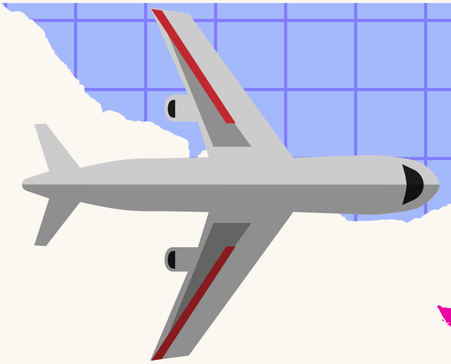
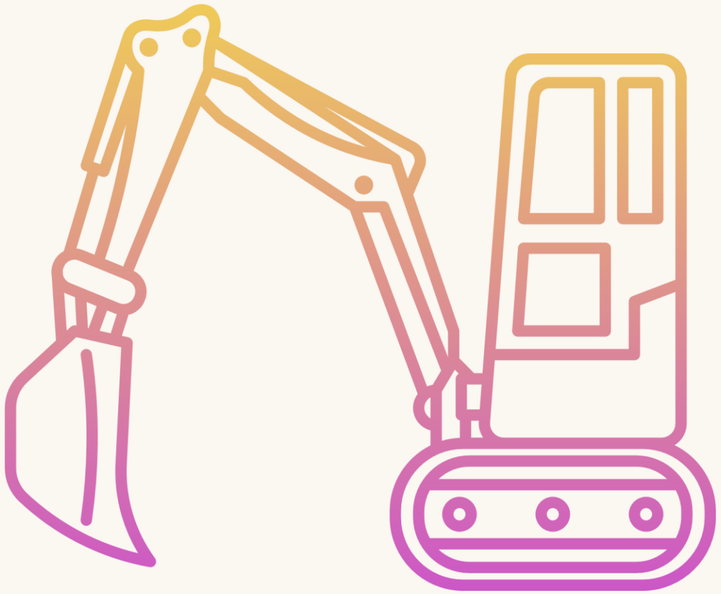
Jennifer Menzies, Hunter PS
Gillian Reilly, PSDO



Pneumatics & HYDRAULICS



All resources and SSERC videos you'll see today have been shared with your school.

Please speak to you SSERC Mentor for more information.

SSERC Bulletin

Primary Science Teaching Trust

The Scottish Government
Riaghaltas na h-Alba

Edina Trust

CfE Experiences and Outcomes
Sciences

Through exploring properties and sources of materials, I can choose appropriate materials to solve practical challenges.
SCN 1-15a

By contributing to investigations into familiar changes in substances to produce other substances, I can describe how their characteristics have changed.
SCN 2-15a

Benchmarks:

- Identifies properties of different materials, for example, rigidity, flexibility, rough, smooth and waterproof, and their uses linked to their properties.

Benchmarks:

- Explores and describes the characteristics of solids, liquids and gases, for example, solids retain the same volume and shape, liquids keep the same volume but the shape changes to fit the container and that gases change shape and volume to fill the container

