Questions matter

Teaching guide: Maths in Product Design

Introduction

This resource provides guidance and advice to support teachers delivering the maths content in A-level Design and Technology: Product Design (7552).

Throughout the specification, learners must show their knowledge and understanding of maths skills within a Product Design context. This resource outlines maths skills required by the specification, links to maths and science, how they link to a Product Design context and how to prepare learners for assessment.

The aim of this resource is to help teachers embed maths confidently and meaningfully in their lessons to support the Design and Technology Product Design curriculum. It is important to note that this resource focuses on the application of maths in Design and Technology, rather than the delivery of maths as a standalone subject.

Many of the mathematical concepts also overlap with science, particularly in areas such as the understanding of material properties and structural elements of design. Leaners are best prepared for this course if they have prior experience with GCSE Design and Technology or an equivalent qualification, where applied maths skills are already embedded. This foundation supports their ability to engage with the technical and analytical aspects of product design. Maths in A-level Product Design helps learners make informed, technical decisions in design and production. Embedding maths in creative and practical contexts builds confidence and prepares learners for industry relevant challenges.

The examples within this document, of maths in specific Design and Technology contexts, are there to help teachers consider where they can embed this teaching in their curriculum. They are not an exhaustive list of possibilities, nor is it necessary to cover all of them to teach this qualification. The examples discussed can be used as an aid to help teachers cover the content of the specification.

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Maths in the specification

- **15%** of the A-level assessment must cover maths and science (from Ofqual's subject level guidance).
- Maths is assessed in the written exam.
- The maths content is drawn from Level 2 Maths and applied in Product Design contexts.

Reference	Mathematical skills requirements	Examples of Product Design applications
a	Confident use of number and percentages	Calculation of quantities of materials, costs and sizes
b	Use of ratios	Scaling drawings
c	Calculation of surface areas and/or volumes	Determining quantities of materials
d	Use of trigonometry	Calculation of sides and angles as part of product design
e	Construction, use and/or analysis of graphs and charts	Representation of data used to inform design decisions and evaluation of outcomes. Presentation of market data, user preferences, outcomes of market research etc.
f	Use of coordinates and geometry	Use of datum points and geometry when setting out design drawings
g	Use of statistics and probability as a measure of likelihood	Interpret statistical analyses to determine user needs and preferences. Use data related to human scale and proportion to determine product scale and dimensions.

Embedding maths in teaching

Throughout the A-level Product Design course it is useful if learners are able to convert between units. While the metric and International System of Units (SI) are the primary systems used, learners should also be familiar with imperial units, which are still common in certain materials and components. Learners could use their knowledge of standard form and powers of 10 when modelling in scale or investigating commercial viability when increasing the scale of manufacture.

When completing the NEA, learners may need to calculate tolerances and allowances in material sizes or ensure that their costs remain within budget when ordering materials and components in bulk. The ability to calculate percentages will be particularly useful in these contexts. Teachers can embed these skills by designing projects that require learners to select materials from stock forms, compare supplier costs or plan for bulk ordering. These activities not only meet the specification requirements but also support informed decision making in the design process.

During practical sessions and/or when prototyping, when learners are required to measure, encourage them to convert units as needed and check the accuracy of their measurements. This can also apply to the manufacturing of jigs, fixtures and templates and not just in the manufacture and development of the dimensioning of the final prototype. Promoting teamwork among learners to check and re-check measurements using the metric system can help reinforce these skills further.

Number and percentages

Reference	Mathematical skills requirements	Examples of Product Design applications
a	Confident use of number and percentages	Calculation of quantities of materials, costs and sizes

Understanding stresses on materials is a key part of the A-level Design and Technology curriculum, particularly when learners are designing products that must withstand physical loads or perform under pressure.
Applying the appropriate formulae can help learners make informed decisions about which materials are suitable for a given application. Teachers can contextualise this by asking learners to calculate the stress on a component in a chair, a bridge, or a piece of sports equipment, and then compare different materials based on their properties, This may support the testing and development within the NEA design process.

