PRIMARY + STEM

Teaching Resource

ACTIVITY:

Peculiar matter (oobleck)

ACTIVITY OVERVIEW

Oobleck is a well-known, easy-to-source activity that is always happily received by students. It allows exploration of a range of topics that span the primary chemistry curriculum, including materials, properties, and states of matter. This fun activity provides students with an opportunity to use appropriate language for their stage of learning and make links with prior knowledge.

Students will be able to relate oobleck to other materials that they find interesting - including slime they may have made, liquids and solids that share some properties with this peculiar material, and even descriptive language and literature (with the name 'oobleck' originating from a Dr Seuss story.).

SYNOPSIS

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The study of materials and properties, as well as states of matter, is fundamental to our understanding of chemistry in our world; and is, therefore, a valuable lesson to share with students. Oobleck is a very engaging activity and, with the proper background knowledge and lesson objectives, would be a great addition to your chemistry lessons.

Foundation – Year 2

- Objects are made of materials that have observable properties (VCSSU044)
- Everyday materials can be physically changed or combined with other materials in a variety of ways for particular purposes (VCSSU045)

Year 3 – 4

- A change of state between solid and liquid can be caused by adding or removing heat (VCSSU059)

Year 5 - 6

- Solids, liquids and gases behave in different ways and have observable properties that help to classify them (VCSSU076)

ACTIVITY, MATERIALS AND INSTRUCTIONS

ACTIVITY - Oobleck

Oobleck is a peculiar material. It is neither a solid nor a liquid, but, rather, something in between. Make your own oobleck and investigate its properties in this messy and fun activity. This activity is best conducted outdoors, with students working on the ground, around a bowl.

This activity works well with students working in groups of two or three around a bowl of oobleck. If you have larger trays or tubs, you could share between five or six students.

Materials for one bowl of oobleck:

- 1 cup cornflour (130g)
- ½ cup water (approx.)
- 1 bowl
- 1 cup measure
- ½ cup measure (or plastic cup that can be half filled)
- Bucket of water to rinse hands (warm water is nice!)

Materials for 10 bowls of oobleck (class of 20 – 30, working in groups of two-three)

- 10 cups cornflour (1.3kg)
- 5 cups water
- 10 x bowls
- 10 x 1 cup measure
- 10 x ½ cup measure (or plastic cup that can be half filled)
- At least 2 buckets of water to rinse hands

1. Measure 1 cup of cornflour into each bowl (teacher to assist younger students, as they tend not to fill cup completely).

2. Gradually add approximately ½ cup of water to the cornflour. The oobleck should be a consistency similar to mayonnaise.

3. Students may be directed to explore the oobleck with the following suggestions:

Rest your hand and feel the oobleck sucking it in, then yank your hand out quickly and feel the oobleck holding on to it.

Grab a big chunk of oobleck and squeeze, then watch how the oobleck holds its shape. Release the oobleck and watch how it starts to lose its shape. Do this a few times.

Give the surface of the oobleck a good punch! See how the oobleck doesn't splash?

4. Cleaning up (is important)

To clean up students – remove as much oobleck as possible from hands, then rinse hands in a bucket of water (you can add soap, or just dip them in warm water). Wash hands with soap thoroughly before eating.

To clean up any spills on clothes – do not try to wipe them off while wet. Wait until oobleck dries and dust off cornflour.

To clean up hand-washing buckets – tip onto garden/lawn.

To clean up oobleck bowls – scrape oobleck into rubbish bin, then rinse bowls with tap running (or hose on the lawn). DO NOT put oobleck down the sink.

5. Discussion.

Oobleck is a **non-Newtonian fluid.** This means that it does not behave the same way as most other liquids. Oobleck becomes thicker when you punch, poke, or squeeze it. When force is applied to oobleck, its **viscosity** (rate of flow, thickness) changes. When you remove that force (gently put your hand in, release a handful of oobleck), the oobleck returns to lower viscosity and flows readily. If we compare this to another liquid that we know well, water, we can see that its viscosity does not change when you apply force. Water that you poke, splash, or hold in a cupped hand still all flows in the same way. It does not change viscosity.

