

Unit 7A(ii) Understanding materials

Focus: resistant materials

About the unit

The main aim of this unit is to develop pupils' understanding of the properties of materials and how to apply this understanding when designing with resistant materials.

In this unit, pupils tackle a design and make assignment (DMA) on the theme 'Carry it all', in which they design and make a carrying device for someone in the local community. They must use materials appropriately to meet a specific technical purpose.

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

- classify materials by their properties and sources, *eg hard/soft, ferrous/non-ferrous metal, thermoplastic/thermosetting plastic*
- consider basic surface finishes, *eg edge polishing acrylic, sealing wood, primer, undercoat and gloss paint on mild steel*
- consider physical properties, *eg the grain of wood, brittleness of acrylic, elasticity of PVC, malleability of aluminium*
- become aware how the extraction, use and eventual disposal of some materials affect the natural environment

Where the unit fits in

This is one of three resistant materials units that focus on understanding materials: this one in year 7 on using and understanding materials; 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 7 on understanding materials; there are equivalent units, with similar learning outcomes, on food and textiles. Together these units are expected to take 15–24 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.

If pupils are encouraged to use textiles in their design, they could work across materials.

Expectations

At the end of this unit

most pupils will: select materials and components from a given range for particular purposes, considering their working properties, the available tools and equipment, and processes for working with the material; apply their understanding of how materials are classified according to their use, origin and properties; recognise that the properties of materials meet different needs; use their understanding of the limitations of materials to guide their ideas and help them make final decisions about which materials to use; combine materials and components to suit particular purposes; process materials to change their working properties and performance, applying an increasing range of cutting, shaping and forming techniques, as appropriate; choose from the range of finishing processes available to enhance the appearance of materials and improve their performance, *eg sealing wood*, and recognise where self-finishing techniques are available, *eg edge polishing acrylic*

some pupils will not have made so much progress and will: choose the most appropriate materials from those available and draw on some previous experience of working with materials; explain their choice of materials; cut, shape and form materials, as appropriate; select and 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 processes; recognise the advantages and disadvantages of particular tools and equipment, and processes; make decisions which resolve conflicting demands, *eg the cost with the suitability of a material for the chosen design*; check that materials are capable of taking the desired form, have aesthetic appeal, are an appropriate weight and have other properties needed

Prior learning

It is helpful if pupils have:

- related the way things work to their intended purpose, the use of materials and components, people's needs, and what users say about them
- learnt how the working characteristics of materials relate to how they are used
- learnt how materials can be combined and mixed in order to create more useful properties
- learnt how structures can fail when loaded, and investigated techniques for reinforcing and strengthening them
- carried out simple tests on a small range of textiles which are suitable for a carrying device, for water resistance and strength
- joined and combined materials and components accurately in temporary and permanent ways, using framework materials and suitable textiles

Pupils should have gained the above knowledge, skills and understanding in years 5 and 6, through unit 5A 'Musical instruments' and unit 6A 'Shelters' in the key stage 2 scheme of work, 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:

- materials and their classifications, *eg wood (softwood, medium density fibre board, ash, mahogany), metal (mild steel, aluminium, brass, copper), plastic (polyethylene, polystyrene, acrylic, polyester, poly-tetra-fluoro-ethylene, PVC)*
- the characteristics and properties of materials, *eg low density, bends, breaks, grain, malleable, malleability, shatters, strong*

Speaking and listening – through the activities pupils could:

- ask questions to gain clarification and further information, *eg Why...? How...? What...? What then...?*
- share information and discuss ideas in groups, and solve problems

Reading – through the activities pupils could:

- use skimming, scanning, highlighting and note-taking as appropriate to different texts

Vocabulary and spelling – through the activities pupils could:

- read and use accurately terms which relate to key concepts in D&T
- recognise links between words related by word families and roots
- understand and use correctly terms of qualification and comparison
- learn and spell D&T-specific key words correctly
- use strategies to attempt, find and check spellings

Resources

Resources include:

- a collection of pictures/photographs of similar products, *eg containers*, made from different materials and in other times, cultures and countries
- tools and equipment for processing materials, *eg vacuum forming*
- tools and equipment for carrying out material testing, *eg strength testing*
- computers for researching databases and analysing materials
- useful websites, *eg*
 - www.design-council.org.uk
 - www.youngeng.org
 - www.incpen.org
 - www.materialise.com

Future learning

Pupils could go on to further units on materials: unit 8A 'Exploring materials' and unit 9A 'Selecting materials'. Applying an understanding of materials when designing and making is an important part of every design and make assignment. In year 8, pupils learn how to apply their understanding of the properties of materials when designing in a range of materials, so that they are able to identify those that are suitable for a task.