Encouraging learners to explore material properties, such as tensile strength, elasticity, and toughness through practical testing and data analysis can deepen their understanding. This also provides opportunities to reinforce the use of units, standard form and interpreting data from graphs or technical datasheets. This can be particularly useful in the NEA where learners will need to identify an appropriate material for their design solutions.

When designing for manufacture, learners may investigate whether a product could be produced in quantity. This opens opportunities up to apply multiplication, ratios and standard form, especially when dealing with large scale production figures or very small component measurements. These skills are also relevant when interpreting technical drawings to scale or calculating the amount of paint or finish required for a surface.

Introducing learners to material and labour costings supports their understanding of how design decisions impact commercial viability. Teachers can provide costing sheets or real world supplier data to help learners estimate production costs and compare different manufacturing methods. This not only reinforces mathematical skills but also encourages critical thinking about sustainability, efficiency and value for money.

The ability to rearrange formulae and apply skills such as selecting the appropriate formula, rounding, substitution, simplifying and showing accuracy in final units is also crucial to successful understanding of the application of maths.

Ratios

Reference	Mathematical skills requirements	Examples of Product Design applications
b	Use of ratios	Scaling drawings

Supporting learners in developing their understanding of ratios can be achieved through project work. For example, when designing, learners may need to represent their ideas at a reduced scale on paper, while maintaining proportional accuracy. This is equally applicable in physical or virtual model making, or when producing a prototype.

When mixing liquids, such as resin or composites, learners can apply their knowledge of ratios, percentages and volume to calculate material requirements, minimise waste and cost, and plan effectively. These mathematical principles also apply when subtracting materials such as calculating the volume of material removed during CNC machining or estimating offcuts and wastage.

In addition, it might also be necessary to adjust quantities in manufacturing. This might be presentable in a project based scenario whereby the learner needs to consider commercial viability, or in an exam based question whereby a manufacturing company may require less or more of a material or component in the production process.

Surface area and volume

Reference	Mathematical skills requirements	Examples of Product Design applications
c	Calculation of surface areas and/or volumes	Determining quantities of materials

In addition to the guidance provided under 'Number and percentages', teachers can support a leaner's understanding of surface area and volume by embedding these calculations into practical tasks. Encouraging learners to justify their decisions using data and modelling how these mathematical skills apply to real world design and manufacturing scenarios, helps reinforce their relevance and application.

Building conceptual models that relate to real world contexts, such as packaging, containers, or furniture, and then breaking them down into familiar geometric forms (e.g. cubes, cylinders, pyramids etc) allows learners to measure and calculate surface area and volume more effectively. This hands on approach helps learners visualise what these measurements represent and supports design decisions, such as determining how much material is needed or how much a product can hold.

Learners can also be encouraged to calculate surface area and volume from orthographic and isometric drawings, reinforcing the link between mathematical understanding and design communication. Scenarios such as estimating the amount of paint, varnish or fabric required to cover a surface helps learners appreciate why surface area matters in production planning.

Further opportunities arise when considering subtractive manufacturing processes, such as CNC machining. Learners can calculate the volume of material removed and estimate wastage, supporting sustainable design thinking. Combining surface area and volume tasks with ratio, percentage and costing calculations helps learners understand how multiple mathematical skills work together in real design scenarios.

Trigonometry

Reference	Mathematical skills requirements	Examples of Product Design applications
d	Use of trigonometry	Calculation of sides and angles as part of product design

Trigonometry plays a vital role in helping learners develop accurate and functional design solutions. It supports a range of design activities, from initial concept sketches to final manufacturing specifications, and is particularly useful when calculating sides and angles in product design.

Learners should be confident in measuring and marking out angles in degrees, especially when working with materials in the workshop or developing geometric patterns. Understanding how angles interact, such as in tessellated surfaces or structural components; ensures designs are both mathematically sound and visually coherent. Teachers can reinforce this by encouraging the use of protractors, CAD tools and angle measuring devices during practical tasks.

