THE MAKING OF INVENTION

Strand: Materials | Strand unit: Properties and characteristics of materials / Materials and change

Look around you. The world we live in is made up of all types of materials used for all sorts of things; shoes, books, furniture, bikes, buildings, you name it, it's made of something, and usually quite a few somethings all working together to make a finished product. But not all materials are the same and selecting the right materials is an important part of inventing, designing and building. By testing materials, we can see what properties they have and think about what they would be most useful for.

INTRODUCTION

In this lesson the children will carry out a variety of mini-experiments to test a range of materials to learn about their properties. Materials are used in all aspects of our life from the clothes we wear, the furniture we sit on, the toys we play with and the cars we move around in. Why do we wear clothes made out of fabric, fly in planes made out of metal, and beds made of wood? Why don't we wear clothes made of metal, fly in planes made of wood, and sleep in beds made of fabric?! Because materials have different properties and some are really good for some jobs but not so good at others. Metal clothes would be strong but really heavy and hard to move in. A bed made of fabric may be comfy, but it would be floppy and not very strong. A wooden plane would not be able to cope with carrying hundreds of people and deal with the effects of the weather. Have the children look around the classroom and see what materials they can see and share their thoughts on why those materials were used?

Now look at this picture of a 'Bunny suit', worn by workers at Intel. Intel makes microchips. These are in all your phones, computers, even some of your pets! Microchips are tiny and making them requires super clean environments and working with chemicals. The workers wear these 'bunny suits' so they don't contaminate the microchips. These must be flexible, breathable and non-static. The suit must also be non-corrosive and liquid resistant.
Based on what we learned, what materials would be good for this?
Watch the video and see!

Today we want you to think about testing material for suits. Not a suit like the principal wears, but special suits, a diving suit, a fire-fighter's suit, or for going into space. What materials would you need? What conditions must they be able to deal with to keep the wearer safe and comfortable? We need a covering for the body, shoes, a helmet, a visor, gloves, flexible parts, rigid parts, maybe waterproof or heat-proof or pressure-proof! As you test materials, keep these things in mind. The children will work in groups to test, explore and understand why different materials are best suited for different jobs, they will record their results on a record sheet and can discuss their results at the end of the lesson.
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NOTE: The importance of trial and error must be highlighted for these experiments. Instead of the class thinking their experiments are "not working" allow them to see that that is part of the scientific process and this is how we figure out what materials are best for certain tasks

TEST 1 - THERMAL PROPERTIES: CONDUCTION & INSULATION

Uh oh! The fridge in the lab has broken, how can we keep the things inside cold until a mechanic arrives? Lets test what different materials will work!

PART A) CONDUCTION

The aim of this experiment is to test what materials conduct heat best. Materials that are more conductive will allow the heat from the water to move through them and melt the butter faster. This is why saucepans are made out of metal, as they allow heat to travel through them from the cooker to the food and heat it up.

Aparatus
- Tape
- Cups/Containers
- Clock or Stopwatches
- Water
- Ice
- Weights
- String
- Eggs
- Butter

Suggested Materials
- Tinfoil
- Bubble wrap
- Cotton/Cloth
- Rubber
- Hard Plastic (e.g. plastic ruler)
- Soft Plastic (e.g. clingfilm)
- Tissue
- Leaves
- Styrofoam
- Paper/Cardboard
- Sponge
- Metal spoon
- Wood (e.g. lollipop stick, wooden ruler)

There are many different materials that can be used in this section. The box above is a list of some suggested materials, it is good to have a combination of soft and rigid materials, although most of the tests work best with soft materials.

1. Give the children cups and a range of materials to test (plastic ruler, lollipop stick, cardboard, metal spoon) and have them record the materials on their record sheets.
2. Place each of the materials into the empty cups.
3. Scoop up equally sized balls of butter and place one ball at the end of each of the materials.
4. Get the children to record their predictions of what will happen.
5. Pour the hot water into each of the cups and wait.
6. Use a stop-watch or a clock with a second hand to note the time.
7. See which ball of butter melts most quickly (or at all). Record the time for each material and note the result.

Note: This can take a while so best to set aside and check every so often. It may need to be topped up with hot water. Have the butter on the underside of the object to help it melt and slip. This experiment can be dependent on the type of spoon for results.

PART B) INSULATION

The aim of this experiment is to test what materials insulate best. Materials that are insulators are good at stopping heat from passing through them; think of your woolly coat on a cold day keeping your body heat in, or an ice box keeping your picnic food cold on a hot day. We will test which materials are the best insulators to prevent an ice cube from melting quickly.

1. Give the children a range of materials to test (paper, tin foil, cloth, bubble wrap, cotton) and have them record the materials on their sheets.
2. Get the children to record their predictions of which material will insulate best/worst.
3. Give out the ice-cubes of equal size and have the children wrap them in each of the different materials.

4. Place the ice cubes by a heat source (on a tray on the radiator, on the windowsill in sunlight, or above cups of hot water) and wait.

5. Use a stop-watch or a clock with a second hand to note the time.

6. Keep checking to see which ice cube is melting most quickly.
Record the time for each material and note the result.

TEST 2 – DURABILITY & FLEXIBILITY

You have lost your footstool to reach a high shelf in the lab. What materials could you use to make a small platform to boost you up? Lets test how rigid/flexible different materials are!

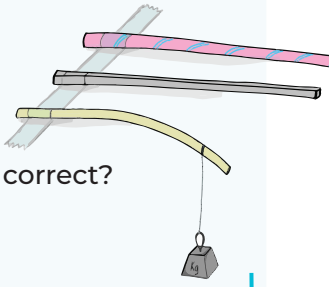
The aim of this experiment is to test which materials are flexible and which are rigid. More rigid materials won't bend as much when weight is applied, but something too rigid could snap. You can develop on this by asking the class to figure a way that they could make some of the flexible materials more rigid, or brittle materials more strong. Experiment by testing the same material but using a different structure, for example folded paper vs rolled paper and a small and large bunch of spaghetti.