What's happening inside the oobleck? The cornflour is suspended in the water, it does not fully rip apart and dissolve like salt in water. When gentle force is applied to the oobleck, like slowly putting your fingers in, the cornflour molecules spread apart, and your finger slides into the watery part of the oobleck. When your fist punches the oobleck, the cornflour molecules lock together, acting like a solid.

HOW TO USE THIS ACTIVITY WITH YOUR STUDENTS

Foundation - Year 2

Younger students are learning about different types of materials and how they behave (their properties). They can sort materials by properties (e.g. bend, stretch) and explore the different words that we use to describe many of these properties. It's always a delight to move around a group of children exploring oobleck and hear the different vocabulary being used.

Students could be asked to share these words as they work, or record them after the activity, perhaps also making a drawing of their oobleck. Students can start to think about why particular materials have been used to make certain items (e.g. their shoes, the playground, toys) and describe the properties that make materials useful.

Note – younger children tend to add too much water to oobleck, so if you don't want to waste too much cornflour it can be helpful to pre-measure water for these students.

What does that feel like? How is it moving? What did you do to the oobleck? How did you make it do that? What does it look like? What words can you use to describe the properties of oobleck?

To extend students in their learning of materials and properties, you could investigate another special material – nappies. Inside nappies are special crystals that can absorb a lot of water. What a great invention! How much water can your students pour into a nappy? Ask students to predict how much liquid a nappy can hold. How many cups? Let's try it! Use cups of water that you have coloured with a few drops of food dye.

Years 3/4

Students from Years 3 and 4 are formally introduced to the states of matter, at least covering solids and liquids. After being introduced to the properties of solids and liquids (shape, volume, energy) (see more information in Key Themes section), students can explore the properties of oobleck.

- What properties of oobleck are like a solid?
- What properties of oobleck are like a liquid?

Students can make slime to further explore how materials can behave both like a solid and a liquid under different conditions. Using PVA glue and borax solution (1 teaspoon borax mixed in 1 litre of water).

Safety note – teacher to prepare borax solution, do not allow children to touch solid borax. If your school does not permit the use of borax, substitute with contact lens solution that contains boric acid (PureMoist brand works well). Set a challenge for students to make a slimeball that bounces like a solid, but flows like a liquid when it is not bouncing.

What are the properties of a good slime? Does it need to ooze, plop, stretch? This can be a great link to descriptive language used to describe the properties of different materials.

Years 5/6

In the Earth and Space Sciences, students learn about volcanic eruptions, earthquakes and tsunamis. Plate tectonic theory explains how movement in the Earth's outermost layer (crust) is responsible for bringing about these catastrophic geological events. Oobleck can be used to model the molten layer of rock that lies just under the crust (mantle) that can be both strong like a solid, and fluid like a liquid.

Students learn about the three main ways that plates (large pieces of the Earth's crust) move as a result of convection of the molten mantle layer – apart from each other (divergent), towards each other (convergent), side-to-side (transform). Students explore the outcomes and find examples representing each type of movement, e.g. earthquakes, volcanic eruptions, making new surface crust.

What about Australia? What kind of plate movement does Australia experience?

DISCUSSION SECTION AND KEY THEMES

What is chemistry?

Chemistry is one of the physical sciences that help us to describe and explain our world. Many people think of chemists as being white-coated scientists mixing strange liquids in a laboratory, but the truth is we are all chemists.

It is involved in everything we do, e.g. from making our first cup of hot drink in the morning, to choosing what clothes to wear for the day; to how we experience the world, e.g. the changing weather.

Every material in existence is made up of matter. Chemistry is the study of matter, its properties, how and why substances combine and separate to form other substances, and how substances interact with energy.

What is matter?