Applying trigonometric ratios and Pythagoras' theorem in real world scenarios helps embed mathematical understanding. For example, learners might calculate the angle of a support strut or determine the length of a diagonal brace in a structure. These calculations are often supported by CAD and technical drawings, which provide opportunities to interpret and apply geometry in context.

Learners use trigonometric ratios, such as sine, cosine and tangent; to solve problems involving right angled triangles, particularly when working with technical drawings or CAD models. These calculations are essential when designing parts that must fit together precisely or when analysing forces and stresses in structural elements and can play a particularly important part of design work and development in the NEA.

Graphs and charts

Reference	Mathematical skills requirements	Examples of Product Design applications
e	Construction, use and/or analysis of graphs and charts	Representation of data used to inform design decisions and evaluation of outcomes. Presentation of market data, user preferences, outcomes of market research etc.

Learners are regularly required to gather and interpret data to inform their design decisions. This presents a valuable opportunity to develop their understanding of how to present data clearly and effectively using a range of methods, including diagrams, bar charts, histograms and frequency tables. It is encouraged to provide contexts that support their understanding of qualitative and quantitative data as this will help determine the appropriate method of representation.

During the investigative phases of a project or within a feasibility analysis, learners might collect anthropometric data to determine appropriate dimensions for a product. Organising this data into a frequency table helps them identify patterns and supports the development of analytical skills. From there, they can select the most suitable method to present their findings, such as a bar chart to show the distribution of hand sizes within a target user group.

Performance testing and client surveys also offer opportunities for data presentation. For instance, learners can record durability results for different materials and use line graphs to compare performance over time. Client preferences gathered through surveys can be visualised using bar charts, helping learners justify design decisions based on user needs.

Histograms are particularly useful when representing continuous data, such as the time taken to complete a task using different prototypes. This allows learners to identify trends and make informed decisions about which design features are most effective.

Teachers can support this by modelling how to construct each type of chart accurately, discussing when each is most appropriate, and guiding learners in interpreting what the data reveals. This not only reinforces mathematical understanding but also strengthens the leaner's ability to justify their design choices, an essential skill for the NEA.

It is important to encourage learners to analyse data in context, so that their design and manufacturing decisions are more appropriate. For instance, the most common response to a multiple choice question may not reflect the majority view when considering the full data set. Being able to justify decisions based on thorough data analysis will also support learners in developing strong examination technique.

Learners should also be confident in translating information between graphical and numerical forms. This skill is particularly useful when working with technical specifications, such as interpreting load bearing data from a graph, extracting measurements from a CAD drawing or analysing data from FEA (Finite Element Analysis) testing.

In addition, a learner might be given a graph showing the tensile strength of various materials and asked to identify which material meets the required specification. Alternatively, they may need to convert a scaled drawing into real world dimensions to calculate the amount of material needed for a prototype. These activities reinforce the importance of accuracy and precision in both design and manufacturing.

Geometry and coordinates

Reference	Mathematical skills requirements	Examples of Product Design applications
f	Use of coordinates and geometry	Use of datum points and geometry when setting out design drawings

Geometry and trigonometry are essential tools in helping learners develop accurate and functional design solutions. These skills underpin many aspects of the design process, from initial concept sketches to final manufacturing specifications.

The ability to visualise and represent both 2D and 3D forms is crucial when communicating design ideas. Learners should practise isometric and orthographic projections, as well as using CAD/CAM software to create digital and physical models where possible. This helps them convey their intentions clearly to others, whether in peer reviews, client presentations or the NEA. Teachers can support this by modelling drawing techniques and encouraging learners to annotate their sketches with dimensions and material details. The understanding of referencing a datum point in relation to 2D and 3D drawings and in manufacture, particularly when using CAD/CAM can help reinforce its relevance.

Statistics

Reference	Mathematical skills requirements	Examples of Product Design applications
g	Use of statistics and probability as a measure of likelihood	Interpret statistical analyses to determine user needs and preferences. Use data related to human scale and proportion to determine product scale and dimensions.

