LET'S DO CHEMISTRY

Cleaning Oil Spills with Chemistry Program Guide

ACTIVITY LEARNING GOALS

Learners will develop positive attitudes toward learning about chemistry:

- Learners will increase their feelings of **interest** in chemistry through hands-on exploration.
- Learners will increase their understanding of the **relevance** of chemistry by exploring the applications of chemistry.

Learners will explore chemistry concepts, tools, and practices:

- Chemists use models, tools, and the scientific process to understand our world and to discover and make new things.
- Chemistry can help solve challenges and problems in areas like energy, agriculture, health care, and the environment.

FACILITATION STRATEGIES

- Encourage **interest** and **relevance** through hands-on interaction and experimenting with the different methods of using chemistry. Try asking participants questions about what they are observing and how the tools they are using to clean up the spill compare to one another.
- Help participants develop a **sense of self-efficacy** and confidence through hands-on, open-ended exploration of the materials.

ACTIVITY LENGTH: 15-20 minutes not including clean up

MATERIALS

- 9-ounce plastic cups (2 per station)
- Vegetable oil
- Black tempera paint powder
- Teaspoon for measuring paint powder
- Beaker for mixing oil and paint
- Plastic spoons (1 per station)
- Non-latex gloves (enough for 1 per participant)
- Tweezers (1 per station)
- Cotton pads (makeup remover pads, 1–2 per station)
- Dishwashing liquid (such as Dawn™)
- Dropper bottle (for soap solution)
- 3M Chemical Sorbent Particulate P-500 (divided into small containers, 1 per every 2 stations)
- Small (portion) cups for oil mixture and particulate
- Lipped trays (1 per station)
- Waste bowls (1 per every 2 stations)
- Waste and rinse buckets
- Water (access to a sink or 5-gallon buckets of water to rince cups)
- Microfiber cloths or paper towels
- Safety data sheets
- Marker and labels
- Table covering like old newspaper or cloth—materials will bead up on plastic table cloths (optional)
- Goggles + goggle wipes (optional)
- Protective lab smocks (optional)

The physical Let's Do Chemistry kit includes material for 4 stations. If you do this program with a larger group you will need to acquire additional materials.

ADVANCE PREPARATION

This is a very **messy** activity! Choose a suitable location that will not be greatly affected by the general messiness of the activity and which will be easy to clean up afterward. Skilled facilitation and personal interaction with staff or volunteers can help mitigate some of the mess, but you may want to cover tables with old newspaper or absorbant table cloths and protect floors. Be sure to have ample trash receptacles and water available.

In the beaker, mix one teaspoon of powdered tempera paint into about 100mL of oil. 100mL of this mixture is enough for approximately 7 stations. Once mixed, fill the small (portion) cups about two thirds of the way with the oil mixture. Label them "oil." There will be a paste like layer of paint on the bottom of the beaker. Do not scrape this into the small cups. Leave that in the larger beaker for disposal.

Prepare a soap solution in each of the dropper bottles using a one-to-one ratio of dishwashing liquid and water. Label the bottle.

Fill each 9 ounce plastic cup about 2/3 with water. Prepare enough cups for 2 per station. It is also valuable to prepare extra cups of clean water to demonstrate what the model ocean would look like before an oil spill.

Place a couple teaspoons of the particulate into the small (portion) cups; each station will need approximately a teaspoon. Lable the small cups “particulate.”

Set-up stations:

- Each station (designed for 2-3 people) will need a tray, two 9oz cups of water, one spoon, a pair of tweezers, a small cup of oil mixture, and at least 2 cotton pads.
- Between every two stations there should be a waste bowl and a small container of particulate.
- You can share the dropper bottle of soap solution between stations.

SAFETY

Always follow and model prudent practices when doing chemistry activities.
Think about:

- What **hazards** exist and what associated risks may arise from these hazards?
- How to minimize **risks** through protocols we have designed into the activities and training materials.
- How **safe practices and protocols** should best be communicated with facilitators, participants, and others

The nontoxic oil and paint mixtures can be very messy. Take appropriate precautions to protect participants, tables, floors, and other surfaces and materials from the materials and the mess.

