

Unit 8A(ii) Exploring materials

Focus: resistant materials

About the unit

The main aim of this unit is for pupils to explore the properties of materials when designing, so that they will be able to identify appropriate materials for a task.

In this unit, pupils tackle one of three design and make assignments (DMAs) on the themes:

- Computer mouse
- Kit rack
- Kites

They have to design and make a product, identifying suitable materials taking into account appearance, function, safety and reliability.

Pupils gain the knowledge, skills and understanding they need to carry out the DMA successfully through product evaluation activities and focused practical tasks. They:

- apply their understanding of the properties of materials, *eg the hardness of steel, strength of manufactured board*
- consider more complex finishing processes, *eg enamelling, dip coating, wood staining*, including their potential environmental impact and health hazards
- use thermoforming processes
- identify methods of using the structural properties of metals when reinforcing and strengthening frames, *eg through triangulation, by bracing with struts and ties*

Where the unit fits in

This is one of three resistant materials units that focus on understanding materials: one in year 7 on using and understanding materials; this one in year 8 on exploring materials in greater depth; and one in year 9 on critically selecting materials. These units ensure progression in understanding about materials.

This is part of a series of three units in year 8 on exploring materials; there are equivalent units, with similar learning outcomes, on food and textiles. Together these units are expected to take 15–22 hours. It is important that the department plans as a team so that pupils are able to draw on knowledge, skills and understanding from across the units to reinforce their learning and avoid unnecessary repetition.

If you choose not to teach this unit, then plan to include the essential activities identified by the symbol ■, as part of another unit.

Expectations

At the end of this unit

most pupils will: select materials for particular purposes, considering their working properties and performance characteristics, the available tools and equipment, and the form, size and performance specifications of the material available; process materials to change their working properties and performance in use, if appropriate, using techniques to alter materials on a temporary basis, to make them easier to work with; apply their understanding of the properties of materials and how these can be managed and exploited; select finishing techniques for materials that are appropriate to their end use, with the aim of enhancing their appearance and maintaining their performance in use

some pupils will not have made so much progress and will: choose appropriate materials from those available, drawing on their previous experience of working with them, and explain reasons for using particular materials; cut, shape and form materials, working with a range of tools and equipment; use finishing techniques that are suitable for the product's end use

some pupils will have progressed further and will: draw on their knowledge of materials and production processes, recognising the advantages and disadvantages of particular tools and equipment and processes; make decisions which resolve conflicting demands, *eg balancing cost and aesthetic appeal against function and performance*; evaluate how effectively they have used information on the properties of materials when testing their product

Prior learning

It is helpful if pupils have:

- learnt how materials and components can be used
- learnt how structures can fail when loaded, and investigated techniques for reinforcing and strengthening them
- joined and combined materials and components accurately in temporary and permanent ways
- learnt that many different materials can be used on a product, *eg in a slipper*, some to stiffen, some to provide a hard-wearing surface and some for appearance
- classified materials by their properties and sources, *eg hard/soft, ferrous/non-ferrous metal, thermoplastic/thermosetting plastic*
- considered basic surface finishes, *eg edge polishing acrylic, sealing wood, primer, undercoat and gloss paint on mild steel*
- considered physical properties, *eg the grain of wood, brittleness of acrylic, elasticity of PVC, malleability of aluminium*
- become aware of how extraction, use and eventual disposal of some materials affect the natural environment

Pupils should have gained the above knowledge, skills and understanding in years 6 and 7, through unit 6A ‘Shelters’ and unit 6B ‘Slippers’ in the key stage 2 scheme of work and unit 7A(ii) ‘Understanding materials (resistant materials)’, or similar projects.

