Design and technology

GCE AS and A Level subject content

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Contents

Content for design and technology

Introduction

1. The AS and A level subject content sets out the knowledge, understanding and skills common to all AS and A level specifications in design and technology.

2. It provides the framework within which awarding organisations create the detail of the subject specification. AS and A Level specifications in design and technology must reflect the subject aims and objectives.

Aims and objectives

3. Design and technology is an inspiring, rigorous and practical subject. Specifications in design and technology should encourage students to use creativity and imagination when applying iterative design processes to develop and modify designs, and to design and make prototypes/products[1] that solve real world problems, considering their own and others' needs, wants, aspirations and values. Specifications should enable students to identify market needs and opportunities for new products, initiate and develop design solutions, and make and test prototypes/products. Students should acquire subject knowledge in design and technology, including how a product can be developed through the stages of prototyping, realisation and commercial manufacture.

4. Students should take every opportunity to integrate and apply their understanding and knowledge from other subject areas studied during Key Stage 4, with a particular focus on science and mathematics, and those subjects they are studying alongside AS and A level design and technology.

5. Due to the need for students to demonstrate expertise in depth in specialist areas, three subject endorsements are available, linked to design disciplines that reflect possible higher education routes and industry.

6. All specifications must encourage students to:

- be open to taking design risks, showing innovation and enterprise whilst considering their role as responsible designers and citizens

[1] The term 'product' is understood throughout to be a generic term for all final outcomes of design practice including systems and objects. The term 'prototype' refers to a design outcome which is a preliminary version of a product from which other forms may be developed.

- develop intellectual curiosity about the design and manufacture of products and systems, and their impact on daily life and the wider world
- work collaboratively to develop and refine their ideas, responding to feedback from users, peers and expert practitioners
- gain an insight into the creative, engineering and/or manufacturing industries
- develop the capacity to think creatively, innovatively and critically through focused research and the exploration of design opportunities arising from the needs, wants and values of users and clients
- develop knowledge and experience of real world contexts for design and technological activity
- develop an in-depth knowledge and understanding of materials, components and processes associated with the creation of products that can be tested and evaluated in use
- be able to make informed design decisions through an in-depth understanding of the management and development of taking a design through to a prototype/product
- be able to create and analyse a design concept and use a range of skills and knowledge from other subject areas, including mathematics and science, to inform decisions in design and the application or development of technology
- be able to work safely and skillfully to produce high-quality prototypes/products
- have a critical understanding of the wider influences on design and technology, including cultural, economic, environmental, historical and social factors
- develop the ability to draw on and apply a range of skills and knowledge from other subject areas, including the use of mathematics and science for analysis and informing decisions in design

Subject content

7. AS and A level specifications in design and technology must specify that students engage in both practical and theoretical study in design and technology. Specifications must require students to cover the design and technology skills, knowledge and understanding as set out below. These have been separated into:

- technical principles
- designing and making principles

8. AS level specifications must require students to undertake a small-scale design, make and evaluate project in response to a realistic contextual challenge, taking into account the needs and wants of the user. The project must enable students to draw, as

appropriate, on the requirements set out in paragraphs 12 and 14 of the core content and the additional requirements set out in the relevant endorsed title.

At A level, students will undertake a substantial design, make and evaluate project that enables students to draw, as appropriate, on the requirements set out in paragraphs 12, 13, 14 and 15 in the core content, and the requirements set out in the relevant endorsed title. The project should be of sufficient complexity and offer an appropriate degree of uncertainty of outcome to enable students to demonstrate their ability to initiate, sustain and manage the iterative processes of designing, making, testing, refining, improving and evaluating, in response to a context of their choice and the needs and wants of a user or market.

Specification titles

9. Design and technology specifications may offer one or more of the endorsed titles listed below. The endorsed title should prepare students for tertiary education and/or work-based study and training in the design, creative, engineering and/or manufacturing industries:

- design and technology (product design)
- design and technology (fashion and textiles)
- design and technology (design engineering)

10. The subject content has been arranged to define a core content of knowledge and understanding applicable to all AS and A level specifications with additional content for each endorsed title.

Core technical principles

11. All AS and A level specifications must require students to demonstrate the mathematical and scientific knowledge, understanding and skills set out in appendix 1.

