

**Curriculum topics:**

- Matter
- Molecules
- Chemistry
- Polymers

**Subject:**

**Physical Science**

**Grade range: 4 – 12**

**Who we are:**

Resource Area for Teaching (RAFT) helps educators transform the learning experience through affordable “hands-on” activities that engage students and inspire the joy and discovery of learning.

For more ideas and to see RAFT Locations

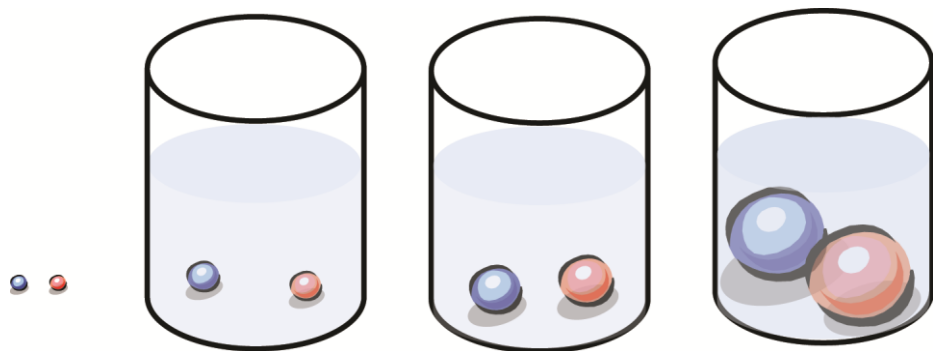
Visit [www.raft.net/more](http://www.raft.net/more)

# WATER BEADS

Superabsorbent-polymer in bead form



These tiny beads can soak up and hold over 100 times their weight in water! Each bead maintains its spherical shape and color. Observe how the beads absorb water over time. Create a fun illusion using the optical properties of the beads.



# Materials required

- Water Beads (superabsorbent polymer in bead form)
- Container, water-tight, clear, 2
- Water, hot & cold
- Ruler (in millimeters- mm)
- Timer or watch
- Water Bead Data Sheet
- Marble
- Clear watertight tube, which the marble will fit into, with a tight-fitting cap
- Water, hot and cold

*Note: For external use only. This substance is non-toxic. However, the saturated water beads can pose a choking hazard. Use proper safety precautions. Do not use with children under 6 years old. Do not eat, drink, or inhale the water beads. Do not let children use the water beads, dry or wet, without adult supervision.*

## To do and notice

### Measurement activity

- 1 Measure and record the diameter of a dry water bead (in mm) on the **Water Bead Data Sheet**.
- 2 Label one container “hot water” and the other “cold water”. Put hot water and cold water in the appropriate containers. Optional: measure and record the starting temperatures of the water in each container.
- 3 Record the starting time and place 2 or 3 water beads in each container. Over time, measure and record the diameter of the beads. Notice the difference in the rate of growth with hot water versus cold water. Does the difference in size persist after the hot water cools? Optional: add more hot water to the “hot water” container.
- 4 Observe the beads over the next few days and weeks, adding more water when needed. Note what happens to beads that are allowed to dry out.

## Water Bead Data Sheet

**Diameter of dry water bead (mm)**      $D_{dry}$  = \_\_\_\_\_     **Starting time** \_\_\_\_\_

Elapsed Time	Diameter of water bead in Hot Water (in mm)	Diameter of water bead in Cold Water(in mm)
2 min.		
5 min.		
10 min.		
30 min.		
1 hour		
2 hour		
5 hours		
1 day		

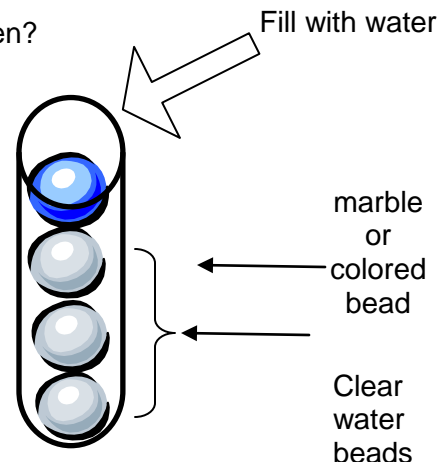
## Exploration activities

- 5 Drop one fully hydrated (soaked) bead on a hard surface. Observe what happens. Does it bounce? What happens if it breaks?
- 6 Place different colors together in one container of water. Do the colors diffuse between the beads? Are some colors easier to see than others?

