

Squish! (Not-so-Solid Science)

Workshop for *Expanding Your Horizons*

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We will make a mess doing hands-on activities like turning liquids into solids (making and tasting butter from cream, cornstarch/water) and solids into liquids and back (tapping sandpiles), and other similar activities to be tested and planned. The scientific focus will be understanding that there are states of matter beyond solid/liquid/gas, and that there are non-heat ways of changing the state of matter of a material, but mostly we'll be having fun and asking questions about the phenomena we see.

Girls will work in groups of 3 (total of 4 groups).

50 minutes total of activities, including discussion and cleanup.

Materials:

Consumables (#/group)	General Equipment (#/group)
Ice cube (1)	box of sand
Small plastic plates (2)	paper towel tubes (1)
Plastic knife(1)	seal-able plastic container (1)
1 cup cream	mixing bowl, mixer
crackers	silly putty (1)
tall drink cups (2)	spoon (1)
1 cup cornstarch	hot plate & small pot
½ cup water	dishsoap/sponge/paper towels
newspaper to cover tables	LCD projector
pie tin (1)	laptop w/ internet connections
ziplock bags (3)	whiteboard
	coins, marbles for floating/sinking
	hourglass

Introduction: (0:00)

Have workshop leaders introduce themselves (where they are from, hobbies/interests)

What we do: scientists at a university are both researchers and teachers

some days we're something like what you'll do today

conducting experiments and watching what happens and trying to provide explanations

other days, we:

write computer programs to collect and analyze data

solve equations which describe the science

write scientific papers to describe our results

write grant proposals to have money to pay for equipment and salaries (grad students are paid!)

work in a machine shop to build apparatus

design electronics for making measurements

visit other states and countries to go to scientific conferences and discuss our results

teach college students about physics

As we're walking around today, feel free to ask us questions about our jobs and doing science, and how we got there.

Solids vs. Liquids: (0:05)

Who has learned the 3 states of matter in their science class?

How can you tell solids from liquid?

brainstorm

zoom in at the molecular level: what's going on?

show M&I ball and spring model video: BallSpring.mov (5 fps, then 60 fps)

available at: <http://matterandinteractions.org/Content/Materials/materials.html>

micro picture vs. macro pictures

Ice: solid or liquid?

Put ice cube on small plate and let sit undisturbed

Silly putty: solid or liquid?

Form into a ball and bounce it ...

Put it on small plate and let set undisturbed (just as for ice cube)

We'll compare these in a little while....

Sand: Solid or Liquid? (0:10 to 0:20)

Brainstorm: is sand a solid or a liquid?

Think of arguments in favor of each side, then vote.

Show hourglass, sandpile, etc. using box of sand

What we're going to do today is try to understand materials which are neither solid nor liquid, but someplace

Brainstorm: Are there other materials like sand which have similar issues?

These are called "granular materials" by scientists

Activity: Pour sand around outside of paper towel tube inserted into tall drink cup.

Try to pick it up by the tube!

Try again, this time tapping the whole setup on the table before you try to pick it up.

Brainstorm: What's going on?

What happens to the level of sand when you tap?

Compaction of cereal.

Brainstorm: Can you think of places/situations where there's a granular material you'd like to stay solid-like? Stay liquid-like?

Suspensions: A Mix of Solid and Liquid (0:20 to 0:35)

pie tin, mixing bowl, spoon

1 cup of cornstarch in bowl

add < ½ cup water, added slowly (until like thick batter)

bags for throwing it out/keeping it

Pour into pie tin, then try to slap it, vs. slowing poke with finger
can you roll it into a ball? What happens if you put the ball down?

Do objects sink or float?

How is this like a solid? Like a liquid?

This is a suspension of a solid within a liquid (2/3 solid, 1/3 liquid). Like quicksand.

When you squeeze it quickly, the particles line up and resist, trapping the water between them.

But if you go slowly enough they can move out of the way.

Cornstarch is a polymer, which means a long chain-like molecule. When you push on it, the chains get tangled, but when you go slowly enough they slip past each other.

Just like a crowd of people. If you can take your time, you can weave your way through the crowd, but if tried to run through you'd have trouble.

How does quicksand happen? Water gets into loose sand and can't get back out.

Does it matter how much water your add?

Lots of water: sand sinks to bottom

Just a little water: make sand castles (water “glues” the sand grains together).
In between: quicksand

How would you get out of quicksand, based on what you learned today?
Better to move around? Or float on top surface? Would you float
Swimming pool filled with cornstarch mixture: <http://www.youtube.com/watch?v=f2XQ97XHjVw>

Texas Faraday waves: <http://www.youtube.com/watch?v=nq3ZjY0Uf-g>

How should we dispose of this? What happens if we flush it down the drain?

What are some experiments you might do with this at home?

Making Butter (0:35 to 0:45)

Cream: solid or liquid? Which criteria does it fulfill?

Cream is actually a suspension (a bit like the cornstarch/water mixture) and we want to re-separate the two parts (fat + protein + water)

Put it into mixer ... make whipped cream (bubbles of air inside liquid) ... then butter.

Notice that we separated the solid (butter) from the liquid (buttermilk)

Butter + whey: solid or liquid? Which criteria does it fulfill?

Cream has fat droplets surrounded by milk membranes.

Whipping it makes a foam of air and cream.

When bubbles pop, the foam leaks liquid (buttermilk), and the fat starts to stick together.

Could we put this back together again into cream?

What happens if we melt it?

Wrap-Up: (0:45 to 0:50)

Look back at ice cube and silly putty.

Similarities, differences?

What are the different ways we turned liquid into a solid?

Solid into liquid?

Other questions for us, about either the experiments we did today, or our jobs?

Further Reading

The Physics Teacher **44**, 276-279, May 2006