



## Swelling Gels

Gels are jelly-like materials made mostly of liquid, but with a little polymer added to hold it all together and make it a solid. In these experiments, we will experiment with a hydro-gel that is filled with water. The more water we add, the more swollen the gel and softer the gel will get. Gels are useful in many applications ranging from diapers to contact lenses to all sorts of foods.

### What you will need to get started

- Gel crystals
- Water
- 1Qt Ziploc bags
- Clear plastic containers with screw on lids
- Food coloring
- Probes - fingers
- Clean up - Paper towels

### Making the Gels

1. Mixing different amounts of the gel crystals with water will produce gels of different stiffness. The gels must be given at least 12 hours to fully absorb the water.
2. Mix 1/4 teaspoon of crystals with 50ml, 100ml, 200ml and 250ml of water in separate Ziploc bags and leave for about 12 hours. The gel crystals will become transparent and all the water will be adsorbed.
3. For fun, visual appeal and science, food coloring can be added to the different gel and water mixtures.
4. Once fully formed, the gels can be stored in sealed plastic containers indefinitely and reused.





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### Let's experiment!

1. Dip your fingers into the different gel colors. Do all the gels feel the same? Are they different in size?
2. Which gel feels the softest/squishiest? What do you think makes them so soft/squishy? Feel an unswollen gel crystal. Compare that to the ones that have absorbed the water.
3. Take some of the gels into your hands. Are they solid? Do they bounce? Are they liquid? Does the water leak out? What if you squeeze it?
4. Which of the gels do you find to be the weirdest? What makes them so weird?

### More experimental fun

1. The water within the gel crystals is not bound to the polymer. It can diffuse from one crystal to another. To see diffusion in action, layer some blue crystals on top of yellow crystals. Leave them for a few hours. What has happened to the color of the crystals where the blue and yellow crystals meet?
2. The rate of diffusion can be measured by using by tracking the color change in the crystals with time. How does diffusion change with dye color? How does the diffusion rate change with the amount of water adsorbed in the gel?
3. What happens when the crystals dry out? Leave a few out uncovered overnight and see.



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### **How does it work?**

The gel crystals used in this demo are made out of a superabsorbent polymer called polyacrylamide. Polymers are very large molecules which can have thousands or even millions of carbon molecules connected together to form a long chain. Think about a piece of spaghetti or a length of rope. In gels, the polymers are connected to each other at various points along the chain to create what is known as a cross-linked network. Because these polymers like water, they can store large volumes of water inside the network.

Hydrogels like these can absorb up to 1000 times their weight in water. As water molecules are absorbed the polymer network swells and the resulting gels get softer and softer, but remain solid. Imagine that the gels we are holding are made of up of 99.99% liquid water and 0.01% solid polymer and the resulting gel isn't a liquid. It's a solid!! Incredible!!

Hydrogels are found in a variety of commercially available products. Any product that requires a gel or absorbent properties could be performed by a hydrogel. Some applications include uses to store water in soil for farming in dry areas, additives to improve fire extinguishers, better absorbing disposable diapers, more comfortable contact lenses and many different food products.