Your institution may have special rules or protocols for chemistry related activities, so check with your facilities staff, safety committee, and/or others. Learn more about safe practices in the *Let’s Do Chemistry: Safety Guide* included in the physical kit and with the online digital kit resources.

TALKING POINTS *Let's explore different methods of cleaning up a pretend oil spill using chemistry.*

Put on your gloves. First, to do this experiment, we need to create an oil spill. The cup in front of you will be our model of the ocean. Our really tiny model! Add few drops of black oil to your model ocean. What do you notice about how the oil and water behave?

Try removing the oil from the cup by using a spoon to skim and scoop oil off the surface of the water. Dump the oil you scoop up into the waste bowl.

- This approach is a model for the ***boom-and-skimmer*** method of cleaning up oil spills. How effective is it to use a spoon as the skimmer for this purpose?
- You can use the model ocean with no oil spill as a point of comparison.

BOOM-AND-SKIMMER:

Advantages: Contains oil effectively. Recovered oil can be used for low-grade purposes.

Disadvantages: Takes a long time and requires a lot of labor.

Next, try removing oil from the model ocean spill by using a cotton pad to absorb as much oil as possible. This can be messy! Use tweezers to remove the pad and place the used cotton pads in the waste cup.

- This approach models an ***absorbent*** method, which is sometimes used to clean up open-water oil spills. Absorbent materials easily soak up or take in liquids like the oil. How effective is this method compared to the spoon/skimmer method? How does your model ocean compare to the model that did not have an oil spill?

ABSORBER:

Advantages: Works faster than skimmers. Absorbers holding oil can be burned for heat.

Disadvantages: Requires extensive labor. Oil can't be reused for original purposes.

Finally, try using a small amount of polypropylene particulate. Use the tweezers to add some of this solid onto the oil in the model ocean. Count to ten and then use the spoon to scoop out the particulate and oil mixture. Place the mixture in the waste cup.

- This approach models an ***adsorbent*** method of cleaning up oil spills. Some liquids, like the oil, chemically adhere to the surface of adsorbent materials—making a new material. How effective is this method compared to using a skimmer or the absorbent?

ADSORBER:

Advantages: Works fast and is good in irregular areas like shorelines. Can be burned for heat.

Disadvantages: Polypropylene has higher costs. Doesn't work well in thicker oil spills.

Let's keep experimenting! Create a new oil spill in a second, different cup of water (a new model ocean). Add a few drops of detergent solution to this new spill. What happens to the oil?

- This models the use of a ***dispersant*** to clean up oil spills. Detergent has been used to treat oil spills in open water and is also gentle enough to clean oil off animals. How does this method compare to the others? How does your model ocean compare to the model that did not have an oil spill?

DISPERSANT:

Advantages: Works fast without a lot of labor. Works well for cleaning animals.

Disadvantages: Does not remove oil from the water, just spreads the oil over a larger area so it's less concentrated.

Together, let's talk about the possible advantages and disadvantages of each of these different methods for cleaning up oil spills. What do you think are the benefits and limitations of each method we tried?

Chemists use the scientific process to understand the world around us and make new things.

We use many different methods, including spreading chemical disspersants from above to help clean-up oil spills.

In this activity, you experimented with different ways to clean up simulated oil spills in cups of water. Understanding the different properties of fresh and ocean water, as well as those of oil spills, allows chemists to devise tools that will remove as much oil from our natural water environments as possible. For example, oil is less dense than water and will float together to form a *slick* on top of the water. Scientists use this to their advantage. Using a spoon to remove oil from the sides of the cup represents the *boom-and-skimmer* method. This method works by corralling the oil into a much smaller area, where it can then be skimmed off the surface mechanically. The *absorbent* cotton pads have properties that pull in fluid, like the oil and water, and hold it in the empty spaces between the cotton fibers, making it easier to remove the oil. The *adsorbent* particulate has a molecular structure with tiny "hooks" that can grab on to parts of oil molecules. Together, the particulate and oil actually create a new material, which can easily be removed from the water. The soapy *dispersant* mixture acts as a *surfactant* in treating an oil spill. Surfactants reduce the surface tension of the water and cause the oil to bead up into little balls. The action of waves in the ocean or currents in fresh water will then disperse, or spread, those much smaller droplets of oil over a very large area, diluting the oil across a lot of water. Each of these different methods has different advantages and disadvantages. ***Which tool worked the best for you?***

Chemists and other scientists can use their knowledge to solve challenges and problems.

