A LEVEL
Design and Technology

Qualification Accredited

OCR
Oxford Cambridge and RSA

A LEVEL
Specification

DESIGN AND TECHNOLOGY

H404 Design Engineering
H405 Fashion and Textiles
H406 Product Design
For first assessment in 2019

Version 1.2 (August 2018)

ocr.org.uk/aleveldesignandtechnology

Contents

1 Why choose an OCR A Level in Design and Technology?

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1a. Why choose an OCR qualification?

Choose OCR and you've got the reassurance that you're working with one of the UK's leading exam boards. Our new A Level in Design and Technology course has been developed in consultation with teachers, employers and Higher Education to provide learners with a qualification that's relevant to them and meets their needs.

We're part of the Cambridge Assessment Group, Europe's largest assessment agency and a department of the University of Cambridge. Cambridge Assessment plays a leading role in developing and delivering assessments throughout the world, operating in over 150 countries.

We work with a range of education providers, including schools, colleges, workplaces and other institutions in both the public and private sectors. Over 13,000 centres choose our A Levels, GCSEs and vocational qualifications including Cambridge Nationals and Cambridge Technicals.

Our Specifications

We believe in developing specifications that help you bring the subject to life and inspire your students to achieve more.

We've created teacher-friendly specifications based on extensive research and engagement with the teaching community. They're designed to be straightforward and accessible so that you can tailor the delivery of the course to suit your needs. We aim to encourage learners to become responsible for their own learning, confident in discussing ideas, innovative and engaged.

We provide a range of support services designed to help you at every stage, from preparation through to the delivery of our specifications. This includes:

- A wide range of high-quality creative resources including:
    - Delivery Guides
    - Transition Guides
    - Topic Exploration Packs
    - Lesson Elements
    - …and much more.
- Access to Subject Advisors to support you through the transition and throughout the lifetime of the specification.
- CPD/Training for teachers to introduce the qualifications and prepare you for first teaching.
- Active Results – our free results analysis service to help you review the performance of individual learners or whole schools.

All A Level qualifications offered by OCR are accredited by Ofqual, the Regulator for qualifications offered in England. The accreditation number for OCR's A Level in Design and Technology is QN603/1131/9.

1b. Why choose an OCR A Level in Design and Technology?

Design and technology is an inspiring, rigorous and practical subject. In formulating this specification, OCR has worked closely with representatives from higher education and industry professionals to ensure that the direction of the qualification fulfils the requirements that support progression. There has also been a focus on ensuring the content reflects authentic practice, as best as it can within the school environment, giving an insight into the way that creative, engineering and/or manufacturing industries function. Learners are thus enabled to make the connection between the knowledge, understanding and skills they develop and how this will benefit them in the future.

Learning about design and technology at A level strengthens learners' critical thinking and problem solving skills within a creative environment, enabling them to develop and make prototypes/products that solve real-world problems, considering their own and others' needs, wants, aspirations and values. OCR's A Level qualification requires learners to identify market needs and opportunities for new products, initiate and develop design solutions, and make and test prototypes/products. Learners should acquire subject knowledge in design and technology, including how a product can be developed through the stages of prototyping, realisation and commercial manufacture.

This qualification will excite and engage learners with contemporary topics covering the breadth of this dynamic and evolving subject. It will create empathetic learners who have the ability to confidently critique products, situations and society in every walk of their lives now and in the future.

Learners will build their skills in thinking and designing to support the requirements that they will need to demonstrate when progressing to higher education or industry. In order to support the in-depth learning of different routes that learners may progress to, three subject endorsements are available, linked to design disciplines that reflect possible higher education routes and industry:

- Design Engineering
- Fashion and Textiles
- Product Design.

OCR's A Level in Design and Technology enables learners to 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. This qualification offers the opportunity to apply learners' wider learning through creativity and innovation.

OCR has a comprehensive and dynamic support package in place for the delivery and understanding of this qualification, including a range of free resources available on our website, CPD opportunities and Design and Technology Subject Advisors who are available to support teachers. This support will continuously evolve to suit the requirements of teaching and learning through the lifetime of the specification, based on continued feedback from teachers.

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Aims and learning outcomes

OCR's A Level in Design and Technology will encourage learners to:

- be open to taking design risks, showing innovation and enterprise whilst considering their role as responsible designers and citizens
- 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 a strong core knowledge and understanding of principles in design and technology enabling them to make informed decisions in broader contexts
- become independent and critical thinkers who can adapt their technical knowledge and understanding to different design situations
- 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
- develop an experienced understanding of iterative design processes that is relevant to industry practice
- 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 skilfully 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
- become empathetic and successful designers, who not only consider global and local change, but also the wider social implications of products to meet multiple needs and requirements
- 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
- develop and use key design and technology terminology to communicate effectively in future education and employment.

1c. What are the key features of this specification?

The key features of OCR's A Level in Design and Technology for you and your learners are:

- clarity on the application of iterative design processes to support teaching and learning
- a specification that encourages creative thinking leading to design innovation, by using authentic and contemporary design strategies and techniques that are centred around iterative design processes of 'explore/create/evaluate', thus preparing learners to become critical and creative designers, engineers and consumers of the future
- three endorsed titles giving access to learners with a range of future aspirations in the design and engineering industries
- content that can be co-taught alongside groups following the OCR AS level
- freedom in approaches towards designing and making so as not to limit the possibilities of project work or the materials and processes being used
- clear marking criteria for non-exam assessment that supports internal marking and preparatory teaching and learning, rewarding iterative design processes, problem solving and creative thinking
- examined assessment that supports both a practical and exploratory approach to learning, keeping all assessment relevant and purposeful to industry and learners' design interests
- supported by research, authentic practices and contextual challenges developed by DOT*
- a glossary to explain key terms and clarify definitions from the specification content (see Section 5f)
- a flexible, dynamic and engaging support package for teachers developed through listening to teachers' needs and working with industry and educational professionals to ensure relevance. The support package is designed to evolve to support teachers' delivery and continuing CPD and keep teachers and learners up-to-date with contemporary practice and research in design, technology and engineering.

* OCR has drawn research and authentic practices of an initiative called Designing Our Tomorrow (DOT), from University of Cambridge.

Designing Our Tomorrow

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1d. How do I find out more information?

If you are already using OCR specifications you can contact us at: www.ocr.org.uk

If you are not already a registered OCR centre then you can find out more information on the benefits of becoming one at: www.ocr.org.uk

If you are not yet an approved centre and would like to become one go to: www.ocr.org.uk

Want to find out more?

Contact a Subject Advisor:
Email: D&T@ocr.org.uk
Phone: 01223 553998

Explore our teacher support:
http://www.ocr.org.uk/qualifications/by-subject/design-and-technology/

Join our communities:
Twitter: @OCR_DesignTech

OCR Community:
http://social.ocr.org.uk/groups/design-technology

Check what CPD events are available:
www.cpdhub.ocr.org.uk

2 The specification overview

2a. OCR's A Level in Design and Technology (H404, H405 and H406)

There are two submission options for the non-exam assessment (NEA). These options determine the entries, but do not signify different routes through the qualification. Learners must take either:

- components 01, 02 and 03 for OCR Repository submission option, or
- components 01, 02 and 04 for postal submission option
- in order to be awarded the OCR A Level in Design and Technology.

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The three components outlined are set out generically to explain the structure of assessment within this qualification for all three endorsed titles.

Content Overview	Assessment Overview	
This paper is set out through four sets of questions that predominantly cover technical principles within each endorsed title. Learners will be required to: • analyse existing products • demonstrate applied mathematical skills • demonstrate their technical knowledge of materials, product functionality, manufacturing processes and techniques • demonstrate their understanding of wider social, moral and environmental issues that impact on the design and manufacturing industries.	**Principles of… (01)** 80 marks 1 hour 30 minutes Written paper	**26.7%** of total A Level
This component has a series of longer answer questions that require learners to demonstrate their problem solving and critical evaluation skills. Learners will be required to: • apply their knowledge, understanding and skills of designing and manufacturing prototypes and products • demonstrate their higher thinking skills to solve problems and evaluate situations and suitability of design solutions.	**Problem Solving in…* (02)** 70 marks 1 hour 45 minutes Written paper	**23.3%** of total A Level
The 'Iterative Design Project' requires learners to undertake a substantial design, make and evaluate project centred on the iterative processes of explore, create and evaluate. Learners identify a design opportunity or problem from a context of their own choice, and create a portfolio of evidence in real time through the project to demonstrate their competence.	**Iterative Design Project* (03, 04)** 100 marks** Approx. 65 hours Non-exam assessment	**50%** of total A Level

*Indicates inclusion of synoptic assessment (see Section 3g).
** NEA is weighted up to 150 marks.
Learners who are retaking the qualification may carry forward their result for the non-exam assessment component (see Sections 4a and 4d).

2b. Content of A Level in Design and Technology (H404, H405 and H406)

Central to the content of this qualification is the requirement for learners to understand and apply processes of iterative designing in their design and technology practice. They will need to demonstrate their knowledge, understanding and skills through interrelated iterative processes that 'explore' needs, 'create' solutions and 'evaluate' how well the needs have been met.

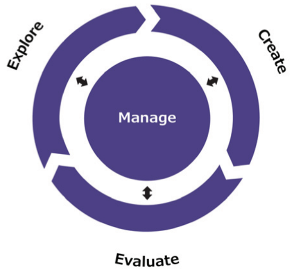

Fig. 1 Iterative Design Wheel
© Designing Our Tomorrow, University of Cambridge

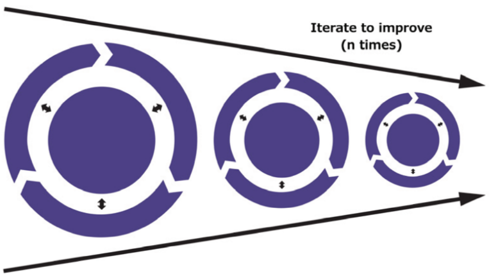

Fig. 2 Multiple iterations of design
© Designing Our Tomorrow, University of Cambridge

At the centre of any iterative process is the need to develop critical-creative thinking skills to manage and organise opportunities that are identified. This learning will equip learners with life-long skills of problem spotting and problem solving, and enable them to apply their learning to different social, moral and commercial contexts.

The enquiry nature of this specification's content will encourage learners to make links between topics and to explore, create and evaluate a range of outcomes. It encourages a creative approach supported by subject knowledge in order to design and make prototypes that solve authentic, real-world problems and have real potential to become viable products.

The knowledge, understanding and skills that all learners must develop are underpinned by technical principles predominantly assessed in the written exam, and designing and making principles predominantly assessed in the non-exam assessment (NEA) although there is an expectation that learning builds a holistic understanding of the subject.

There is distinct content for the exam and non-exam assessment, but this is held together through nine topic areas that shape all components and give clarity, these are:

1. Identifying requirements
2. Learning from existing products and practice
3. Implications of wider issues
4. Design thinking and communication
5. Material considerations
6. Technical understanding
7. Manufacturing processes and techniques
8. Viability of design solutions
9. Health and safety.

Experiencing learning through practical activity, (both designing and technical principles) is fundamental to the delivery of this specification, as is the importance of the contextual relevance of design and technology practice. Learners should, as a result, be given increased autonomy to make decisions in order to justify their reasoning when solving problems in their own way.

The 'Iterative Design Project' is a substantial design, make and evaluate project that allows learners to reposition or develop further an existing product in relation to a given context. The experience of this will be supported by and support their learning for the 'Principles' written exam.

Design and technology requires learners to apply mathematical skills and understand related science. This reflects the importance of Design and Technology as a pivotal STEM subject. This specification along with prior learning in Design and Technology and other subjects offers the opportunity for learners to build on and apply their learning at Key Stage 4 and Key Stage 5.

2c. Summary of endorsed titles

The OCR A Level in Design and Technology offers three endorsed titles listed below. The endorsed titles are to prepare learners for tertiary education and/or work-based study and training in the design, creative, engineering and/or manufacturing industries:

- Design and Technology: Design Engineering (H404)
- Design and Technology: Fashion and Textiles (H405)
- Design and Technology: Product Design (H406)

Each of the endorsed titles relate to disciplines of design and technology that learners most commonly progress to at higher education following their AS or A level studies. Though there are naturally many similarities and overlaps in the design processes, materials and thinking that designers from each approach may take, there are also significant distinct features of each endorsed title.

Design Engineering is focused towards engineered and electronic products and systems; the analysis of these in respect of function, operation, components and materials, in order to understand their application and uses in engineered products/systems that have commercial viability.

Fashion and Textiles is focused towards fashion and textiles products and accessories in a range of applications; their analysis in respect of materials, process, trends and use in relation to industrial and commercial practices of fashion and textiles.

Product Design is focused towards consumer products and applications; their analysis in respect of materials, components, and marketability to understand their selection and uses in industrial and commercial practices of product development.

Throughout the OCR specification, we allow the distinction between the endorsed titles to be fully realised, not limiting design developments from any discipline. There could be many occasions when using textiles, using electronic or mechanical systems may be appropriate within another endorsed title.

In order to support each endorsed title, content and information have been kept separate where possible to allow identification of the specific learning requirements when following each route. The table below supports the identification of pages for individual endorsed titles.

