YR10 ENGINEERING

Unit 3

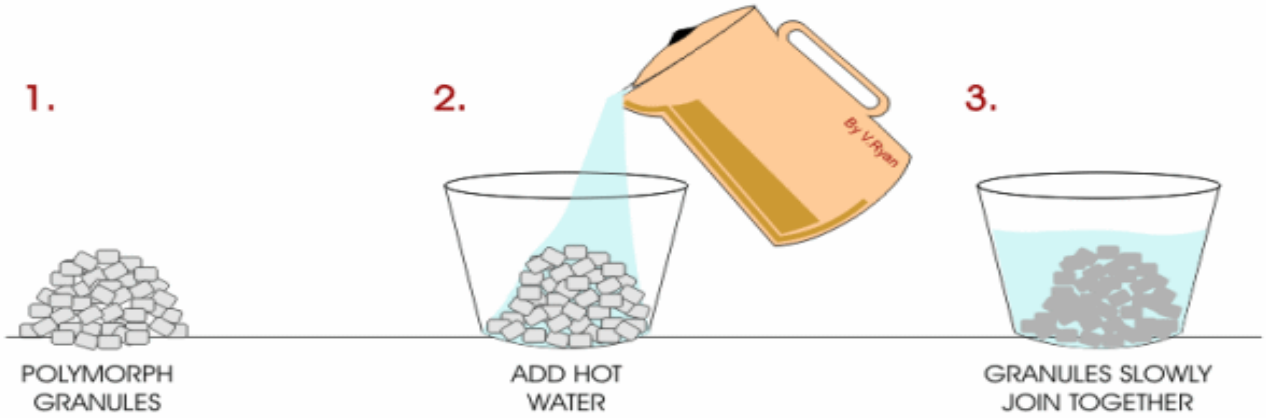
In the table below try to describe what each heading is

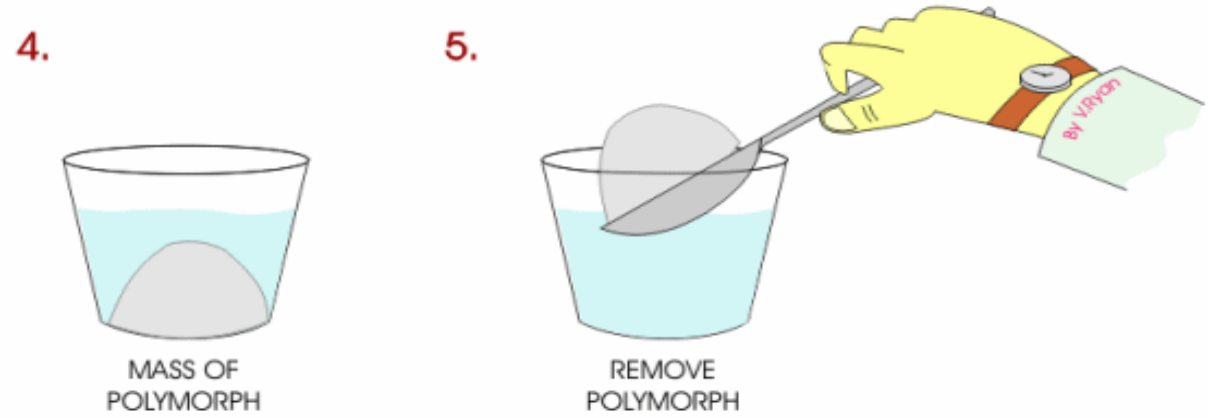
Key Term	Understanding before lesson	Understanding after lesson
Thermoplastic		
Thermosetting Plastic		
Polymorph		
Nitinol		

Smart Materials

- Polymorph
- Polymorph is a thermoplastic material that can be shaped and reshaped any number of times. It is normally supplied as small plastic beads. In the classroom it can be heated in hot water and when it reaches 62°C the granules form a mass of 'clear' material. When removed from the hot water it can be shaped into almost any form. When cooled it becomes as solid as a material such as nylon.

- Although expensive, polymorph is suitable for 3D modelling as it can be shaped by hand or pressed into a shape using a mould.

