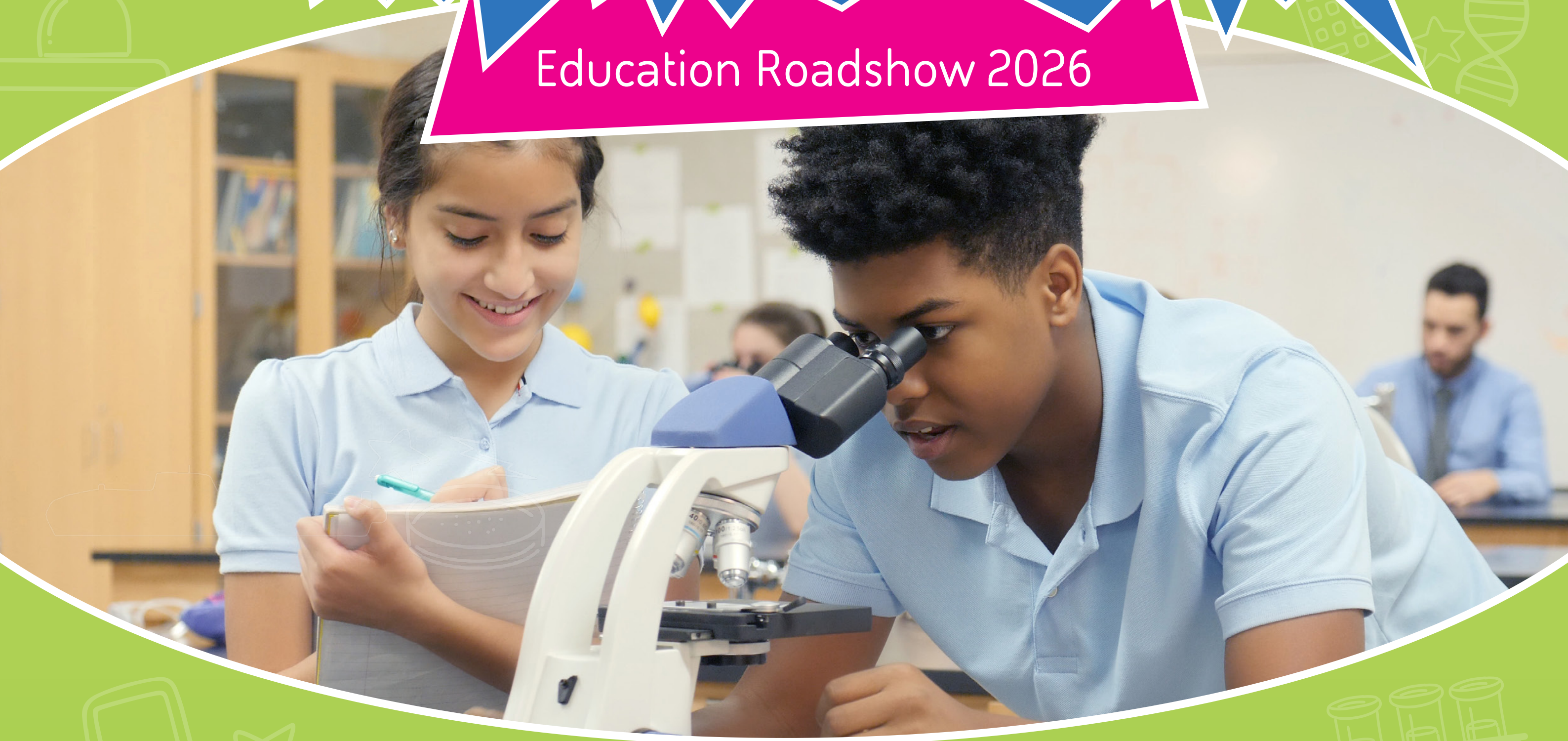
AGES 11-14

The Material World

Education Roadshow 2026



Aligned to the National Curriculum in England, Scotland's Curriculum for Excellence & The Curriculum for Wales

Includes 5 Activities!