At the most fundamental level, all material is known as matter. This is because all materials are made up of 'stuff', take up space, and are made up of smaller building blocks. If we took apart every material to its smallest parts, we would see they are made up of atoms and molecules.

It is not just materials that are made up of atoms and molecules - everything around us is matter. Matter is defined as anything that:

has mass (measured in grams and kilograms), and

takes up space (measured in cm3 or L)

So what is not matter?

Emotions like love, joy, hate, anger, thoughts, and dreams. They matter. But they are not matter.

States of matter

Matter can exist in different forms, also known as states of matter. Depending on how much energy they possess, the same atoms and molecules may exist in different states, with each state showing very different properties. Because the atoms and molecules themselves do not change while they change states, this process is considered a physical change.

Solids and liquids

Solids have a fixed volume and shape. Some examples of solids are a chair, a book, a person, a pair of glasses. These materials will remain the same shape and take up the same amount of space, no matter where they are placed.

Liquids have a fixed volume but can change shape. Some examples of liquids are milk, water, and orange juice. These materials will change their shape to fit the container they are in, but still take up the same amount of space (volume).

The atoms in liquids have more energy (movement) than the atoms in solids. We can change the state of matter from solid to liquid by adding more energy.

For example, water is changed from solid ice to liquid water by adding heat energy. Children might be more interested in changing the state of a material like chocolate, than just water!

Oobleck shows the properties of both solids and liquids. It is hard like a solid and can also break when you apply force (punch, poke, squeeze), but flows and changes shape like a liquid when force is not applied.

Gases

Gases do not have a fixed shape or volume. Instead, they change shape and size to fill the space. Gases have more energy than solids and liquids.

Suggested demonstrations for shape and volume (solid, liquid, gas)

Use a chair to demonstrate the unchanging shape and volume of solids. No matter what room/venue the chair is placed in, the chair's shape and volume is fixed.

To demonstrate changing shape and fixed volume of liquid, transfer 200ml of coloured water from one small container to a large container of a different shape . What do students expect will happen when 200ml from a small container is transferred to a larger flask? Will it be less/more/maintained at 200ml? It stays at 200ml. The liquid's shape is not fixed but its volume is fixed.

'Catch' air in a plastic bag or a balloon, and 'release' it to illustrate changing shape and volume of gas. Where would the gas particles go? Are they trapped in the room? No. In fact, it will travel as far as possible. The shape and volume of gas are not fixed.

Suggested demonstrations for energy and speed (solid, liquid, gas)

Show something odoriferous in front of the classroom, e.g. a room fragrance. Can you smell it? The smell is a gas and it has travelled to your nose. Has the solid bottle travelled to your nose? No. Has the liquid travelled to your nose?

Point to something solid like the chair. Will the atoms and molecules in the chair travel and bring the chair elsewhere? No.

Add some food colouring to a beaker of water. Even though we can't see the water molecules, we can see what they are doing by using food dye. This shows us that liquid water molecules have energy and speed. Also, because the water molecules are constantly moving, it explains why liquid water doesn't have a shape of its own.

To demonstrate that gases have the most energy, create a small explosion (e.g. vinegar + bicarb in a cream container, or an alka seltzer film canister rocket). Which state of matter was responsible for the pop/bang? It was the gas that we created. When we hear pops, bangs, and fizzes, we know that a gas, with high energy, is present.

What are materials?

Materials describe the basic substances we use to make objects. These objects also define periods of human history by the technologies or materials that made the greatest impact on society at the time - like the Stone Age, Bronze Age, Iron Age (and maybe the Plastic Age of today?).

Materials may be natural or processed (man-made). Natural materials exist in nature and can be used in their original state without altering their properties (e.g. gold, silver, wood, bamboo, limestone, marble, cotton, wool, leather, clay). Processed materials, on the other hand, are manufactured through human effort, and are made using a mixture of natural and synthetic materials (e.g. aluminium, stainless steel, paper, plastic, glass, polyester). The choice of materials for a specific purpose depends largely on their properties, and any given object may be made of more than one material.

What are properties?