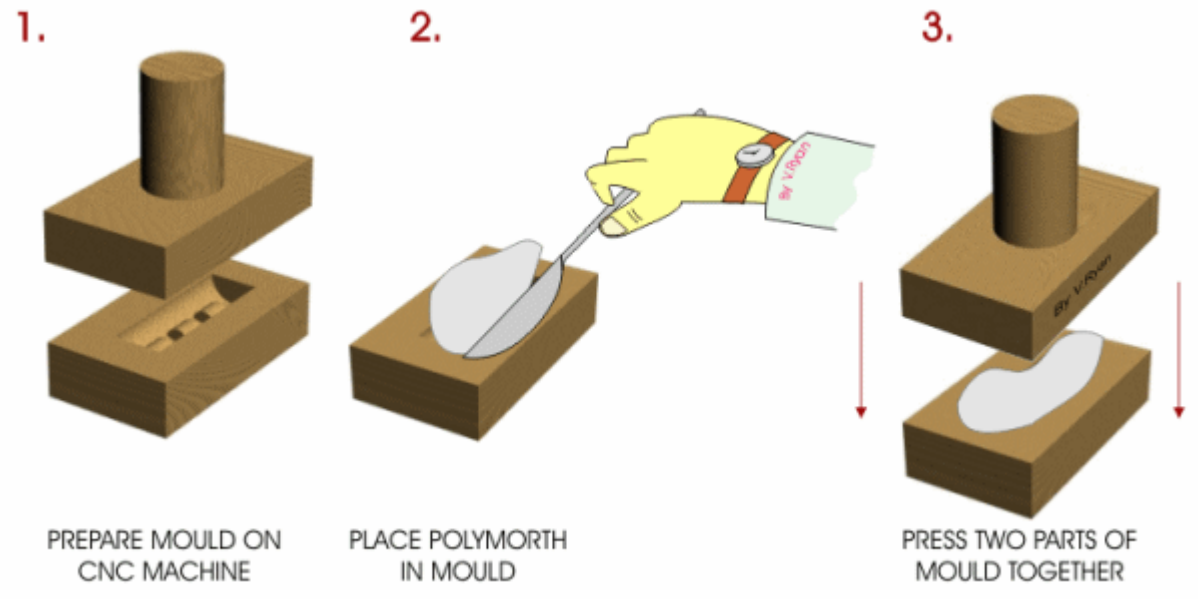

1.
2.
3.
By V.Ryan
POLYMORPH GRANULES
ADD HOT WATER
GRANULES SLOWLY JOIN TOGETHER


4.
5.
By V.Ryan
MASS OF POLYMORPH
REMOVE POLYMORPH


6.
7.
8.
By V.Ryan
MOULD POLYMORPH GRANULES
MODEL ERGONOMIC SCREWDRIVER HANDLE
ADD SCREWDRIVER BLADE FOR REALISM

Polymorph

- A mould can be made to form an accurate shape using polymorph

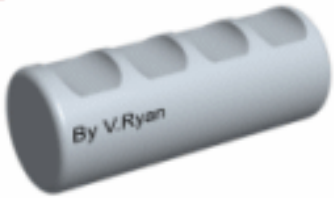


Polymorph

4.

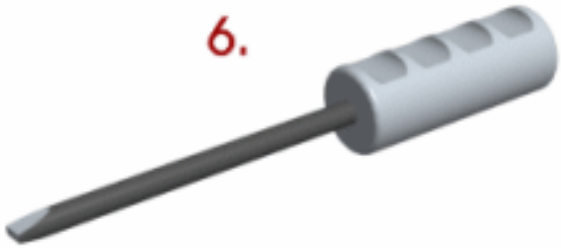
POLYMORPH MOULD
NEEDS TRIMMING

5.



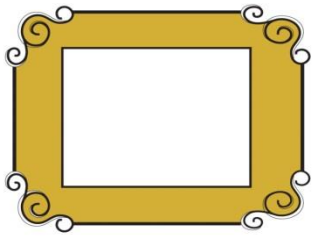
MODEL ERGONOMIC
SCREWDRIVER HANDLE

6.



ADD SCREWDRIVER BLADE
FOR REALISM

Polymorph



- What's the advantage of using polymorph?
- Where could we use it in real life?
- Are there any disadvantages?