Grow your own bioplastic
Introduces the challenge of plastic waste. Students will step into the role of an inventor, synthesising plastic-like material.

Solid or liquid?
Introduces Non-Newtonian fluids and challenges our basic understanding of states of matter.

The shape-shifting sponge
Exploring polymers and the concept of viscoelastic materials.

Waterproof wonder fabrics
Understanding absorption and repellency and how adding hydrophobic coatings can change the function of a textile material.

Magnetic smart slime
Introduces smart materials, designed to react to changes in their environment.

ROYAL AIR FORCE Youth STEM
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Introduction

We are excited to share this collection of Materials Science and Engineering activities! This guide is designed for educators to read, plan, and deliver engaging lessons following the Education Roadshow in 2026. However, you do not need to have participated in the Roadshow to use these activities.

These activities focus on exploring how materials are made, why they behave the way they do and how engineers utilise these properties to design our world.

For educators:

STEM Ambassadors and adult leaders: Please read through the activities carefully. They rely on common, accessible materials but it is best to confirm you have everything before starting. Please complete risk assessments as required by your organisation.

For students:

Be careful and sensible. These activities encourage experimentation and creative problem-solving. We hope you have fun, learn about the materials all around you and get inspired by engineering. These activities support the curriculum for students aged 11-14 (Key Stage 3 in England/Wales and S1-S3 in Scotland) in Science and Technology.

The Fundamentals: Materials Science

Materials Science and Engineering is the study of all substances — from the metals in a bridge to the plastic in a phone case — and the creation of new ones with specific properties.

Atoms and structure (tiny building blocks): Everything is made of tiny particles called atoms (the tiny, invisible building blocks of everything). How these atoms are put together determines the material's properties.

Polymers (super chains): Imagine tiny links of chain that join up. These chains are called polymers! Plastics and rubber are polymers and engineers make them for things like phone cases and stretchy clothes.

Composites and alloys (super mixes): Sometimes mixing two materials makes a totally new, stronger one! This is called a composite or an alloy. For example, mixing metal with carbon makes steel, which is super strong and can be used for building bridges and cars.

Viscosity: This describes how easily a liquid flows (how "thick" or "runny" it is). Honey has high viscosity (it's slow); water has low viscosity (it's fast).

1 Grow your own bioplastic!

Introduction

Introduce the challenge of plastic waste. Every year, millions of tonnes of plastic are produced from oil, which takes hundreds of years to break down.

Material Scientists are working hard to create sustainable polymers made from plants (like the cornstarch used here). In this activity, students will step into the role of an inventor and attempt to synthesise their own basic plastic-like material using a safe, room-temperature chemical reaction. The goal is to understand how materials can be changed permanently through mixing and chemical reactions. This activity links to broader concepts in Chemistry (Changing Materials) and Design and Technology (Sustainable Packaging and Prototyping).

Concept:
Making polymers from natural, sustainable resources to explore alternative plastic-like materials through a safe chemical reaction.

Learning outcomes:
Students will observe how two liquids combine to form a solid, demonstrating that a chemical reaction can change a material's properties permanently, creating a new substance (a polymer).

Resources

Cornflour

White PVA Glue

Water

Small bowl or cup

Mixing spoon

Measuring spoons (tablespoons/teaspoons)

Method (30-40 mins)

- Mix 2 tablespoons of PVA glue and 2 tablespoons of cold water in the bowl. Stir until smooth.
- In a separate cup, mix 2 tablespoons of cornflour with 1 tablespoon of cold water to form a thin paste.
- Slowly add the cornflour paste to the glue mixture, stirring continuously.
- The mixture will begin to thicken almost instantly. Use your hands to knead and mix the substance as it firms up. This is the polymerisation process!
- Keep kneading until the mixture is firm but still slightly pliable.
- Test the properties of the cold-set material: Is it flexible? Is it strong? Can you stretch it?

SAFETY NOTES: Although the materials are food-based, the final bioplastic product and mixture are not for consumption. Also, please do NOT dispose of the materials down the sink.