	Design Engineering	Fashion and Textiles	Product Design
Exam content	Section 2e	Section 2f	Section 2g
NEA content	Section 2h (generic)	Section 2h (generic)	Section 2h (generic)
NEA interpretations	Section 2i	Section 2j	Section 2k
Task setting	Section 3a (generic)	Section 3a (generic)	Section 3a (generic)
Task taking	Section 3a (generic)	Section 3a (generic)	Section 3a (generic)
Required evidence	Section 3a (generic)	Section 3a (generic)	Section 3a (generic)
NEA marking criteria	Section 3f (specific)	Section 3f (specific)	Section 3f (specific)
Administration of NEA	Section 4d (generic)	Section 4d (generic)	Section 4d (generic)
Maths requirements	Section 5c (specific)	Section 5c (specific)	Section 5c (specific)
Science requirements	Section 5d (generic)	Section 5d (generic)	Section 5d (generic)

2d. Introduction to the content of the Principles (/01) and Problem Solving (/02) components

There are two written exam components for each endorsed title, the 'Principles' component and the 'Problem Solving' component and these draw on the same content.

The exam content is set out through an enquiry approach to support teaching and learning. The content is set out separately for each of the three endorsed titles, to ensure the focus is specific to the required learning and progression related to that field of study. There is, however, considerable comparability between many areas of learning that enables much of the content to be co-taught. This reflects the core principles in design and technology that are common to all.

In order to make clear whether the principles refer to design or technical principles, these are also highlighted down the left-hand side of the content.

Where content is listed using a Roman numeral bullet e.g. (i), it denotes content that **must** be taught and may be directly assessed in the examination. Where content is listed using bullet points '•' or '○' or follows an e.g., this content is illustrative only and does not constitute an exhaustive list. A direct question will not be asked about the examples listed but learners will need to draw on such examples when responding to questions in the examination.

In the written examinations, all learners are required to demonstrate their mathematical skills and scientific knowledge as applied to design and technology practice. The level of mathematical and scientific knowledge within this qualification should be equivalent to higher tier GCSE (9–1) learning.

It is a requirement that 15% of the marks within the written exam for Fashion and Textiles and Product Design assess the use of mathematical skills at a level of demand which is not lower than that expected at higher tier GCSE (9–1) Mathematics. Within the Design Engineering this requirement is 25%, this extra 10% covering the specific mathematical skills associated with scientific formulae.

Learners are permitted to use a scientific or graphical calculator for their written exam. Calculators are subject to the rules in the document *Instructions for Conducting Examinations* published annually by JCQ (www.jcq.org.uk).

The scientific knowledge is integrated into the content and outlined in Appendix 5d.

Within Appendix 5c and 5d there are formulae that learners are expected to be able to recall when responding to mathematical questions in the written examination. Those in Appendix 5d are only relevant to learners following the Design Engineering endorsed title.

Symbols are used to clearly identify examples where mathematics and/or science could be considered relevant:

 = Maths

 = Science

The subject content of this component should be underpinned by understanding and applying it to a range of contextual approaches that allow learners to develop their skills, knowledge and understanding through iterative designing, innovation and communication; studying materials and technologies; making; consideration of manufacture and production; critiquing; reviewing values and ethics.

2e. Design Engineering (H404/01 and H404/02)

The subject content of this component is focused towards electronics and engineered products and systems and their analysis in respect of:

- materials and components, and their selection and uses in products/systems
- wider issues affecting design decisions.

It is essential that materials, components and systems are studied from the perspective of analysing modern engineered products. Learners should gain practical experience of using materials, components and systems and, where possible, the content which follows should be learned through applied practical activities, set within realistic design scenarios.

The aim of the component is to give learners a framework for analysing existing products/systems that enables them to make considered selections of appropriate materials, components, systems and manufacturing processes when designing.

The component brings together the knowledge, understanding and skills acquired in the NEA.

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1. Identifying requirements

DESIGNING PRINCIPLES

Considerations	*Maths & Science*
1.1 What can be learnt by exploring contexts that design solutions are intended for?	
a. Understand that all design practice is context dependent and that investigations are required to identify what makes a context distinct in relation to: i. environment and surroundings ii. user requirements iii. economic and market considerations iv. product opportunities.	
1.2 What can be learnt by undertaking stakeholder analysis?	
a. Demonstrate an understanding of methods used for investigating stakeholder requirements, such as: • user-centred design and stakeholder analysis • SWOT analysis • focus groups • qualitative observations • market research to identify gaps for new products or opportunities to update existing products.	
b. Demonstrate an understanding of how enterprise can help drive the development of new product ideas through routes to innovation such as: • entrepreneurship • commercial partnerships • venture capitalists and crowd funding websites.	

2

TECHNICAL PRINCIPLES

Considerations	*Maths & Science*
1.3 How can usability be considered when designing prototypes?	
a. Learners should be able to analyse and evaluate factors that may need consideration in relation to the user interaction of a design solution, including: i. the impact of a solution on a user's lifestyle ii. the ease of use and inclusivity of products iii. ergonomic considerations and anthropometric data to support ease of use iv. aesthetic considerations.	
b. Demonstrate an understanding of the ergonomic factors that may need considering when developing engineered products, including: i. anthropometric data to help define design parameters associated with the human body ii. user comfort, layout of controls, software user-interface.	

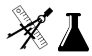
DESIGNING & MAKING PRINCIPLES

2. Learning from existing products and practice

Considerations	*Maths & Science*
2.1 Why is it important to analyse and evaluate products as part of the design and manufacturing process?	
a. Analyse and evaluate the features and methods used in existing products and design solutions to inform opportunities and constraints that may influence design decisions to offer product enhancement, including: i. the context of the existing product and the context of future design decisions ii. the multiple materials and components used iii. methods of construction and manufacture iv. how functionality is achieved v. the ease of use, including; ergonomic and anthropometric considerations vi. inclusivity of products and appropriate consideration of application to a wide variety of users vii. fitness for purpose viii. the impact on user lifestyles ix. the effect of trends, taste and/or style x. the effect of marketing and branding. xi. the considerations of how to get a product to market.	
2.2 Why is it important to understand technological developments in design engineering?	
a. Be able to critically evaluate how new and emerging technologies influence and inform the evolution and innovation of products and systems in both contemporary and potential future scenarios, including consideration of blue sky and incremental innovation.	

DESIGNING & MAKING PRINCIPLES	*Considerations*	*Maths & Science*
	2.3 Why is it important to understand both past and present developments in design engineering?	
	a. Recognise how past and present design engineers, technologies and design thinking have influenced the style and function of products from different perspectives, including: i. the impact on industry and enterprise ii. the impact on people in relation to: lifestyle, culture and society iii. the impact on the environment iv. consideration of sustainability.	
	b. Understand how key historical movements and figures and their methods have had an influence on future developments.	
	2.4 What can be learnt by examining lifecycles of products?	
	a. Demonstrate an understanding of a product's marketing lifecycle, from initial launch to decline in popularity, including: i. consideration of initial demand, growth in popularity and decline over time ii. methods used to create more demand and maintain a longer product popularity iii. new models of marketing and the influence of social media.	

3. Implications of wider issues

Considerations	*Maths & Science*
3.1 What factors need to be considered when designing and manufacturing products to overcome possible conflicts between moral and commercial factors?	
a. Understand how social, ethical and environmental issues have influenced and been impacted by past and present developments in design practice and thinking, including: i. consideration of lifecycle assessment (LCA) at all stages of a product's life from raw material to disposal ii. the source and origin of materials and the ecological and social footprint of materials iii. the depletion and effects of using natural sources of energy and raw materials iv. planned obsolescence v. buying trends vi. environmental incentives and directives.	
3.2 What factors need to be considered when developing design solutions for manufacture?	
a. Awareness of the responsibilities and principles of designing for manufacture (DFM), including: i. planning for accuracy and efficiency through testing and prototyping ii. being aware of issues in relation to different scales of production iii. designing for repair and maintenance iv. designing with consideration of product life.	
b. Awareness of product lifecycle management and engineered lifespans considering; system compatibility, the need for maintenance of machinery, product support and end of life (EOL).	
c. Demonstrate an understanding of how environmental factors impact on: i. sourcing and processing raw materials into a workable form ii. the disposal of waste, surplus materials and components, by-products of production including pollution related to energy iii. cost implications related to materials and process.	
d. Demonstrate an understanding of sustainability issues relating to industrial manufacture, including: i. fair trade and the Ethical Trade Initiative (ETI) ii. economic issues and globalisation iii. material sustainability and optimisation, availability, recycling and conservation schemes, such as: ○ exploring the impact and use of eco-materials ○ exploring how materials can be up-cycled.	

TECHNICAL PRINCIPLES

Considerations	*Maths & Science*
3.3 What factors need to be considered when manufacturing products?	
a. Demonstrate an understanding of how to achieve an optimum use of materials and components, including: i. the cost of materials and/or components ii. stock sizes and forms available iii. sustainability production.	
3.4 What factors need to be considered when distributing products to markets?	
a. Understand the issues related to the effective and responsible distribution of products, such as: • cost effective distribution • environmental issues and energy requirements • social media and mobile technology • global production and delivery.	
b. Demonstrate an understanding of the implications of intellectual property (IP), registered designs, registered trademarks, copyright, design rights and patents, in relation to ethics in design practice and consumer rights.	
3.5 What energy factors need to be considered when developing design solutions?	
a. Understand wider issues relating to the selection of energy sources, storage, transmission and utilisation in order to select them appropriately for use.	
3.6 How can skills and knowledge from other subject areas, including mathematics and science, inform decisions in design engineering?	
a. Demonstrate an understanding of the need to incorporate knowledge from other experts and subjects to inform design and manufacturing decisions, including the areas of science and mathematics.	
b. Understand how undertaking primary and secondary research and being able to interpret technical data and information from specialist websites and publications supports design development.	

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TECHNICAL PRINCIPLES

4. Design thinking and communication

Considerations	*Maths & Science*
4.1 How do designer engineers use annotated 2D and 3D sketching and digital tools to graphically communicate ideas?	
a. Demonstrate an understanding of how to use annotated sketching and digital tools to graphically communicate ideas and sketch modelling to explore possible improvements, in terms of physical requirements, such as: • function, usability, construction, movement, stability, composition, strength • aesthetic qualities • manufacturing processes • suitability of materials and components.	
b. Demonstrate an understanding of methods used to represent systems and components to inform third parties, including: i. constructional diagrams/working drawings ii. digital visualisations iii. circuit and system diagrams iv. flowcharts with associated symbols v. prototypes and models.	Maths, Science
4.2 How do industry professionals use digital design tools to support and communicate the exploration, innovation and development of design ideas?	
a. Demonstrate an understanding of how designers develop products using digital tools and online collaboration, such as: • discussing and exchanging ideas with specialists • developing designs concurrently with other designers • explaining and communicating their design decisions to stakeholders.	
b. Demonstrate an understanding of how digital design software, including CAD and CAE are used during product development, such as: • visual presentation, rendering and photo-quality imaging • product simulation and systems simulation • scientific analysis of real-world physical factors to determine whether a product will break or work the way it was intended.	

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DESIGNING & MAKING PRINCIPLES	*Considerations*	*Maths & Science*
	4.3 How do design engineers use different approaches to design thinking to support the development of design ideas?	
	a. Awareness of different strategies, techniques and approaches to explore, create and evaluate design ideas, including: • iterative designing • user-centred design • circular economy • systems thinking.	
	b. The importance of collaboration to gain specialist knowledge from across subject areas when delivering solutions in the design and manufacturing industries.	
	c. Understand how design engineers use system design processes to define and develop systems that satisfy specified requirements of users using the three sub-tasks of: i. user-interface design ii. data design iii. process design.	
	d. Understand how design teams use different approaches to project management when faced with large projects, such as critical path analysis, scrum and six sigma.	

5. Material and component considerations

Considerations	*Maths & Science*
5.1 What factors influence the selection of materials that are used in products?	
a. Understand that the selection of materials and components is influenced by a range of factors, including: i. functional performance ii. aesthetics iii. cost and availability iv. properties and characteristics v. environmental considerations vi. social, cultural and ethical factors.	
5.2 What materials and components should be selected when designing and manufacturing products and prototypes in Design Engineering?	
a. Understand that most products consist of multiple materials and that design engineers are required to discriminate between them appropriately for their use, including: i. ferrous, non-ferrous and alloy metals, such as: o mild steel, aluminium and brass. ii. thermo softening and thermosetting polymers, such as: o HIPS, ABS and polyester resin, epoxy resin and polyimides. iii. timbers and manufactured boards, such as: o oak, plywood and MDF. iv. textiles used for reinforcement and coverings, such as: o geotextiles used in civil engineering and construction. v. composite materials, such as: o fibre-reinforced plastics, glass-reinforced plastics (GRP) and carbon fibre (CFRP). vi. smart materials, such as: o shape memory alloy, motion control gel, self-healing materials, thermochromic, photochromic and electrochromic materials. vii. modern materials, such as: o sandwich panels, e-textiles, rare earth magnets, high performance alloys and super-alloys, graphene and carbon nanotubes.	
5.3 Why is it important to consider the properties/characteristics of materials when designing and manufacturing products?	
a. Understand the characteristics and properties of materials that are significant in Design Engineering, such as: • density, tensile strength, strength to weight ratio, hardness, durability, thermal and electrical conductivity, corrosion resistance, stiffness, elasticity, plasticity, impact resistance, malleability and ductility, machinability.	
b. Understand how the available forms, costs and properties of materials contribute to the decisions about suitability of materials when developing and manufacturing their own products.	