CfE Experiences and Outcomes

Technologies - Craft, Design, Engineering and Graphics

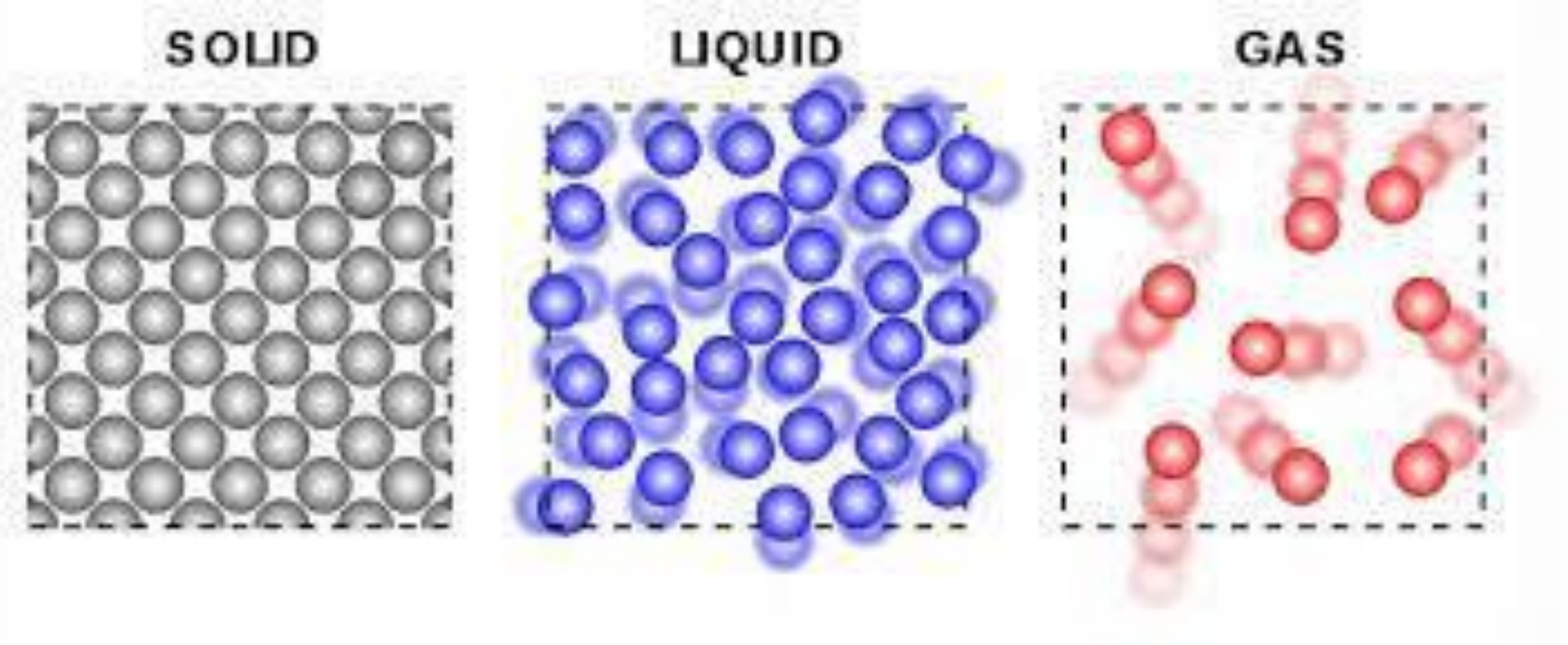
I explore a variety of products covering a range of engineering disciplines.
TCH 0-12a

I explore and discover engineering disciplines and can create solutions.
TCH 1-12a

I can apply my knowledge and understanding of engineering disciplines and can develop/build solutions to given tasks.
TCH 3-12a

I can extend my knowledge and understanding of engineering disciplines to create solution.
TCH 2-12a

The States of Matter
Solid, Liquid and Gas



BBC Bitesize

[BBC Bitesize Video 1]
[BBC Bitesize Video 2]

Practical task

Solid, Liquid and Gas

Properties of materials ...

Think about solids, liquids and gases

	Solid	Liquid	Gas
Volume	Fixed	Fixed	Takes volume of container
Shape	Fixed	Takes shape of container	Takes shape of container
Flow	-	Flows easily from one container to another	Flows easily from one container to another
Compressibility	No movement	No movement	Can be compressed
Particles	Tightly packed together	Some space between particles so they can move more freely	A lot of space between particles so they can move freely

Pneumatics

Pneumatic systems are mechanical systems that use compressed gases in the transfer of forces.

Pneumatic Systems use gases, which are compressible, so these systems are preferred when there must be a certain amount of “give” or “play” in the system.

Leaks in pneumatic systems result in the loss of gas which can be replaced when the leak is fixed.

Uses of Pneumatics

Pneumatic Systems are almost everywhere in the modern world:

- Dentists use pneumatics to operate drills and reposition their chairs
- Carpenters use pneumatics to power air hammers
- Trucks and buses use pneumatic brakes
- NASA use pneumatics to control the operation of satellite launch vehicles
- Other applications include jackhammers, the cylinder delivery systems used by some banks and various launchers and guns designed to propel objects.

A new application of technology is a French automobile that runs on compressed air

Pneumatics

Activity 1: Make a system pneumatic, **Part 1**

5ml
syringe

5ml
syringe

Have a go and think about how you can fill the syringes and tubing with air to make a pneumatic system.

Practical task

Pneumatics

Activity 1: Make a system pneumatic, **Part 2**

5ml
syringe

10ml
syringe

This time, have a go at making a pneumatic system with 2 syringes of different volumes, a 5ml (slave) and a 10ml (master) syringe.

The master is doing a little bit of work leading to larger movement in the slave.