Shape Memory Alloy

- SMA wire is sometimes called ‘Nitinol’, as it is a composed of nickel and titanium. This special wire looks like ordinary wire and even has many of the same properties. It can be folded to form complex shapes quite easily and it conducts electricity.
- It is very expensive when compared to ordinary steel or even copper wire. However, it has properties that make it very special
- https://www.youtube.com/watch?v=wI-qAxKJoSU

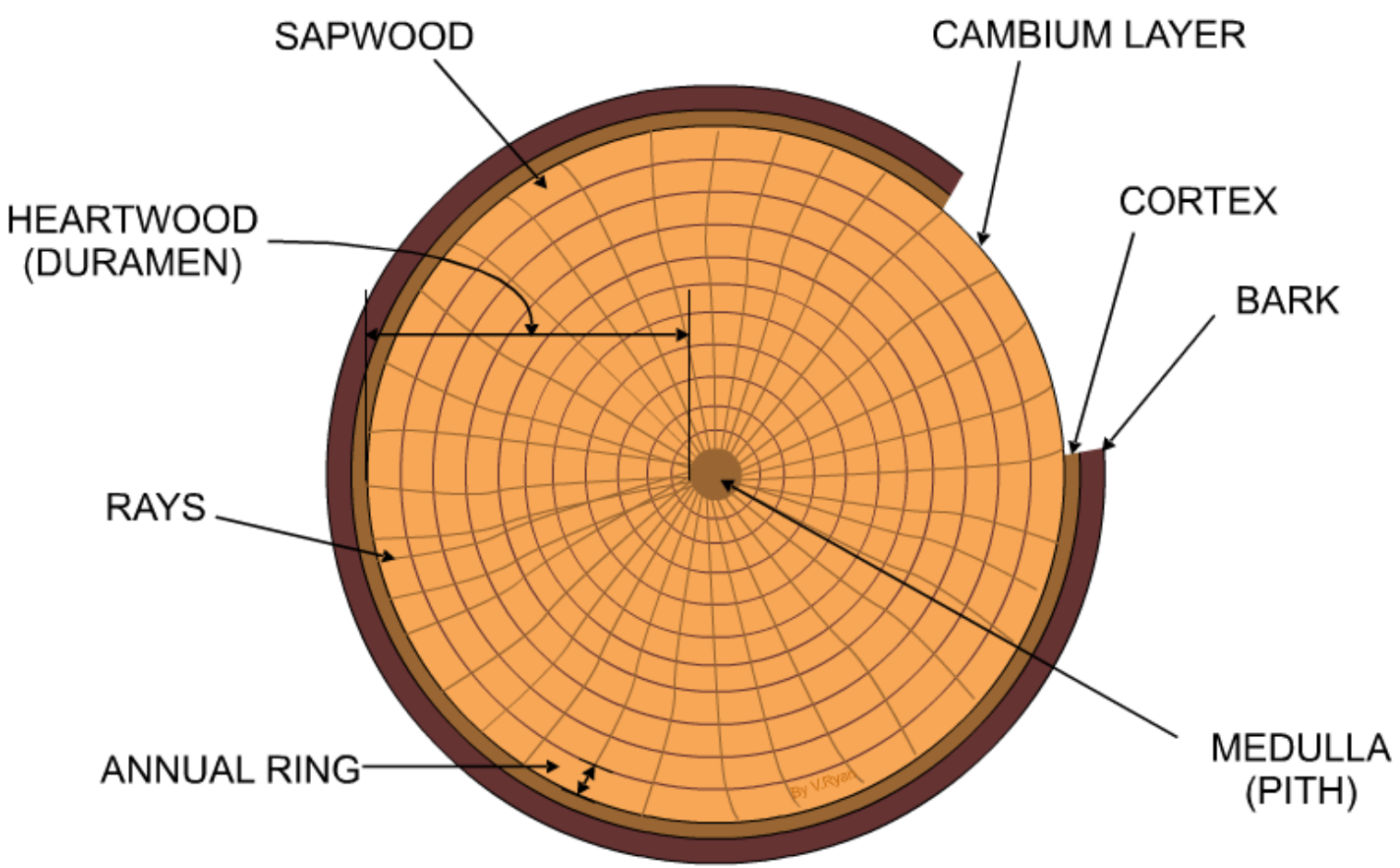
In the table below try to describe what each heading is

Key Term	Understanding before lesson	Understanding after lesson
Thermoplastic		
Thermosetting Plastic		
Polymorph		
Nitinol		