6. Technical understanding

TECHNICAL PRINCIPLES

	Considerations	*Maths & Science*
6.1 What considerations need to be made about the structural integrity of a design solution?		
a.	Learners should understand how and why some materials and/or system components need to be reinforced or stiffened to withstand forces and stresses to fulfil the structural integrity of products.	
b.	Learners should understand processes that can be used to ensure the structural integrity of a product, such as: • triangulation • reinforcing.	
6.2 How do mechanisms provide functionality to products and systems?		
a.	Demonstrate an understanding of the functions that mechanical devices offer to products, providing different types of motion, including: i. rotary ii. linear iii. reciprocating iv. oscillating.	
b.	Demonstrate an understanding of devices and systems that are used to change the magnitude and direction of forces and torques, including: i. gears, cams, pulleys and belts, levers, linkages, screw threads, worm drives, sprockets, chain drives and belt drives ii. epicyclic gear systems iii. bearings and lubrication iv. efficiency in mechanical systems.	
6.3 What forces need consideration to ensure structural and mechanical efficiency?		
a.	Demonstrate an understanding of static and dynamic forces in structures and how to achieve rigidity, including: i. tension, compression, torsion and bending ii. stress, strain and elasticity iii. mass and weight iv. rigidity v. modes of failure.	
6.4 How can electronic systems offer functionality to design solutions?		
a.	Demonstrate an understanding of how electronic systems provide input, control and output process functions, including: i. switches and sensors, to produce signals in response to a variety of inputs ii. programmable control devices iii. signal amplification iv. devices to produce a variety of outputs including light, sound, motion.	

Considerations	*Maths & Science*
b. Demonstrate an understanding of the function of an overall system, referring to aspects including: i. passive components: resistors, capacitors, diodes ii. inputs: sensors for position, light, temperature, sound, infra-red, force, rotation and angle iii. process control: programmable microcontroller iv. signal amplification: MOSFET, driver ICs v. outputs: LED, sounder, solenoid, DC motor, servo motor, stepper motor, piezo actuator, displays vi. analogue and digital signals and conversion between them vii. open and closed loop systems including feedback in a system and how it affects the overall performance viii. sub-systems and systems thinking.	
c. Demonstrate an understanding of what can be gained from interfacing electronic circuits with mechanical and pneumatic systems and components, such as: • the ability to add electronic control as an input to mechanical or pneumatic output • the use of flow restrictors to control cylinder speed • the use of sensors to measure rotational speed, strain/force, distance.	
d. Demonstrate an understanding of networking and of communication protocols, including: i. wireless devices, such as: RFID, NFC, Wi-Fi, bluetooth ii. embedded devices iii. smart objects iv. networking electronic products to exchange information.	
e. Demonstrate an understanding of the basic principles of electricity, including: i. voltage ii. current iii. Ohm's law iv. power.	
6.5 How can programmable devices and smart technologies provide functionality in system design?	
a. Demonstrate an understanding of how smart materials change the functionality of engineered products, such as: • colour changes, shape-shifting, motion control, self-cleaning and self-healing.	
b. Demonstrate an understanding of how programmable devices are used to add functionality to products, relating to coding of and specific applications of programmable components, such as: • how they incorporate enhanced features that can improve the user experience and solve problems in system design • how they use basic techniques for measuring, controlling, storing data and displaying information in practical situations • electronic prototyping platforms and integrated development environments (IDE) for simulation in virtual environments • the use of programmable components and microcontrollers found in products and systems, such as robotic arms or cars • creating flowcharts to describe processes and decisions within a process to control input and output components.	

7. Manufacturing processes and techniques

DESIGNING & MAKING PRINCIPLES

	Considerations	*Maths & Science*
7.1 How can materials and processes be used to make iterative models?		
a.	Understand that 3D iterative models can be made from a range of materials and components to create block models and working prototypes to communicate and test ideas, moving parts and structural integrity.	
b.	Demonstrate an understanding of simple processes that can be used to model ideas using hand tools and digital tools, such as rapid prototyping, or digital simulation packages.	
7.2 How can materials and processes be used to make final prototypes?		
a.	Understand how to select and safely use common workshop tools, equipment and machinery to manipulate materials by methods of: i. wasting/subtraction processes such as cutting, drilling, turning, milling ii. addition processes such as soldering, brazing, welding, adhesives, fasteners iii. deforming and reforming processes such as bending, vacuum forming.	
b.	Demonstrate an understanding of the role of computer-aided manufacture (CAM) and computer-aided engineering (CAE) to fabricate parts of a final prototype: i. additive manufacturing (3D printing) to fabricate a usable part ii. subtractive CNC manufacturing such as laser/plasma cutting, milling, turning and routing.	
c.	Demonstrate an understanding of measuring instruments and techniques used to ensure that products are manufactured accurately or within tolerances as appropriate.	
d.	Understand how the available forms, costs and working properties of materials contribute to the decisions about suitability of materials when developing and manufacturing their own products.	
7.3 How can materials and processes be used to make commercial products?		
a.	Demonstrate an understanding of the industrial processes and machinery used for manufacturing component parts in various materials, including: i. polymer moulding methods, such as injection moulding, blow moulding, compression moulding and thermoforming ii. metal casting methods such as sand casting and die casting iii. sheet metal forming methods using equipment such as punches, rollers, shears and stamping machines.	
b.	Demonstrate an understanding of the industrial methods used for assembling electronic products, including: i. surface mount technology (SMT) ii. PCB assembly using solder stencils, pick-and-place machines and reflow soldering ovens.	

TECHNICAL PRINCIPLES

Considerations	*Maths & Science*
c. Demonstrate an understanding of the benefits and flexibility of using computer-controlled machinery during industrial production, such as: • automated material handling systems • robot arms to stack, assemble, join and paint parts.	
d. Understand the necessity for manufacturers to optimise the use of materials and production processes, such as: • economical cutting and costing, ensuring cost effective production for viability • working to a budget through efficient manufacture and making the best use of labour and capital throughout the design and manufacturing process.	
7.4 How is manufacturing organised and managed for different scales of production?	
a. Understand how and why different production methods are used when manufacturing products, dependent on market demand, including: i. one-off and bespoke, batch and high volume production systems ii. modular/cell production systems iii. lean manufacturing iv. just-in-time manufacture v. fully automated manufacture.	
b. Understand how ICT and digital technologies are changing modern manufacturing: i. customised manufacture systems ii. rapid prototyping iii. additive and digital manufacture methods iv. stock control, monitoring, purchasing logistics in industry.	
7.5 How is the quality of products controlled through manufacture?	
a. Understand the processes that need to be undertaken to ensure products meet legal requirements and are high quality: i. quality control ii. quality assurance iii. 'Total Quality Management' (TQM) iv. European and British standards.	

8. Viability of design solutions

DESIGNING & MAKING PRINCIPLES

TECHNICAL PRINCIPLES

Considerations	*Maths & Science*
8.1 How can design engineers assess whether a design solution meets its stakeholder requirements?	
a. Critically evaluating how a design solution has met its intended requirements, including: i. functionality ii. ease of use and inclusivity of the solution iii. user needs.	
b. Demonstrate an understanding of the needs and methods for testing design solutions with stakeholders throughout the design development, and when testing the success of a product or system.	
c. Demonstrate an understanding of the importance of testing the feasibility of getting a product to market including considerations of cost, packaging and appeal.	
d. Understanding the relevant standards that need to be meet and how to ensure these are delivered, including: i. those published by the British Standards Institute (BSI) ii. those published by the International Organisation for Standardisation (ISO) specific to the subject.	
8.2 How can design engineers assess whether a design solution meets the criteria of technical specifications?	
a. Demonstrate an understanding of the methods and importance of undertaken physical testing on a product to ensure it meets the criteria it is meant to fulfil, including: i. functionality ii. accuracy iii. performance.	
b. Recognise how physical testing systems are integrated into the manufacturing process to test functionality, including: i. destructive and non-destructive methods ii. testing of materials for durability iii. testing models and prototypes for performance and fitness for purpose iv. testing products in use through different methods, such as: o consumer testing o virtual testing.	

2

Considerations	*Maths & Science*
8.3 How do design engineers and manufacturers determine whether design solutions are commercially viable?	
a. Demonstrate an understanding of the value of feasibility studies to determine the likely factors that influence the commercial viability of a product to market, such as: • the design solution's impact on user lifestyles • how well a product performs • technical difficulty of manufacture • stock availabililty of materials and components • costs and profit • timescales involved • promotion, brand awareness and advertising potential • balancing supply and demand • market analysis of similar products.	

9. Health and safety

Considerations	*Maths & Science*
9.1 How can safety be ensured when working with materials in a workshop environment?	
a. Demonstrate an understanding of safe working practices in the workshop situation, including: i. understanding the need for risk assessments ii. identifying hazards and implementing control measures to minimise risks.	
b. Demonstrate an understanding of how to work safely with specialist tools, techniques, processes, equipment and machinery during the design and manufacture of products.	
9.2 What are the implications of health and safety legislation on product manufacture?	
a. Demonstrate an understanding of how the regulatory and legislative framework in the Health and Safety at Work Act (HASAW) sets out duties of employers and employees in the product manufacturing industries, including: i. Control of Substances Hazardous to Health (COSHH) ii. Personal Protective Equipment at work regulations (PPE) iii. ensuring machinery is well maintained.	
b. The responsibility of manufactures to appropriately label products and offer warranties to their consumers to deliver the correct levels of product assurance related to safety.	

2f. Fashion and Textiles (H405/01 and H405/02)

The content of this component is focused towards fashion and textiles products and applications and their analysis in respect of:

- materials, components and their selection and uses in fashion and textiles
- industrial and commercial practices
- wider issues affecting design decisions.

It is essential that materials and components are studied from the perspective of analysing modern consumer products that are designed to meet identified consumer needs, their design and manufacture, and taught within the context of product development and industrial and commercial practices.

Learners should be familiar with a range of materials and components used in the manufacture of commonly available products, and should be able to make critical comparisons between them. The aim of the component is to give learners a framework for analysing existing products, which enables them to make considered selections of appropriate materials and manufacturing processes when designing.

The component brings together the knowledge, understanding and skills acquired in the NEA.

Identifying requirements

DESIGNING PRINCIPLES

Considerations	*Maths & Science*
1.1 What can be learnt by exploring contexts that design solutions are intended for?	
a. Understand that all design practice is context dependent and that investigations are required to identify what makes a context distinct in relation to: i. environment and surroundings ii. user requirements iii. economic and market considerations iv. product opportunities.	
1.2 What can be learnt by undertaking stakeholder analysis?	
a. Demonstrate an understanding of methods used for investigating stakeholder requirements, such as: • user-centred design and stakeholder analysis • SWOT analysis • focus groups • qualitative observations • market research to identify gaps for new products or opportunities to update existing products • use of forecasting companies to identify technological and fashion trends.	
b. Demonstrate an understanding of how enterprise can help drive the development of new product ideas through routes to innovation such as: • entrepreneurship • commercial partnerships • venture capitalists and crowd funding websites.	

TECHNICAL PRINCIPLES

Considerations	Maths & Science
1.3 How can usability be considered when designing prototypes?	
a. Learners should be able to analyse and evaluate factors that may need consideration in relation to the user interaction of a design solution, including: i. the impact of a solution on a user's lifestyle ii. the ease of use and inclusivity of products iii. ergonomic considerations and anthropometric data to support ease of use iv. aesthetic considerations.	
b. Demonstrate an understanding of the ergonomic factors that may need considering when developing products, including: i. anthropometric data to help define design parameters associated with the human body ii. user comfort, layout of controls, software user-interface.	

2. Learning from existing products and practice

DESIGNING PRINCIPLES

Considerations	Maths & Science
2.1 Why is it important to analyse and evaluate products as part of the design and manufacturing process?	
a. Analyse and evaluate the features and methods used in existing products and design solutions, to inform opportunities and constraints that may influence design decisions to offer product enhancement, including: i. the context of the existing product and the context of future design decisions ii. the multiple materials and components used iii. methods of construction and manufacture iv. how functionality is achieved v. the ease of use, including ergonomic and anthropometric considerations vi. inclusivity of products and appropriate considerations of application to a wide variety of users vii. fitness for purpose viii. the impact on user lifestyles ix. the effect of trends, taste and/or style x. the effect of marketing and branding xi. the considerations of how to get a product to market.	
2.2 Why is it important to understand technological developments in fashion and textiles?	
a. Be aware of and able to critically evaluate how new and emerging technologies in fashion and textiles influence and inform the function and innovation of products, such as: • military textiles • nano fibres • medical textiles • conductive dyes • innovative sportswear.	