Questions

- How is this material different from the glue and cornstarch you started with?
- Do you think this change is reversible (can you easily turn it back into glue)? Why or why not?
- What property would need to be improved if you wanted to use this material to make a strong container?
- If your bioplastic recipe didn't solidify, what changes could you make next time?
- Why is a positive attitude towards fixing experimental mistakes important?

Extensions

- Add food colouring or glitter to the glue mixture before starting to make coloured bioplastic.
- Allow the material to dry overnight and test how its properties change when moisture is removed.

Working scientifically:

Planning and designing enquiries

Controlling variables

Measuring and observing

Evaluating results

Key skills: Problem solving, Creativity, Listening

Difficulty rating: 2 of 5

2 Solid or liquid? Non-Newtonian fluids

Introduction

Ask students about the differences between a solid and a liquid. Solids hold their shape, liquids flow. But what about materials that seem to do both?

Non-Newtonian fluids challenge our basic understanding of states of matter. Engineers encounter these properties when designing technologies to handle substances like concrete, certain food products or protective layers. In this activity, students will create a fluid that acts like a liquid when gently stirred but becomes a hard solid when it is hit suddenly. This phenomenon is critical in industries such as civil engineering and food science.

This activity links to Physics (Forces and Pressure) and Mathematics (Ratios and Data Analysis).

Concept:
Understanding viscosity and non-Newtonian fluids (materials whose viscosity changes based on applied stress or pressure).

Learning outcomes:
Students will be able to distinguish between Newtonian and non-Newtonian fluids and explain how applied stress can temporarily change a material's state (viscosity).

Resources

Cornflour

Water

Large mixing bowl

Spoon or craft stick for stirring

Optional: food colouring

Method (30-40 mins)

- Pour the cornflour into the mixing bowl.
- Slowly add water, stirring continuously. Start with a ratio of approximately 2 parts cornflour to 1 part water (e.g., 4 teaspoons of cornflour to 2 teaspoons of water).
- Continue adding water until the mixture is difficult to stir but still flows when the spoon is removed. The final mixture should resemble thick pancake batter.
- Test 1 (Slow Force): Slowly dip your finger into the mixture. What happens? (It flows like a liquid).
- Test 2 (Fast Force): Try to quickly press the surface of the mixture. What happens? (It resists the pressure and feels like a solid).
- Test 3 (Shear): Scoop up a handful and roll it into a ball. As long as you keep rolling it, it stays a solid. Stop rolling, and it flows away.

Questions

- In slow-motion, the material acts like a liquid. In fast motion, it acts like a solid. Why? (Hint: Think about what the water molecules are doing when pressure is applied).
- Where are non-Newtonian fluids used in engineering? (e.g., protective gear, sports, speed bumps).

Extensions

Challenge students to make the best possible material for a "protective layer" (e.g., inside a crash helmet) and explain why their ratio of cornflour to water is optimal.

Based on the three tests, suggest three different ways you could use the cornflour mixture to protect a raw egg dropped from a height. Which way would you choose and why? Justify your best choice.

Working scientifically:

Developing models

Testing and recording

Interpreting data

Communicating findings

Key skills: Problem solving, Speaking, Listening

Difficulty rating: 2 out of 5

3 The shape-shifting sponge

Introduction

Engineers designing things like mattresses, protective padding or the soles of running shoes need to understand how materials absorb and release stress. Some materials, like memory foam, are amazing because they absorb energy slowly rather than bouncing it back, to protect whatever they cover.

This activity focuses on measuring the properties of different foam structures. Students will investigate which material is the most elastic (bounces back fastest) and which is the most protective (recovers slowly), linking it directly to real-life product design. This links to Physics (Energy, Forces and Elasticity) and Design and Technology (Product Analysis).

Concept:
Exploring polymers and the concept of viscoelastic materials (materials that exhibit both viscous fluid and elastic solid characteristics) like memory foam.

Learning outcomes:
Students will understand the concepts of viscoelasticity and shape recovery and how the internal structure of a material (like foam density) affects its ability to absorb and release energy.

