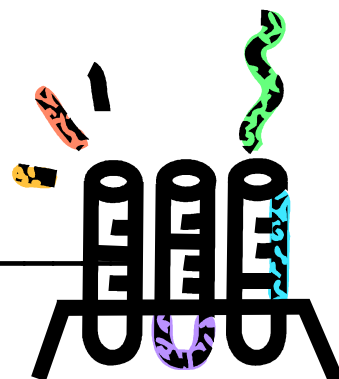


Clean Chemistry Lab Notebook

University of Oregon
Mad Duck Science Friday

Name: _____

Lab Group: _____



Chemicals in Our Daily Lives

Every day people use various cleaning products to wash dishes, counter tops, clothing, floors, hands, and more.

Even you!: What are some cleaning products you and your family use around your house?

Chemistry is behind the cleaning products we use daily to fight germs, remove stains, and shine silver. But what is really happening when the dish soap suds on the sponge? How does it work to remove the food?

Before we can answer these questions, we need to first learn more about the concepts that help scientists create the chemicals we use daily.

Terms to Know

Polar molecule – A molecule with electrons distributed unequally across its bonds, so one side has a greater charge than the other

Non-polar molecule – A molecule with electrons distributed symmetrically across its bonds, so it lacks an abundance of charges at the sides

Soluble – Able to be dissolved, especially in water

Insoluble – Incapable of being dissolved, especially in water

Hydrophobic – Repels water; does not mix with water

Hydrophilic – Attracts water; mixes well with water

Hydrocarbon – A molecule consisting of only carbon and hydrogen; it is non-polar molecule and hydrophobic

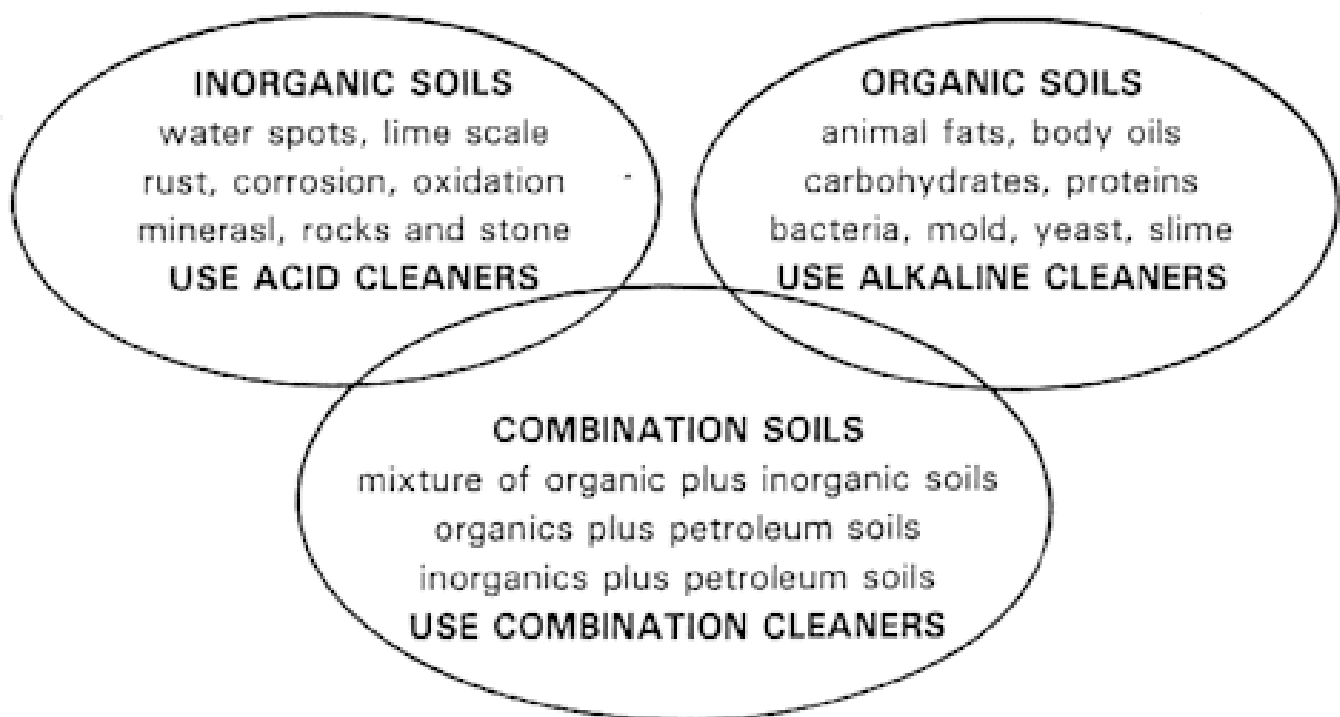
Physical Properties – An observable, measurable trait of a substance used to describe it (i.e. appearance, texture, color, weight, density, solubility, etc.)

