WJEC Eduqas GCSE (9-1) in

DESIGN AND TECHNOLOGY

ACCREDITED BY OFQUAL

SPECIFICATION

Teaching from 2017
For award from 2019

SMART AND MODERN MATERIALS

SMART AND MODERN MATERIALS

A modern material is a material that has been developed through the invention of new or improved processes to improve the properties of the material, eg to make them stronger, faster, lighter and tougher.

Many modern materials are developed for specialist applications; however, some have become available for general use.
Concrete, aluminium and **steel** are all commonly used modern materials, but more recent additions include materials that have changed the way we manufacture and use products.

To be classed as a 'smart material' they need to exhibit a physical change in response to some external stimuli.

While smart materials are modern materials, modern materials are not necessarily smart.
To be classed as a 'smart material' they need to exhibit a physical change in response to some external stimuli.
In other words, they change when you do something to them, and when you remove what is causing that change they return to their original form.

SMART MATERIALS

To be classed as a ‘smart material’ they need to exhibit a physical change in response to some external stimuli such as:

HEAT / LIGHT / SOUND

- This cat mug changes appearance when hot liquid is poured into it. **(HEAT)**
- These glasses change depending on the amount of light. **(LIGHT)**

THERMOCHROMIC PIGMENT

Thermochromic pigments change colour when their temperature changes. The term ‘thermo’ relates to heat, and chroma means colour - so thermochromic pigments change colour when they are heated up. These pigments can be mixed with paint or polymers to give the materials the same colour-changing properties as the pigment. You may have seen this technology on colour-changing mugs or bath items for children.

Cool use for thermochromic pigment: https://www.youtube.com/watch?v=ZFOSVOI8QvE

PHOSPHORESCENT WIRE

A thin copper wire that is coated in **phosphor**, which glows brightly when a current is applied to it. It is commonly used in fancy dress and decorative luminescent clothing, nightlights, waterproof displays, medical tool display screens and car's speed dials.

POLYMORPH

Polymorph is a **polymer** that becomes **malleable** when heated to about 62°C. When it cools down it becomes hard enough to drill and cut. This makes it perfect for modelling as it can be reheated and formed again. It is also excellent for creating ergonomic handles.

https://www.youtube.com/watch?v=wGiwsj5FH0g

REFLECTIVE FABRICS

Reflective fabrics change colour when the light changes. When bright light is focused on them they glow or light up. Very useful for safety jackets or cyclists clothing that may be illuminated by the headlights of a car!

RHOVYL

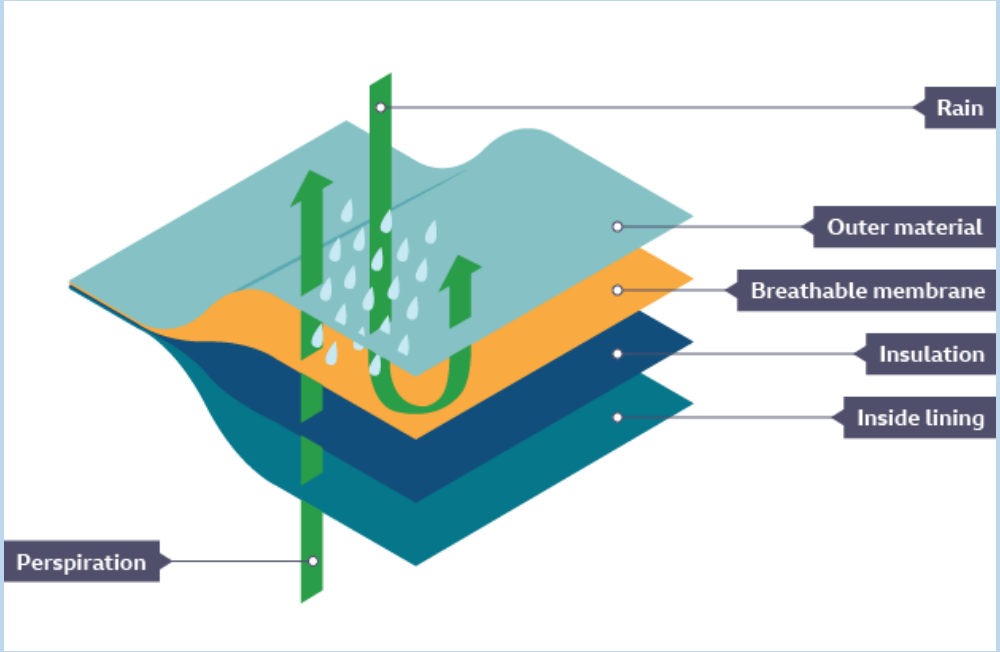
Rhovyl. is an antibacterial material that has antibacterial agents integrated into the fibre itself. This prevents the formation of bacteria. It is perfect for sports wear like these sock or running jacket. It also “wick’s sweat away from the skin to keep you cool when exercising.