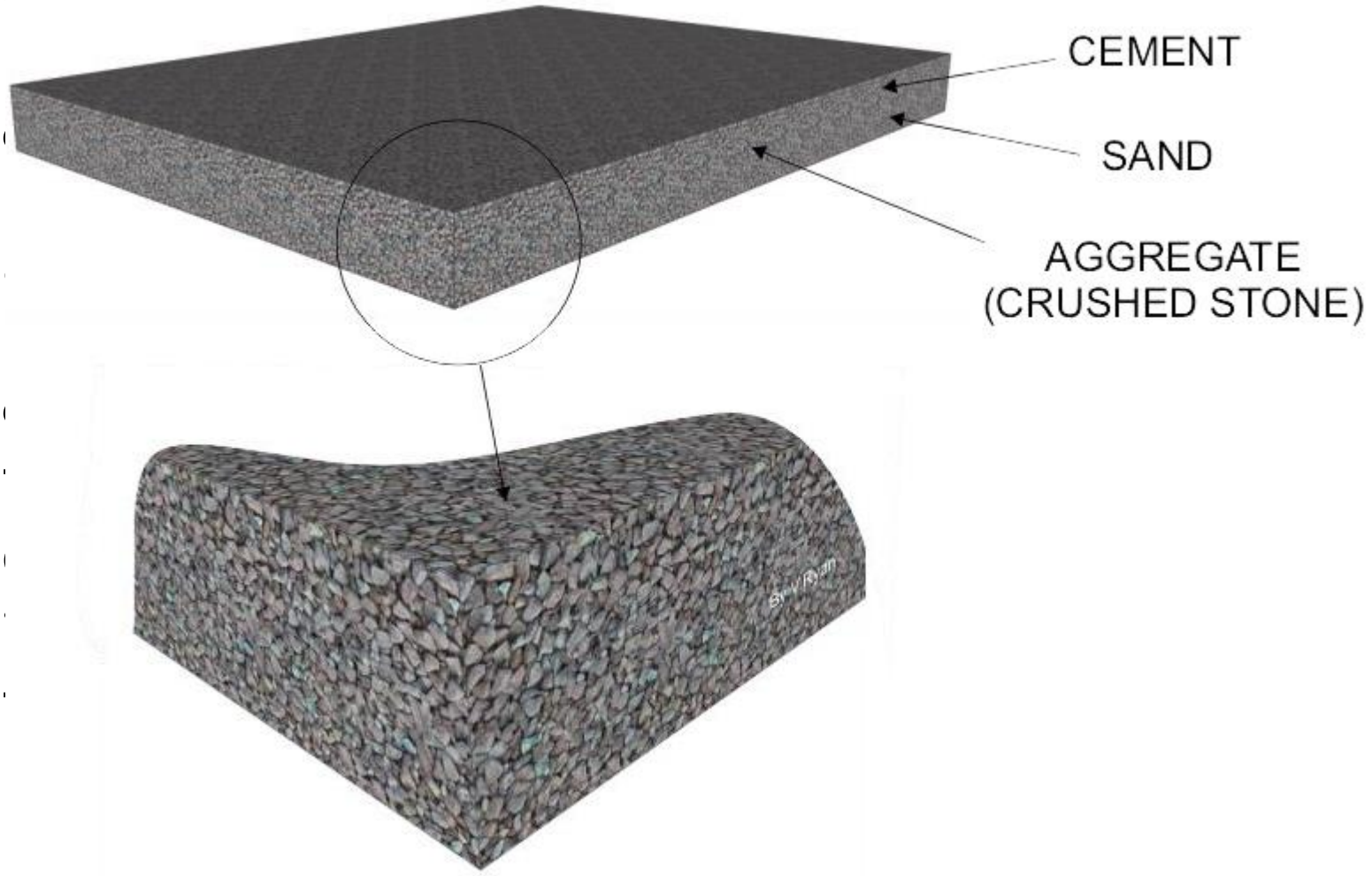
How do I succeed today?

- Bronze: I can name most of the different materials we can use and I can make a list of the processes we saw today
- Silver: I can name all of the materials that we can use and I am able to describe what the different processes are
- Gold: I can name all the different materials we use, I can describe all of the processes in detail, and I can describe different situations in which the various materials can be used

Composite Materials



Composite Materials



Composite Materials

- Fibreglass is an excellent example of a relatively modern composite material (Invented in 1938 by Russel Games). In industry it is often referred to as Glass Reinforced Plastic (GRP).

  GRP is composed of strands of glass. Each individual glass fibre is very fine with a small diameter, and they are woven to form a flexible fabric. The fabric is normally placed in a mould. The process is repeated so that there are many layers of fibre glass and resin and allowed to dry/cure. The resulting material is strong and light. Glass Reinforced Plastic can be sanded for a smooth finish and painted.