Identifying the “Dirt” in Our Lives

Soil – Something in the wrong place, making a shirt or dish “dirty.”

Soil types:

- **Inorganic** – Does not contain carbon and was never alive
 - Soluble or Insoluble in water
- **Organic** – Contains carbon and was once alive
 - Soluble or Insoluble in water
- **Petroleum (Oil)** – **Hydrophobic**; repels water
- **Combination** – A mixture of an inorganic/organic soil, inorganic/petroleum soil, or organic/petroleum soil
 - Very difficult to remove



Once identified, the other three soils have some **physical properties** that allow us to find a cleaning solution to more easily remove them.

Give a specific example of each of the following soil types:

Inorganic –

Organic –

Petroleum –

Combination –

Now let's get dirty!

- 1) Find a group of 3-4 fellow scientists and a place at a sink
- 2) Pour a spoonful of oil into your right hand
- 3) Pour an equal amount of coffee grinds into your left hand.
- 4) Shake hands with members of your group.
- 5) Rub the oil and coffee grinds into each other's hands.
- 6) Half of your group will put soap on their hands. The other half will leave their hands covered in oil and grinds.
- 7) WITH A CLEAN HAND, begin running the water at the sink.
- 8) Wash your hands thoroughly. Do NOT use soap unless you added it in the previous step.
- 9) Turn off the water.
- 10) Use one paper towel to *gently* pat your hands completely dry.
- 11) Use a second, clean paper towel to wipe your hands, as vigorously as you need to.
- 12) Compare your paper towels and how your hands feel with other members of your group. Record your findings.
- 13) Wash both of your hands thoroughly with soap and water.

Observations:

What type of soil is the oil? What about the coffee grinds?

When you combined the oil and the coffee grinds, what would you say your hands were soiled with?

Why did we have you shake hands with members of your group? (Hint: Think about germs)

How did the hands washed without soap feel?

How did the hands washed with soap feel?

Was there a difference between the paper towels between members of your group? If so, what were they?

Hard Water and How to Make it “Soft” Again

Water is a **liquid**, so how can it be deemed hard or soft? Purpose: Learn what causes hard/soft water, the effects those have on our cleaning habits, and how we can make hard water “soft” again.

Hard water – water that contains dissolved salts

Salt – Ionic compounds, like NaCl

The hardness of tap water is dependent upon the types of rocks that the groundwater in your town flows through.



People in areas with hard tap water have to use more soap and detergent than people in areas with soft tap water. **Why do you think this is so?**

- 1) Label your jars with numbers 1–6 with your Sharpie.
- 2) To jar 1, fill it half way with tap water.
- 3) To jars 2–5, fill them half way with distilled water.
- 4) To jars 3–5, add 1 tsp (about a spoonful!) of the product listed in the table below.
- 5) Cap and shake each jar to dissolve the chemicals as much as possible.
- 6) Add 1/4 tsp of Dawn dish soap to jars 1–5.
- 7) Cap and shake each jar at least 10 times. In the table below, record the relative quantity of soap suds you observe, along with any other relevant observations.
- 8) Based on your observations, rank each jar with 1 having the fewest soap suds and 5 having the most soap suds.
- 9) For the jar with the fewest soap suds, make a fresh batch of that solution by following the previous instructions. Use jar 6 for this solution.
- 10) Add 1/4 tsp of laundry detergent to the fresh solution in jar 6. Cap and shake the jar at least 10 times.
- 11) **Record your observations in the table below.**

Which jar produced the most soap suds when you added the oil soap? Which produced the fewest suds?

Jar	Test Solution	Observations	Ranking	
1	Tap Water			
2	Distilled Water			
3	Distilled Water + Epsom Salt			
4	Distilled Water + Chalk			
5	Distilled Water + Washing Soda			
6				

Was there a difference when you added the dishwashing detergent instead of the oil soap?

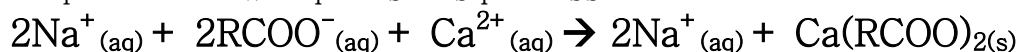
Did you note other observations for any of the jars? If so, what were they?

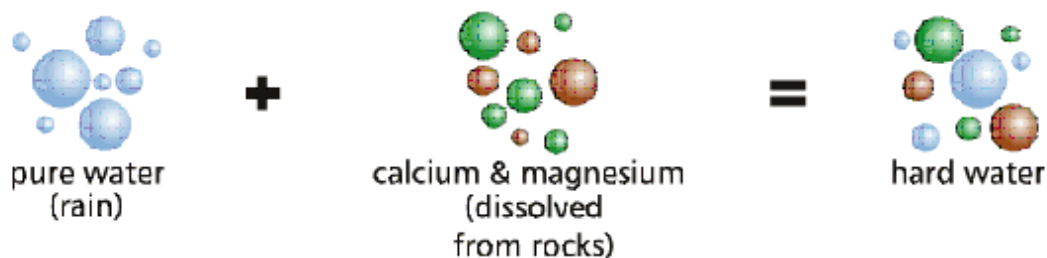
The Epsom salt and chalk both contain **minerals** that simulate those found naturally in hard water: **magnesium** and **calcium**.

