

**Week 4 Work booklet – Composites, smart materials and 6R's**

**HARDWOODS 1  
OAK**

A **very strong wood** which can be **light or dark in colour**. Open grain. **Hard to work** with. Produces high quality furniture.  
Very **expensive**.

**Uses:** **High quality furniture, boats**, beams used in building



**HARDWOODS 2  
MAHOGANY**

Easy to wood with wood. Reddish-brown in colour. Very expensive normally, used in high quality furniture.

**Uses:** Expensive indoor furniture, shop fitting, bars.



**HARDWOODS 3  
BEECH**

Straight grained with a fine texture. Light in colour. Easy to work with. Beech is also very hard to good for products that are used day-to-day.

**Uses:** Quality furniture, toys, door handles



**SOFTWOODS 1  
SCOTS PINE**

Straight grained. Soft but knotty. Light in colour. Fairly strong and easy to work with. Cheap

**Uses:** DIY, cheap quality furniture. Constructional work on buildings.



**SOFTWOODS 2  
PARANA PINE**

Hard and straight –grained. Almost knot free. Fairly strong and durable. Pale yellow in colour. Expensive.

**Uses:** Good quality furniture such as doors and staircases.



**SOFTWOODS 3  
SPRUCE**

Creamy whit in colour. Not very durable. Cheap and easy to work with.

**Uses:** General indoor work, furniture used in bathrooms and kitchens.



**MAN-MADE WOODS 1  
MDF**

A quality board, relatively cheap. Composed of fine wood dust and resin pressed into a board. Can be worked, shaped and machined easily.

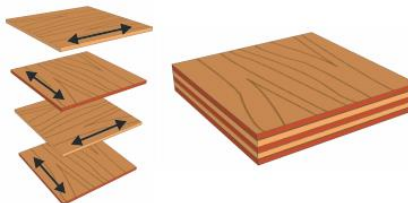
**Uses:** Shop fitting, cheap doors, flat-packed furniture



**MAN-MADE WOODS 2  
PLYWOOD**

Plywood is a composite (*made from more than one material*) material. Thin wood veneers glued together at right angles. Supplied in a range of sizes and thicknesses.

**Uses:** Construction work, shelves, tables



**MAN-MADE WOODS 3  
CHIPBOARD**

This is made up of small chips of wood bonded together with resin and formed into sheets by compression. It is not as strong as plywood, but it is not as expensive

**Uses:** Cheap furniture, Computer desks, Kitchen table tops.



### THERMOSETTING PLASTIC 1 POLYESTER RESIN

**Resins** are combined with materials such as 'fibre glass', the result is a **very tough** material that can **resist impact**. Known as **Glass reinforced Plastic**.

**Uses:** **Car body repairs**, sailing boats and **airplanes**.



### THERMOSETTING PLASTIC 2 MELAMINE FORMALDEHYDE

Smooth and hygienic qualities, used for kitchen laminate surfaces.

**Uses:** Electrical plugs and sockets, because it can be cast and is an excellent insulator



### THERMOSETTING PLASTIC 3 UREA FORMALDEHYDE

Has high hardness and toughness, so its suitable for strong, knock-resistant electrical fittings. Scratch resistant, very good electrical insulator.

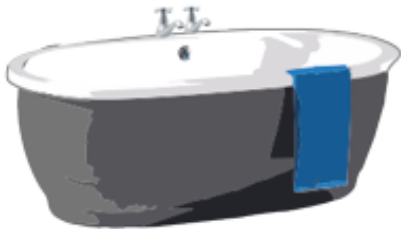
**Uses:** TV cases, plugs, refrigerator case



### THERMOPLASTIC 1 ACRYLIC

This is the most common plastic in a school workshop. Purchased in the form of sheets and comes in a range of colours. Easy to cut shape. Polishes well.

**Uses:** Baths, safety glasses, signs



### THERMOPLASTIC 2 HIGH IMPACT POLYSTYRENE (HIPS)

Light material and yet strong. Available in a range of colours. Can be vacuum formed. Thinner HIPS is quite flexible.

**Uses:** Food containers, chairs, packaging and storage units.



### THERMOPLASTIC 3 POLYPROPYLENE

Thermoplastic often formed into products through injection and blow moulding. It is robust, strong, flexible and supplied in a range of colours

**Uses:** Used for electrical casings, packaging, trays



## NON-FERROUS METALS ALUMINIUM

Light grey in colour. Smelted from bauxite ore. Aluminium 95%, Copper 4%, Manganese 1%

Ductile, soft, malleable, machines well on lathes and milling machines. Very light and resists corrosion. Can be cast into products from ingots.

Used widely in aircraft, drinks cans, window frames, ladders, and kitchen ware.



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## NON-FERROUS METALS COPPER

Reddish brown in colour, darkens slowly when in contact with air. This metal is not an alloy.