Composite Materials

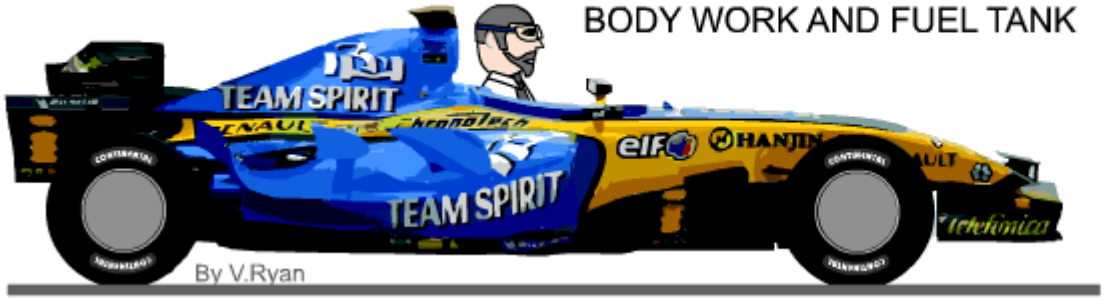
- Glass reinforced plastic is lightweight and has good thermal insulation properties. It has a high strength to weight ratio, making it useful for the production of products such as water tanks, surfboards, canoes, small boat hulls and similar products.

Composite Materials

- Kevlar is a liquid that is converted into a fibre (called aramid fibres) and then woven into a textile material. The resulting textile material is extremely strong, lightweight, corrosion and heat resistant. It is often used in combination with other materials, forming composites.
- Kevlar has a high tensile strength to weight ratio, far exceeding steel and even specialist metal alloys. (Roughly 20 times stronger than steel)

Where do we use it?

FORMULA ONE - RACING CARS
BODY WORK AND FUEL TANK



BULLET / STAB PROOF VESTS

DIVING GLOVES

WALKING BOOTS

MILITARY HELMET

CUT RESISTANT GLOVES

BICYCLE TYRES

CAR TYRES

FIRE PROOF CLOTHING

Advantages

- Kevlar has a range of advantages, not only its relative low weight and high strength:

  Laminated Kevlar is very stable at high temperatures and it is impact and scratch resistant.

  Kevlar is often combined with other materials, to produce textiles with enhanced properties, such as fire resistant clothing for the Fire Services.

Advantages

- Kevlar is used in some quality walking boots because it is waterproof (when combined with other materials as a composite) but also breathable, ensuring comfort.

- When Kevlar is used as a composite with rubber, it retains its flexibility. This composite material is used in the manufacture of Formula One Racing Car petrol tanks. The tank holds the petrol safely, even in the event of an accident. The material cannot be pieced by other car components, even during a high speed impact. The petrol does not escape / leak, avoiding fire and explosions.

Disadvantages

- Kevlar textiles tend to absorb moisture. It must be combined with moisture resistant materials, if there is a need for moisture resistance as a physical property. Consequently, very few general cloths are manufactured with Kevlar.

- Kevlar reacts well under a tensile force (stretching force) but badly under a compressive force. It is not used where compression resistance is needed, such as bridge building or the structure of a building.

Disadvantages

- It is difficult to cut and shape, unless through the use of special tools and equipment. Laminated Kevlar is also difficult to machine and consequently special cutters are required. Special cutting techniques were developed to enable the manufacture of Kevlar parts, for the Eurofighter.
- Kevlar reacts badly to UV light (sunlight) unless it is protected / hidden from direct sunlight.
- Kevlar suffers some corrosion if exposed to chlorine.

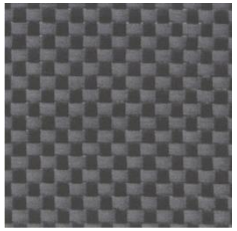
How do I succeed today?

- Bronze: I can name most of the different materials we can use and I can make a list of the processes we saw today
- Silver: I can name all of the materials that we can use and I am able to describe what the different processes are
- Gold: I can name all the different materials we use, I can describe all of the processes in detail, and I can describe different situations in which the various materials can be used

Composite

- What's the advantage of using a composite material?
- Where could we use it in real life?
- Are there any disadvantages?