1. Place the materials (sticks, cardboard, ruler, spoon, spaghetti, paper) over the edge of a table and secure with tape. Ensure all pieces of material are of equal sizes so the test is fair.

2. Get the children to record their predictions of which material will be the most rigid or flexible.

3. Hang a weight off the end of the materials and note if they are flexible or rigid.

4. Record which material bends the most, or if any materials snapped.
Older classes could use a protractor to measure the angle of flex on each material. Which material was the most flexible/rigid? Was your prediction correct?



TEST 3 – TRANSPARENCY

**You are conducting an experiment with torches that needs to be done in the dark!
What materials will we make the box out of that we can put the laser inside?
Let's test transparency!**

The aim of this experiment is to see which materials let light through the most and which block light altogether. Materials can be transparent, meaning they let all the light through, translucent, meaning they let some light through, or opaque, meaning they block light passing through. Older classes can learn that there are some forms of light we cannot see that can pass through materials normal light can't. Ask them if they have ever seen infrared or thermal imaging of animals at night on nature documentaries. This is a type of light we cannot see but using special cameras we can pick it up!

1. Gather your materials and a torch and record what materials you are testing (plastic, clingfilm, cardboard, paper, metal).

2. Get the children to record their predictions of which materials will be transparent, translucent or opaque.

3. Turn out the lights and close the blinds to make the classroom as dark as possible.

4. Hold up different materials to the light and note which of the three categories they fall into.
Which material let the most light through? Was your prediction correct?

TEST 4 - HYDRO PROPERTIES

Uh oh! You have spilled some liquid in the lab! What is the best material for absorbing the liquid and cleaning up? Let's test the hydro properties of different materials. Some absorb water while others are impermeable (water proof).

The aim of this experiment is to see how water affects different materials. Paper can absorb water but will not return to its original state, it will be warped or mushy or may even dissolve into bits, but a sponge or cloth can absorb water and squeeze it back out again and return to its original state!

1. Gather your materials, bowls and water, and record what materials you are testing.
2. Get the children to record their predictions of which materials will absorb the water best and which will not.
3. Fill up one bowl with water, dip the material in the bowl and let it sit in the water for a while before transferring to the other.
4. Note your results. Which material absorbed the most water? Was your prediction correct?
5. Older classes can squeeze the sample over a measuring cup to see exactly how much water was absorbed.

TEST 5 - PROTECTION

You are testing old egg fossils in the lab and now need to transport them somewhere. As they are precious and fragile, we need to ensure they are protected safely and won't get damaged on the journey. What should we wrap them in?

The aim of this experiment is to see what materials are best at absorbing energy, by cushioning, crumpling, or distorting in shape to protect the delicate egg inside. Think of it like a car; in the past cars were made of rigid hard metals and had no airbags. In an accident between two cars, all the energy from the impact would be transferred to the other car and also to the passengers inside causing a lot of damage. Nowadays, cars are rigid, but have crumple-zones to absorb energy and airbags to cushion the people inside.

1. Give the children some eggs and a range of materials to test. Have them record the materials used on their record sheets and make predictions of which ones they think will work the best.
2. Prepare a testing area. Use a ruler or chair/table as a reference point to make sure the eggs are always dropped from the same height. Use a newspaper or a bin-bag to cover the floor for easy clean up afterwards.
3. Prepare the eggs by wrapping them in the various materials you have. Try to use equal amounts/thicknesses of material so the test is fair. Some materials could be manipulated to protect in different ways e.g. scrunched up paper vs wrapped paper vs paper rolled into tubes, be sure to record this information.
4. Drop the eggs in the testing area. If none of the eggs break, try again from a different height. You could record the height if you like to add more useful data.
5. Note the results on your sheet. Which material protected best? Was your prediction correct?

RESULTS

Have the groups share their results with the class and discuss what they found. They can evaluate the materials they used and the tests they carried out for effectiveness.

What other materials could they test? What other tests could they do or how could they make the tests more scientific? Which materials tested do they think would be best for a diving suit, a fire-fighter's suit or a spacesuit?

EXPERIMENTAL CONCLUSION

The class should now have a better understanding of the different properties of materials that were tested and how they were affected by the different tests. They should be able to recognise the importance of categorising materials, particularly when it comes to implementing them into design elements like a transparent visor, or a waterproof suit. They should have a feel for how material scientists, engineers and designers must think about what materials are best for the job they need them to do and test them to make sure that they are up to the job.

GOING FURTHER

Today we tested individual materials for very specific properties. Based on what you've learned today, extend this process by designing something using a range of materials that works well for a number of real-world challenges. Some suggestions: A model car that is heavy, strong and waterproof, a piece of clothing that is waterproof, flexible and cool, a bridge that is strong, light and can deal with strong wind, or a model of a house that uses natural and recycled materials. Once built, carry out tests designed to push your creations to their limits. Put weights on your car and wheel it through some puddles, leave your model house outside exposed to the elements for a week, do some exercise in your clothing designs and see how comfortable and durable they are. Use your imaginations, have fun and record your results!

RISE

At Intel, we care about the world and people. That is why we created our RISE goals!

Intel makes sure that their materials are all being sourced in a responsible manner. Within this they strive for full workforce inclusion and diversity. Intel reached 5 million women in Sub-Saharan Africa through their technology empowerment initiative goal.

RISE MOMENT
Remember to recycle properly! Use reusable bottles and coffee cups instead of buying new ones each time!