Oil spills happen when crude oil is accidently dumped into a body of water.

Oil spills negatively impact ocean ecosystems, affecting the water and the animals and plants that live there. They need to be cleaned up quickly and thoroughly. Booms, adsorbents, absorbents, and dispersants are all methods of separating oil and water. Scientists developed these methods based on knowledge of the physical and chemical properties of materials. In real life, most oil spills are cleaned up or treated using different combinations of all of these methods. There are also products that combine the properties of two or more methods for greater efficiency. Chemists and other scientists use their knowledge to combine these methods to figure out the best way to clean up each specific oil spill. But chemists can sometimes inadvertently create problems. Some oil spill solutions involve introducing new materials to the environment, which may not be easy to remove, and could potentially cause different environmental problems. The more we know about the materials involved, the more effectively and safely we can deal with oil spills and other challenges.

CLEAN UP

Be ready for a mess! Discard all used adsorbent and absorbent materials and the oil into the trash. Collect and separate as much of the oil mixture as you can with the cotton pads or particulate and dump all soilds into the trash. Collect extra dry particulate and store it for future use. You can store and reuse the dropper bottles of soapy water or empty them down the sink. Pour any remaining clean water from the model ocean cups down the drain. If the water is still very oily, consider dumping it down the toilet rather than the sink. Check with facilities staff or others at your institution to be sure your systems can handle the oil.

Throw the cups away, or wipe them down and wash them if you plan to reuse them. Separate and label the cups that contained a dispersant (soap solution). Unless you thoroughly wash them, you won't be able to use the dispersant cups for the other methods, because even a tiny amount of residual soap in a cup will prevent an oil slick from forming.

Wipe down and wash:

- Spoons
- Trays
- Waste bowls
- Waste beakers

Throw away:

- Used particulate
- Used cotton pads
- Used gloves
- Leftover oil/paint mixture and recovered oil/paint mixture (do not pour large amounts of oil down a drain!)
- Table and floor coverings

FACILITATION NOTES

Once again, be ready for a mess! Participants and presenters should wear gloves when doing this activity. You may also choose to wear other protective clothing. The tray can contain small drips and spills, but you may also need to think about protecting and covering tables and floors. And remember to choose a suitable location that will not be greatly affected by the general messiness of the activity and which will be easy to clean up afterwards.

Many participants will use each method to remove all of the oil in their cups, so more oil will probably be needed in between each step.

It is important to keep the non-dispersant and dispersant (soap) cups separate. This will allow you to reuse the cups.

Younger participants may have never heard of an oil spill before. Prompt them with additional questions, such as, “Do you think it is a good thing?” or, “How might the presence of oil affect the environment in which different plants and animals live?” It is valuable to ask open-ended questions that connect this activity to what it would be like in the ocean, where both the problem and the solution take place on a much bigger scale! Encourage participants to make observations after each method of cleaning the oil spill. You can even have them record their results on a larger chart or classroom chalkboard. If the group struggles, facilitators can fill in items. This analysis can be adjusted to meet interest levels of different ages.
This activity does not have a single right answer for the best way to clean up oil spills. Scientists are still working to figure this out. Brainstorm what other methods or tools could be used or developed to clean up oil spills. Think about the pros and cons of each of the methods together.

This activity can also be facilitated as an open ended exploration. Setting up the materials and allowing kids to experiment and explore the different oil spill solutions in pairs or individually. It is helpful to have a debrief after open exploration to think about the different materials and share any questions participants come up with.

An activity training video is available at vimeo.com/channels/nisenet.

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