# *STUDENT GLOVEBOX*

**NASA SUMMER OF INNOVATION**
**UNIT**
*Physical Science—States of Matter*

**GRADE LEVELS**
*4 – 6*

**CONNECTION TO CURRICULUM**
*Science*

**TEACHER PREPARATION TIME**
*4 hours*

**LESSON TIME NEEDED**
*4 hours* *Complexity: Moderate*

## LESSON DESCRIPTION
Students design their own investigation of the characteristics of various liquids.

## OBJECTIVES
Students will
- Design a Droplet Investigation of Liquids experiment
- Design experiment hardware that can be used in their team's Glovebox
- Experiment with various fibers and liquids
- Determine which fibers and liquids produce the most spherical droplet
- Determine ways to mount fibers
- Write instructions to conduct the activity
- Present their conclusions

**NATIONAL STANDARDS**

**National Science Education Standards (NSTA)**
*Science as Inquiry*
- Understanding of scientific concepts
- An appreciation of "how we know" what we know in science
- Understanding of the nature of science
- Skills necessary to become independent inquirers about the natural world
- The dispositions to use the skills, abilities, and attitudes associated with science

*Physical Science*
- Properties of objects and materials

*Science and Technology*
- Abilities of technological design
- Understanding about science and technology

## MANAGEMENT
One option is to send a note home to parents telling them about the project a week or two ahead of time. Include the materials list and ask them to send in materials from this list. The liquids and fibers listed are merely suggestions. Encourage students to try others. If your use rubbing alcohol, be sure the room is well vented.

## CONTENT RESEARCH

A glovebox is a sealed container with built-in gloves. Astronauts perform small experiments and test hardware inside of them. Gloveboxes have flown on the space shuttle and Mir. The International Space Station has a permanent glovebox on the U.S. Laboratory, Destiny. There are good reasons for doing an experiment in a glovebox on orbit. The sealed glovebox keeps flames, particles, fumes, and spilt liquids away from crew members and out of the cabin air. Fumes or particles can irritate crew members' skin and eyes or make the crew sick. Spills could damage electrical equipment.

A glovebox is a valuable research tool. Any work with flames requires precautions, especially on a spacecraft. For some studies, it is important to protect experiment samples from the cabin air and crew. A closed environment may be essential to control experiment variables. Using a glovebox helps scientists find more effective methods for performing an experiment, like growing better crystals. Scientists can use the glovebox to make sure small parts of a large experiment work. This helps build more reliable equipment. For example, they can see if a part like a nozzle will work on orbit and see which nozzle shape works the best.

One reason NASA created the glovebox was so researchers could fly simple investigations into space more quickly. Normally, science teams work with NASA about 7 years before their experiment is ready to go into space. Seven years may seem long, but the process is complex and takes careful planning. Glovebox research has a shorter development time, usually taking 3 to 5 years.

The Fiber Supported Droplet Combustion (FSDC) investigation was performed on the Space Shuttle Columbia in 1995 and 1997 and will fly again aboard the International Space Station. The investigation studied ways to position droplets of liquid fuels on thin fibers and then ignite them on orbit. This research allowed scientists to develop efficient droplet deployment (positioning) techniques and to study droplet combustion processes. Such research may improve fuel efficiency and reduce pollution on Earth.

**Key Concepts:**

- Surface tension and viscosity are properties that will vary among liquids.
- The scientific process is used for effective experimenting.
- Data can be communicated using tables and charts.

**Misconceptions:**

- A liquid is flat and runny.
- A liquid is gas (gasoline).
- Liquids are not matter because we drink them.
- Liquids are things you drink.
- Liquids spill and run all over.
- Liquids can be compressed (liquids in a plastic bottle).
- Liquids have water in them.
- The thicker the liquid the heavier and more dense it is.

**MATERIALS**

For the chamber:

- Empty copier paper box with lid
- Glovebox artwork
- Masking tape
- Scissors
- Utility knife
- Metal edge ruler
- Two pieces of 11 by 17 construction paper
- Pencil
- Heavy cardboard cutting
- Surface
- Clear contact paper
- (optional)

For the lid:

- Copier paper box lid
- Clear, 2-inch packing tape
- Two overhead transparency sheets
- Ruler
- Duct tape
- Utility knife
- Scissors

For the gloves:

- Four jumbo plastic cups (32 oz)
- Thick rubber bands (size #64 or wider)
- Dish washing gloves (long)
- Disposable surgical gloves
- Utility knife
- Scissors

Optional:

