Chemistry

New properties from superficial changes 2 – wetness

(Spain)

Background:

Properties of so-called magical, kinetic sands compared with common sand are explored by performing simple experiments. The chemical composition of the sand does not vary, but by changing the chemical that the sand is coated with, it is possible to change its properties in a superficial way.

Various types of sand can be created for testing, using DIY instructions, details of which, including other areas of extension can be found here bit.ly/SonS2019

MAGIC SAND: The hair like molecules of trimethylhydroxysilane, repel water molecules. Submerged in water this creates a layer of air bubbles around the sand allowing water to run off the sand without wetting it. Magic sand was developed originally to use in oil spill clean-ups.

KINETIC SAND: Developed as a commercial sand moulding product, polydimethylsiloxane (PMDS) is the chemical coating that gives kinetic sand its superficial properties.

Both these sands are hydrophobic, and can be used to introduce and explore the polarities of various liquids, consolidating student understanding of solubility, when related to the charges on various substances.

You will need:

- ✓ Dry sand
- ✓ Magic sand (or dry sand mixed with Scotchguard)
- ✓ Kinetic sand (or dry sand mixed with shaving foam)
- ✓ Three plastic plates (or large clock glasses)
- ✓ Five Pasteur pipettes
- ✓ Teaspoon
- ✓ Permanent marker
- ✓ Water
- ✓ Acetone
- ✓ Petrol (petroleum spirit)
- ✓ Detergent (washing-up liquid)
- ✓ Engine oil

Follow these steps:

1. Section a plastic plate into five segments
2. Label each segment by writing the name of the test liquids on the plate rim, (fig 1).
3. Repeat for two more plastic plates.
4. Place a roughly equal amount of dry sand in each segment of one of the plates (approximately 1 teaspoon).
5. Repeat for magic sand and kinetic sand.
6. Using a Pasteur pipette place 2 – 3 drops of water onto the dry sand, magic sand and kinetic sand.
7. Repeat for acetone, petrol, detergent and engine oil.
8. Record the soakage/non-soakage in a results table, (Fig 2).

So what happened?

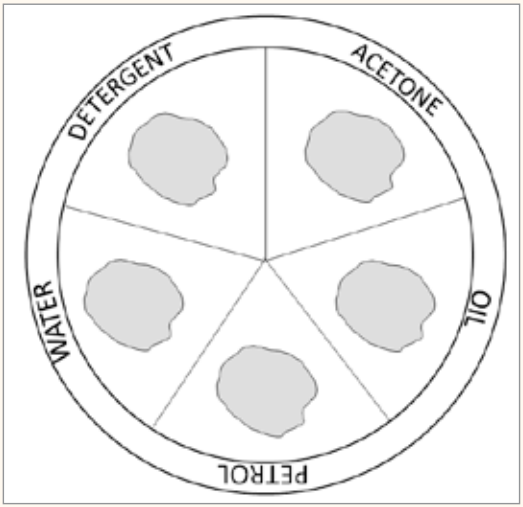
Soakage implies attraction between polar substances, and in non-polar substances a lack of repulsion. Non-soakage implies repulsion due to polar/non-polar interaction, or substances of the same polarity repelling each other. A simple analogy is the interaction of water and oil.

What next?

- Scientists try to recreate this in a number of contexts, in order to waterproof materials exposed to moisture. Waterproof coatings on shoes and clothing often use the water repellent effects of various natural waxes and oils, as well as synthesised chemicals. Modern car waxes and paints work similarly. High rise buildings, where it is unsafe for window cleaners to operate use water repellent coatings on glass, which cause water to run off. Running down from the top of a build-

ing this water effectively cleans the glass.

- Dimethicone (a form of PDMS used in shampoo and skin moisturisers), or beeswax spray can be used to form alternative water repellent sands, for comparison.
- Other hydrophobic substances found in the lab that might be tested are: ethanol, hexane, heptane, soap solution, various cooking oils.
- Student might also extend the waterproofing to textiles, perhaps examining "breathability" e.g. Gore-Tex.



TEST LIQUIDS	DRY SAND	MAGIC SAND	KINETIC SAND
water	soaks	repelled	repelled
acetone	soaks	soaks	soaks
petrol	soaks	soaks	soaks
detergent	sits on surface	sits on surface, rolls off	some soakage
engine oil	some run off, some soakage	soaks quickly	sits on surface