Out-of-school activities and homework

Pupils could:

- investigate the type of materials used at home for containers and carriers, relating them to their purpose and how they will be used
- examine packaging to evaluate how folds, tucks, adhesives, thickness of materials, reinforcements, weight and finish affect its performance
- examine a collection of similar objects, *eg a range of telephones or calculators, including older models*, to investigate the use of different materials. They could relate the materials to structural, functional and safety considerations, explore how they have been combined and finished, and how components have been used and organised
- develop a flow chart or storyboard explaining a particular processing technique, *eg hardening or tempering metal, vacuum forming*

Links with other subjects

- Science: classification of materials by their working characteristics. Links to unit 7G 'Particle model of solids, liquids and gases' and unit 7I 'Energy resources' in the science scheme of work.
- English: displaying and communicating information.
- Art and design: investigating, combining and manipulating materials, taking account of purposes and audiences.
- Sustainable development: considering the effects of the extraction, use and eventual disposal of some materials on the natural environment and human health.

Learning objectives

Pupils should learn:

Possible teaching activities**Learning outcomes**

Pupils:

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

- to design a product to meet a specific technical purpose, choosing appropriate materials, by applying the knowledge, skills and understanding they developed during the product evaluation activities and focused practical tasks

Set the pupils an assignment to design and make a product to meet a specific technical purpose, choosing appropriate materials.

Example

This example DMA has been written so it can be copied and given directly to pupils. Further details and contexts can be added, as appropriate.

Carry it all

With increasing concern for the environment, there is likely to be greater demand for carrying devices which can be used when travelling on foot or on public transport. Research carrying devices that already exist in different parts of the world, and use this information to design and make an environmentally friendly carrying device for someone in your local community.

- find and select information that informs and clarifies the task
- draw on their understanding of familiar products, including how, where and why they are used
- design to meet a set of criteria in a specification
- select materials according to their working characteristics and availability
- show an understanding of the situation in which their design will be used
- express ideas in discussion, and as 2-D and 3-D models
- suggest an ordered sequence for managing the task
- use tools, equipment and techniques with precision
- discuss with users the design criteria and the extent to which their design meets them, using questions to clarify users' needs and views and to gain insights into how to improve their design
- consider the environmental impact of their design, and to justify their use of materials

Some pupils can also be expected to:

- propose alternative materials and ways of working*

Language for learning when talking to users

- When preparing to discuss their design with users, *eg parents of small children*, pupils will need to plan questions in advance. To check out the design criteria and the effectiveness of their design, they might ask users
 - *How would you modify our criteria?*
 - *Why do you think our design would or would not work?*
 - *What changes or improvements would you suggest?*

Use of ICT

- Pupils could use CAD/CAM (computer-aided design and manufacture) software linked to a cutter/plotter to produce vinyl 'stick-on' symbols to be incorporated in the design or nets for the product. This would cover aspects of unit 7C 'Using ICT to support researching and designing'.

Pupils should learn:

Pupils:

PRODUCT EVALUATION

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

- examine, describe and evaluate similar products. This will help pupils to understand why materials and processes have been chosen, and will inform their own designing and making
- consider how products work and look
- name materials and investigate and explain processes



Health and safety – product evaluation activities which involve products with potentially dangerous features, *eg sharp edges*, should be carefully supervised by a teacher. The possibility of products breaking during testing, or components causing harm, should also be assessed

- how to classify materials by properties, uses and sources, *eg hard/soft, ferrous/non-ferrous metal, thermoplastic/thermosetting plastic*

- Ask the pupils to identify products that are made from a variety of materials originating from many sources worldwide. Ask them to investigate the original sources of materials used to make a product, *eg drinks containers (water bottles, jars, cans, cartons)*.
Discuss ways of classifying materials by their properties and the ways in which the properties are used.

- state the names and types of common materials used in familiar products, *eg mild steel, PVC, softwood, aluminium*
- explain where the materials come from and why they are used
- spell and use the names of materials accurately

Language for learning during product evaluation

- Give pairs of pupils a selection of products made from different materials. Ask them to describe:
 - the original sources of materials
 - how the materials can be classified
 - what the names of materials mean
 - where the materials come from
 Each pair presents the information for each product in the form of maps and presents one sample on an overhead transparency (OHT) to the class.
- With teacher support, ask pupils to develop a word bank or dictionary. The teacher will need to:
 - highlight the meaning of key prefixes, word families and roots, *eg poly-, synthetic*
 - highlight the ‘built-in’ qualification and comparison in names, *eg softwood/ hardwood, medium density/low density*
 Less able pupils will need more support and guidance when organising a word bank. Teachers may prefer to create a class resource, possibly with an ICT version as well.

- to consider the properties of materials, *eg flexibility, elasticity, brittleness of acrylic, malleability of aluminium*
- to consider how the properties of a material suit a particular product

- Ask the pupils to examine a range of existing products. Discuss what materials they are made from and why these materials were chosen by the manufacturer. Consider the characteristics and working properties of materials, *eg absorbency, aesthetic appeal, comfort, colour, stability, flexibility, ease of access and availability, cost, quality of material chosen for the target market, maintenance, product lifespan*.

For example, pupils could examine and discuss the materials that a range of carriers and containers is made from. Discuss why particular materials may have been chosen. Look for changes in materials used over time.

Extension: some pupils may also be able to consider the impact of a product beyond the purpose for which it was designed.