Language for learning

Through the activities in this unit, pupils will be able to understand, use and spell correctly words relating to:

- the properties of materials and their working characteristics, *eg flexibility, load bearing, strengthening, reinforcing, protecting, structural, hardness, tension, compression, elasticity, aesthetics*
- texture, *eg brittle, rubbery, gritty, sandy, waxy, soft, rough, bumpy, smooth, corrugated, abrasive*
- appearance, *eg flat, crystalline, wet, fragile, dull, shiny*

Reading – through the activities pupils could:

- select relevant information and link to other information, from a range of sources
- undertake independent research using knowledge of how texts, databases, etc are organised and of appropriate reading strategies

Writing – through the activities pupils could:

- organise facts/ideas/information in an appropriate sequence
- group sentences into paragraphs that are clearly focused and well developed
- link ideas and paragraphs into continuous text which is organised and coherent
- show relationships between ideas by links which show purpose, *eg in order to, so that*, and reservation, *eg although, unless, if*
- use punctuation correctly, *eg full stops, commas, dashes, brackets, bullet points, colons*, to extend and clarify sentences

Resources

Resources include:

- a collection of products in order to investigate how different materials are used
- tools, equipment and materials to practise finishing techniques or thermoforming
- useful websites, *eg*
 - www.incpen.org
 - www.materialise.com

Future learning

Pupils could go on to a further unit on materials: unit 9A(ii) ‘Selecting materials (resistant materials)’. Applying an understanding of materials when designing and making is an important part of every design and make assignment.

Out-of-school activities and homework

Pupils could:

- compare load-bearing structures used for different types of chair, investigating how they deform under load
- investigate structures used to protect vulnerable items, *eg packaging of goods, casings for electrical items*
- find out about decorative techniques, *eg painting and polishing*. They could collect visual records of their use and record a simple flow chart to show how the effect is achieved
- survey users’ reactions to a range of products, including those intended to meet the same need, in order to identify the criteria used to evaluate and compare them

Links with other subjects

- Science: this unit links to work in unit 7K ‘Forces and their effects’. It also builds on year 8 work on compounds and mixtures by explaining changes of state of materials and chemical changes in terms of atoms.
- ICT: using databases.
- English: displaying and communicating information.

Learning objectives

Pupils should learn:

Possible teaching activities**Learning outcomes**

Pupils:

Points to note**DESIGN AND MAKE ASSIGNMENT (DMA)**

- to design and make a product, identifying materials that are appropriate for the task, taking into account appearance, function, safety and reliability, by applying the knowledge, skills and understanding they developed during the product evaluation activities and focused practical tasks

Set the pupils a DMA in which they identify and work with materials that are suitable for the task, applying their understanding of the properties of materials.

Examples

These example DMAs have been written so they can be copied and given directly to pupils. Further information about the context will be needed to make the DMAs specific enough for your pupils.

Computer mouse

Designers often make 3-D models to find out if their idea looks good, is the right size and shape, and is strong enough to withstand appropriate wear and pressure during use. Design and make a concept model for a new computer mouse to fill a gap in the market.

Kit rack

Design and make a foldable structure that could hold tools or other items of your choice, up to a maximum size of 200mm x 200mm x 200mm when assembled.

Kites

Design and make a kite that incorporates a logo. Design a mechanism for the storage and release of the string while the kite is in use.

- take into account appearance, function, safety and reliability
- make preliminary models to explore and test their design thinking
- make their product within constraints
- use their knowledge of how databases are organised, and how to read them to select relevant technical information about materials and processes
- consider a range of materials and methods
- choose materials and methods, and give details of these in a manufacturing specification
- write a report (300 words) justifying and reviewing their choice of materials and methods of making. The report should have a clear focus and include linked paragraphs and topic sentences

Language for learning when writing a report

- When pupils write their reports, ask them to:
 - link ideas, *eg on materials selected*, by purpose links, *eg in order to, so that*, and reservation links, *eg although, if*
 - use appropriate punctuation correctly, *eg colons, brackets, dashes*

PRODUCT EVALUATION

Organise a range of activities that give pupils an opportunity to:

- identify the properties of different materials and components and consider why they have been used
- learn about the structural properties of materials
- identify possible design weaknesses in the choice or processing of the materials used
- name and describe the methods and processes used to make and finish the product
- specify design criteria and set up tests to evaluate products objectively
- learn words to describe the form and function of products



Health and safety – pupils should understand about hazards, risks and risk control when dismantling products. They could carry out a risk assessment of the product they are dismantling, to develop their understanding of health and safety issues

■ essential activities

○ optional activities

Learning objectives

Pupils should learn:

- about the properties of materials and the characteristics they give to products
- about ways of processing materials
- about the structural properties of materials, and functional and safety considerations
- about finishing and decoration and its impact on a product's performance
- about processing, assembly and packaging