Epsom salt is **magnesium sulfate** (MgSO_4).

Chalk is **calcium sulfate** (CaSO_4).

Water **dissolves** these compounds to form **ions** of the salt. The soap, which contains an **anion**, reacts with the minerals to form a new salt. The ionic chemical equation below explains this process:





After all the calcium or magnesium ions in the hard water react with the soap, the soap can then form suds.

Now add even more soap to jars 3 or 4. What do you notice?

Now you see why some people need to use more soap than others.

But why did the dishwashing detergent or the jar with the washing soda not have problems forming suds? **Detergents** have different chemical compositions than regular oil soaps. This increases the detergent's ability to clean.

Builders – group of minerals found in detergents that improve the quality of the water and prevent the formation of soap scum

Sodium carbonate (Na_2CO_3) – a builder found in detergents that removes the calcium or magnesium ions from hard water, making the water softer and preventing the formation of soap scum

Jar 5 contained sodium carbonate, or washing soda.

Now can you rank your jars from the ones containing the hardest (1) to softest water (5)? Do these rankings correlate to the number of soap suds found in your jars?

If your tap water was hard, what do you think you could do to decrease the amount of soap you need to wash your dishes or hands?

The Speeding Rubber Band

Have you ever gone fishing and watched bugs “skip” across the water? Why don’t they sink or get their wings too wet to fly? Like most magic-like events, there’s a scientific explanation for it!



The simple explanation is **surface tension**.

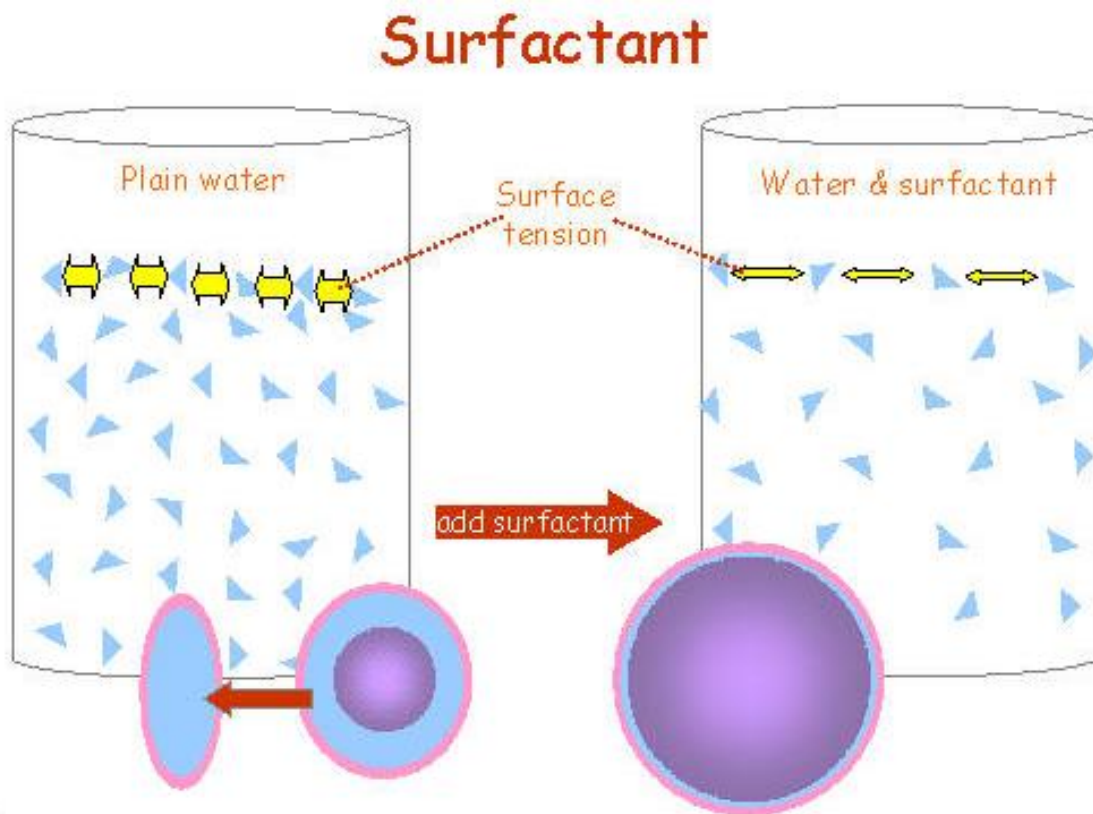
Surface tension – Property of water caused by water molecules at the surface attracting each other strongly

This creates a layer that is essentially stronger than the rest of the water. This forms a “tight” surface of water, allowing items to glide through while floating on the water.