Carbon Fibre



- Carbon Fibre Reinforced Plastic is similar to fibre glass
- Carbon fibre is woven into a textile material and resin such as epoxy resin is applied and allowed to cure. The resulting material that is very strong as it has the best strength to weight ratio of all construction materials. It is an improvement on glass fibre reinforced plastic, although much more expensive.

Carbon Fibre

- Carbon Fibre Reinforced Polymers tend to be used in the manufacture of expensive sports cars, where strong and light materials are required.

Carbon Fibre

- Expensive, competition bicycles and motorbikes tend to have CFRP frames, forks, handlebars to keep weight to a minimum and yet retain great strength.
- The aerospace industry has embraced the use of CFRP in the manufacture of planes.

Carbon Fibre

- Describe two advantages of using Carbon Fibre (CFRP) over GRP (fibreglass) or titanium.
- Describe one disadvantage
- What is CFRP?

Tungsten Carbide

- **Tungsten carbide** containing equal parts of tungsten and carbon.
- In its most basic form, tungsten carbide is a fine grey powder, but it can be pressed and formed into shapes for use in industrial machinery, cutting tools, abrasives, armour-piercing rounds, other tools and instruments, and jewellery.

Advantages

- Tungsten carbide is approximately two times stiffer than steel
- is much denser than steel or titanium
- Hardness is similar to ruby or sapphire
- Can you think or any disadvantages?

Carbon Ceramic

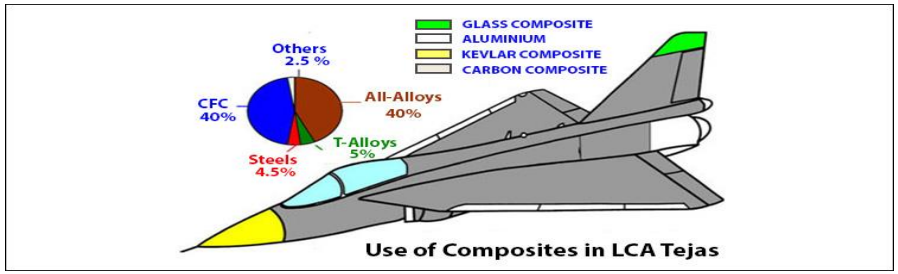
- https://www.youtube.com/watch?v=Q_3PebbkGpo

- During the Video write down 2 advantages and 2 disadvantages of carbon ceramic brakes.

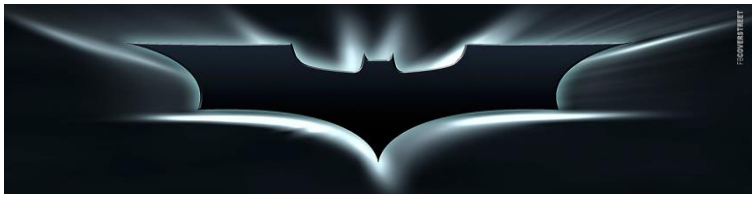
- Where can we use them?

Materials

Why do we need so many different materials?



What is a composite material?

