Nail varnish removal

Aims

- To revise the terms solvent, solute and solution.
- To appreciate that not everything will dissolve in water and that different solvents work well for different solutes.

For the more able:

- To introduce the idea that water dissolves things which have a charge or are polar but not things which are uncharged or non-polar.
- To provide an opportunity to discuss the concepts of the reliability and limits of evidence.

Notes on the activity

- This activity is straightforward. It will take no more than 15 minutes (including time for students to fill in the table) once the nail varnish is dry.
- The nail varnish will take a while to dry so ask students to paint it on a white tile early on in the lesson. If behaviour is a problem, you might wish to consider using a fast drying nail varnish. Students can copy the table ready for completion and answer the introductory questions while the nail varnish dries.
- Hydrochloric acid is included in the table because students often think acids will dissolve anything.
- The practical activity itself does not take very long – its purpose is to provide an opportunity for discussing why things dissolve and the limits of the evidence available.
- The extension sheet entitled **Dissolving** asks students to explain why some substances dissolve and others do not. This exercise is aimed at more able students.

Equipment required

- Nail varnish – a dark colour will work best (try not to use old, dried up nail varnish and have several bottles available to reduce waiting times)
- White tile – if these are in short supply, glass beakers also work well but do not use anything made of plastic
- Ethanol (**Highly flammable**) – ensure all solvent bottles have the correct hazard labels on them
- Propanone (acetone) (**Highly flammable and irritant**)
- Ethyl ethanoate (**Highly flammable and irritant**)
- Hydrochloric acid 1 mol dm–3 (or less concentrated) (**Irritant**)
- Cotton wool pads – you can cut them into quarters to make them last
- Access to water
- Tongs
- Eye protection.

You may like to provide students with bottles of commercial nail varnish remover for comparison, especially if you can find one with the solvents it contains listed on the packaging.

Answers – nail varnish removal

1. The solvents are the ethanol, propanone etc.

The solute is the nail varnish.
The solution is the nail varnish dissolved in the solvent (on the cotton wool).

2. This is not really a fair test – the amount of solvent, the thickness of the nail varnish, how hard you rub in your attempt to remove it and which nail varnish you use could all affect the result. The best remover could be ethyl ethanoate or propanone – it is hard to tell. (This last part of the answer may vary depending on which nail varnish you are using but these are usually the best two solvents.)
3. To make the test fair and therefore the evidence more reliable, you would need to find a way of making the nail varnish the same thickness for each test and use a controlled amount of solvent. Students may think of various ways of solving the problem.
4. No, you cannot tell which solvent would be the best nail varnish remover. The experiment does not take into account how the solvents might affect the nails/skin of the person using the nail varnish remover.
5. The further information needed could include the effect of the solvents on skin/nails, likelihood of allergic reaction etc.
6. Testing on humans/animals – you could use this question to start an ethical debate if you wish.
7. This nail varnish avoids solvents that may harm young children's skin. An alternative answer is that children should not be using anything containing flammable solvents without close supervision.
8. Nail varnish does not dissolve in water because its particles are not attracted to the water particles. Water is polar (it has an uneven distribution of charge in its molecules) and dissolves other charged or polar substances. Nail varnish dissolves in uncharged solvents better as it is itself uncharged. Students are unlikely to come up with this on their own, but it is good to get them thinking and talking about some of their ideas before giving them the explantion or the **Dissolving** extension sheet. Answers to the questions on the extension sheet are provided below. A further explanation of dissolving is provided in the RSC Particles in Motion CD ROM.

Answers to the extension sheet – Dissolving

1.

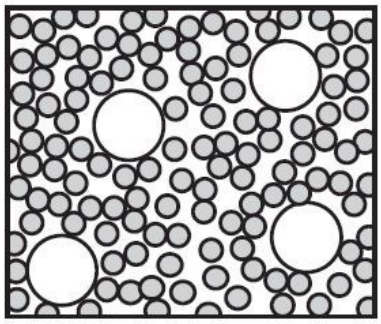


Figure 1 A dissolved solid (solid particles unshaded)

2. The solid particles have to separate/break apart, *ie* the bonds between the particles have to break.
3. No, the nail varnish did not dissolve in the water.
4. No, the nail varnish does not have charged particles.
5. No, ethyl ethanoate and propanone do not have charged particles.