Resources

Various types of sponges

Small containers or trays

Stopwatch or clock

Water

Small weights (e.g., heavy stones, stacks of coins, small metal blocks)

Method (30 mins)

- Ask students to examine the different foam materials. Predict: Which is the most durable? Which will hold a compressed shape the longest?
- Test 1 (Compression): Place a weight on each dry foam sample for one minute. Remove the weight and observe how quickly each sample returns to its original shape. Measure the time it takes to fully recover.
- Test 2 (Viscosity/Moisture): Saturate a piece of one type of foam with water (to simulate a change in temperature/environment, as memory foam reacts to heat).
- Place the weight on the wet sample for one minute. Remove the weight.
- Observe and record: Does the water change the foam's ability to resist compression or its rate of recovery?

Questions

- Memory foam is a viscoelastic polymer. Why is it used in mattresses?
- How does the structure (e.g., size of the holes/bubbles) in the foam relate to its ability to absorb impact?
- If you wanted to design a material for a running shoe sole, what properties would you need?
- Was your prediction correct? How do your test results prove or disprove your hypothesis about the most durable sponge?

Extensions

- Apply gentle heat (e.g., rubbing with hands) to a sample after compression to simulate the shape memory effect (if using a foam with good viscoelastic properties) and see if it recovers faster.

Working scientifically:

Predicting and hypothesising

Measuring accurately

Comparing and contrasting

Drawing conclusions

Key skills: Problem solving, Speaking, Planning

Difficulty rating: 1 of 5

4 Waterproof wonder fabrics

Introduction

Imagine designing a tent for a camping trip or a coat for a sailor—you need materials that repel water, not absorb it. This is the goal of engineers working with hydrophobic materials—surfaces that actively repel water. The secret lies in adding a material (like wax or oil) that prevents the water from sinking in.

In this activity, students will become engineers and test different everyday coatings to design the ultimate waterproof fabric, investigating the concept of absorption and repellency. This links directly to Chemistry (Water and Materials Properties) and Design and Technology (Functional Textiles and Coatings).

Concept:
Understanding absorption vs. repellency and how adding hydrophobic (water-fearing) coatings can change the function of a textile material.

Learning outcomes:
Students will understand the principle of hydrophobicity and explain how coating a material changes its surface properties, making it repel water rather than absorb it.

Resources

Small squares of absorbent fabric (eg. cotton, felt)

Dropper or small pipette

Water

Worksheet / data table

Hydrophobic coatings:
- Petroleum jelly / lip balm
- Vegetable oil
- Clear sellotape / plastic wrap

Method (35 mins)

- Take 4 squares of fabric. Leave one untreated (control).
- Treat the other three squares with one of the waterproof coatings (petroleum jelly, oil, tape/plastic). Rub the petroleum jelly or oil deeply into the fibres.
- Place the control fabric over a small, dry area of the desk. Use the dropper to place drops of water onto the fabric. Observe: Does the water bead? Does it soak through?
- Repeat the test for each of the three treated fabrics.
- Record the results in a table, noting: how many drops the fabric repelled, the shape of the water drops, and whether the fabric underneath the drops remained dry.
- Compare the results to find the "best" waterproofing agent.

Questions

- The untreated fabric is hydrophilic (water-loving). The coated fabric is hydrophobic (water-fearing). Which coating created the best hydrophobic barrier?
- How does the oil/wax prevent the water from soaking into the fabric's tiny holes?
- If you were making a backpack, would you choose the waterproof material that beaded the water best, or the one that was quickest to dry? Why?
- If you found one coating that repels water well and another coating that dries super fast, how could you mix or combine those ideas to create a much better fabric?

Extensions

- Design a test to see if repeated use (rubbing or washing) reduces the waterproofing of the best sample.

Working scientifically:

Setting up a control

Predicting and testing

Measuring accurately

Comparing and contrasting

Key skills: Problem solving, Listening, Creativity

Difficulty rating:

5 Magnetic smart slime

Introduction

Did you know that some materials are "smart" and can react to things around them, like heat, light or magnets? Engineers use these smart materials to design everything from toys that change colour to high-tech medical devices.