Practical task

Pneumatics

Activity 2: Snappy Dragon

Resources:

- 1 egg box
- 2 litre plastic bottle
- 2 balloons
- 2 elastic bands
- 20cm plastic tube
- 2 treasury tags
- Scissors
- Pencil
- Blu Tack

Pneumatic Snappy Dragon Video

Practical task

Pneumatics

Snappy Dragon

Take an egg box, 2l plastic bottle, 2 balloons, 20cm plastic tube, elastic band, treasury tags and scissors

Step 1:

Attach one of the balloons to the tubing with an elastic band. Cut off the end of the balloon and attach to the bottle neck - make sure that the end of the tube protrudes into the bottle neck.

Pneumatics

Snappy Dragon

Step 2:
Poke a hole for the tube in the back of the egg box
Feed the open end of the tubing through the hole.

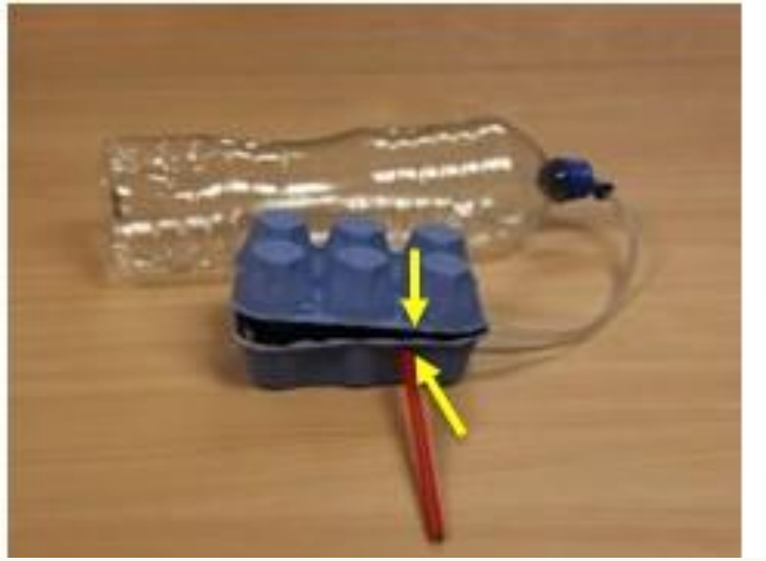
Step 3:
Inflate the second balloon with the balloon pump to stretch it (this is the tongue)
Attach it to the tube with an elastic band (making sure it's through the egg box first)

Try it out at this stage!

Pneumatics

Snappy Dragon

Step 4:
Make holes in the top and the bottom of the box on both sides



Step 5:
Secure the treasury tag to the box leaving enough “slack” for the mouth to open.

Inflate and deflate the balloon to open and close the dragons mouth!

Hydraulics

Hydraulic systems are mechanical systems that use liquids in the transfer of forces.

As we know, liquids cannot be easily compressed so hydraulic systems have the advantage in that they can handle heavy loads.

Hydraulic systems are preferred when high pressures must be maintained.

However, the disadvantage is that if they leak it can be expensive to fix.

Uses of Hydraulics

Planes use hydraulics in many places:

- adjusting wings
- putting out/ bringing in landing gear
- opening/ closing doors

Flyboarding

Pascals Law- Topical Science

Hydraulics

Activity 3: Make a system hydraulic, **Part 1**

5ml syringe

5ml syringe

tubing

ice cream tub

water

Have a go and think about how you can fill the syringes and tubing with water without getting any air bubbles in the hydraulic system

Practical task

Hydraulics

Activity 3: Make a system hydraulic, **Part 2**


5ml syringe


10ml syringe


water

- **Fully fill** the 10ml syringe with water
- Attach the tube to the 10ml syringe
- Hold the tubing over the water tub and depress the plunger until a small amount of water emerges from the tubing
- Now repeat by filling up 10ml syringe and attach tubing but this time attach the empty 5ml syringe to the other end of tubing
- Push the 10ml syringe and observe …

Practical task

Pneumatics

Activity 4: Pneumatic Burger Box Buddy

Resources:

- 1 burger bun box
- paper/ plastic cup
- 5ml syringe
- 10ml syringe
- 20cm plastic tube
- 1 x pipe cleaner
- Pencil
- Blu Tack

Practical task

Pneumatics

Activity 4: Pneumatic Burger Box Buddy

Practical task

Pneumatics

Activity 5: Pneumatic Pop Up Pet

Resources:

- 1 cylinder shape
- paper/ plastic cup
- 5ml syringe
- 10ml syringe
- 20cm plastic tube
- sticky dots
- scissors
- Pencil
- Blu Tack

Practical task

More Examples of Pneumatic Pop Up Pets

Additional Resources/ Links

First Level SCN 1-15a

Materials - Properties and uses of substances
SCN1-15a Through exploring properties and sources of materials, I can choose appropriate materials to solve practical challenges.