12. Specifications must require students to develop knowledge and understanding of:

- how manufactured products typically involve multiple materials, processes and techniques and that designers need to be able to discriminate between them and select them appropriately for use, experimenting in order to improve, refine and realise a design
- the requirements for product design, development and manufacture, including: fitness for purpose; meeting the criteria of specifications; accuracy of production; appropriate use of digital technologies; aesthetics; ergonomics and anthropometrics

- the use of media, communication and presentation techniques, including drawing and sketching, and writing reports to record, explain and communicate their design decisions, providing sufficient information to enable others to interpret their design intentions
- digital design and digital manufacture, including computer-aided dsign (CAD)/compter-aided manufacturing (CAM), modelling and simulation
- safe working practices, including identifying hazards and understanding the need for risk assessments
- how skills and knowledge from other subject areas, including mathematics and science, inform decisions in design and the application or development of technology

13. In addition, all A level specifications must require students to develop knowledge and understanding of:

- the main features of manufacturing industries, including stages of production, quality assurance and quality control, modern manufacturing methods and systems when combining or processing materials, sustainability, and services to the customer including legal requirements
- the regulatory and legislative framework for health and safety and the impact on designing and making
- the use of feasibility studies on the practicability of proposed solutions to problems
- design for manufacturing, repair or maintenance, and product life
- how to achieve an optimum use of materials and components by taking into account the relationship between material cost, form, and manufacturing processes, and the scale of production
- the implications of intellectual property, registered designs, registered trademarks, copyright, design rights and patents
- the role of marketing, enterprise, innovation and collaboration in the development of products

Core designing and making principles

14. All AS and A level specifications must require students to develop knowledge and understanding of:

- user-centred design: the investigation and analysis of a problem within a context, and the needs, wants and values of users, to define a design opportunity or problem leading to the production of a design brief and specification to direct, inform and evaluate their design practice
- design theory, including key historic movements/figures and their methods

- the application of knowledge and understanding in a product development process to design, make and evaluate prototypes/products
- how the appraisal of technological developments, both current and historic, needs to take into consideration social, moral and ethical factors and how these can impact on the work of designers and technologists
- how to critically analyse and evaluate their own ideas and decisions whilst using iterative design and make processes
- in relation to the subject endorsement, how to select and safely use a range of specialist tools, techniques, processes, equipment and machinery appropriate to the design and manufacture of domestic, commercial and industrial products and systems
- how to measure, determine, and apply the degree of accuracy and precision required for products to perform as intended
- how to evaluate their prototypes/products taking into account the views of potential users, customers or clients

15. In addition, all A level specifications must require students to develop knowledge and understanding of:

- a range of strategies, techniques and approaches to explore, create and evaluate design ideas, such as user-centred design, circular economy, and systems thinking
- approaches to project management, such as critical path analysis, scrum or six sigma
- design for manufacture, including planning for accuracy and efficiency when making prototypes and making recommendations for small, medium and large scale production
- the environmental factors affecting disposal of waste, surplus materials, components and by-products, sustainability, and costs
- the application of relevant standards to their design tasks including those published by the British Standards Institute (BSI) and the International Organisation for Standardisation (ISO) specific to the subject
- the stages of a product life cycle

Additional specialist knowledge

Product design

16. All A and AS level design and technology (product design) specifications must require students to have knowledge and understanding of:

- the characteristics and working properties of materials relevant to product design and manufacture, including: metals, woods, polymers, textiles, composites, smart and modern materials
- the use of adhesives, permanent, and semi-permanent fixings
- the use of surface finishes and coatings to enhance appearance, and methods of preventing corrosion and decay such as paints, varnishes, sealants, preservatives, anodising, plating, coating, galvanization and cathodic protection
- the performance characteristics of woods, metals, and polymers including toughness, hardness, elasticity and durability in relation to specific product applications
- the application of smart and modern materials
- production processes including moulding, extrusion, laminating, milling, turning, casting, stamping, and forming; the use of ICT, prototyping, jigs and fixtures

17. In addition, all A level design and technology (product design) specifications must require students to have a knowledge and understanding of:

- industrial and commercial practice including manufacturing processes and systems, product manufacture and maintenance, production scales, and quality control in relation to manufacturing and the design industries
- modular/cell production systems, just-in-time manufacturing, bought-in parts and components and the use of standardised parts
- rapid prototyping

Fashion and Textiles

18. All A and AS level design and technology (fashion and textiles) specifications must require students to have knowledge and understanding of:

- the characteristics and working properties of materials relevant to fashion and textiles design, development, and manufacture, including:
    - the sources and classification of the main fibre groups, fabrics and yarns
    - the production processes associated with mixtures and blends
    - laminating as a finishing process
- methods of joining fabrics including the use of fastenings
- the working properties and physical characteristics of fibres and fabrics in relation to their suitability for various products
- the performance characteristics of fibres and fabrics including tensile strength, elasticity, resilience, durability, flammability, and weight