Surfactant – Amphiphilic molecule; lowers the surface tension of the water by breaking up the connections between the water molecules

This allows grease and dirt to more easily mix with the water in order to rinse it out.

But what happens if the surface tension inside a flexible vessel is lower than that outside the vessel?



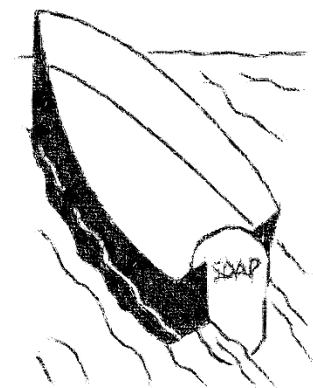
- 1) Fill a bowl with water. Place a rubber band in the water.
- 2) Place a small drop of Dawn soap inside the rubber band.
- 3) Record your observations.
- 4) Repeat steps 2 and 3 but use liquid handsoap instead. What changes?
- 5) Cut the rubber band in half in order to make a U shape.
- 6) Repeat steps 1-3. Be sure to record your observations!

Observations:

What happened when you put soap inside the closed rubber band? Why do you think this happened?

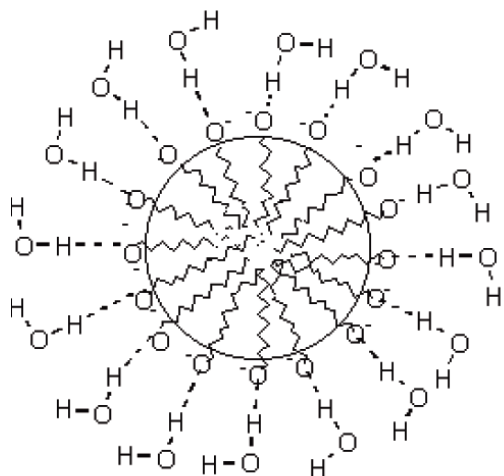
Did anything change between the soap scraping and the liquid soap?
What happened when you dropped soap at the tip of the U-shaped rubber band?
Why do you think that happened?

The U-shaped rubber band is similar to a boat.
When the soap was added to the water, the surface tension inside the boat was reduced. The stronger surface tension outside the boat pulls it forward, making it move along the water.



Know Your Stain

If you've ever played a sport, chances are you've likely seen your fair-share of grass and mud stains. How does stain remover and a good wash get your white uniform white again, though?



We learned in the soiled hands experiment that water is **hydrophilic** and oil is **hydrophobic**. Soap molecules are **amphiphilic**.

Amphiphile – Molecule with a hydrophobic and hydrophilic end

Micelle – A group of amphiphilic molecules surrounding a hydrophobic substance in water

Micelles dissolved in excess water create an **emulsion**, which can be washed away.

Emulsifier – something that can make oil and water mix

However, some stains cannot be washed away with just an emulsifier. **Biological stains**, like those caused by food or blood, need **enzymes** to break down the molecules.

Enzyme – A substance produced by living organisms that help to digest specific molecules, like proteins and fats

Below is a **general guideline** for removal of specific stain types.

Blood

If wet, rinse with lukewarm water.

If dry, soak in ammonia solution, then treat with dilute [2-5%] oxalic acid [found in auto radiator cleaner and in bar tenders cleanser]

Coffee

Wash in concentrated salt water

Grass

Fresh stains may be removed using rubbing alcohol; older stains try sodium perborate solution [drug store]. On white clothing, bleach followed by sodium thiosulfate solution.

Ink

Dissolve in alcohol or acetone [dissolves acetate fabrics] and cover solvent-stain solution with cornstarch or paper towel. Usually needs to be repeated several times.

Iodine	Chemically react with a solution of sodium hyposulfite [hypo or photographer's fixer]
Rust	Try citric acid [Tang, Gator Aid, or Crystal Light drink powder] or 5% oxalic acid with 5% glycerin.

Using your knowledge of how detergents work at the molecular level, you and your group will now try to remove a stain from a fabric using just the supplies listed below.

Please record a detailed procedure (we should be able to repeat it!) and observations about your stain.

Supplies:

Tap water (cold and hot), Dishwashing soap, Hand soap (liquid and bar), Hand sanitizer, Sponge/Towels, Laundry detergent, Washing soda

1) Stain your piece of fabric with ONE of the following: grass, dirt, coffee, tea, marker, or pizza sauce.

Procedure:

Observations:

Why did you choose the procedure you chose? What worked to remove your stain? What didn't work?

Can you name at least 3 items found in your kitchen at home that could be used to remove a stain caused by artist paint?