

Solid, Liquid, & Gas Demonstration

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Main concepts:

- A pure substance can change forms from Solid to Liquid to Gas
- Heat is just movement of atoms
- Definitions of Melt, Boil, Vaporize, Condense, Freeze, or Solidify
- Liquids pour / take any shape or the shape of the container.
- Gas takes up more space than liquid (for same number of atoms)

What to do:

Question: Ask the children, “what are the 3 states of matter ? ”

Answer: Solid, Liquid, & Gas. Put Solid Liquid & Gas cards up on the poster.

Characteristics of **Solids** (hard/soft sponge, powder, clear, opaque, salt, glass, metal)

Characteristics of **Liquids** (pour, Honey, Water, Oil, Soap, Alcohol)

Characteristics of **Gases** (Air, helium in a balloon, bubbles in soda, exhaust from a car)

Solids can be soft or they can be clear, but solids keep their shape. That’s why we say we eat a piece of bread, or a chunk of cheese. But we never say we drink a piece of water, breath a chunk of air. Instead we drink a cup of water or breath some air, because liquids and solids don’t have any shape.

In order to understand Solid, Liquids, and Gases we first need to think about **atoms**.

Show the box of atoms briefly. Explain that the ping pong balls represent atoms.

Explain that everything is made of Atoms. Atoms are very very small.

Put a cookie on a plate, cut into $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, etc... Look with a magnifying glass. Ask the children how much smaller would we have to go to get to just one atom ?

Measure the thickness of a human hair (Diameter = 2 thousandths of an inch = 500,000 atoms across).

Laptop - show relative sizes: Dust Mite, Bacteria, Cells, Virus, Atoms.

Question: What is the difference between liquid and gas ? Use the **Box of Atoms** to show a Solid (neighbors stay next to each other), Liquids: the atoms roll over each other. Liquids can pour like orange juice into a cup. Can you pour a solid ? No. Finally show a gas. The atoms bounce around violently. Notice that a gas takes up more space than a liquid does. Compare the density of each.

Question: How can we change a Solid to a Liquid to a Gas ??

Question: First let’s think of something that comes in all 3 forms ? **Ans:** ice, water, & steam.

Have each child hold a piece of ice in their hand. What happens to the ice ? It melts. We add **Heat**. Heat is just atoms moving around in every direction. Heat is a form of Energy. Show the box of Atoms again.

Introduce Temperature. Hands in 3 water paths, cold, warm, hot. Children read the thermometers in each. Show poster of a big Thermometer & Ref Temperatures (Venus 800°F, Boil water 212°, comfortable 72°, Ice freezes at 32°, Antartica approx -100°).

Optional: for the older children. Approximation to convert from temperature in Celsius to Farenheight.

$T_F \approx 2 \times T_C + 30$. Plug in $T_F = 0, 20, 100$. Compare with the exact results using: $T_F = 5/9 \times T_C + 32$.

Show the steam source. Water changes into steam, and then steam condenses back into water.

Question the children and add these words to the poster.

Boil water (Liquid to Gas)

Vaporize (Liquid to Gas)

Condense the steam back into water (Gas to Liquid).

Melt ice (Solid to Liquid)

Freeze or Solidify (Liquid into Solid)

Optional: For older children explain “**conservation of mass**”. Mass is conserved in Transformations from solid to Liquid to gas. But Mass is also conserved in chemical reactions. (not here).

Example: Where does a Log go when it burns in a fire ?

Can anything change from Solid to Liquid, to Gas ?

Can a metal melt ? Can a metal turn into gas ?

Show that Torch melts metal solder.

Now let's go to the cold end of the scale

Pour some **Liquid Nitrogen** into a metal bowl.

Poster of Thermometer. Unroll to show LN₂ is -320 deg F

Freeze a balloon in Liquid Nitrogen (air condensed into a liquid). Show the liquid in the bottom. Lift the balloon out with metal tongs. Balloon expands back to full size as it warms (Liquid back to Gas)

Question: What would happen if we freeze our finger ?

Freeze a hot dog, sponge, flower, rubber ball, and a racquet ball.

Show liquid Nitrogen boils in a pan.

Nailing contest with a frozen banana.

Throw a frozen racquet ball. It smashes into pieces.

Equipment needed

4 tables (2 tables in front of me, plus 1 table on each side of me)

Marker Board & markers

Safety glasses for all the children.

Solids; wood, metal, plastic, glass, salt, cotton balls, plastic wrap, baby powder

Liquids: water, oil, honey

Cookie on a plate w/ knife & Magnifying Glass.

Laptop with Size comparison Bacteria, Cells, Virus, Atoms

Notebook of pictures Bacteria, Virus, Atoms...

Atoms in a box

Poster of Solid, Liquid, Gas, Melt, Boil, Condense, Freeze.

Cooler full of ice, & a bowl for ice.

Poster of a Thermometer, (rolls out), velcro.

3 plastic boxes + 3 thermometers for water baths.

Coffee maker (a source of hot water).

Extension cord, Power strip

Steam source: Ring stand, clamp, flask, rubber stopper, glass tube

Bunsen burner, Propane tank, Gas regulator valve & gas hose. Spark igniter

Condenser: Plastic box for ice bath, copper tubing, clear rubber tubes,

Calipers to measure a human hair.

Solder & soldering gun (heavy metal can to put soldering Iron into).

Cryo-gloves, & Tongs

Metal bowl & Block of styrofoam for LN₂

Hammer, 2 Boards, Nails, C-clamp

Consumables

Liquid Nitrogen in a Dewar

Balloons, hot dogs, bananas, flowers, super ball, Racquet balls, Ice

Access to hot water

Where to buy Liquid Nitrogen and the Dewar

Liquid Nitrogen Dewars are very expensive, but you can rent one at:

Polar Cryogenics Inc.
2734 SE Raymond street (near 26th & Holgate)
in Portland Oregon
503-239-5252

10 Liters of LN ₂	\$40.00
<u>Dewar rental</u>	<u>\$25.00</u>
Total	\$65.00

Solid, Liquid, & Gas and Temperature (Outline)

What are the 3 states of Matter ?

Poster (Solid, Liquid, Gas)

Characteristics of Solids, Liquids, Gases

Atoms

Show the Box of Atoms Briefly

Cookie

Human hair (500,000 atoms diameter)

Laptop (Dust Mite, Bacteria, Virus, Atoms)

Solid Liquid & Gas

What is the difference between Liquid & Gas ?

Box of Atoms to show the differences between Solid, Liquid, & Gas.

Gas takes up more space than liquid

Heat

How can we change Solid → Liquid → Gas ?

What comes in all 3 forms ? (Ice, Water Steam).

Ice in hands

Explain Heat

Temperature

Hands in water

Thermometer Poster (Venus 800°F Boil 212°F, comfortable 70°F, ice 32°)

Older kids: $T_F = (2 \times T_C) + 30$

Safety Glasses

Steam Source

Poster add: Melt, Boil, Condense, Solidify

Older kids: Conservation of Mass

Example: A Log in a Fire. Where does it go ?

Liquid Nitrogen

Now let's go colder

Unroll - Thermometer Poster

Liquid Nitrogen - Balloon / Hot Dog / Sponge / Rubber ball / Banana

- Boil LN2