# Materials Matter – Workshop Outline READY TO USE

## WELCOME

Meeting Room

Usual health and safety briefing

## STARTER – 2 MINUTES A display of a variety of tins of Quality Street! As many as possible to create a wow as pupils enter the room!

## Do the quick ‘chocolate’ ID quiz!

## Introduce the challenge – for this workshop pupils are going to become engineers planning a brand-new machine. To do this was are going to use our scientific skills to investigate. We are thinking about a machine for melting chocolate ready to mould into new shapes.

## THE BIG PICTURE – 8 MINUTES

At the museum we care for lots of machines which have been very important to industry in Halifax. One industry which grow in Halifax during the Industrial Revolution was to actually make machines for the new mills and factories.

To make efficient machines, the engineers would have had to think very carefully about materials and two important areas of science;

* The properties of materials
* States of matter

Have two demo tables set up – one labelled as properties of material and the other as states of matter

#### What are materials?

Materials is a substance which has a name. Wood, paper, air, water, rubber, stone etc. Everything is made up of materials. When we want to make something we need to choose the best material for the job. To do that we think about the properties of different materials to help us choose.

#### Properties of Materials table;

The properties of the materials from which the machines and tools in the museum have been made from were carefully considered when they were designed. Using the right material for each part of the machine reduces the number of times it will break or wear down and need replacing.

Materials have different properties which make them useful for different jobs.

#### Show items which demo these;

* Waterproof – don’t soak up water
* Strong – difficult to break
* Flexible – easy to bend
* Hard – difficult to scratch
* Magnetic – attracted to magnets
* Conductors – heat or electricity can travel through them (Insulators – don’t let hear or electricity travel through them)

#### Show examples of broken or worn materials? Could include rusted metal?

#### States of Matter table;

Every material will exist in one of the three states of matter.  
Pictures

* Solid (ice)
* Liquid (water)
* Gas (water vapour)

Matter can change from one state to another – depending on temperature.

Show changes of state cycle cards order with pupil help and describe the changes.

* Solid melts to liquid
* Liquid evaporates (boils) to gas
* Gas condenses to liquid
* Liquid freezes to solid

Thinking about changes of state can be very important when designing and making machines.

I’m sure you are thinking that machines are made from solids! But liquids and gases can important too.

For example steam was a very important energy source during the Industrial Revolution and steam engines became an important machine to power mills and factories.

Steam Engine demo here TBC? Discuss the change of state from liquid to gas

Show a video of the Robson oil engine working? Discuss the change of state from liquid to gas

Sometimes we also need to think about the states of matter of the product we are making too.

#### Introduce the activity

During this session we are going to split into two groups and explore;

* The properties of materials
* States of matter

First we need to get ready;

Group 1: Boiler Suits/High Vis

Group 2: Lab coats

## ACTIVITY – 100 minutes

Split class into two groups for 50-minute sessions, then swap over

Group 1: Properties of Materials tour and gallery activities

Group 2: States of Matter Investigation

#### **Group 1: Properties of Materials Tour**

(5 minutes for moving around the museum)

Start in the CLASSIC CARPETS Gallery – 15 minutes

CORK

Cork is an amazing material! It was even used by the Romans and the Ancient Greeks, so we have know about it for a very long time.

It has a honeycomb structure, which means it is filled with air – about 89% of the cork bark is air. This means that cork has a lot of very useful properties;

*Show cork bark and cork samples  
  
Show cork images*

Elastic – when cork is squeezed or compressed the air inside is not squeezed out (due to the cell membranes) so it is very elastic and will always return to its original shape. This makes it ideal for bottle stoppers! When you take the cork out of bottle it is very difficult to get it back in – this is because it has returned to its original size and shape!

Low mass – cork is very light which means it can float on water. It is also waterproof so does not absorb any water. This makes it ideal for fishing floats!

*(can demo this with a cork and small bowl of water)*

Insulation – cork doesn’t conduct heat, this means it doesn’t let heat move through it very easily. This means it can be used for insulating houses and keeping them warm!

Durable – cork is very good at dealing with friction and it can survive repeated impact or rubbing. This make it very good for cork soled shoes.

Being durable and an insulator means it is also very good as parts in machines which are producing friction and heat.