Ductile, can be beaten into shape as it is relatively soft. Conducts electricity and heat.

Electrical wiring, tubing, kettles, bowls, pipes and plumbing. Used also in the production of printed circuit boards.



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## NON-FERROUS METALS BRONZE

A copper / tin alloy. Tin content up to 10%.

Engineers well on lathes and works quite well with handtools.

Once used for ship fittings, due to its resistance to corrosion. Now replaced by stainless steel. Used for ornaments, cast bronze sculptures and ships propellers. Used also for bearings in engineering.



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## FERROUS METALS - IRON

Wrought Iron was used by the Romans. Roman iron weapons were forged, not cast. Iron was forged by heating it to high temperatures (to red heat) and hammering it into shape. Britain had numerous Roman iron ore mines. It also had large forests, which provided the wood required for smelting (extracting the iron from the ore).



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## FERROUS METALS THE ALLOY STEEL

Iron is the most used metal in the world, largely due to it being the main constituent of the alloy steel.

Common steel typically has 0.2 to 2.1% carbon content, with the rest being iron.

Our modern world relies on steel

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## FERROUS METALS STAINLESS STEEL

Alloy of iron, nickel and 10.5% to 11% chromium.

Tough, resistant to rust and stains. Does not corrode.

Cutlery, medical instruments, specialist corrosion resistant products such as pipes. Stainless steel pots and pans. Jewellery and watches.

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### COMPOSITE MATERIALS – CONCRETE

Concrete is composed of a number of materials, that **combine** to form this **versatile building material**. Most concrete is made up of **Cement, aggregates (gravel, crushed stones) and sand**. Water is added to the mix.

**Uses:** construction, roads, brick laying, building and many more.



### COMPOSITE MATERIALS - STEEL REINFORCED CONCRETE

Reinforced concrete has long steel rods passing through its length, adding great strength to the final composite material. Able to resist tensile forces.

**Uses:** Used for bridge building, skyscrapers and general large scale construction.



### COMPOSITE MATERIALS - KEVLAR

Kevlar® is a liquid, converted into a fibre (called aramid fibres) and woven into a textile material. Extremely strong, lightweight, corrosion and heat resistant. Has a high tensile strength to weight ratio, far exceeding steel

**Uses:** When combined with other materials: bullet proof jackets, armour for military vehicles and planes. Formula 1 fuel tanks.



### SMART MATERIALS – POLYMORPH

Polymorph is a thermoplastic material that can be shaped and reshaped any number of times. Supplied as granules.

Heated in hot water - at 62 °C the granules form a mass of 'clear' material that can be shaped into almost any form.

On cooling it becomes as solid.

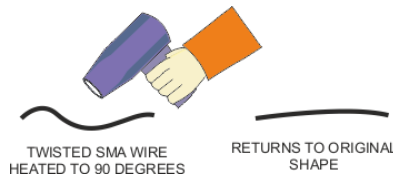
**Uses:** Suitable for 3D modelling, rubber tool handles



### SMART MATERIALS – SHAPE MEMORY ALLOY (SMA)

SMA wire also called 'Nitinol', as it is a composed of nickel and titanium. Looks like ordinary wire and has many of the same properties.

SMA has a memory - for example, if it is folded to form a shape and then heated above 90 degrees (centigrade) it returns to its original shape.



### SMART MATERIALS – THERMOCHROMIC

Thermochromic inks change colour in response to changes in temperature. These inks have serious applications such as in the food industry. They can be used to indicate when a packaged food has reached the correct temperature in an oven. They are also used in forehead thermometers.

**Uses:** Food packages, thermometers





# SIX Rs

## Activity sheet



**RETHINK**



Reprocess a material or product and make something else



**REUSE**



When a product breaks down or doesn't work properly, try to fix it



**RECYCLE**



Do we make too many products? Design in a way that considers people and the environment



**REPAIR**



Cut down the amount of material and energy you use as much as you can



**REDUCE**



Don't use a material or buy a product if you don't need it or if it's bad for people or the environment



**REFUSE**



Use a product to make something else with all or parts of it

## FURTHER QUESTIONS AND ANSWERS ON SMART MATERIALS

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1. Explain what is meant by the term 'smart material'.

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2. Name a smart material and name / describe a product in which it is used.

SMART MATERIAL: \_\_\_\_\_

PRODUCT/DESCRIPTION: \_\_\_\_\_

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3. Explain why the smart material you named is used in the product.

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4. Describe / explain the following smart materials:

HYDROCHROMIC INKS: \_\_\_\_\_

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POLYMORTH: \_\_\_\_\_

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SHAPE MEMORY ALLOYS (SMA): \_\_\_\_\_

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HYDROMORPHIC POLYMERS: \_\_\_\_\_

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HYDROCARBON ENCAPSULATING POLYMERS: \_\_\_\_\_

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AROMA PIGMENTS: \_\_\_\_\_

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