- Ask small groups of the pupils to investigate a selection of carriers or containers for different functions which have a range of features, including strengthened handles, sections or pouches. Discuss the stages in which the carriers or containers were constructed, with the pupils examine how many pieces there are, how they have been shaped and joined, and what materials have been used.

- state why particular materials are chosen for functional and aesthetic properties, *eg metal is strong and smooth*
- judge how far a product is fit for its purpose, and whether resources have been used appropriately
- identify the working characteristics of common materials, *eg PVC is pliable when heated*

■ essential activities

○ optional activities

Learning objectives

Pupils should learn:

- to consider how the extraction, use and eventual disposal of some materials affects the natural environment and human health
- to investigate different cultural contexts in which materials, eg plastics, such as PVC, have been produced

Possible teaching activities

- Discuss with pupils the values issues relating to sources of materials, eg *finite resources and reuse of materials*. Pupils could consider the following questions
 - *What happens to this product after it has been used?*
 - *What effect will it have on the built and natural environment?*
 - *How easily can it be recycled?*
 - *Who will pay the cost of recycling?*
 - *Where do resources come from?*
 - *Are they likely to run out?*
 - *Is there a problem with side effects such as pollution or waste disposal?*
 - *What is the social, cultural or economic effect of this project?*
- Ask the pupils to look at how the materials used for a particular product have changed over time, or are different in other parts of the world. Discuss where the materials have come from, how they are processed, what local resources are used, and why the materials used may have changed or be different.

For example, the pupils could put together a scrapbook of carrying devices and annotate important design features. Discuss the skills and experience of designers in a number of countries around the world, developing the pupils' awareness of the wide range of solutions developed by different cultures over time in response to their particular needs.

Learning outcomes

Pupils:

- recognise that choosing the best materials for the job may not simply mean choosing the materials most appropriate for the design's functional needs
- know it is important to consider recycling, reusing and reducing the amount of materials when designing a new product
- understand how the use of materials has changed over time and is influenced by local resources, technological developments and social and cultural factors

Points to note**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 *consider the physical properties of materials and how to bend, fold and form them*.

- to explore materials with different properties by mixing, forming, cutting and heating them, to find out about their working characteristics
- to measure and consider the effects of varying materials, eg on flexibility

- Ask the pupils to explore the behaviour of materials during particular processes, eg *heating, forming, reforming*. Discuss the impact on the end product and how the physical properties can be used to achieve particular results when designing and making.

For example, pupils could set up a range of tasks to show how to bend, fold and form curves in sheet materials, to give pupils a practical understanding of the rigidity/flexibility possibilities.

- demonstrate how to process materials to make best use of their working properties
- demonstrate an increasing range of techniques for mixing, cutting, shaping, forming and line bending
- know the health and safety rules for working with the range of materials and processes



Health and safety – pupils should be taught about hazards, risks and risk control during activities using heat treatment equipment. Teachers will need to judge when it is appropriate to introduce pupils to cutting, shaping and forming techniques. They should ensure that pupils recognise hazards, assess risks and take steps to control the risks to themselves and others

■ essential activities

○ optional activities

Learning objectives

Pupils should learn:

- to investigate and develop skills in basic surface finishing, *eg edge polishing acrylic, sealing wood*

- to carry out fair tests for evaluation purposes

- to develop skills in seeking information about materials from different sources
- to use highlighting, skimming and scanning to identify key points and to develop critical reading approaches to advertisements

Possible teaching activities

- Ask the pupils to make a display about all the different things that can be achieved by processing or finishing one material, *eg acrylic, PVC*, in different ways.
The production of a display can be divided into group work.

- Show the pupils simple ways that materials can be tested against performance characteristics. Examine how fair tests can be carried out.
For example, pupils could design and carry out tests to determine the strength and abrasion resistance of materials, such as fabrics that might be used as part of a container or tubing for a handle.

- Show the pupils how to research sources of information about materials, *eg databases, advertisements for products*, to help them select appropriate materials.

Learning outcomes

Pupils:

- apply their understanding of the properties of materials, and how these can be exploited

- select and carry out controlled tests to find out information about materials, *eg testing the strength of different types of fabric or widths of tubing to be used for a handle, using weights*

- use research techniques effectively to find relevant information about materials, *eg how PVC is produced*
- identify key points from information on a product

Points to note

Health and safety – correct procedures should be written down, demonstrated and then followed when testing materials. Some tests carry significant risks and teachers should judge when it is appropriate to use them. Pupils should be taught to manage their environment to ensure their own and others' health and safety

Language for learning when researching information

- Ask pupils to work in small groups and analyse advertisements for products. Pupils could highlight or underline facts in one colour and anything they think is opinion in another colour. They could then discuss how the advertisements use factual information.
- Ask the pupils to formulate three questions a reader could ask about the product, *eg Is it good value? How environmentally friendly are the materials used?*
- Extension: more able pupils could highlight suspect claims.

Use of ICT

- There is an opportunity to use databases when identifying information about materials.

■ essential activities

○ optional activities