Note that they do have small charges on their particles – but these charges are not as great as those on water and ethanol particles, which can form hydrogen bonds. With the most able students, you could discuss the fact that the size of the charges on the solid and solvent particles is important, as is the strength of the bonds between the particles in the solid. Most students at this level do not need to appreciate the subtleties of this, but the gifted may find it interesting.

6. Propanone and ethyl ethanoate have uncharged particles so they are better than water (which is polar) at dissolving the uncharged nail varnish particles.

Nail varnish removal

You will need

- Nail varnish
- White tile
- Ethanol – highly flammable
- Propanone – highly flammable and irritant
- Ethyl ethanoate – highly flammable and irritant
- Hydrochloric acid –irritant
- Cotton wool pads
- Water
- Tongs
- Eye protection.

What to do

- Paint five nail-sized areas of the white tile with a thin layer of nail varnish. Keep them about 3 cm away from each other.
- While the nail varnish dries, copy the chart below and fill in the prediction column.

	Will it remove the nail varnish?	Does it remove the varnish in one go?	Does it remove the varnish eventually?	Put the substances you have tested in order from 1 (best) to 5 (worst).	What problems might there be with this remover? (Hint: check the hazards)
Ethanol – Highly flammable					
Propanone – highly flammable and irritant					
Ethyl ethanoate (Highly flammable and irritant)					
Water					
Hydrochloric acid (Irritant)					

1. In this experiment, what is the:

Solvent?

Solute?

Solution?

Wear eye protection.
Once the nail varnish is dry try the various substances listed in the table to see which is the best nail varnish remover. Hold some cotton wool in tongs, put a little of one of the test solvents on it and rub one of your nail varnish samples gently. Repeat with the other substances and fill in the table as you go.

2. Is this a fair test? Can you say with certainty which is the best solvent for nail varnish?

3. How could you change this experiment to make the evidence more reliable?

4. Can you tell from this experiment which solvent would make the best nail varnish remover?

5. What other information might you need in order to decide?

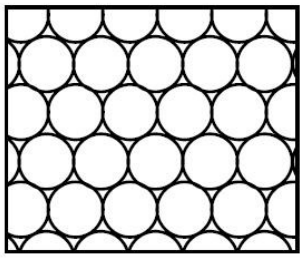
6. How could you obtain this information?

7. You can buy special nail varnish for young children that will dissolve in water. Why might this be preferable for young children?

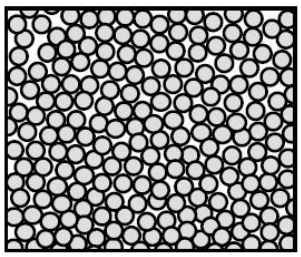
8. Why does nail varnish not dissolve in water? Discuss in groups and prepare an answer to share with the class.

Dissolving

Why does nail varnish dissolve in propanone but not in water? Why don't oil and water mix? To answer these questions, we need to think carefully about what happens when a substance dissolves.



Solid, eg salt



Liquid, eg water

1. Draw a diagram of a solid dissolved in a liquid. Use one colour for the solid and another for the liquid particles.

2. What happens to the solid particles when the solid dissolves?

_____

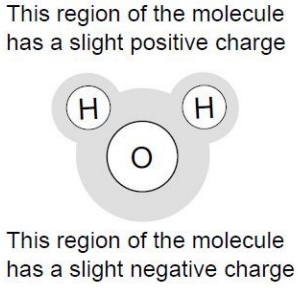
_____

_____

During dissolving two things happen:

- The bonds between particles in the solid break. This requires energy.
- The particles from the solid form new, weak bonds to the liquid particles. This releases energy.

If not enough energy is released by the formation of weak bonds between the solid and liquid particles, then the solid will not dissolve. If the liquid has charges on its particles, it forms stronger bonds with solids that also have charged particles. If the liquid particles are not charged, the liquid bonds better with solids whose particles are not charged.



Water has small charges on its particles as shown above. It is best at dissolving substances that also have charged particles.

Think back to your nail varnish practical and answer the questions below.

3. Did the nail varnish dissolve in the water?

4. Do you think the nail varnish has charges on its particles?

5. Do you think propanone and ethyl ethanoate have charges on their particles?

6. Explain why the nail varnish will dissolve in propanone and ethyl ethanoate, but not in water.