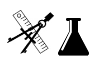
2

DESIGNING PRINCIPLES

Considerations	*Maths & Science*
2.3 Why is it important to understand both past and present developments in fashion and textiles?	
a. Recognise how past and present fashion and textiles designers, technologies and design thinking have influenced the style and function of products from different perspectives, including: i. the impact on industry and enterprise ii. the impact on people in relation to: lifestyle, culture and society iii. the impact on the environment iv. consideration of sustainability.	
b. Understand how key historical movements and figures and their methods have had an influence on future developments in fashion and textiles design.	
2.4 What can be learnt by examining lifecycles of products?	
a. Demonstrate an understanding of a product's marketing lifecycle from initial launch to decline in popularity, including: i. consideration of initial demand, growth in popularity and decline over time ii. methods used to create more demand and maintain a longer product popularity iii. new models of marketing and the influence of social media.	

3. Implications of wider issues

DESIGNING PRINCIPLES

Considerations	*Maths & Science*
3.1 What factors need to be considered whilst investigating design possibilities?	
a. Understand how social, ethical and environmental issues have influenced and been impacted by past and present developments in design practice and thinking, including: i. consideration of lifecycle assessment (LCA) at all stages of a product's life from raw material to disposal ii. the source and origin of fibres and the ecological and social footprint of materials iii. the depletion and effects of using natural sources of energy and raw materials iv. planned obsolescence v. consumer buying trends vi. environmental incentives and directives.	
3.2 What factors need to be considered when developing design solutions for manufacture?	
a. Awareness of the responsibilities and principles of total quality management (TQM), including: i. planning for accuracy and efficiency through testing and prototyping ii. being aware of issues in relation to different scales of production iii. designing for repair and maintenance iv. designing with consideration of product life.	

2

DESIGNING PRINCIPLES

TECHNICAL PRINCIPLES

Considerations	*Maths & Science*
b. Awareness of issues related to product lifecycles that extend useful product life, such as: • products standing the test of time in terms of durability and style • maintenance and aftercare • re-working and recycling systems.	
c. Demonstrate an understanding of how environmental factors impact on: i. sourcing and processing raw materials into a workable form ii. the disposal of waste, surplus materials and components, by-products of production including pollution related to energy iii. cost implications related to materials and process.	
d. Demonstrate an understanding of sustainability issues relating to industrial manufacture, including: i. fair trade and the Ethical Trade Initiative (ETI) ii. economic issues and globalisation iii. material sustainability and optimisation, availability, recycling and conservation schemes, such as: ○ exploring the impact and use of eco-materials in the fashion/textiles chain ○ exploring how materials can be up-cycled.	
3.3 What factors need to be considered when manufacturing products?	
a. Demonstrate an understanding of how to achieve an optimum use of materials and components, including: i. the cost of materials and/or components ii. stock sizes and forms available iii. sustainable production.	
3.4 What factors need to be considered when distributing products to markets?	
a. Understand the issues related to the effective and responsible distribution of products, such as: • cost effective distribution • environmental issues and energy requirements • social media and mobile technology • global production and delivery.	
b. Demonstrate an understanding of the implications of intellectual property (IP), registered designs, registered trademarks, copyright, design rights and patents, in relation to ethics in design practice and consumer rights.	
3.5 How can skills and knowledge from other subject areas, including mathematics and science, inform decisions in fashion and textiles?	
a. Demonstrate an understanding of the need to incorporate knowledge from other experts and subjects to inform design and manufacturing decisions, including the areas of science and mathematics.	
b. Understand how undertaking primary and secondary research and being able to interpret technical data and information from specialist websites and publications supports design development.	

4. Design thinking and communication

	Considerations	Maths & Science
TECHNICAL PRINCIPLES	**4.1 How do fashion and textiles designers use annotated 2D and 3D sketching and digital tools to graphically communicate ideas?**	
	a. Demonstrate an understanding of how to use annotated sketching and digital tools to graphically communicate ideas and sketch modelling to explore possible improvements, in terms of physical requirements, such as: • function, usability, construction, movement, stability, composition, strength • aesthetic qualities • manufacturing processes • suitability of materials and components.	
	b. Demonstrate an understanding of methods used to communicate the construction of design solutions to inform third parties, such as producing: i. working/technical drawings ii. digital visualisations iii. pattern drafting with relevant cutting and construction symbols iv. economical lay plans v. prototypes and toiles.	
	4.2 How do industry professionals use digital design tools to support and communicate the exploration, innovation and development of design ideas?	
	a. Demonstrate an understanding of how designers develop products using digital tools and online collaboration, such as: • discussing and exchanging ideas with specialists • developing designs concurrently with other designers • explaining and communicating their design decisions to stakeholders.	
	b. Demonstrate an understanding of how digital design software is used during product development, such as: • visual presentation, rendering and photo-quality imaging • product simulation.	
DESIGNING & MAKING PRINCIPLES	**4.3 How do fashion and textiles designers use different approaches to design thinking to support the development of design ideas?**	
	a. Awareness of different strategies, techniques and approaches to explore, create and evaluate design ideas, including: • iterative designing • user-centred design • circular economy • systems thinking.	
	b. The importance of collaboration to gain specialist knowledge from across subject areas when delivering solutions in the design and manufacturing industries.	
	c. Understand how design teams use different approaches to project management when faced with large projects, such as critical path analysis, scrum and six sigma.	

5. Material considerations

Considerations	*Maths & Science*
5.1 What factors influence the selection of materials that are used in products?	
a. Understand that the selection of materials and components is influenced by a range of factors, including: i. functional performance ii. aesthetics iii. cost and availability iv. properties and characteristics v. environmental considerations vi. social, cultural and ethical factors.	
5.2 What materials should be selected when designing and manufacturing products and prototypes in fashion and textiles?	
a. Understand that most products consist of multiple materials and that fashion and textiles designers are required to discriminate between them appropriately for their use, including: i. natural and synthetic textiles ii. polymers used in component parts, blended textiles iii. metals used for jewellery, component parts and conductive threads iv. wood used for component parts v. rubber used for performance and functionality.	
b. Demonstrate an understanding of the classification and source of textile fibres and materials, including: i. natural animal textiles, such as: ○ wool, silk and cashmere ii. natural plant textiles, such as: ○ cotton and flax iii. natural mineral textiles, such as: ○ glass fibre iv. synthetic textiles, such as: ○ nylon, polyester and acrylic.	
c. Demonstrate an understanding of the classification of different yarns, including: i. single fibre spun yarns ii. mixed and blended fibre spun yarns, such as cotton/polyester and wool/acrylic iii. filament yarns iv. fancy yarns, such as boucle, chenille and lurex v. bulked and textured yarns.	

TECHNICAL PRINCIPLES

Considerations	Maths & Science
d. Demonstrate an understanding of the classification of different structures of fabrics, including: i. knitted fabrics, including weft, warp and pile knits through hand and machine knitting ii. structured fabrics, such as knotted and braided fabrics/structures, 3D novel structures iii. woven fabrics, such as brocades, jacquards, plaid, tartans and crêpe iv. non-woven fabrics, such as felt, and heated, mechanical and adhesive bonded fabrics v. microfibres.	
5.3 Why is it important to consider the properties/characteristics of materials when designing and manufacturing products?	
a. Understand why the natural characteristics and properties of the fibres, yarns and fabrics in 5.2 to make them suitable for use in a variety of products dependent on the contextual application, including: • tensile strength, softness, texture, durability, resilience, weight, stiffness, elasticity, flammability, absorbency, washability, breathability, thermal and electrical conductivity, resistance to decay, biodegradable.	
b. Understand how the available forms, costs and properties of materials contribute to the decisions about suitability of materials when developing and manufacturing their own products.	

6. Technical understanding

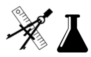
TECHNICAL PRINCIPLES

Considerations	Maths & Science
6.1 What considerations need to be made about the structural integrity of a design solution?	
a. Learners should understand how and why some materials and/or system components need to be reinforced or stiffened to withstand forces and stresses to fulfil the structural integrity of products.	
b. Understand how constructional solutions can be used to make fabrics suitable for purpose, including: i. the difference between whole garment knitting and fully fashioned panels ii. shaping through the addition of boning for structural integrity iii. reduction of fullness according to the design; darts, gathers, elastic, pleats iv. quilting to add thermal insulation.	
c. Understand how a variety of components fulfil functional requirements through their application in the manufacture of a textiles product, including: i. fastenings, such as: button and buttonholes, zips, poppers, velcro, hooks and eyes, parachute clips, eyelets and ties and toggles ii. decorative components, such as: appliquéd motifs, ribbon, lace, braid, beads, sequins and piping iii. constructional components, such as: shoulder pads, cuffing and interfacing.	

Considerations	*Maths & Science*
6.2 How can products be designed to function effectively within their surroundings?	
a. Demonstrate an understanding of surface finishes, decorative techniques and surface pattern technology that can be used to enhance the aesthetic qualities of products, including: i. printing and dyeing techniques, such as screen, block, roller and discharge printing, and methods of resist and vat dyeing. ii. biological techniques, such as the use of natural enzymes to create stone wash effects on jeans iii. embroidery and apliqué techniques iv. mechnical process, such as embossing and heat setting used on thermo polymer fabrics to shape or create pleats. v. digital technolgies used to print, embose and cut designs, such as dye sublimation printing and use of a laser cutter.	
b. Understand how materials and products can be finished in different ways to prevent corrosion or decay, or enhance their performance for their intended purpose, including: i. methods of laminating to strengthen fabrics ii. chemicals finishes used to improve a fabric's performance such as: water repellence, stain resistance, flame resistance, anti-static, moth-proofing, anti-pilling, rot proofing, anti-felting, hygienic (sanitised) iii. breathable coatings for high performance wear iv. transparent coatings on fine fabrics.	
6.3 What opportunities are there through using smart materials, e-textiles and technical textiles within products?	
a. Demonstrate an understanding of how smart materials change the functionality of products, such as: • colour changes using thermochromic, photochromic and electrochromic fibres • shape-shifting such as shape memory alloy • breathable membranes like Gore-Tex.	
b. Understand and recognise how e-textiles are innovative, wearable textiles that incorporate conductive fibres or elements directly into the textile itself, integrating functional performance into products. Consider developments, such as: • a range of conductive threads and pigments • fibretronics • a range of programmable controllers using a range of sensors.	
c. Understand how technical textiles are developed for a range of industry sectors, such as: i. geotextiles used in civil engineering, coastal engineering and the construction industry ii. the development of fabrics for hi-tech clothing.	

7. Manufacturing processes and techniques

TECHNICAL PRINCIPLES

	Considerations	*Maths & Science*
7.1 How can materials and processes be used to make iterative models?		
a.	Understand that iterative models can be made from a range of materials to create samples, toiles and other modelled concepts to communicate and test ideas, fit and structural integrity.	
b.	Demonstrate an understanding of how to develop iterative models using pattern making, pattern drafting and toiles to be able to test garments and form of other textiles products.	
c.	Understand the use of both hand tools and digital tools such as rapid prototyping, or digital simulation packages to support the creation of iterative developments.	
7.2 How can materials and processes be used to make final prototypes?		
a.	Recognise the order of assembly for different fashion and textiles products, including: i. assembly of fabric pieces including lining ii. addition of working parts such as zips and fastenings iii. reduction of fullness according to the design; darts, gathers, elastic, pleats iv. adding embellishment v. adding functional details; pockets and quilting.	
b.	Demonstrate an understanding of the tools, processes and machinery required to accurately manufacture fashion and textiles products in a workshop environment, including: i. dyeing and printing processes ii. hand and digital printing processes such as, screen, roller and transfer printing methods iii. transferring pattern markings using tailor's chalk, tailor's tacks and tracing wheel iv. cutting fabrics using fabric shears or a cutting wheel v. joining fabrics using a sewing machine, overlocker, needles and pins vi. finishing fabrics and garments using a steam iron.	
c.	Understand how digital technology, including the use of computer-aided design (CAD) and computer-aided manufacture (CAM) can be used in the making of final prototypes.	
d.	Understand how the design of templates and patterns can ensure quality and accuracy when making a final prototype.	
e.	Understand how the available forms, costs and working properties of materials contribute to the decisions about suitability of materials when developing and manufacturing their own prototypes.	
f.	Demonstrate an understanding of the principles of pattern cutting, including: i. pattern sizing ii. pattern symbols and instructions iii. how to manipulate patterns for different applications.	

Considerations	*Maths & Science*
7.3 How can materials and processes be used to make commercial products?	
a. Recognise the tools, processes and machinery required to complete a range of textiles products in industry, including: i. dyeing processes ii. hand and digital printing processes such as, screen, roller and transfer printing methods iii. transferring pattern markings using thread markers, drills and hot notchers iv. cutting fabrics using multi-ply fabric cutting, computer-controlled knives, lasers, water jets, plasma or ultra sound to cut fabric and prevent fraying v. joining fabrics using lockstitch, overlocker, seamcover, linking, automatic buttonhole and computer-controlled sewing machines vi. finishing fabrics and garments using pressing units, ironing and sleeve boards, steam dollies, tunnel finishers and flatbed presses for trousers.	
b. Understand the necessity for fashion and textiles manufacturers to optimise the use of materials and production processes, such as: • economical lay plans and costing; ensuring cost effective production for viability • working to a budget through efficient manufacture and making the best use of labour and capital throughout the design and manufacturing process.	
7.4 How is manufacturing organised and managed for different scales of production?	
a. Understand how and why different production methods are used when manufacturing products, dependent on market demand, including: i. one-off and bespoke, batch and high volume production systems ii. modular/cell production systems iii. lean manufacturing iv. just-in-time manufacture v. bought-in parts and components, standardised parts vi. fully automated manufacture.	
b. Understand how ICT and digital technologies are changing modern manufacturing such as: • customised manufacture systems • rapid prototyping • additive and digital manufacture methods • stock control, monitoring, purchasing logistics in industry.	
7.5 How is the quality of products controlled through manufacture?	
a. Understand the processes that need to be undertaken to ensure products meet legal requirements and are high quality such as: i. quality control ii. quality assurance iii. 'Total Quality Management' (TQM) iv. European and British standards.	