Through creative play, I explore different materials and can share my reasoning for selecting materials for different purposes. SCN 0-15a	Through exploring properties and sources of materials, I can choose appropriate materials to solve practical challenges. SCN 1-15a	By contributing to investigations into familiar changes in substances to produce other substances, I can describe how their characteristics have changed. SCN 2-15a

Prior Knowledge
- There are different types of materials including glass, brick, wool, rocks, paper, cardboard, plastic and metal
- Some materials are soft, hard, stretchy, rough, smooth, fluffy,squashy
- Some materials are waterproof
- All objects are made of some kind of material

Benchmarks for Assessment
- Classifies materials into natural and human-made (synthetic).
- Identifies properties of different materials, for example, rigidity, flexibility, rough, smooth and waterproof, and their uses linked to their properties.

First Level Skills

Inquiry and investigative skills
Plans and designs scientific investigations
Carries out practical activities in a variety of learning environments
Analyses, interprets, evaluates and presents scientific findings
Scientific analytical thinking skills
Provides creative solutions to scientific issues and problems.
Contributes to the design processes
Demonstrates reasoning skills through making and testing predictions.
Provides explanations which are supported by evidence.
Skills and attributes of scientifically literate citizens
Discusses science topics in real-life contexts including those appearing in the media.

Suggested Learning Experience(s)
- Have opportunities to use the terms 'synthetic' and 'natural' when describing materials
- Classify materials into synthetic and natural
- Research how synthetic materials are made
- Identify properties of materials through using senses
- Within a given context, e.g. clothes and equipment for the Antarctic, designing a shopping bag, identify which materials would be fit for the task
- In recycling context identify properties which determine whether something can be recycled or which bin it goes into.
- Investigate what materials are best at keeping a snowman cold

Common Misconceptions
- Confusion between the object and the material therefore describe properties of the object rather than the material it is made from
- Focus on what the object's use rather than what it is made of
- Focus on differences rather than finding similarities

Glossary of Key Vocabulary

Material: the matter or stuff from which something is made
Human-made: made or caused by humans
Natural: comes from nature i.e. not made by humans
Synthetic: especially textiles, made or caused by humans

Key Questions

What is a material?
A material is the matter or stuff from which a thing is made.
Can you tell or explain the difference between a natural material and a human-made material?
A man-made material is something created. It is not found in nature i.e. plastic. A natural material is found in nature e.g. wool or wood.
Can you identify different properties of materials and say what they could be used for?
Answers may vary.

IDL Opportunities
Literacy: Book Topic e.g Rosie Revere Engineer/ Ava Twist Scientist/ Iggy Peck Architect/The Lighthouse Keeper's Lunch/The Rainbow Fish/Elmer
LIT1-09a – discussing ideas with others
MathsMNU1-20b data handling
ART: EXA 1-02a using different media
1+2 Language: MLAN1-04a/1-11a Stories in L2 e.g. Three Little Pigs
Social Subjects: SOC1-02a/1-06a where materials come from and their different uses, inventors
Technologies: TCH1-10a plastics and recycling/choosing appropriate materials for a task

Suggested Assessment
SAY: identify some materials which are natural (wool, wood) and some materials which are man-made (plastic, foam)
Say: Recognise that the differences and similarities are the properties of the material
DO: Design the clothes and equipment needed for a particular context identifying appropriate materials and justifying choices.
MAKE: construct models for particular context using appropriate materials.
WRITE: explain why some materials are more suited to a task than others with reference to their properties.