Possible teaching activities

- Carry out scenario activities. Ask the pupils to discuss choosing materials and processes for a product, *eg a folding structure, computer mouse or kite*. Ask them to choose materials and processes from a limited range of options and discuss why they made particular choices, *eg by looking at how a frame structure reacts under compression if joints and fixings distort; by looking at the flexibility of a plastic container*.
- Ask the pupils to look at the impact of different sorts of processing on the end product, *eg to investigate the effect on surface finish of heating a range of sheet materials*.
- Ask the pupils to examine a collection of items, *eg cutlery, lights, sunglasses, telephones, computer mouse*, and to investigate the use of different materials. Ask them to relate this to structural, functional and safety considerations, and to explore how the materials have been combined, reinforced and finished, and how components have been used and organised, *eg to carry out a life-cycle analysis of a computer mouse by drawing a flow chart showing the materials used from source to disposal*.
- Ask the pupils to investigate finishes and surface decorations used on a variety of materials and discuss how they alter performance characteristics.
- Ask the pupils to disassemble a product, *eg a commercially available kite*, and to examine how it was processed, assembled and packaged.

Learning outcomes

Pupils:

- apply their understanding of the physical and chemical properties of materials, *eg the hardness of steel*, and recognise the connection between the properties of a material, its performance and how it is used
- identify an increased range of plastics, *eg polypropylene, polystyrene*
- explain how common sorts of processing change the main characteristics of an end product
- identify methods of reinforcing and strengthening structures
- identify common finishing processes, *eg enamelling, dip coating, staining wood, sandblasting acrylic*
- understand the processing of raw materials and their potential end uses, and how products are assembled and packed

Points to note**Language for learning about the properties of materials**

- Remind pupils of the correct names of a range of properties and their spelling and roots, *eg resistance, biodegradable/biodegradability*.

■ essential activities

○ optional activities

Pupils should learn:

Pupils:

FOCUSED PRACTICAL TASKS (FPTs)

These practical tasks should focus on the knowledge, skills and understanding outlined in 'About the unit'. They should give pupils an opportunity to practise any new skills they will need during the DMA, *eg considering finishing processes*.

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| <ul style="list-style-type: none"> ■ how finishing and decorative techniques are used and about their potential environmental impact | <ul style="list-style-type: none"> ■ Demonstrate to the pupils a range of finishing techniques, <i>eg self-finishing techniques (casting polyester resin), enamelling, dip coating, painting, polishing</i>, and discuss why they are appropriate to their end use. Discuss with the pupils the difference between improving appearance and improving performance. Discuss the environmental impact and health hazards of different finishing techniques. | <ul style="list-style-type: none"> ■ evaluate the benefits and hazards of different finishing techniques and their effect on quality, before deciding which techniques to use, <i>eg they choose between painting and polishing, and explain why they chose this finishing technique</i> |
| <ul style="list-style-type: none"> ■ how thermoforming processes are used | <ul style="list-style-type: none"> ■ Demonstrate to the pupils how thermoforming processes can be used (choose ones which are appropriate to the DMA, <i>eg injection moulding, vacuum forming</i>). Allow the pupils to practise processes by making simple items. Discuss the appropriate and safe use of equipment. | <ul style="list-style-type: none"> ■ use thermoforming processes appropriately and safely |
| <ul style="list-style-type: none"> ○ how changing and moving load affects the structure | <ul style="list-style-type: none"> ○ Examine different structures with the pupils, <i>eg those used in frameworks</i>, and ask them to try to identify the forces acting upon the structure. As part of this discussion, pupils should consider <i>Which parts are in compression? Which are in tension?</i> | <ul style="list-style-type: none"> ○ know that excessive loads can cause structures to fail by bending, buckling and twisting |
| <ul style="list-style-type: none"> ○ how a changing load affects the internal and external forces of tension and compression | <ul style="list-style-type: none"> ○ Examine with the pupils how designers take account of loads on structures, and forces exerted within them, by using arches, frame structures and shell structures. or ○ Ask the pupils to investigate the effects of loads on test structures of different kinds, varying the materials used, to see how the structures deform under load and the way in which they fail. | <ul style="list-style-type: none"> ○ use simple tests to determine the effects of excessive loads |

■ essential activities

○ optional activities