8. Viability of design solutions

DESIGNING & MAKING PRINCIPLES

TECHNICAL PRINCIPLES

Considerations	*Maths & Science*
8.1 How can designers assess whether a design solution meets its stakeholder requirements?	
a. Critically evaluating how a design solution has met its intended requirements, including: i. functionality ii. ease of use and inclusivity of the solution iii. user needs.	
b. Demonstrate an understanding of the needs and methods for testing design solutions with stakeholders throughout the design development, and when testing the success of a product.	
c. Demonstrate an understanding of the importance of testing the feasibility of getting a product to market, including: considerations of cost, packaging and appeal.	
d. Understanding the relevant standards that need to be met and how to ensure these are delivered, including: i. those published by the British Standards Institute (BSI) ii. those published by the International Organisation for Standardisation (ISO) specific to the subject.	
8.2 How can fashion and textiles designers assess whether a design solution meets the criteria of technical specifications?	
a. Demonstrate an understanding of the methods and importance of undertaken physical testing on a product to ensure it meets the criteria it is meant to fulfil, including: i. functionality ii. accuracy iii. performance.	
b. Recognise how physical testing systems are integrated into the manufacturing process in the textiles industry to test functional feasibility, including: i. testing of fibres and fabrics for durability and aftercare ii. testing prototypes, toiles and samples for performance and fitness for purpose iii. sampling garments and products through different methods, such as: ○ consumer testing, wearer trials ○ virtual testing.	
8.3 How do designers and manufacturers determine whether design solutions are commercially viable?	
a. Demonstrate an understanding of the value of feasibility studies to determine the likely factors that influence the commercial viability of a product to market, such as: • the design solution's impact on user lifestyles • how well a product performs • technical difficulty of manufacture • stock availabililty of materials and components • costs and profit • timescales involved • promotion, brand awareness and advertising potential • balancing supply and demand • market analysis of similar products.	

9. Health and safety

TECHNICAL PRINCIPLES

Considerations	*Maths & Science*
9.1 How can safety be ensured when working with materials in a workshop environment?	
a. Demonstrate an understanding of safe working practices in the workshop situation, including: i. understanding the need for risk assessments ii. identifying hazards and implementing control measures to minimise risks.	
b. Demonstrate an understanding of how to work safely with specialist tools, techniques, processes, equipment and machinery during the design and manufacture of products.	
9.2 What are the implications of health and safety legislation on product manufacture?	
a. Demonstrate an understanding of how the regulatory and legislative framework in the Health and Safety at Work Act (HASAW) sets out duties of employers and employees in the product manufacturing industries, including: i. Control of Substances Hazardous to Health (COSHH) ii. Personal Protective Equipment at work regulations (PPE).	
b. The responsibility of manufactures to appropriately label products and offer guarantees to their consumers to deliver the correct levels of product assurance related to safety, including: i. care labelling code and symbols ii. flamability.	

2g. Product Design (H406/01 and H406/02)

The content of this component is focused towards products and applications and their analysis in respect of:

- materials, components and their selection and uses in products/systems
- industrial and commercial practices
- wider issues affecting design decisions.

It is essential that materials and components are studied from the perspective of analysing modern consumer products that are designed to meet identified consumer needs, their design and manufacture, and taught within the context of product development and industrial and commercial practices.

Learners should be familiar with a range of materials and components used in the manufacture of commonly available products, and they should be able to make critical comparisons between them.

The aim of the component is to give learners a framework for analysing existing products that enables them to make considered selections of appropriate materials and manufacturing processes when designing.

The component brings together the knowledge, understanding and skills acquired in the NEA.

1. Identifying requirements

DESIGNING PRINCIPLES

Considerations	*Maths & Science*
1.1 What can be learnt by exploring contexts that design solutions are intended for?	
a. Understand that all design practice is context dependent and that investigations are required to identify what makes a context distinct in relation to: i. environment and surroundings ii. user requirements iii. economic and market considerations iv. product opportunities.	
1.2 What can be learnt by undertaking stakeholder analysis?	
a. Demonstrate an understanding of methods used for investigating stakeholder requirements, such as: • user-centred design and stakeholder analysis • SWOT analysis • focus groups • qualitative observations • market research to identify gaps for new products or opportunities to update existing products • use of forecasting companies to identify technological and fashion trends.	
b. Demonstrate an understanding of how enterprise can help drive the development of new product ideas through routes to innovation such as: • entrepreneurship • commercial partnerships • venture capitalists and crowd funding websites.	

Considerations	*Maths & Science*
1.3 How can usability be considered when designing prototypes?	
a. Learners should be able to analyse and evaluate factors that may need consideration in relation to the user interaction of a design solution, including: i. the impact of a solution on a user's lifestyle ii. the ease of use and inclusivity of products iii. ergonomic considerations and anthropometric data to support ease of use iv. aesthetic considerations.	
b. Demonstrate an understanding of the ergonomic factors that may need considering when developing products, including: i. anthropometric data to help define design parameters associated with the human body ii. user comfort, layout of controls, software user interface.	

2. Learning from existing products and practice

Considerations	*Maths & Science*
2.1 Why is it important to analyse and evaluate products as part of the design and manufacturing process?	
a. Analyse and evaluate the features and methods used in existing products and design solutions, to inform opportunities and constraints that may influence design decisions to offer product enhancement, including: i. the context of the existing product and the context of future design decisions ii. the multiple materials and components used iii. methods of construction and manufacture iv. how functionality is achieved v. the ease of use, including: ergonomic and anthropometric considerations vi. inclusivity of products and appropriate considerations of application to a wide variety of users vii. fitness for purpose viii. the impact on user lifestyles ix. the effect of trends, taste and/or style x. the effect of marketing and branding xi. the considerations of how to get a product to market.	
2.2 Why is it important to understand technological developments in product design?	
a. Be able to critically evaluate how new and emerging technologies influence and inform the evolution and innovation of products in both contemporary and potential future scenarios.	

2

DESIGNING PRINCIPLES

Considerations	*Maths & Science*
2.3 Why is it important to understand both past and present developments in product design?	
a. Recognise how past and present product designers, technologies and design thinking have influenced the style and function of products from different perspectives, including: i. the impact on industry and enterprise ii. the impact on people in relation to: lifestyle, culture and society iii. the impact on the environment iv. consideration of sustainability.	
a. Understand how key historical movements and figures and their methods have had an influence on future developments in product design.	
2.4 What can be learnt by examining lifecycles of products?	
a. Demonstrate an understanding of a product's marketing lifecycle from initial launch to decline in popularity, including: i. consideration of initial demand, growth in popularity and decline over time ii. methods used to create more demand and maintain a longer product popularity iii. new models of marketing and the influence of social media.	

3. Implications of wider issues

DESIGNING & MAKING PRINCIPLES

Considerations	*Maths & Science*
3.1 What factors need to be considered whilst investigating design possibilities?	
a. Understand how social, ethical and environmental issues have influenced and been impacted by past and present developments in design practice and thinking, including: i. consideration of lifecycle assessment (LCA) at all stages of a product's life from raw material to disposal ii. the source and origin of materials; and the ecological and social footprint of materials iii. the depletion and effects of using natural sources of energy and raw materials iv. planned obsolescence v. buying trends vi. environmental incentives and directives.	
3.2 What factors need to be considered when developing design solutions for manufacture?	
a. Awareness of the responsibilities and principles of designing for manufacture (DFM), including: i. planning for accuracy and efficiency through testing and prototyping ii. being aware of issues in relation to different scales of production iii. designing for repair and maintenance iv. designing with consideration of product life.	

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DESIGNING & MAKING PRINCIPLES

TECHNICAL PRINCIPLES

Considerations	*Maths & Science*
b. Awareness of product lifecycles that extend useful product life through planning for and consideration of maintenance, repair, upgrades, remanufacture and recycling systems.	
c. Demonstrate an understanding of how environmental factors impact on: i. sourcing and processing raw materials into a workable form ii. the disposal of waste, surplus materials and components, by-products of production including pollution related to energy iii. cost implications related to materials and process.	
d. Demonstrate an understanding of sustainability issues relating to industrial manufacture, including: i. fair trade and the Ethical Trade Initiative (ETI) ii. economic issues and globalisation iii. material sustainability and optimisation, availability, recycling and conservation schemes, such as: o exploring the impact and use of eco-materials o exploring how materials can be up-cycled.	
3.3 What factors need to be considered when manufacturing products?	
a. Demonstrate an understanding of how to achieve an optimum use of materials and components, including: i. the cost of materials and/or components ii. stock sizes and forms available iii. sustainable production.	
3.4 What factors need to be considered when distributing products to markets?	
a. Understand the issues related to the effective and responsible distribution of products, including: i. cost effective distribution ii. environmental issues and energy requirements iii. social media and mobile technology iv. global production and delivery.	
b. Demonstrate an understanding of the implications of intellectual property (IP), registered designs, registered trademarks, copyright, design rights and patents, in relation to ethics in design practice and consumer rights.	
3.5 How can skills and knowledge from other subject areas, including mathematics and science, inform decisions in product design?	
a. Demonstrate an understanding of the need to incorporate knowledge from other experts and subjects to inform design and manufacturing decisions, including the areas of science and mathematics.	
b. Understand how undertaking primary and secondary research and being able to interpret technical data and information from specialist websites and publications supports design development.	

4. Design thinking and communication

		Considerations	*Maths & Science*
TECHNICAL PRINCIPLES		**4.1 How do product designers use annotated 2D and 3D sketching and digital tools to graphically communicate ideas?**	
	a.	Demonstrate an understanding of how to use annotated sketching and digital tools to graphically communicate ideas and sketch modelling to explore possible improvements, in terms of physical requirements, such as: • function, usability, construction, movement, stability, composition, strength • aesthetic qualities • manufacturing processes • suitability of materials and components.	
	b.	Demonstrate an understanding of methods used to communicate the construction of design solutions to inform third parties, such as producing: i. working/technical drawings ii. digital visualisation iii. schematic diagrams and lay plans if appropriate iv. flowcharts with associated symbols v. prototypes and models.	
		4.2 How do industry professionals use digital design tools to support and communicate the exploration, innovation and development of design ideas?	
	a.	Demonstrate an understanding of how designers develop products using digital tools and online collaboration, such as: • discussing and exchanging ideas with specialists • developing designs concurrently with other designers • explaining and communicating their design decisions to stakeholders.	
	b.	Demonstrate an understanding of how digital design software is used during design development, such as: • visual presentation, rendering and photo-quality imaging • product simulation • scientific analysis of real-world physical factors to determine whether a product will break or work the way it was intended.	
DESIGNING & MAKING PRINCIPLES		**4.3 How do product designers use different approaches to design thinking to support the development of design ideas?**	
	a.	Awareness of different strategies, techniques and approaches to explore, create and evaluate design ideas, including: • iterative designing • user-centred design • circular economy • systems thinking.	
	b.	The importance of collaboration to gain specialist knowledge from across subject areas when delivering solutions in the design and manufacturing industries.	
	c.	Understand how design teams use different approaches to project management when faced with large projects, such as critical path analysis, scrum and six sigma.	

5. Material and component considerations

Considerations | *Maths & Science*

5.1 What factors influence the selection of materials that are used in products?

a. Understand that the selection of materials and components is influenced by a range of factors, including:
   - i. functional performance
   - ii. aesthetics
   - iii. cost and availability
   - iv. properties and characteristics
   - v. environmental considerations
   - vi. social, cultural and ethical factors.

5.2 What materials should be selected when designing and manufacturing products and prototypes in product design?

a. Understand that most products consist of multiple materials and that product designers are required to discriminate between them appropriately for their use, including:
   - i. hardwoods and softwoods, such as:
     - o oak, teak and beech; pine, spruce and fir
   - ii. manufactured boards, such as:
     - o plywood, MDF and block board
   - iii. ferrous and non-ferrous metals, such as:
     - o cast iron, mild steel and stainless steel; aluminum and copper
   - iv. metal alloys, such as:
     - o brass, bronze and tungsten
   - v. thermopolymers and thermosetting polymers, such as:
     - o PET, HDPE, PVC, LDPE, polypropylene, polystyrene and ABS; urea formaldehyde, epoxy resin and polyester resin.
   - vi. natural and synthetic fibres, such as:
     - o cotton, wool and silk; polyester and nylon
   - vii. textile fabrics, such as:
     - o woven, non-woven, knitted and blended textiles
   - viii. composite materials, such as:
     - o fibre-reinforced plastics, glass-reinforced plastics (GRP) and carbon fibre (CFRP)
   - ix. modern materials, such as:
     - o e-textiles, super-alloys, graphene, bioplastics and nanomaterials
   - x. smart materials, such as:
     - o thermochromic, photochromic and electrochromic materials; shape memory alloy and shape memory polymers; conductive paints and e-textiles.