Properties are all the things that materials can do, or how it behaves. Different materials have different properties, owing to the nature of their atoms and molecules, and how they are arranged. Examples of properties include size, colour, texture, lustre, weight, absorbency, density, strength, hardness, flexibility, elasticity, transparency, magnetism, and state of matter.

Viscosity

Viscosity describes how a liquid flows, or its thickness. For example, honey has a high viscosity – it is slow to flow and is thick. Water is less viscous than honey – it flows quickly and is not thick. Oobleck is interesting because it can change its viscosity, depending on the force applied. This is why it is classified as a non-Newtonian fluid.

Bartholomew and the Oobleck by Dr Seuss

We all love reading Dr Seuss books, but have you ever read this one? King Derwin, of the Kingdom of Didd, is tired of the same old weather – snow, fog, sunshine, and rain. He summons his royal magicians and makes a wish for something new to fall from the skies.

"Won't look like rain. Won't look like snow.
Won't look like fog. That's all we know.
We just can't tell you any more.
We've never made oobleck before.

...Go make the oobleck tumble down
On every street, in every town!
Go make the wondrous oobleck fall!
Oh, bring down oobleck on us all!"

Green blobs start falling from the sky. The oobleck is described as greenish molasses, gooey, gummy, like glue, lumpy, sticky, and oozing. It covers the kingdom. The oobleck is only stopped when Bartholomew helps the king to realise that it was his fault and he should say sorry to everyone. The king apologises and decides that, from now on, he will be happy with his old-fashioned rain, sunshine, fog, and snow.

QUESTIONS AND ANSWERS

Can I take the oobleck home after class?

No, please don't. Oobleck would make a horrible mess if it spilled in your school bag. Also, the oobleck probably contains microbes, like bacteria and mould, from your hands (and your classmate's hands), which will grow in the moist oobleck. Oobleck can get really disgusting if left in bowls for more than a day. It's easy to make, so best to clean up straight away and make a new batch when needed.

Can I fill up my pool with oobleck and walk on top of it?

Yes, you could. But, oh what a mess! You probably shouldn't use your own pool, but you can watch video clips of other people who have done this:

"These people are walking on water"

https://www.youtube.com/watch?v=q-DZ0f0_NCA

"What kind of liquid lets you run across its surface?" Science Channel

https://www.youtube.com/watch?v=JJfppydyGHw

Mythbusters – excerpt from episode where they try to walk on water

https://www.youtube.com/watch?v=-wiYtoG9kZE

Who was Isaac Newton?

Sir Isaac Newton was a scientist (physicist and mathematician) who lived from 1643 – 1727 in London, England. He had many areas of interest, but is most well-known for:

Optics – colours, light, rainbows

Mechanics – laws of motion (including fluids), gravity

Maths – calculus

Newtonian fluids follow laws of movement developed by Isaac Newton, while Non-Newtonian fluids do not. Newtonian fluids remain at the same viscosity (thickness, rate of flow) when force is applied. Non-Newtonian fluids change viscosity when force is applied.

What can I add to oobleck to make it more interesting?

Food dye – can be added to the water before mixing with the cornflour.

Shampoo – mix a big squirt of shampoo in with the cornflour before adding the water. This will make a lovely smelling, more slime-like material.

Can I eat oobleck?

Yes, if you are making it at home with your own clean equipment, you could taste a bit. It is just cornflour and water, so not very interesting. Of course you are not going to taste something that other kids in your class have stuck their hands in.

In Bartholomew and the Oobleck the Captain of the Guards eats some oobleck and it glues his mouth shut. He can't speak, but can only blow lots of little sticky green bubbles!

Some recipes ask you to mix a paste of cornflour and water (oobleck) to add to a sauce to thicken it (so you may have already eaten oobleck many times already).

What's the difference between cornflour and other types of flour? Why don't they all make oobleck?