Online Links
http://www.sciencekids.co.nz/experiments/dissolvingsugar.html
https://www.bbc.co.uk/bitesize/topics/z43396f/articles/zx8hhyt
TigTag
https://www.tigtagworld.co.uk/film/properties-of-materials-PRM00583/
https://2e1hrx40ew3t1oo1bvqfy70u-wpengine.netdna-ssl.com/wp-content/uploads/2019/07/PB_60.pdf
https://2e1hrx40ew3t1oo1bvqfy70u-wpengine.netdna-ssl.com/wp-content/uploads/2019/07/PB_43.pdf

Extended Learning
- Solve a practical challenge showing awareness of various properties of materials e.g. choose materials to design a coat that is both warm and waterproof or take part in an investigation to find out which material will keep ice lollies frozen the longest
- Investigate how heat or cold can change a material

Science Capital

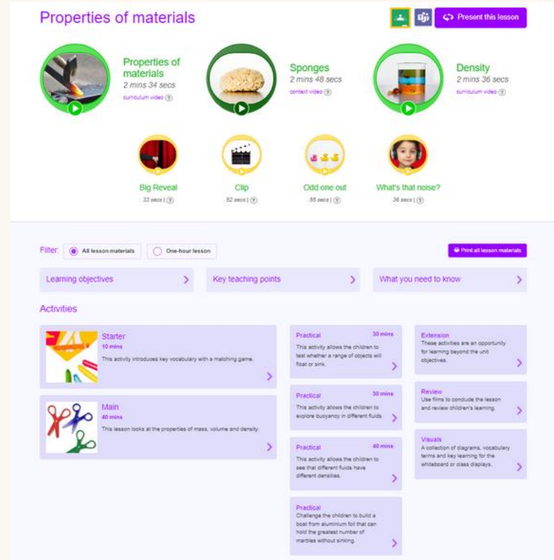
Real Life
Recycling - Bins for different materials
Manufacturing projects – designing clothes and products
Developing Young Workforce
Materials engineer
Oil industry
Aerospace
Construction
Home Learning
Investigating local centres ie; recycling, foodbanks, charity and Fairtrade

Bibliography

Primary Science: Teaching The Tricky Bits: Teaching the Tricky Bits By Rutledge, Neil
Planning for Learning Through What are Things Made from? by Rachel Sparks-Linfield, Ray Emiko
What Are Things Made Of? (What Do You Know About? Books) by Nuria Roca, Rosa Maria Curto

TigTag's

Properties of Materials



TAPS Planners:

- Reflectiveness
- Materials - Transparency
- Float and Sink
- Waterproof
- Separating Colours
- Boat Materials
- Macintosh Waterproof
- Egg Packaging
- Rocks Report

Additional Resources/ Links

TAPS Planners

- Dissolving
- Forensics Powder
- Cleaning Coins
- Dunking Biscuits

Second Level SCN 2-15a

Materials - Properties and uses of substances
SCN2-15a By contributing to investigations into familiar changes in substances to produce other substances, I can describe how their characteristics have changed.

Through exploring properties and sources of materials, I can choose appropriate materials to solve practical challenges. SCN 1-15a	**By contributing to investigations into familiar changes in substances to produce other substances, I can describe how their characteristics have changed. SCN 2-15a**	I have developed my knowledge of the Periodic Table by considering the properties and uses of a variety of elements relative to their positions. SCN 3-15a

Prior Knowledge
- A material is the substance or matter from which a thing is made
- There are different types of materials and some are natural and some are human-made (synthetic)
- Materials have different properties that make them useful for different purposes

Benchmarks for Assessment
- Investigates and explains physical changes to the properties of materials which are fully and partially reversible, for example, salt dissolving in water, chocolate melting and water freezing.
- Uses scientific vocabulary such as 'melting', 'freezing', 'evaporating' and 'condensing' to describe changes of state.
- Investigates and records chemical changes to the properties of materials which are irreversible, for example, cooking, rusting and striking a match.
- Observes and identifies some of the signs of a chemical reaction, for example, production of bubbles, colour/texture change
- Explores and describes the characteristics of solids, liquids and gases, for example, solids retain the same volume and shape, liquids keep the same volume but the shape changes to fit the container and that gases change shape and volume to fill the container

Second Level Skills
Inquiry and investigative skills Plans and designs scientific investigations and enquiries; Carries out practical activities in a variety of learning environments; Analyses, interprets, evaluates and presents scientific findings
Scientific analytical thinking skills Applies analytical thinking skills, working with less familiar or more complex contexts; Applies understanding, of more than one concept, to solve problems and provide solutions; Demonstrates creative thinking through the processes of design, construction, testing and modification.
Skills and attributes of scientifically literate citizens Presents a reasoned argument based on evidence, demonstrating understanding of underlying scientific concepts, and engages with the views of others; Expresses informed views about scientific and environmental issues based on evidence.