- the qualities given to fabrics by the construction methods used, finishes and surface decoration, and through surface pattern technologies
- the applications of smart materials, e-textiles, and technical textiles
- how materials, other than fibres and fabrics, can be used in textiles and fashion design and development
- a variety of components and their appropriateness for a range of products in relation to the end-user, fabrics used, and design considerations

19. In addition, all A level design and technology (fashion and textiles) specifications must require students to have a knowledge and understanding of:

- industrial and commercial practice including manufacturing processes, the use of ICT, pattern cutting, product manufacture, re-use and recycling, production scales, testing systems, and quality control in relation to textiles and the fashion design industry
- the use of pattern drafting and toiles

Design Engineering

20. All A and AS level design and technology (design engineering) specifications must require students to have knowledge and understanding of:

- system design processes and methods
- the use of ‘blue sky’ and incremental innovation, and of new/emerging technologies
- visualisation and simulation including the application of computer aided design (CAD) and computer aided engineering (CAE) software
- the characteristics and working properties of materials relevant to engineering including smart and modern materials
- the principles of electronics including sensing, control, and output systems
- static and dynamic forces in structures, including the forces of: tension, compression, torsion and bending; stress, strain and elasticity; rigidity and modes of failure
- mechanical systems
- energy sources, energy storage, transmission, and utilisation
- programmable and control devices including how to use such devices to solve problems in system design
- how to represent systems and components through the use of circuit diagrams, flowcharts and constructional diagrams
- how to develop and use production plans

21. In addition, all A level design and technology (design engineering) specifications must require students to have a knowledge and understanding of:

- industrial and commercial practice including manufacturing processes and systems, the use of ICT, prototyping, product manufacture and maintenance, production scales, and quality control in relation to the engineering industries
- how to interface electrical/electronic circuits with mechanical and pneumatic systems and components
- communication protocols, including an understanding of interfacing with wireless devices, embedded devices, and smart objects
- product lifecycle management, engineered lifespans including planned obsolescence, the need for maintenance of machinery, product support, and end of life (EOL)
- how testing, including the use of destructive and non-destructive methods, is used to inform and modify designs
- the prediction of performance through modelling, including the use of IT based tools

Appendix 1: mathematics and science

All AS and A level specifications in design and technology must require students to demonstrate their application of knowledge, understanding and skills of mathematics and science in both theoretical and practical ways.

Design and technology uses mathematics and science to support decisions made in the processes of designing and making.

Mathematics

Ref	Mathematical skills requirement	Potential applications: product design	Potential applications: fashion and textiles	Potential applications: design engineering
a	Confident use of number and percentages	Calculation of quantities of materials, costs and sizes	Calculation of quantities of materials, costs and sizes	Calculation of quantities of materials, components, costs and sizes
b	Use of ratios	Scaling drawings	Pattern grading	Scaling drawings
c	Calculation of surface areas and/or volumes	Determining quantities of materials	Determining quantities of materials	Determining quantities of materials
d	Use of trigonometry	Calculation of sides and angles as part of product design	Calculation of sides and angles as part of fashion and textiles product design	Projectile motion. Representation of frequency, period, amplitude and phase

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	Representation of data used to inform design decisions and evaluation of outcomes. Presentation of market data, user preferences, outcomes of market research	Representation of data used to inform design decisions and evaluation of outcomes. Velocity-time graphs. Stress-strain and resistance-temperature graphs
f	Use of coordinates and geometry	Use of datum points and geometry when setting out design drawings	Use of datum points and geometry when setting out patterns	Use of datum points and geometry within engineering 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	Interpret statistical analyses to determine user needs and preferences. Use data related to human scale and proportion to determine required sizes and dimensions of fashion products	Understanding of dimensional variations in mass produced components. Defects in batches and reliability linked to probabilities

Science

Ref	Scientific knowledge and skills	Potential applications: product design	Potential applications: textiles and fashion	Potential applications: design engineering
a	Use scientific laws - Newton's laws of motion, Hooke's law, Ohm's law as appropriate to the designed product			Applied to electronic circuit design, projectiles, linear and circular movement of objects under the influence of forces,and problems involving stress, strain and elasticity
b	Describe the conditions which cause degradation	Ensure products are designed to take account of potential corrosion due to environmental factors	Ensure products are designed to take account of potential degradation through environmental factors	Ensure products are designed to take account of potential corrosion due to environmental factors
c	Know the physical properties of materials and explain how these are related to their uses	Understand the appropriate use of materials, including glass and ceramics, polymers, composites, woods, and metals, based on their physical properties	Understand the appropriate use of materials, including textiles, fibres, polymers, technical textiles, ceramics, and metals, based on their physical properties	Understand the appropriate use of materials, including ceramics, polymers, composites, woods, and metals based on their physical properties

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