- Tube socks
- Low-temperature glue gun
- Low-temperature glue sticks

## LESSON ACTIVITIES

A model glove box is constructed of a copy paper box and craft materials and used to investigate properties of liquids.
http://virtualastronaut.tietronix.com/teacherportal/pdfs/StudentGlovebox.pdf

## ADDITIONAL RESOURCES

Video learning clip on astronauts in space using specially designed equipment to work safely with harmful substances.
http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Using_the_General_Purpose.html

Video learning clip on how surface tension takes over when liquids are free of the effects of Earth's gravity.
Fluid Physics Experiments in Space

Article on the space station's glovebox.
http://science.nasa.gov/science-news/science-at-nasa/1999/msad14sep99_1/

Information on glovebox experiment named SPICE.
http://issresearchproject.grc.nasa.gov/MSG/SPICE/

Article titled "Astronaut Tests Virtual Glovebox for Space Experiments"
http://www.nasa.gov/centers/ames/news/releases/2002/02_95AR.html

## DISCUSSION QUESTIONS

What made your hardware design work well? *Answers should be based on student experience and will vary.*

What liquids and fibers produced the most spherical droplets? *Possible answers: we tested corn syrup, canola oil, rubbing alcohol, and water using waxed and unwaxed dental floss, fine jewelry wire, cotton sewing thread, nylon fishing line, and twine. Here's our ranked list of the combinations for the most spherical droplets, from most to least spherical.*

*Corn syrup and nylon fishing line or unwaxed floss: By far the most spherical droplets resulted from the corn syrup on the plain nylon fishing line, and next best on the unwaxed dental floss. Corn syrup was also the most interesting liquid to observe because it is so viscous. Droplets held their shape even if the fiber was held vertically.*

*Water and cotton sewing thread: Water has the highest surface tension of the liquids we tested. Fibers with plastic bead anchors could hold up to two droplets; however, the shape was not spherical.*

*Canola oil and nylon fishing line: Oil on the knot of the nylon fishing line produced a small semi-spherical droplet. Single drops formed below most plain fibers once the fiber was coated with oil. Small droplets hung from the bottom of the beads for all of the fibers.*

*Rubbing alcohol: On the knot of the nylon fishing line and fine jewelry wire, alcohol produced the smallest droplets, and it formed the least spherical droplets.*

Based on your observations, predict which liquids have the lowest to highest surface tension? *From lowest to highest surface tension: (1) alcohol, (2) corn syrup, (3) canola oil, (4) water. Students may notice surface tension by the way a liquid seems to "stick" to itself and the way it interacts with fibers. Water has the greatest surface tension of these liquids, forming the largest droplets. As a droplet falls, it forms a sphere. Drops of water suspended from a dropper seem to bounce off waxed floss. In contrast, alcohol forms the smallest droplets, and does not cling well to fibers.*

How well did your group work as a team? *Answers will vary.*

What made this team project challenging? *Answers will vary.*

What did you learn about conducting a scientific investigation? *Answers will vary.*

How would you improve the way you conducted this investigation if you could do it again? *Answers will vary.*

How could you make your data collection more precise? *Use a computer spreadsheet program to record observational and measurable data from the experiment. Create a bar or pie chart to give a clear visual indication of the collected data and help draw conclusions from the observations and measurements. Spreadsheet programs usually have a feature that will automatically draw graphs and charts from the data entered into rows and columns. Record additional personal notes and observations on paper or in a log book. A log book is valuable for collecting data when many entries need to be recorded, as when making observations daily over a period of weeks or months or taking dozens of measurements.*
How to Collect Data From a Science Project:
*http://www.ehow.com/how_5988780_collect-data-science-project.html - ixzz1JpUfej5W*

Do you think your team's results are reproducible? Explain. *Answers will vary.*

Would you feel comfortable designing and conducting an investigation of your own, if asked? Why or why not? *Answers will vary.*

**ASSESSMENT ACTIVITIES**
The activity description includes a suggested format for a Droplet Investigation of Liquids Data Table and drawings.

**ENRICHMENT**
Consider using the following activities to enrich the concepts taught in this lesson.

Study surface tension and the fluid flows caused by differences in surface tension.
http://www.nasa.gov/pdf/315964main_Microgravity_Surface_Tension.pdf

Investigate the effects of temperature on the surface tension of a thin liquid.
http://www.nasa.gov/pdf/315965main_Microgravity_Temperature_Effects.pdf

Study gravity-driven fluid flow caused by differences in solution density.
http://www.nasa.gov/pdf/315955main_Microgravity_Gravity_Driven.pdf