TECHNICAL PRINCIPLES

	Considerations	*Maths & Science*
	5.3 Why is it important to consider the properties/characteristics of materials when designing and manufacturing products?	
a.	Understand why the characteristics and properties of the materials in 5.2a make them suitable for use in a variety of products dependent on the contextual application, including: • density, strength, hardness, durability, strength-to-weight ratio, stiffness, elasticity, impact resistance, plasticity, malleability and ductility, corrosive resistance to chemicals and weather, flammability, absorbency, washability, thermal and electrical conductivity, resistance to decay, biodegradable.	
b.	Understand how the available forms, costs and properties of materials contribute to the decisions about suitability of materials when developing and manufacturing their own products.	

2

6. Technical understanding

	Considerations	*Maths & Science*
6.1 What considerations need to be made about the structural integrity of a design solution?		
a.	Learners should understand how and why some materials and/or system components need to be reinforced or stiffened to withstand forces and stresses to fulfil the structural integrity of products.	
b.	Learners should understand processes that can be used to ensure the structural integrity of a product, such as: • triangulation • reinforcing.	
6.2 How can products be designed to function effectively within their surroundings?		
a.	Understand how surface finishes and coatings can be used to enhance the appearance of products and the methods of preparing different surfaces to accept finishes in order to deliver a decorative, colourful and quality outcome.	
b.	Understand how materials and products can be finished in different ways to prevent corrosion or decay in the environment they are intended for, such as: • paints, varnishes, sealants, preservatives, anodising, plating, coating, galvanisation and electroplating.	
6.3 What opportunities are there through using smart and modern technologies within products?		
a.	Demonstrate an understanding of how smart materials change the functionality of products, such as: • colour changes, shape-shifting, motion control, self-cleaning and self-healing • smart materials used in medical procedures to act in a way that conventional materials and processes would not previously have permitted.	
b.	Understand how modern technologies can support the function of products, such as: • programmable components that can be built into a product and coded to respond to inputs that command an action.	

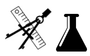
2

7. Manufacturing processes and techniques

DESIGNING & MAKING PRINCIPLES

TECHNICAL PRINCIPLES

	Considerations	*Maths & Science*
7.1 How can materials and processes be used to make iterative models?		
a.	Understand that 3D iterative models can be made from a range of materials and components to create block models and working prototypes to communicate and test ideas, moving parts and structural integrity.	
b.	Demonstrate an understanding of simple processes that can be used to model ideas using hand tools and digital tools such as rapid prototyping, or digital simulation packages to support the creation of iterative developments.	
7.2 How can materials and processes be used to make final prototypes?		
a.	Understand methods of joining similar and dissimilar materials within products to fulfill the following functions: i. permanently joining materials to include constructional joints ii. temporarily/semi-permanently joining materials iii. adhesion and heat iv. using standard components and fixings.	
b.	Demonstrate an understanding of a variety of processes, tools and machinery used to accurately manufacture final prototypes in the workshop made from wood, metal and polymers, including: i. wasting techniques, such as drilling, sawing, shaping and abrading ii. moulding methods, such as thermoforming and vacuum forming iii. milling metals and turning woods iv. casting of metals such as lost wax casting, sand casting, low temperature and resin casting v. forming and lamination vi. bending, rolling and forming sheet material.	
c.	Understand how digital technology, including the use of computer-aided design (CAD) and computer-aided manufacture (CAM) can be used in the making of final prototypes.	
d.	Understand how the design of templates, jigs, formers and moulds ensure quality and accuracy when making a final prototype.	
e.	Understand how the available forms, costs and working properties of materials contribute to the decisions about suitability of materials when developing and manufacturing products.	

Considerations	*Maths & Science*
7.3 How can materials and processes be used to make commercial products?	
a. Understand commercial production processes and machinery used to manufacture products to different scales of production, including: i. moulding methods, such as injection, rotational, compression, extrusion and blow ii. thermoforming and vacuum forming iii. die casting and sand casting iv. sheet metal forming and stamping v. automated material handling systems vi. robotic arms to stack, assemble, join and paint parts.	
b. Understand how the design of jigs, fixtures, presses, formers and moulds in commercial production are used to ensure consistent accuracy and quality, and different scales of production methods.	
c. Understand the necessity for manufacturers to optimise the use of materials and production processes, such as: • economical lay plans and costing; ensuring cost effective production for viability • working to a budget through efficient manufacture and making the best use of labour and capital throughout the design and manufacturing process.	
7.4 How is manufacturing organised and managed for different scales of production?	
a. Understand how and why different production methods are used when manufacturing products dependent on market demand, including: i. one-off and bespoke, batch and high volume production systems ii. modular/cell production systems iii. lean manufacturing iv. just-in-time manufacture v. bought-in parts and components, standardised parts vi. fully automated manufacture.	
b. Understand how ICT and digital technologies are changing modern manufacturing: i. customised manufacture systems ii. rapid prototyping iii. additive and digital manufacture methods iv. stock control, monitoring, purchasing logistics in industry.	
7.5 How is the quality of products controlled through manufacture?	
a. Understand the processes that need to be undertaken to ensure products meet legal requirements and are high quality: i. quality control ii. quality assurance iii. 'Total Quality Management' (TQM) iv. European and British standards.	

8. Viability of design solutions

DESIGN & MAKING PRINCIPLES

TECHNICAL PRINCIPLES

2

	Considerations	*Maths & Science*
8.1	**How can designers assess whether a design solution meets its stakeholder requirements?**	
a.	Critically evaluating how a design solution has met its intended requirements, including: i. functionality ii. ease of use and inclusivity of the solution iii. user needs.	(icon)
b.	Demonstrate an understanding of the needs and methods for testing design solutions with stakeholders throughout the design development, and when testing the success of a product.	(icon)
c.	Demonstrate an understanding of the importance of testing the feasibility of getting a product to market including considerations of cost, packaging and appeal.	(icon)
d.	Understanding the relevant standards that need to be meet and how to ensure these are delivered, including: i. those published by the British Standards Institute (BSI) ii. those published by the International Organisation for Standardisation (ISO) specific to the subject.	
8.2	**How can product designers and manufacturers assess whether a design solution meets the criteria of technical specifications?**	
a.	Demonstrate an understanding of the methods and importance of undertaken physical testing on a product to ensure it meets the criteria it is meant to fulfil, including: i. functionality ii. accuracy iii. performance.	(icon)
b.	Recognise how physical testing systems are integrated into the manufacturing process in the design industry to test functional feasibility, including: i. testing of materials for durability and aftercare ii. testing models and prototypes for performance and fitness for purpose iii. testing products in use through different methods, such as: ○ consumer testing ○ virtual testing.	(icon)
8.3	**How do designers and manufacturers determine whether design solutions are commercially viable?**	
a.	Demonstrate an understanding of the value of feasibility studies to determine the likely factors that influence the commercial viability of a product to market, such as: • the design solution's impact on user lifestyles • how well a product performs • technical difficulty of manufacture • stock availabililty of materials and components • costs and profit • timescales involved • promotion, brand awareness and advertising potential • balancing supply and demand • market analysis of similar products.	(icon)

TECHNICAL PRINCIPLES

9. Health and safety

Considerations		*Maths & Science*
9.1 How can safety be ensured when working with materials in a workshop environment?		
a.	Demonstrate an understanding of safe working practices in the workshop situation, including: i. understanding the need for risk assessments ii. identifying hazards and implementing control measures to minimise risks.	
b.	Demonstrate an understanding of how to work safely with specialist tools, techniques, processes, equipment and machinery during the design and manufacture of products.	
9.2 What are the implications of health and safety legislation on product manufacture?		
a.	Demonstrate an understanding of how the regulatory and legislative framework in the Health and Safety at Work Act (HASAW) sets out duties of employers and employees in the product manufacturing industries, including: i. Control of Substances Hazardous to Health (COSHH) ii. Personal Protective Equipment at work regulations (PPE).	
b.	The responsibility of manufacturers to appropriately label products and offer guarantees to their consumers to deliver the correct levels of product assurance related to safety.	

2h. Introduction to non-exam assessment (NEA) content – Iterative Design Project

The Iterative Design Project is a substantial design and make project that is individual to each learner and follows the methodology of iterative designing. Learners will be required to explore contexts of their own choosing that are both contemporary and challenging. The focus should be on identifying problems and opportunities to be resolved in an innovative way within the endorsed title they are working in. The undertaking of their project should demonstrate their self-management and a clear and thorough understanding of iterative design processes in practice.

Learners will need to demonstrate their knowledge, understanding and skills through overlapping, repeated iterative processes that:

- ‘**explore’** needs
- ‘**create’** solutions that demonstrate how the needs can be met, and
- ‘**evaluate’** how well the needs have been met.

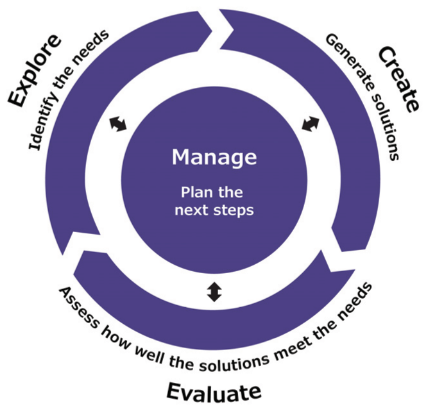


Fig. 3 Iterative Design Wheel showing key activities
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Based on the exploration of the context they have chosen, the related stakeholder needs and requirements are identified and design solutions created. The design solutions are tested and evaluated considering user feedback to identify any further improvements required for future ‘iterations’ of the design solution. In turn, these modified design solutions are tested and the processes repeated. This continuous system of designing produces constantly evolving iterations that build clearer needs and better solutions for a concept. Prototypes are developed into a progressively improved product.

The needs and requirements of users and stakeholders are important considerations throughout all iterative processes, as is analysing and interacting with existing products. The processes are repeated until requirements are met and problems are reduced to the lowest level possible. In this way the final prototype before production is of the highest quality and fit for purpose. In a type of ‘trial and error’ process, design solutions that satisfy users and stakeholders continue to influence future iterations through further improvement and refinement. Those that do not are discarded.

Central to any iterative designing process is the thinking and management around the development of the processes, which is sometimes very complex, requiring learners to manage competing problems to progress their iterative project. Mistakes are an inherent part of this learning experience and should not be hidden, but rather evidenced and used to improve future iterations.

So long as the interrelated principles of **'explore, create** and **evaluate'** are followed, there are no hard and fast rules as to how and when to start or develop a project, learners should decide how to manage and record the processes as their individual project demands. It is often beneficial to break down more complex problems into smaller more manageable areas.

2

Explore (AO1)

Exploring is about systematically understanding the need(s), known as requirements, of the primary user and stakeholder(s). The requirements should be used in a way that stimulates the 'create' stage of design development and forms the basis of measurable criteria in the 'evaluate' stage of the process. The requirements can be derived by exploring the following questions:

- *Who* are the stakeholders? e.g. using personas with an interest in the context or anticipated product outcomes.
- *What* do stakeholders do and *when* do they do it? e.g. using task analysis.
- *Where* do stakeholders do it? e.g. through primary and secondary investigation that helps understand the physical, organisational, social and cultural environments.
- *Why* do stakeholders do what they do? e.g. establishing what stakeholders want to achieve by using/promoting the product.
- *What* is the impact of what stakeholders do on society (people), the environment (planet) and economics (profit)?

This exploration may take various forms, but as with other stages in the iterative processes, a key element will be direct personal interaction between the learner and the stakeholder(s).

Create (AO2)

Creating focuses on the cognitive processes that are associated with creative thought. Creative ideas to develop the design solution should be both *novel* and *appropriate* (or functional in design terms). In order to be *novel,* ideas must go beyond clichéd or stereotypical responses – something known as [design] fixation. Recognising fixation and understanding the conceptual processes that help avoid it, is crucial to creative thought. For example, the process of conceptual combination, which is the merging of two or more concepts to form a *novel* idea, which, if *appropriate*, is by definition creative.

Suitable communication and presentation techniques are essential to record and share creative thoughts clearly to a third party. Initially, the focus is on the generation of a wide variety of ideas, using quick methods of communication such as freehand sketching. There is absolutely the freedom for learners to approach their designing in the way they feel most appropriate, e.g. with the use of digital technology or rudimentary models. Working up rough prototypes of ideas using readily available materials allows evaluation for future iterations. The presentation of later iterations may include techniques such as detailed sketches, more substantive models and photos of models with annotations of technical requirements and general thoughts. Learners' final design solutions can similarly be presented in any medium, but should be drawn with enough skill and detail to show relevant technical details, projections and rendering, resulting in final prototype(s) that resembles the intended iterative design solution for presentation and evaluation. The final design solution will also be required to be presented through the making of a final functioning and quality prototype. It is not intended that the resulting final prototype necessarily be made to full scale or using the manufacturing techniques, but learners will be required to understand how the final prototype could be manufactured into a working product.