Statistics and probability play an important role in helping learners interpret data and make informed design decisions. In A-level Design and Technology, learners should be encouraged to use statistical analysis to understand user needs and preferences of a target market. For example, survey data collected during the research phases of a project can be analysed to identify trends, preferences and potential design directions. Teachers can support this by guiding learners in calculating averages, identifying outliers and interpreting frequency distributions or graphical representations such as bar charts and histograms. Trends and the shape of graphs will also depend on the frequency of data and so using examples to show how to estimate averages within group data is also important when analysing data.

Probability can also be introduced to assess the likelihood of certain outcomes, such as the success of a design feature or the reliability of a material under specific conditions. This helps learners evaluate risk and make decisions based on evidence, which is particularly relevant when considering user safety or product performance.

In addition, using data related to human scale and proportion, such as anthropometric measurements, enables learners to determine appropriate product dimensions, particularly through using the concept of percentiles and inclusivity in design. This ensures that designs are both functional and user centred. Teachers can embed this into project work by encouraging learners to collect and analyse relevant data, and use it to justify decisions about size, shape and ergonomics.

Preparing for assessment

Questions in the written exam that require the application of maths are embedded within Design and Technology, requiring learners to apply multiple skills to solve real world problems. To prepare learners effectively, it's important to practise maths in context and not just as isolated calculations that they may be familiar with in a maths exam. Embedding mathematical tasks within design briefs, material selection, or performance testing helps learners understand the relevance of maths and builds confidence in applying it meaningfully.

Using past papers is a valuable strategy for identifying common question types and understanding how different skills; mathematical and design related, may be required to answer questions successfully. Teachers can guide learners through these papers, highlighting how to interpret data, apply formulae and justify decisions using evidence. This also helps learners recognise the structure and expectations of exam questions.

Learners should be taught to show their working clearly and label units consistently. This not only supports their understanding but ensures they meet the requirements of the mark scheme. Even when the final answer is incorrect, clear working out can earn method marks and demonstrate their reasoning. It is important to note that classes within the subject can have a wide range of ability and mathematical skills, and encouraging learners to attempt all or part of a question is crucial for exam confidence.

Teachers can reinforce confidence further by modelling how to select and apply the correct formulae, checking units and interpreting results. Encouraging learners to practise with calculators during lessons and assessments helps reduce errors and improves fluency.

Learners should be encouraged to justify their design decisions using calculations and data. Whether comparing material costs, analysing user feedback or evaluating performance data, the ability to support choices with evidence is a key skill in both the NEA and written exam. This analytical approach not only strengthens their responses but also reflects the real world decision making process in design and engineering.

Maths questions that appear in the written exam are often in technical scenarios. Learners may be asked to apply formulae to solve design problems, interpret data and graphs, justify decisions using calculations or evaluate prototypes using measurable criteria, including the specification or material, components and product specifications.

Learners may use a calculator in the exam. It is useful to support confident use of the calculator to improve fluency in calculations during planning, modelling and evaluation. They must ensure that their calculator meets the requirements as set out in the Joint Council for Qualifications (JCQ) instructions for conducting examinations. These instructions make it clear what the requirements are and are not for calculators.

Advice for teachers

To help learners succeed with the mathematical elements of Design and Technology, it's important to embed maths within meaningful design contexts rather than treating it as a standalone skill. Learners are more likely to engage with and retain mathematical concepts when they are applied to real world problems, such as calculating material efficiency, determining load bearing capacity, or scaling a design for manufacture.

Using design briefs to introduce mathematical challenges is an effective way to make maths purposeful. For example, a brief that involves designing a piece of furniture might require learners to calculate surface area for finishing or use ratios to scale a prototype. These tasks naturally integrate maths into the design process and help learners see its relevance.