In this activity, students will create their own magnetic smart material by mixing magnetic dust into ordinary slime. They will explore how a hidden force—magnetism—can physically control a material from a distance. This links to Science (Forces and Magnets) and Design and Technology (Product Innovation).

Concept:
Introduction to smart materials, which are designed to react to changes in their environment (light, heat, moisture, magnetism).

Learning outcomes:
Students will understand the definition of a smart material and demonstrate how materials can be engineered to react to external fields (magnetism) by incorporating ferrous particles.

Resources

- White PVA glue
- Bicarbonate of soda
- Contact lens solution
- Iron oxide powder or iron filings
- Strong magnet (e.g., neodymium, available online or from hobby shops)
- Mixing bowls and spoons
- Gloves and eye protection

Method (40 mins)

- Make standard slime: Mix 1 part glue with 1 part water in a bowl.
- Add one tsp of bicarbonate of soda to 100ml of PVA glue, stir until fully mixed.
- Stir in small amounts of contact lens solution at a time, making sure to keep stirring. Make sure you use contact lens solution, NOT saline.
- Lay the finished slime out flat.
- Add 1–2 teaspoons of iron oxide powder or iron filings to the slime and knead it in until the colour is uniformly dark. Use gloves and eye protection for this step.
- Test the Smart Material: Place the magnet near the slime. The iron particles allow the slime to react to the magnetic field—it should stretch, wiggle, or move towards the magnet.

SAFETY NOTES: Gloves and eye protection are mandatory for handling iron filings/powder.

Questions

- How is this slime different from a regular magnet? (It changes its physical shape in response to the field.)
- Where are magnetic smart materials used in the real world? (e.g., magnetic fluid seals, drug delivery systems in medicine.)
- How would the slime's reaction to the magnet change if you doubled the amount of iron powder? What differences might this cause for the material's flexibility?

Extensions

- Challenge students to make the slime "swallow" the magnet and then extract it using only the magnetic field.

Working scientifically:

- Observing phenomena
- Applying and adapting
- Design and innovation
- Problem-solving

Key skills: Problem solving, Listening, Creativity

Difficulty rating: 4/5

Careers in Materials Science and Engineering

Materials Science is a massive field that touches almost every industry, from medicine and aerospace to fashion and sustainability. These professionals use strong science and problem-solving skills. A technical or university qualification was the best way into their role.

Ben Carter: Eco-packaging designer

Role Focus: Developing sustainable biodegradable plastics from plant-based materials to tackle environmental challenges and reduce reliance on fossil fuels.

Imagine the Future: Ben found his Bachelor's Degree in Chemical Engineering provided the core knowledge needed for synthesising new polymers. Alternatives include studying Polymer Science or completing a relevant technical apprenticeship in chemical manufacturing.

Future Study: Focus on Chemistry, Biology, and Design Technology (A-Levels/Highers) to understand both the chemical structure and the practical application of new materials. Subjects focusing on sustainability and environmental science are also excellent choices.

Dr. Aisha Khan: Material inventor

Role Focus: Designing, analysing, and testing high-performance composite materials (like carbon fibre reinforced polymers) to create lighter, stronger, and more resilient aircraft and vehicles.

Imagine the Future: Aisha's path involved achieving a Bachelor's degree in Materials Engineering, which helped her secure her first role. Many engineers also enter the field through a high-level Engineering Degree Apprenticeship, gaining a degree while working. Further study (like a Master's or PhD) helped her specialise in advanced research.

Future Study: The subjects that best support a career like this are typically Physics, Mathematics, and Chemistry (A-Levels/Highers). However, strong skills in Design Technology or Computer Science are also highly valued for the design and analysis aspects of the job.

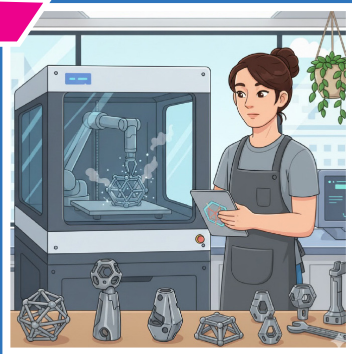
Javier Soto: Medical device builder

Role Focus: Preparing, testing and ensuring the safety of specialised biomaterials used for medical implants, artificial organs and targeted drug delivery systems.