You may have mixed regular wheat flour and water to make a gluey paste when you were making paper mache. Why doesn't this flour make oobleck? Most flour contains gluten - a protein that helps make things like dough and bread stretchy. It's a bit like glue (gluten means glue in Latin), making flour sticky when in contact with a liquid. Sticky is not what we want for oobleck.

Cornflour is high in starch and low in protein. When cornflour, and other gluten-free flours, mix with water the small starch molecules become suspended in the liquid; it doesn't fully dissolve. The molecules can slide past each other and are not sticky like gluten. If you cannot find cornflour to make oobleck, try another gluten-free flour, some custard powder, or some baby powder.

Can non-Newtonian fluids do anything useful?

Our blood is a non-Newtonian fluid and it's one of the most useful fluids that exists! However, blood is the opposite of oobleck, as it gets thinner and flows more easily when force is applied (like toothpaste, tomato sauce and quicksand). This change in viscosity (called shear-thinning) is most useful at moving blood through vessels that have become more narrow (due to build-up of fat/cholesterol), or in the blood of people with high blood pressure. In our heart, large arteries, and veins, the blood behaves like a Newtonian fluid, but in our smaller vessels (capillaries) and porous tissue (muscles, including the heart), we see the non-Newtonian properties of blood. Any industries with non-Newtonian fluids travelling through pipes (where force is applied) need to account for these changes in viscosity, e.g. toothpaste factory, paper factory.

What happens when you put oobleck in the freezer?

When you put oobleck in the freezer, the liquid water changes into ice and the oobleck feels hard. Frozen oobleck looks a bit like frozen milk and it does not show any interesting properties. But, once frozen oobleck returns to room temperature, it is oozy and gloopy, ready to play again. Note – if you freeze oobleck in a sealed container/bag, it will return to its non-Newtonian state. If you freeze oobleck in an open container, it will dry out and, when it returns to room temperature, it will crumble. You can fix this by simply adding more water.

Why can't I wash oobleck down the sink?

Oobleck should never be washed down the sink. We know that it can act like a solid when force is applied, which means that it could block pipes. Oobleck should be scraped/dripped into your rubbish bin (or small amounts put in the garden/compost) and any oobleck dishes should be washed clean with plenty of running water.

What are some other states of matter that aren't solid, liquid, and gas?

There are four fundamental states of matter that we can observe in our daily lives.

Plasma (the fourth state of matter)

When certain gases are given even more energy (e.g. heat, electricity) they transform into plasma. The electrons on these charged gas atoms become excited and give off light in the process. This explains the glowing that we see in stars, neon lights and plasma balls. Plasma is the most abundant state of matter in the universe. It is found in stars, and in the space between planets and star systems. In fact, stars are big balls of burning gases and the extreme heat energy generated within the stars turn the gases into plasma, producing the familiar bright sun in our skies. Plasma rarely exists on Earth's surface, but we do see naturally occurring plasmas in the upper atmosphere in the form of lightning and auroras. Plasma can be artificially generated and we see them in plasma displays, including TV screens and fluorescent lamps. There are several other states of matter that have been identified in recent years, but they are not able to be observed in normal conditions. One that you may be familiar with is liquid crystal.

Liquid crystal

This state of matter describes atoms and molecules that vibrate a little differently than those in solid, liquids, and gases. When energised - either through heat or electricity - the particles vibrate in a perpendicular fashion, which bends light and results in a colour change. Examples include mood rings, colour-changing toys, thermometers that you put on your forehead or your fish tank, and LCD screens.

OUTSIDE OR SUPPLEMENTARY READING

Scientific American

https://www.scientificamerican.com/article/oobleck-bring-science-home/

Penn State Science Outreach

https://science-u.org/experiments/oobleck.html

Babble Dabble Do (for younger children)

https://babbledabbledo.com/how-to-make-oobleck/

Plate Tectonics | National Geographic Society

https://education.nationalgeographic.org/resource/plate-tectonics

TOPIC WORDS

- solid
- liquid
- gas
- matter
- properties
- non-Newtonian
- viscosity
- force
- chemistry

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