Collaboration with the maths department or alignment with the wider maths curriculum can be highly beneficial. Reinforcing shared terminology and concepts, such as interpreting graphs, using formulae or understanding units, helps learners make connections across subjects. Joint planning or cross curricular projects, such as STEM based learning, can further strengthen these links. This collaboration also supports teacher development, helping teachers stay informed about current maths teaching methods and approaches familiar to what the learners are used to.

Visual tools such as graphs, diagrams, CAD models and technical drawings are excellent for supporting mathematical thinking. They allow learners to interpret and communicate data clearly, and to justify their design decisions using evidence. Encouraging learners to explain their reasoning and back up choices with calculations or data analysis not only improves their mathematical fluency but also strengthens their performance in both the NEA and written exam.

As learners in Product Design classes often have varied mathematical abilities, it is important to provide differentiated materials that scaffold techniques and break down processes. This ensures all learners can access the curriculum and develop their skills and understanding effectively.

Maths skills examples

Providing learners with the kind of mathematical skills that could be used in the Design and Technology specification can be a useful support tool. It enables learners to identify which skills they are confident with and which they may find more challenging. This approach helps to unpick the requirements of the subject and encourages targeted revision and practice.

Specification reference	Mathematical skills requirements	Example formula or method	Level of Confidence
a	Confident use of number and percentages	10 mm = 1 cm 100 cm = 1 m 1mm = 0.1cm 1cm = 0.01m Stress (Pa or N/m^2) = Force (N)/Area (m^2) Total Cost = Cost per unit x Quantity Percentage = (part/whole) × 100 Percentage change = ((New – Old)/Original) x 100 Density (kgm^{-3}) = Mass (kg)/Volume (m^3) Pressure (Nm^{-2}) = Force (N)/Area (m^2) Force (N) = Mass (kg) x Acceleration (ms^{-2}) Potential difference (V) = Current (A) x Resistance (Ohm) Weight (N) = Mass (kg) x Gravitational field strength (Nkg^{-1})	
b	Use of ratios	Ratio = A: B 1:n Scaling ratio of Area = 1:n^2 Scaling ratio of Volume = 1:n^3	
c	Calculation of surface areas and/or volumes	Area of a triangle = 1/2 × base × height	

Specification reference	Mathematical skills requirements	Example formula or method	Level of Confidence
		Area of a rectangle = length × width Surface area and volume of a cube: • Surface area of cube = 6 × (side length) ^{2} • Volume of cube = (side length) ^{3} Surface area and volume of a cube: • Surface area of cuboid = 2(lw + lh + wh) • Volume of cuboid = length × width × height Circumference of a circle = 2πr Area of a circle = πr^2 Volume of a sphere = $V=\frac{4}{3}\pi r^3$ Volume of a cylinder = $\pi r^2 h$ Volume of a pyramid = 1/3 x base area x height Volume of a prism = Area of Cross section x height Sum of interior angles in a polygon = (n - 2) x 180° where n is the number of sides of a polygon	
d	Use of trigonometry	Measuring and drawing angles in degrees sin(θ) = opposite/hypotenuse cos(θ) = adjacent/hypotenuse tan(θ) = opposite/adjacent (right angled triangle) Pythagoras' theorem: $a^2 + b^2 = c^2$ (right angled triangle)	

Specification reference	Mathematical skills requirements	Example formula or method	Level of Confidence
e	Construction, use and/or analysis of graphs and charts	$\frac{360}{Total\ frequency\ of\ all\ categories} \times category\ frequency$ = segment angle/degrees for pie chart	
f	Use of coordinates and geometry	X = horizontal coordinates Y = vertical coordinates Z = Depth or Height coordinates in 3D charts Interpret axes, scales, and data points Equation of a straight-line y = mx + c Applied use of ratio (scaled drawing/models) - **review specification reference b** Using isometric, schematic, exploded diagrams, orthographic and virtual modelling methods	
g	Use of statistics and probability as a measure of likelihood	Mean = Sum of values/Number of values Median = Middle value in an ordered set Mode = Most frequent value(s) Probability = Number of favourable outcomes/Total number of outcomes	

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