Imagine the Future: Javier chose a vocational qualification (like an HNC or HND) in Biomedical Science, which gave him the practical skills to start working immediately. Others follow the route of a Bachelor's Degree in Materials Technology or Biomedical Engineering.

Future Study: Strong grades in Mathematics, Biology and Chemistry are highly beneficial. Practical experience through work placements or college technical courses can also be a strong pathway.

Sam Davies: 3D printing master



Role Focus: Operating, maintaining, and programming advanced industrial 3D printing equipment to manufacture complex metal and polymer components for high-tech industries.

Imagine the Future: Sam started her career through an advanced Engineering Apprenticeship, which allowed her to learn practical skills on the job while gaining technical qualifications. Others achieve similar success with a vocational qualification (HNC/HND) or a Bachelor's Degree in Mechanical or Manufacturing Engineering.

Future Study: Excellent skills in Design Technology, Physics and IT/Computing Science are essential for understanding the design process and operating the advanced machinery.

Where do you go from here?

Subject choices at school (S1/S2 & KS3)

To pursue a career in Materials Science or Engineering, you should aim to take the following subjects seriously:

Science: Essential for understanding structure, properties and reactions (Physics, Chemistry, and Biology).

Mathematics: Critical for analysis, testing and calculating required forces or material quantities.

Design and Technology (or Technical Studies): Necessary for designing and prototyping solutions using materials knowledge.

Pathways after age 16

A-Levels / Scottish Highers: These academic qualifications are the traditional route to university. The subjects that best prepare you for a Materials Science degree typically include Maths, Physics, Chemistry, or Computer Science.

Apprenticeships: Engineering Apprenticeships (from age 16) are a great way to earn, learn and gain hands-on experience in manufacturing, design or R&D (Research & Development), leading to nationally recognised technical qualifications.

Degrees & Degree Apprenticeships: These pathways lead to a degree (like a BSc or BEng) in a specialised field. Degree Apprenticeships are a fantastic blend: you study for the degree while working, giving you a university qualification and years of industry experience.

We hope you learnt a lot about how materials shape our world. If you enjoy solving problems, being creative and understanding how things work, maybe you'd like to be a Materials Engineer!

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Educator Notes

Careers education alignment

This resource is designed to help schools meet national careers guidance standards:

Gatsby Benchmarks (England & Wales: Secondary focus):

Benchmark 2 (LMI - Information)
Benchmark 4 (Curriculum links)

Career Education standard (Scotland: S1-S3 Focus):

Developing skills for learning, life and work
Developing knowledge and understanding of the world of work

STEM ambassadors & youth leaders

Engineers use many skills alongside their subject knowledge. These activities have been linked to the Skills Builder Framework:

Ravenscroft, T.M. (2020), Skills Builder Universal Framework of Essential Skills London: Skills Builder Partnership at **www.skillsbuilder.org/framework**

Skills Builder UNIVERSAL FRAMEWORK 2.0

LISTENING · SPEAKING · PROBLEM SOLVING · CREATIVITY · ADAPTING · PLANNING · LEADERSHIP · TEAMWORK

Curriculum alignment

In KS3 England and Wales and S1-S2 in Scotland, these activities are aligned with three core elements of STEM:

Chemistry: Students explore the structure of ceramics, polymers, and composites. They apply the particle model to states of matter and investigate chemical changes like synthesis and polymerisation.

Physics: The focus shifts to forces, pressure, and viscosity—specifically Newtonian and non-Newtonian fluids. Students also examine the elastic and viscoelastic properties of materials.

Design & Technology: Learners investigate functional properties and sustainable materials through prototyping and design.

These tasks bridge the gap between classroom theory and real-world engineering. By practicing scientific investigation—planning, measuring and predicting—students learn to solve practical challenges with a focus on sustainability.

If you enjoyed these activities, why not explore our AI, Electricity, Magnetism and Space resources and much more about STEM learning and careers, here: https://bit.ly/BAE-learning-hub

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