adidas

CLIMACOOL

GORE-TEX – MODERN MATERIAL

Gore-Tex is designed to allow body moisture to evaporate away from the body.
It does this whilst still remaining waterproof.
It is made up of several layers which all have different jobs.
The membrane has microscopic holes, big enough to let body moisture through but too small for rain.



KEVLAR - COMPOSITE

Kevlar is a tightly woven fabric that has great impact resistance. It is used in racing tyres, racing sails, gardening gloves and bulletproof vests.

Watch James May talking about the evolution of bullet protection:
https://www.youtube.com/watch?v=cXv5KcLFn5w

CONCRETE – COMPOSITE

Concrete is an engineering material that simulates the properties of rock and is a combination of particles closely bound together. It is used in construction a lot!

It is relatively cheap.
It has a long life.
It is strong under compression.
It is fire-resistant.
Can be easily shaped before it sets.
A warm material which holds heat well.

Did you know…

- Concrete is the second most used material on earth after water

CARBON-FIBRE - COMPOSITE

- **Fantastic strength and stiffness:**

The road bike / F1 car will absorb bumps in the road and will feel very solid to the rider or driver.

- **Lightweight:**

The lighter a road bike or F1 car the better so that it can get up hills quicker or accelerate quicker.

- **Can be moulded into complex shapes:**

Perfect for bike frames or F1 cars as they can be quite complex shapes with tricky angles.

F1 crash showing carbon fibre shatter!

https://www.youtube.com/watch?v=IKxLTVMbhUE

SMART MODERN MATERIALS, COMPOSITES AND TECHNICAL TEXTILES

Use the fact sheet resources to help you fill in the blanks!

Name	Description	Image
Shape Memory Alloy	A shape-memory alloy (SMA, smart metal, memory metal, memory alloy, muscle wire, smart alloy) is an alloy that "remembers" its original shape and that when deformed returns to its pre-deformed shape when heated.'	
Photo-chromic Materials	Photochromic materials – these change colour according to different lighting conditions and can be used for security markers that can only be seen in ultraviolet light. Photochromic lenses are optical lenses that darken on exposure to specific types of light most commonly ultraviolet (UV) radiation. These lenses may be made of glass, polycarbonate, or another plastic. They are used in eyeglasses that are dark in bright sunlight, but clear in low light conditions.	

SMART MODERN MATERIALS, COMPOSITES AND TECHNICAL TEXTILES

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Thermo-chromic Material	Thermochromic inks or dyes are temperature sensitive compounds that temporarily change colour with exposure to heat. They come in two forms, liquid crystals and leuco dyes. Leuco dyes are easier to work with and allow for a greater range of applications. Thermochromic inks are pigments that change colour to colourless at certain temperature. There are many different types of thermo-chromic pigments including textile inks for tex-tile screen printing.	
Polymorph	Polymorph is a thermoplastic material that can be shaped and reshaped any number of times. It is normally supplied as granules that look like small plastic beads. It can be heated in hot wa-ter and when it reaches 62 degrees centigrade the granules form a mass of 'clear' material. When removed from the hot water it can be shaped into almost any form and on cooling it becomes as solid as a material like nylon.	