Ideas in the form of sketches, models and annotations as described as part of the 'create' stage should be tested and evaluated as described as part of the 'evaluate' stage. In this way, the learner's creative journey is recorded naturally and clearly communicates their creative and critical thought processes and an understanding of how 'explore', 'create', and 'evaluate' are interrelated.

Evaluate (AO3)

Evaluation establishes whether the need(s) of the user(s) and stakeholder(s) have been met. Ideas (sketches, CAD and models) generated and developed within 'create' are used to test and systematically evaluate their *appropriateness* against the stakeholder requirements identified as part of 'explore'. Where needs have not been satisfactorily met, further exploration and creating of ideas will be required. New or developed ideas will need to be systematically evaluated. These iterative processes are repeated until all user and stakeholder needs have been met in line with stakeholder requirements. Each evaluation informs the next iteration and should be evident throughout the learner's product development. In order to do this learners should select from a variety of suitable techniques that will help them to systematically and objectively test the solutions developed to meet the identified stakeholder requirements.

The ethos and aims of the NEA component

The A Level Iterative Design Project will encourage and enable learners to develop a wide range of skills and abilities, which are applicable not only to study in Higher Education but also within the world of work and day-to-day life.

In formulating this component, OCR has worked closely with representatives from higher education and industry professionals to ensure that the content reflects authentic industrial practice and gives an insight into the way that creative, engineering and/or manufacturing industries function. Learners are thus enabled to make the connection between the knowledge, understanding and skills they develop and how this will benefit them in the future.

This component will cultivate important individual/personal qualities and skills including:

- initiative, independence and critical thinking
- curiosity, creativity, innovation and imagination
- a decisive but sensitive approach considering the needs, wants and values of others
- effective communication, for example, listening, reporting, explaining, illustrating, presenting
- an ambitious attitude with persistence and perseverance
- a positive outlook to risk-taking
- an openness to uncertainty, to test unfamiliar ideas and to learn from mistakes and failures
- a responsible approach as an initiator of change
- the ability to analyse, test and evaluate objectively, seeing their work from others' point of view
- able to benefit from expert advice and collaboration with others
- attention to detail.

NEA content requirement

The column on the right indicates where learners may consider mathematical skills or knowledge from wider subjects, including science.

The 'explore', 'create' and 'evaluate' columns have different size dots, not only to indicate their interrelationship, but also their significance within any topic strand.

In order to undertake their Iterative Design Project NEA, learners should:

1. Identifying requirements		Explore	Create	Evaluate	Maths & Science
a.	Understand methods of investigating and analysing contexts in order to identify problems and opportunities that offer potential for an innovative design solution.	⬤	•	•	📐
b.	Be able to develop and prioritise specific issues identified for attention in order to produce a design brief and determine the next steps for design development.	⬤	●	•	
c.	Understand the central importance of obtaining and taking account of the needs, wants, values and views of users and stakeholders throughout the iterative design processes.	●	•	●	
d.	Be able to identify and state user and stakeholder requirements in a form that will direct, inform and offer the opportunity for reflection of their designing and making progress throughout the design process.	⬤	•	●	📐
2. Learning from existing products and practice					
a.	Be able to to critically analyse relevant existing products, understanding how investigations can be used to inform design thinking and delivery solutions to technical requirements that could be utilised within their own design solutions.	●	•	●	⚗
b.	Investigate existing products' fitness for purpose, with reference to aesthetics, ergonomics and anthropometrics, to identify key areas for consideration when designing and creating prototypes.	●	•	●	⚗
c.	Understand and apply relevant design theory, including how key historic movements or figures and their methods may influence or inspire their own designing.	●	•	●	
d.	Consider and use different design strategies, techniques and approaches when exploring, creating and evaluating.	●	•	●	
e.	Use physical testing of existing products, materials and components (including destructive and non-destructive methods) during the iterative processes to determine design requirements and to inform the development of improved designs.	●	•	●	📐 ⚗

3.	Implications of wider issues	Explore	Create	Evaluate	Maths & Science
a.	Understand the impact of social, moral, and ethical factors when investigating and analysing existing products, systems, technologies and technological developments in order to consider and apply these principles when designing and creating prototypes.	•	•	•	
b.	Be able to draw on and apply skills and knowledge from other subject areas, including mathematics and science, to inform and support decisions when designing or when developing technological aspects of their product.	•	•	•	 
c.	Review wider environmental implications when creating prototypes, understanding the use of product lifecycle analysis to consider factors such as the disposal of waste, surplus materials, components and by-products and sustainability.	•	•	•	
4.	**Design thinking and communication**				
a.	Demonstrate an ability to formulate appropriate technical and non-technical specifications reflecting on their own investigations and considering stakeholder requirements, including: • non-technical specifications that cover requirements • technical requirements that outline the specific requirements for needed to support the making of a final prototype.	•	●	•	
b.	Select and use appropriate methods of communication with stakeholders and users, understanding and applying the principles of user-centred design and other relevant design approaches throughout the iterative design process.	•	●	•	
c.	Understand how to use communication skills throughout a project, utilising a range of media and presentation techniques appropriate to the project which clarify, record and explain their thinking, and enable others to understand their decisions and intentions.	•	●	•	
d.	Apply digital and non-digital skills and techniques that are suitable to the stage of development and record real-time progress throughout an iterative design process, such as: • informal 2D and 3D sketching and modelling to communicate initial ideas • system and schematic diagrams, annotated sketches, exploded diagrams, models and written notes, to communicate development iterations • audio and visual recordings to share thinking, explorations and the functionality of ideas • formal 2D and 3D working drawings to outline specification requirements; 3D illustrations, mathematical modelling and computer-based tools to present final design solutions; schedules and flowcharts to deliver planning • writing reports and/or summaries to record the thinking process • presentations and real-time evidence to communicate throughout the project.	•	●	•	

		Explore	Create	Evaluate	Maths & Science
	e. Use project management tools and production plans as appropriate during the project to ensure all phases are managed efficiently.	●	•	●	
5.	**Material considerations**				
	a. Be able to select and work with appropriate materials and components when designing and making prototypes, understanding the role of different materials and material combinations when analysing and considering them for use within their own design solutions.	•	●	•	
6.	**Technical understanding**				
	a. Understand how investigations of existing products and user and stakeholder requirements can be used to understand the requirements for functionality and usability when designing and creating prototypes.	•	⬤	•	
	b. Understand the importance of appropriate materials, components, finishes and use of technology when creating and developing functional and easy-to-use products and systems.	•	⬤	•	
	c. Understand aesthetics, ergonomics and anthropometrics in order to ensure their design solutions are fit for purpose in meeting stakeholder and design requirements.	•	⬤	•	
7.	**Manufacturing processes and techniques**				
	a. Use appropriate and accurate marking out methods including: consideration and use of reference/datum points; use templates, jigs and/or patterns where appropriate; working within tolerances; understanding efficient cutting and how to minimise waste. Ensuring appropriate accuracy and precision required for their product to fulfil its intended purpose.	•	⬤	•	
	b. Select and use appropriate specialist tools, equipment and machinery, both manually and digitally operated, when creating their prototypes, products and systems.	•	⬤	•	
	c. Investigate the feasibility and suitability of techniques and processes to be used during the process of designing and making prototypes through experimentation, testing and modelling.	●	⬤	•	
	d. Select and use appropriate processes and techniques to demonstrate practical making skills with hand, machine and digital technologies through the creation of models, simulations and final prototypes. Reflecting on the effectiveness of the processes and techniques used.	•	⬤	•	
	e. Understand manufacturing methods, scales of production and quality to ensure their final prototype of their design solution meets identified stakeholder requirements.	•	⬤	•	

			Explore	Create	Evaluate	Maths & Science
	f.	Understand the principles of Design for Manufacture and Assembly (DFMA) to develop design solutions that ensure accuracy and precision are met, and economy and efficiency are achieved.	•	●	•	📐
	g.	Understand and apply quality control and quality assurance principles to their project.	•	●	•	
8.	**Viability of design solutions**					
	a.	Design and develop one final prototype or a set of prototypes that meets stakeholder requirements and is fit for purpose.	•	•	●	
	b.	Test and evaluate the viability of potential design iterations against agreed requirements lists and specifications, in liaison with stakeholders and users, to inform future iterations of their design solutions.	•	•	●	📐 🧪
	c.	Evaluate stakeholder requirements whilst also considering commercial viability, including an understanding of cost and marketability.	•	•	●	📐
	d.	Use physical testing (destructive and non-destructive methods), through experiments and trials, scaled models, mock-ups, prototypes and components as appropriate to assess the suitability of design solutions and to inform successive design iterations.	•	●	●	📐 🧪
	e.	Understand and use IT based tools to test and evaluate the viability of specific components and prototypes to predict performance.	•	●	●	📐
	f.	Be able to make informed and reasoned decisions that respond to stakeholder feedback to ensure all needs and requirements are addressed and to identify the potential next-steps for further development and suggest how modifications could be made through design optimisation.	•	●	●	
	g.	Understand and apply relevant standards to measure the viability of design solutions including BSI and ISO	●	•	●	
9.	**Health and safety**					
	a.	Be able to identify relevant hazards when creating prototypes and apply safe working practices when creating designs and prototypes, applying appropriate risk assessments.	•	•	•	

Further details on the requirements for undertaking the non-exam assessment NEA can be found in Section 3a.

Guidance on assessment of the NEA, including the marking criteria is outlined in Section 3f.

Administration requirements of the NEA are outlined in Section 4d.

2

Mathematical Skills in the NEA

In order to support the mathematical skills that are required to be assessed in the written examination, there is an expectation within this specification that learners will continue to demonstrate appropriate mathematical skills in their NEA at a level of demand which is not lower than that expected at higher tier GCSE (9–1) Mathematics. The application of these skills should not be used artificially, but appropriately as opportunities arise, not only to demonstrate accuracy through practical skills, but also to solve problems, support investigations and analyse findings.

Within the NEA, the following skills could be drawn on:

- appropriate use of measurements using metric units to ensure accuracy and minimise waste
- calculations of material and component costs and quantities, considering appropriate tolerances and resourcefulness
- utilising and interpreting appropriate data to support the development of design iterations
- use appropriate methods to present performance data, survey responses and information on design decisions, including the use of frequency tables, graphs and bar charts
- accurate graphical communication to deliver design and manufacturing intentions to others
- the design and testing of design prototypes to meet specific requirements, standards and tolerances, and the calculation and presentation of data and statistics.

In addition, **Design Engineering** learners could utilise scientific formulae to justify their design decisions and consideration of functional success of any product.

2i. Non-exam assessment interpretation – Design Engineering (H404/03, 04)

The focus of an 'Iterative Design Project' undertaken by a learner pursuing Design Engineering will have a more significant focus on the functional requirements and/or systems of a product.

Existing products may be explored through destructive or non-destructive methods of testing, but it is important to be in direct contact with a user and/or wider stakeholders that can offer meaningful feedback to support explorations and testing throughout.

User interaction with a mechanical or electronic product may be focused on the user interfacing, or more widely on how the existing product meets the user's needs. Communicating with stakeholders from engineering industries may also support the thinking behind the product development. A systems approach to the project may be considered.

Consideration of the constructional requirements of any iterative design solutions can be explored through many different ways, including initial hand drawn ideas through to models to explore effective processes and techniques. Learners are likely to benefit from the use of full-scale modelling during the iterative design process to determine ergonomic, dimensional and functional suitability in their proposed design solutions. It is important that learners consider and incorporate their mathematical skills to demonstrate the viability of their design solutions, both economically and functionally.

The use of CAD, CAM, CAE and image manipulation software is expected to support a learner's modelling, visualisation, development, and refinement of their design solutions. Technical/working drawings will be required to demonstrate that the designs are commercially viable to a third party.

As part of their consideration of materials and components it is expected that learners will include consideration of appropriate bought-in and standardised parts for use within their design solutions, though any such applications should be appropriately thought out to ensure they will adequate fulfil the purposes they are intent for and not detract from a final prototype.

A range of hand, machine and digital technologies including CAD/CAM are expected to be used as appropriate in learners' modelling, experimenting and prototyping.

Learners are likely to benefit from the use of full-scale modelling during the iterative design process to determine ergonomic, dimensional and functional suitability in their proposed design solutions.

It is important for learners to consider evidence of the iterative developments, in particular with Design Engineering, demonstration of the functionality of the design solutions. Real-time evidence in the form of short video clips is likely to be the most effective way of demonstrating this within their chronological e-portfolio.

Being in regular direct contact with stakeholders and users will deliver non-biased opinions. Learners are expected to objectively test the prototypes developed to meet the identified stakeholder requirements**.** Listening and observation are key skills for the learner in iterative testing and evaluation.

2j. Non-exam assessment interpretation – Fashion and Textiles (H405/03, 04)

2

The focus of an 'Iterative Design Project' undertaken by a learner pursuing Fashion and Textiles will have a more significant focus on wide ranging products that predominantly utilise textile materials. The products are likely to consider fashions and/or trends and could be applied to industrial or commercial practices.