LEATHER

Leather is a material with properties which make it suitable for a wide variety of uses. It is made from cattle hides, but can be made from other animals like sheep, horses, lamb and even crocodiles. Buffalo?

#### Show kids leather jacket for trying on? Check with teacher beforehand for any children with religious beliefs for which this would not be appropriate

Strong – leather is very strong and tough. It is resistant to abrasion (rubbing) which makes it good for clothing like motorcycle jackets.

Flexible – leather can be formed and shaped, this means it can be used for making sports equipment like balls and baseball gloves.

Insulation – Leather contains a lot of air and air isn’t a very good conductor of heat. This means that leather is a good insulator and is ideal for shoes to keep our feet warm!

The strong and flexibility of leather means it is very good as the fast moving parts in machines particularly as belt drives and loom pickers.

#### Give pupils some free time to explore the Gallery and fill in the Materials worksheet using drawings if this is more suitable.

#### Move on to the Machines that made machines gallery – 15 minutes

METAL

#### Stand at the Foundry display

There are lots of different metals – how many can you name?

Metals come from rocks called ores. Metals can be elements, which means they are found naturally in the rocks. Or they can be alloys, which means different metals have been mixed together. Iron, copper, tin and gold are examples of elements. Iron is a very important metal and you may have already learnt about the Iron Age at school?

#### Iron ore sample for handling?

During the iron age people began to make most of their tools from iron instead of stone or bronze. Bronze is an alloy of copper and tin. Iron was easier to source and it was also easier to make into tools than bronze.

We still use iron today to make machines and tools. Iron ore can be heated in a blast furnace, which heats it to extremely high temperatures. When iron is mixture with carbon it can make an alloy called steel. Steel is harder and stronger than iron. Steel was a very important factor in the industrial revolution, instead of people using hand power machines at home.

Metals are one of the most widely used materials because they have properties which make them so useful for so many different uses.

#### Show pupils examples of everyday metal objects (pans, wiring)

STRONG and HARD – metals can be hammered into different shapes without breaking

GOOD CONDUCTORS – many metals let heat pass through them which makes them ideal for pans. Metals also conduct electricity, which makes metals like copper ideal for electrical wiring.

MALLEABLE – metals have very high melting points which means they have to be heated at very high temperatures before they start to become liquid. But when heated they can be shaped. This makes them good for car parts.

MAGNETIC – iron is magnetic (Demo with a magnet moving iron filing?) so we can test metals to find out if they are iron or not. Do you think steel is magnetic – yes because it contains iron.

This part of the museum contains machines which made machines! In order to make a machine, the metal parts or components need to be shaped.

A foundry is a factory which makes metal castings like this one (show casting). Cast iron can be made into any shapes by heating them at very high temperatures in a furnace, until it has melted into liquid and then pouring it into a mould until it solidifies. Casting can be used to make very complex shapes. In the nineteenth century a detailed wooden pattern was often made first by a specialist pattern maker to ensure that the castings being made were identical (show/handle the wooden cog). This museum used to be a pattern shop.

A lathe is a machine which can shape metal, like this one. It rotates the piece of metal you are shaping, so one of the things it can be used to make is screws (demo turning a screw). In the past the lathe was the most dangerous machine, and losing a finger was a big risk!

Very small lathes which can even be held in your hand are used by watchmakers and jewellers. Very big, heavy lathes are used to make machine tools.

TBC - Demo of candle lathe? See Andy Jackson for information

#### If time give pupils chance to explore the Gallery and fill in the Materials worksheet using drawings if this is more suitable.

#### Swap Over – 5 minutes

#### **Group 2: States of Matter Investigation**

#### Start in the QUALITY SWEETS gallery – 10 minutes

At the start of the workshop we talking about the different states of matter (G,L,S) and that matter could change state depending on temperature changes. This is important thinking about the process of making the products and what the machine needs to do, Here in the Quality Sweets gallery is a good example of changing states.

#### Show pupils the toffee boiling machine

This gallery is about chocolate production here in Halifax. A a brand-new toffee ‘*Mackintosh’s Celebrated Toffee*’ was invented in a sweet shop hre by John Mackintosh and his wife Violet. They combined hard butterscotch with soft caramel recipes to make the *Toffee De Luxe* - later marketed as ‘*The King of All the Toffees*’. The recipe used local ingredients like milk, sugar beets and eggs.