SMART MODERN MATERIALS, COMPOSITES AND TECHNICAL TEXTILES

A spoon needs to be designed for babies. It is important that you think about health and safety. Describe what smart material you could use and describe the benefits to this. Think about further uses for smart materials also. (4)

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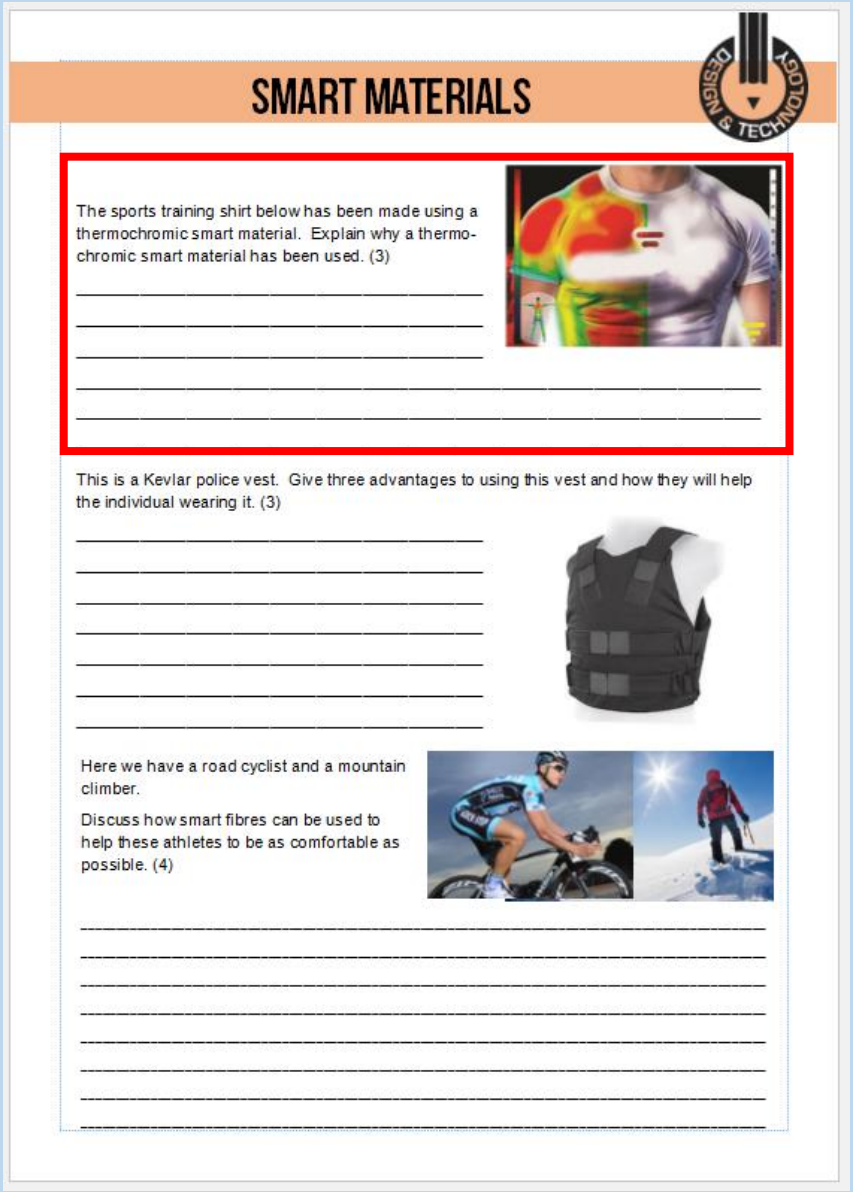
DISCUSSION TIME!

"How did you do on this question? Has anyone got any good ideas about smart materials that could improve this product?"

SMART MODERN MATERIALS, COMPOSITES AND TECHNICAL TEXTILES

It's worksheet time! You are just answering the first question for now. You will probably be able to answer this without listening to the teacher following the previous lesson!

Now, for some theory:



SMART MATERIALS

The sports training shirt below has been made using a thermochromic smart material. Explain why a thermo-chromic smart material has been used. (3)

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This is a Kevlar police vest. Give three advantages to using this vest and how they will help the individual wearing it. (3)

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Here we have a road cyclist and a mountain climber.

Discuss how smart fibres can be used to help these athletes to be as comfortable as possible. (4)

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SMART MODERN MATERIALS, COMPOSITES AND TECHNICAL TEXTILES

Now it's time to complete the rest of the worksheet:

Remember – If the question is worth 3 or 4 marks the examiner probably wants you to write quite a bit about the topic.

Types of exam questions:

Advantages = Give three advantages and explain them

Discuss = Go into detail about the subject and discuss positives and negatives

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