarily incomplete. Teachers need to be particularly vigilant, and a higher degree of supervision is needed than in activities which have more closed outcomes. Students must be encouraged to take a responsible attitude towards safety, both their own and that of others. In planning an activity students should always include safety as a factor to be considered. Plans should be checked by the teacher before implementing them.

You must always comply with your employer's procedures and in some cases may decide that a particular activity is inappropriate in your situation. Further information on Health and Safety should be obtained from reputable sources such as CLEAPSS [<http://science.cleapss.org.uk>] in England, Wales and Northern Ireland and, in Scotland, SSERC [<https://www.sserc.org.uk>].

Eye protection is advisable when heating any substances.

Ammonium chloride, NH_4Cl (s) is harmful if swallowed and an eye irritant. When it sublimes, do not inhale the vapour.

It is the responsibility of the teacher to carry out a suitable risk assessment.

Curriculum links

Sublimation, magnetism, filtration, evaporation, solubility of salts in water. (Groups 1 and 2: chemical elements.)

Possible approaches

Each group should be provided with a sample of each component in its pure form, for any preliminary experiments they may wish to do. Before adding water it is best to separate **(i)** the iron filings from the mixture with a magnet, and **(ii)** the ammonium chloride by sublimation. Then add water to the remaining sand, calcium carbonate and sodium chloride mixture and filter. Filtrate of sodium chloride solution is evaporated. Calcium carbonate and sand are left on the filter paper. Addition of hydrochloric acid to the sand/calcium carbonate mixture forms a solution of calcium chloride (sand removed by filtration). Addition of sodium carbonate solution precipitates calcium carbonate (by double decomposition). Calcium carbonate and sand mixture may also be separated by allowing the two components to settle out over a period of several weeks.

- Cargo can be anything, eg organic material, coloured material becomes a possible extension.
- Few students realise that only a small amount of water is needed to dissolve substances. **If** a large amount of water is used it can take a long time to evaporate (**NB** keep large beakers out of reach of students).

Suggested write-up

Students to write a letter to local environment group with results.

Evaluation of solution

These are suggestions only:

- 1 The yield of each component should be recorded.
- 2 The separated components should be assessed for acceptable purity.
- 3 The winners are the group that produces the greatest total mass of separated components of acceptable purity.

Credits

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Health & safety checked May 2018

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