Suggested Learning Experience(s)
- Explore and describe the characteristics of solids, liquids and gases
- Investigate and record physical changes using a range of materials e.g. salt / sugar dissolving in water and chocolate melting.
- Show that physical changes are reversible ie; water freezing
- Investigate and record chemical changes using a range of materials e.g. striking a match, baking a cake, frying an egg, rusting metal, the reaction of vinegar & bicarbonate of soda
- Observe and identify some signs of a chemical reaction e.g. production of bubbles, colour or texture change, heat taken in/given out
- Show that chemical change is irreversible – bread into toast
- Use appropriate vocabulary e.g. 'heating', 'combining', 'burning'

Common Misconceptions
- Confusion between what is a physical and what is a chemical change.
- Believing boiling and evaporation are the same

Glossary of Key Vocabulary
Physical change: a change where no new substances are formed; it is usually reversible
Change of State: a physical change from solid, liquid or gas to another by e.g. freezing, melting, evaporating, condensing
Chemical change: usually irreversible change where a new substance is formed
Irreversible Change: a change which cannot be turned back again. New materials are always formed.
Reversible Change: the original materials can be got back again. It might change the look or feel of the material but doesn't create new materials.

Key Questions
What are reversible changes? The change can be changed back e.g. melting, dissolving
What are irreversible changes?
A change which cannot be reversed e.g. burning
What is a chemical change?
A change where a new substance is formed e.g. rust, bread to toast
What is physical change? A change where no new substances are formed e.g. ice to water to steam

Online Links
http://mypages.iit.edu/~smile/chbi1100.htm
http://mypages.iit.edu/~smile/ch9312.html
http://www.school-for-champions.com/chemistry/mixtures.htm
http://www.chem4kids.com/files/matter_solution.html
http://www.sciencekids.co.nz/experiments/dissolvingsugar.html
http://www.thunderboltkids.co.za/Grade6/02-matter-and-materials/chapter4.html

IDL Opportunities
Science: SCN 2-19a chemical reactions
Maths: MNU2-20b/2-21a data handling
People, Past Events and Societies: SOC2-04a/2-06a Fireworks, Titanic
People, Place and Environment: SOC2-12a Weather

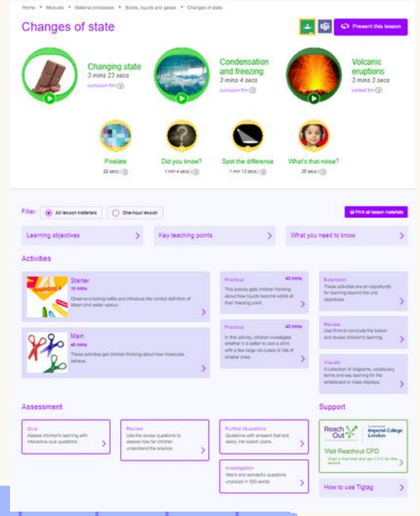
Extended Learning
- Investigating fireworks, how fire works and what is needed
- Investigate what happens to the material which has been burned – where has it gone?

Suggested Assessment
SAY/WRITE : Describe and explain the difference between physical and chemical changes.
DO: Design an investigation to show how materials can be changed physically
DO: Investigate different chemical changes and record findings accurately.
SAY/WRITE: describe signs of a chemical in investigation observations.
SAY/WRITE: Describe the characteristics of solids, liquids and gases

Science Capital
Real Life
Climate change
Developing Young Workforce
Materials engineer
Oil industry
Aerospace
Construction
Home Learning
Bake a cake

Bibliography
Primary Science: Teaching The Tricky Bits: Teaching the Tricky Bits By Rutledge, Neil
https://charlotteteachers.org/wp-content/uploads/2014/01/Nfraser_finalunit_11-27-13.pdf
Misconceptions in Primary Science by Allen. Michael
Changing Matter: Understanding Physical and Chemical Changes, by Tracy Maurer
Matter Change States by Tara Haelle

TigTag's
Changes of State
&
Properties of Materials



Your Turn!

Select an activity/ activities that you'd like to try out!

Remember you have access to all of these resources in your school to deliver this lesson to your class.

Thank you

Jennifer Menzies, Hunter Primary

Gillian Reilly, Primary Science, STEM and Sustainability Development Officer