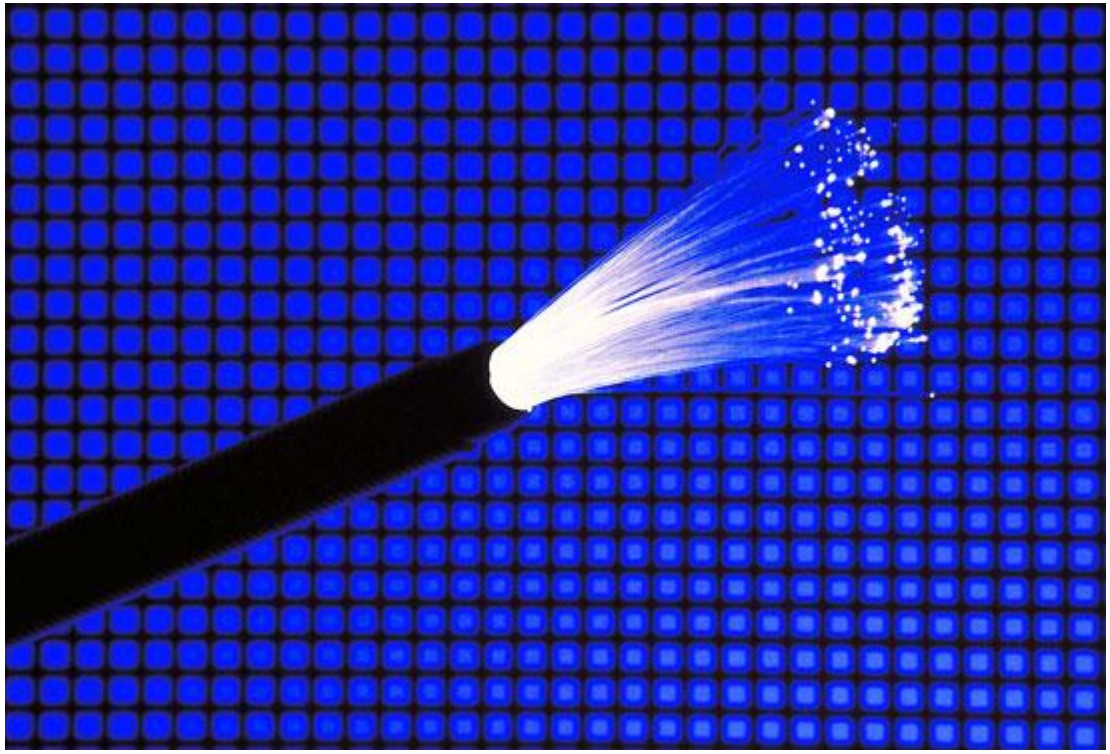


What is a smart material?

http://www.youtube.com/watch?v=CdiSk8XyBu8

Optical fibres

An optical fibre is a flexible, see through fibre made of extruded glass or plastic, slightly thicker than a human hair.



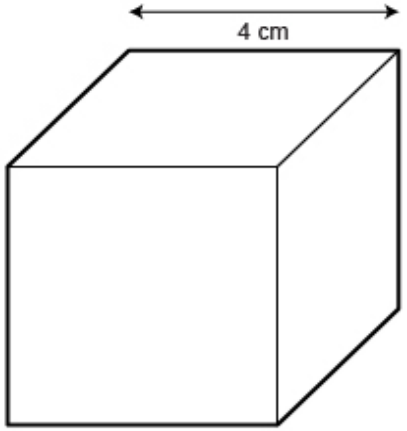
Where do we use it?

- **Communication -** Telephone transmission method uses fibre-optic cables.
- **Medical uses -** Optical fibres are well suited for medical use. They can be made in really thin, flexible strands that can be put in blood vessels, lungs, and other hollow parts of the body. Optical fibres are used in a number of tools that let doctors view internal body parts without having to perform surgery.

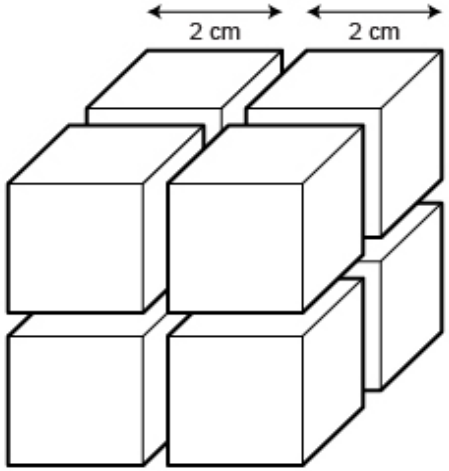
- **Simple uses -** The simplest application of optical fibres is the transmission of light to locations otherwise hard to reach. Also, bundles of several thousand very thin fibres assembled precisely side by side and optically polished at their ends, can be used to transmit images.

Surface Nanotechnologies

The use and control of tiny matter is called nanotechnology. Nanoparticles of a material show different properties compared to larger particles of the same material.



Surface area
= (4 cm x 4 cm x 6 faces) = 96 cm²



Surface area of one cube
= (2 cm x 2 cm) x 6 faces = 24 cm²

Total surface area
= 24 cm² x 8 cubes = 192 cm²

Surface Nanotechnologies

Nanoparticles are used in products that are currently available.

- **sports equipment:** nanoparticles are added to materials to make them stronger and often being lighter. They have been used in tennis rackets, golf clubs and shoes
- **clothing:** silver nanoparticles have been added to socks. This stops them from absorbing the smell of sweaty feet as the nanoparticles have antibacterial properties
- **healthcare:** nanoparticles are used in sunscreens. They offer protection and can be rubbed in so there are no white marks

Surface Nanotechnologies

- **Harmful effects**

There are some concerns that nanoparticles may be toxic to people. They may be able to enter the brain from the bloodstream and cause harm. Some people think more tests should take place before nanoparticles of a material are used on a wider scale.