The solid ingredients of toffee have to be heated to 140 degrees Celsius during production. Heating the ingredients will give you a liquid – they have melted. This toffee boiling machine has a copper pan. Copper is a very good material for pans. It is an excellent conductor of heat (fives times better than iron) so the heat spreads evenly across the pan. It also takes less energy to cook with a copper pan.

As you can see the liquid toffee is then poured out of the pan. This might be onto a cooled metal slab or into moulds.

#### What do you think happens next when the toffee cools down?

Solidifies into toffee which can be broken up and packaged.

#### Move to the Meeting Room for the investigation – 40 minutes

**Melting Chocolate Investigation Instructions**

In this activity you are going to be engineers planning a new machine which instead of boiling toffee melts chocolate. We need to investigate how fast or slowly different types chocolate melt.

*Discuss the change in state, solid to liquid.*

Work together in groups of 3 or 4. You are going to get messy!

#### Ask pupils about the different types of chocolate and how they are different – elicit answer that it is the cocoa content. Show pupils any quality street tins in collection which can be used to examine ingredient highlight the differences in cocoa content between milk and dark chocolate? Or use other Nestle/Mackintosh packaging.

Show pupils the chocolate buttons and discuss their ideas on if the chocolates will melt at different speeds and why. To encourage ideas you could have ‘tasters’ for each button to describe the taste and how sweet/chocolately each is – to spark their ideas about cocoa content.

Ask pupils to write their aim and hypothesis on their Investigation sheet – give a time limit for this.

Divide pupils into groups of three.  
Equipment  
Samples of white, milk and dark chocolate buttons   
Skin/Strip Thermometer  
Stop Watch  
Access to hand washing

Method

Warm your hands up by rubbing them together for one minute.

*Optional - Can you record your temperature using the skin strip thermometer? Record the result.*

Three people in the group choose a different chocolate each. If you have a fourth team member they can be the timer and checker, otherwise an adult helper will do this.

Hold your chocolate button and close your hands.

Every 60 seconds check your hands and observe the state of your chocolate. Has it melted?

Keep checking every 60 seconds.

Record your results – *what order did your chocolate melt in*?

#### Was it a fair test? NO! Discuss why not and how could you make it fair?

No – pupil hands may be different temperatures – use the thermometer strips to demonstrate this. We are trying to investigate one variable – the different type of chocolate.

Discuss improvements to the experiment;

* Keeping a consistent temperature for each chocolate to melt – this means the same amount of heat will be applied to each chocolate
* Include a control – a button left at room temperature for the same amount of time to check its not melting too (or to the same degree)

Use tealights, tealight holders and foil used to heat the chocolate buttons  
<https://www.tts-group.co.uk/tea-light-stands-5pk/1003895.html>

Now re-run the experiment with your improvements to the investigation.

#### Ask pupils if there any effect on the order the chocolates melted?

#### Ask pupils to record their results on their investigation sheet.

Discuss with pupils their results – show have melted in the order white – milk – dark. Elicit a conclusion about ingredients. The higher the cocoa content the slower the chocolate will melt. White chocolate should melt the fastest as it has a high fat content and contains no cocoa (fats have a lower melting point than cocoa). Dark chocolate will melt the slowest as it has the highest cocoa content at 60-70%. Milk chocolate has a cocoa content of about 50%.

Extension

Ask pupils to think about what experiment they might do next to plan their machine;

* Choose one type of chocolate and investigate the effect of different temperatures on how fast the chocolate melts

## PLENARY - 5 Minutes

Gather both groups back together in the meeting room.

Our challenge for this workshop was to investigate ideas for a brand-new machine. Now we have looked around the museum at materials and investigated chocolate melting, what have we found out which will help with our machine design?

#### What materials do you think we should use?

Metal – copper pan and cooled metal slab

#### What machines might we need to use to make our machine? Lathe Foundry to shape metal

#### How can we cause a change in state of the chocolate? Apply heat to melt a solid to a liquid Cold surface to solidify the chocolate bar Why do we need to control the temperature of melting?

Different chocolate will melt at different temperatures

## POST-VISIT ACTIVITY

Challenge pupils to design their chocolate melting machine and email them in?

Can give out the Chocolate Machine Design Sheet to complete at school