## Water bead optical illusion

- 7 Place several fully hydrated clear water beads in a clear watertight tube with a tight-fitting cap. Place a marble or colored water bead on top of the clear water bead.
- 8 Fill container with water. Observe what happens. What can be seen? Add cap to tube and tighten.

To dispose of the beads, simply spread them out on a tray, let them dry thoroughly, and repackage; or mix wet beads into garden beds to assist with plant hydration. Beads swell in water and may clog pipes. **Never flush or pour beads down the drain.**



## The science behind the activity

Each bead is made of a **superabsorbent** (water retaining) **polymer**. Whether the polymer is an **alginate** (a gum extracted from seaweed or brown algae) and/or contains **sodium acrylate**, it can absorb more than 100 times its weight in pure water, depending on the degree of “cross-linking” within the molecules. During the absorption process, water molecules are drawn into the network of polymers. The polymer chains cannot expand, due to the cross-linking, so the particles expand as water moves into the network. As the beads dry, the water leaches out into whatever medium the beads are in, whether that is air or soil. Clear water beads that have been hydrated have an index of refraction identical to the index of the water in which they are immersed.

This and other similar types of polymers can be found in baby diapers, feminine hygiene products, “cooling” products such as bandanas, and are also very useful for keeping plants hydrated. The water bead polymer can be dried out and then rehydrated a number of times. Different types of polymers are used in agriculture and a wide variety of other specialty absorbent applications.

Some of the many uses for superabsorbent polymer:

- Cooling evaporative headbands and collars
- Growing plants without soil
- Crafts and home decorations
- Blocking water penetration in wires and cables, above & below ground
- Hot and cold therapy packs
- Fire-retardant gel
- Medical waste solidification
- Water absorption from gasoline/diesel fuel tanks

## Curriculum Standards:

Structure of matter  
(Next Generation Science Standards: Grade 5, Physical Science 1-1)

Property of materials  
(Next Generation Science Standards: Grade 5, Physical Science 1-3)

Chemical reactions  
(Next Generation Science Standards: High School, Physical Science 1-5, 2-6)

Science & Engineering Practices  
(Next Generation Science Standards Grades 4 – 12)

Additional standards at:  
<http://www.raft.net/raft-idea?isid=685>

# Learn more

- Add plants or cut flowers to the water beads.
- Examine how light passes through the water beads.
- Try salt water instead of regular water.
- Carefully insert a dry water bead into a hydrated water bead and observe
- To see examples of this type of substance in use in everyday life, students can add water to baby diapers, and then dissect diapers to observe the superabsorbent polymer inside.
- Middle and High School Biology concept: Place a partially-hydrated water bead into food colored water and observe rate of absorption of colored water. This simulates concentration gradient diffusion across cell membranes.

**Related activities:** See RAFT Idea Sheets:

### ***Amazing Hydro Absorber***

<http://www.raft.net/ideas/Amazing Hydro Absorber.pdf>

### ***Fizzy Rockets***

<http://www.raft.net/ideas/Fizzy Rockets.pdf>

### ***Is it Really Full***

<http://www.raft.net/ideas/Is it Really Full.pdf>

### ***Overnight Crystals***

<http://www.raft.net/ideas/Overnight Crystals.pdf>

# Resources

Visit [www.raft.net/raft-idea?isid=685](http://www.raft.net/raft-idea?isid=685) for “how-to” video demos & more ideas!

See these websites for more information on the following topics:

- **History of superabsorbent polymer chemistry –**  
[http://www.m2polymer.com/html/history\\_of\\_superabsorbents.html](http://www.m2polymer.com/html/history_of_superabsorbents.html)
- **The components of a typical disposable diaper –**  
<http://disposablediaper.net/faq/what-are-the-components-of-a-typical-disposable-diaper/>