Existing products may be explored through destructive or non-destructive methods of testing such as reverse engineering garments or textiles products, but it is important to be in direct contact with a user and/or wider stakeholders that can offer meaningful feedback to support explorations and testing throughout.

The type of product being developed will determine whether a more commercial approach through consumer testing is appropriate or whether communicating with manufacturing and/or retail stakeholders will be more appropriate to support explorations of the opportunities and constraints of re-developing a product.

Consideration of the product's relationship with users will rely on consideration of anthropometric data or data on clothes sizes, but demonstration of economic viability may also be considered.

It is expected that learners will reflect commercial practice by including marketing aspects in their design thinking at all stages of the iterative process, to ensure their final product will be marketable and ready for market.

The manipulation of fabrics and adding surface finishes including decoration, dyeing and printing can also be explored in their evolving studies. Consideration of the constructional requirements of any iterative design solutions can be explored through many different ways, including initial hand drawn ideas through to creating their own patterns and toiles or samples to explore effective processes and techniques. Learners are likely to benefit from the use of full-scale toiles or modelling during the iterative design process to determine ergonomic, dimensional and functional suitability in their proposed design solutions.

It is crucial that Fashion and Textiles learners of the future utilise new and emerging technologies. This may include the laser cutter, e-textiles, sublimation printer or the 3D printer in the creation of components. The use of CAD and CAM is expected to support a learner's modelling, visualisation, development, and/or refinement of their design solutions; however these can be in support of designing and workshop skills.

It is expected that learners' final design solutions will be defined in sufficient detail for third party manufacture without further guidance. Pattern drafting, lay plans and working drawings will be required to demonstrate that the designs are commercially viable.

A range of hand, machine and digital technologies including CAD/CAM are expected to be used as appropriate in learners' modelling, experimenting and prototyping.

As part of their consideration of materials and components it is expected that learners will include consideration of appropriate bought-in and standardised parts, particularly if e-textiles or programmable components are being considered for use within their design solutions.

It is important for learners to consider evidence of the iterative developments, in particular with fashion and textiles demonstration of the performance of a product or prototype in use. Real-time evidence in the form of short video clips is likely to be the most effective way of demonstrating this within their chronological e-portfolio. All portfolio evidence is to be electronic; therefore it may be necessary to either scan or photograph swatches of textile materials.

Being in regular direct contact with stakeholders and users will deliver non-biased opinions. Learners are expected to objectively test the prototypes developed to meet the identified stakeholder requirements. Listening and observation are key skills for the learner in iterative testing and evaluation.

2k. Non-exam assessment interpretation – Product Design (H406/03, 04)

The focus of an 'Iterative Design Project' undertaken by a learner pursuing Product Design will have a focus on a broad range of domestic, commercial and industrial contexts that embrace products of all types, sizes and complexities.

Disassembly, testing, and comparison of similar products, components and materials will highlight strengths and weaknesses and support technical understanding, but it is important to be in direct contact with a user and/or wider stakeholders that can offer meaningful feedback to support explorations and testing throughout.

Communicating with users and wider stakeholders will support explorations into the opportunities and constraints of developing a product. It is expected that learners give consideration to the wider functionality when designing products, for example, how they may be stored, moved or transported and maintained or adapted to achieve function and fitness for purpose.

It is expected that learners will reflect commercial practice by including marketing aspects in their design thinking at all stages of the iterative process, to ensure their final product will be marketable and ready for market.

Consideration of the constructional requirements of any iterative design solutions can be explored through many different ways, including initial hand drawn ideas through to models to explore effective processes and techniques. Learners are likely to benefit from the use of full-scale modelling during the iterative design process to determine ergonomic, dimensional and functional suitability in their proposed design solutions.

The use of CAD, CAM and image manipulation software is expected to support a learner's modelling, visualisation, development and refinement of their design solutions. This may include animation to show articulation and the analysis of structural features.

It is expected that learners' final design solutions will be defined in sufficient detail for third party manufacture without further guidance, and presented using suitable CAD software to mirror standard practice in the product design industry, showing all relevant technical details using appropriate 2D (e.g. orthographic) and/or 3D (e.g. rendered drawings) formats together with parts lists to present a coherent and complete solution package. Graphic design artwork should be 'print-ready' using suitable DTP software to mirror standard practice in the graphic design industry, showing allowance for bleeds, crop/trim/fold marks, and appropriate colour references.

A range of hand, machine and digital technologies including CAD/CAM are expected to be used as appropriate in learners' modelling, experimenting and prototyping.

As part of their consideration of materials and components it is expected that learners will include consideration of appropriate bought-in and standardised parts for use within their design solutions.

It is important for learners to consider evidence of the iterative developments, in particular with Product Design the demonstration of the performance of a product or prototype in use or in situ. Real-time evidence in the form of short video clips is likely to be the most effective way of demonstrating this within their chronological e-portfolio.

Being in regular direct contact with stakeholders and users will deliver non-biased opinions. Learners are expected to objectively test the prototypes developed to meet the identified stakeholder requirements. Listening and observation are key skills for the learner in iterative testing and evaluation.

2

2l. Prior knowledge, learning and progression

No prior qualification is required in order for learners to enter for an A Level in Design and Technology, nor is any prior knowledge or understanding required for entry onto this course. Learners would however benefit from having completed the GCSE (9–1) in Design and Technology as a foundation to the learning at this level. Higher level GCSE (9–1) qualifications in Maths and Science will also support learners with much of the knowledge and understanding within the content. Prior experience and skills in illustration and the use digital technology would also be beneficial.

These endorsed titles within this qualification will enable learners to progress to higher, further or vocational education routes. This qualification has been designed with consideration of the entry requirements of Higher Education Institutes who offer related undergraduate degrees in engineering, fashion, manufacturing, material science, product design and textile technologies amongst others.

As with EPQs, the substantive project work undertaken as part of this qualification will give learners valuable material to discuss in their personal statement if progressing to higher education. Learners will also have the opportunity to use much of the work undertaken throughout this qualification as part of the portfolio that many universities require when interviewing potential students.

There are links to mathematics and science content within this specification. Where this is to be assessed, the standard level will be equivalent to the learning that expected at the end of Key Stage 4.

There are a number of Design and Technology specifications at OCR. Find out more at www.ocr.org.uk

3 Assessment of A Level in Design and Technology

3a. Forms of assessment

OCR's A Level in Design and Technology is a linear qualification with three endorsed titles, each of which consist of two components that are externally assessed and one component that is assessed by the centre and externally moderated by OCR.

The examined and non-exam assessments account for 50% of the qualification each. Learners must take all three components that related to the endorsed title they have entered.

Principles (01) written examination

This is a single externally assessed examination component with questions covering both 'core' and 'in-depth' content.

Content for assessment in the examination is outlined in Section 2e–2g for each endorsed title.

Principles of 'Design Engineering, Fashion and Textiles or Product Design'	
26.7% of A Level 1 hour 30 minutes Written paper 80 marks	These papers predominantly cover the technical principles of the examined content for each endorsed title. • There will be sets of questions that are focused around a context or existing product. • Learners will be required to answer **all** questions. • The questions will cover a **range** of the outlined exam content. • There will be a mixture of different levels of questions. • At least **one** question will require learners to analyse an existing product. • At least **one** question will require learners to apply mathematical skills that are appropriate to design or technology. • There may be questions requiring learners to use annotated sketching to communication of the construction of a product. • There will be **one extended answer question**. The question will not assess spelling, punctuation and grammar, but will assess the use of subject terminology and the quality of extended response. • The extended response question will require learners to draw on their synoptic knowledge from across the specification. (The NEA and 'Problem Solving' paper will offer further opportunities to assess this further). • Use of calculators is permitted in the written examination.

Problem Solving (02) written examination with drawing

This is a single externally assessed examination component with questions covering both 'core' and 'in-depth' content.

Content for assessment in the examination is outlined in Section 2e–2g for each endorsed title.

Problem Solving in 'Design Engineering, Fashion and Textiles or Product Design'	
23.3% of A Level	These papers require learners to apply their higher level critical thinking and problem solving skills to evaluate the suitability of design solutions and requirements in relation to specific situations.
1 hour 45 minutes Written paper 70 marks	• Learners will be required to apply their knowledge and understanding of technical and designing principles from the examined content for each endorsed title. • Learners will be required to answer **all** questions. • Learners will be given an insert booklet that sets out contexts and detailed information related to the question paper, as well as generic data covering the data sources from Section 5e that are relevant to that endorsed title. • Learners will be required to answer a series of longer answer questions that require learners to demonstrate their problem solving and critical evaluation skills. • At least **one** question will require learners to apply mathematical skills. • At least half of the marks for this paper will require learners to apply the in-depth knowledge and understanding of materials, manufacturing processes and techniques and technical understanding. • At least **two** questions will require learners to reflect on consideration of: o the implications of wider factors of design and technology o current trends o understanding of design thinking and communication. • There will be **two extended answer questions**, these questions will not assess spelling, punctuation and grammar, but will assess the use of subject terminology and the quality of extended response. • The extended response questions will require learners to draw on their synoptic knowledge from across the specification. (The NEA and 'Principles' written paper will offer further opportunities to assess this further). • Use of calculators is permitted in the written examination.

Iterative Design Project (03, 04) non-exam assessment (NEA)

The 'Iterative Design Project' is a single task component, worth 50% of the qualification, giving learners the opportunity to demonstrate their knowledge, understanding and skills over time in order to realise a valid outcome that reflects real-world design considerations. The component is internally assessed and externally moderated.

The content to be considered in the 'Iterative Design Project' is outlined in Section 2h, with interpretations for each endorsed title from sections 2i to 2k.

Guidance on assessment, including the marking criteria is outlined in Section 3f.

Administration requirements for completing the NEA are outlined in Section 4d.

The following sub-headings give further clarity on the requirements for teachers and learners when setting, taking and evidencing the 'Iterative Design Project'.

Setting the project

At A Level, it is for the learner to explore and contextualise the 'Iterative Design Project' they undertake. The project should be of **sufficient complexity** and offer an appropriate degree of uncertainty of outcome to enable learners 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.

To maximise the benefit and potential of the project, learners should look beyond their own desires and immediate interests to real-world situations and problems. Projects may arise from workplaces, businesses and organisations, but more importantly from the identification of real needs and opportunities. They will fall into the category of 'domestic, commercial and industrial products and systems'.

The overall complexity, the breadth and/or depth of designing, making and evaluating skills, and the level of thinking involved is important, rather than the size of the product. The level of difficulty and sophistication involved must be appropriate to Advanced level. 'Simple' and 'straightforward' projects are unlikely to attain high marks where there is insufficient demand and depth.

Iterative Design Projects should:

- be set within an authentic context
- suit the interests of the learner
- cover a sufficient range and depth of designing and making activities to enable the learner to demonstrate their ability and access the full mark range in each of the marking criteria
- enable the learner to mirror industrial and commercial processes
- encourage the learner to look beyond their personal needs
- give the learner opportunities for creativity and innovation
- be manageable and realistic bearing in mind the time, resources and facilities, staff expertise and specialist support available
- enable the learner to complete the project, including the designing, making, and testing of a final quality product, in the time available.

It is expected that the teacher will provide guidance to the learners in relation to the purpose and requirements of the task, ensuring that learners are clear about the assessment expectations and marking criteria they will be assessed against.

Learners will have approximately 65 hours in which to complete the whole 'Iterative Design Project'. This time allowance is for guidance only and does not constitute a maximum or minimum requirement. It should be noted that assessment of this component is reliant on relevant lines of investigation and development, therefore time spent on this component should retain a clear focus on the context explored and brief written by the learner.

Prior learning and practical experience will be required in order that learners are able to demonstrate the knowledge, understanding and skills being assessed. Once the learners are working on their 'Iterative Design Project', all interaction with others should be recorded as part of the on-going real-time progress of the learners own iterative design processes. Teachers are able to offer guidance as a stakeholder, but should not be seen to influence the direction of the learner's project.

As part of the assessment of this component, learners are required to explore their own context and write their own brief. General guidance is permitted to ensure learners undertake achievable projects, though teachers must not set any briefs or deliver specific guidance for their learners when writing their briefs.

Group Projects

In cases where a number of learners choose a project within the same context, each learner must identify a need or opportunity which is unique to themselves. Each learner must complete their own 'Iterative Design Project' and provide their own individual portfolio of evidence for assessment.

Further guidance about the nature of advice can be found in the *JCQ Instructions for conducting non-exam assessment.*

Undertaking the project

The 'Iterative Design Project' requires learners to initiate, develop and make a prototype(s) through iterations of exploring, creating and evaluating that identify opportunities and constantly respond to stakeholder needs, wants and interests. This process should be followed and evidenced to demonstrate an accurate account of their progress.

Throughout the NEA it is essential that the teacher can authenticate that the learner's work is their own.

Developing a brief

Learners are required to write their own design brief to set out how they are going to challenge the problems and opportunities identified as a response to the context they are going to pursue. Prior to writing a design brief, it is essential that a learner has fully explored the context(s) they are considering and conduct a feasibility study of products, stakeholders and/or markets that may offer the opportunities for an innovative challenge to be pursued.

The design brief should outline the approach a learner has chosen in response to the context. Writing the design brief is an essential part of outlining the challenges involved in their 'Iterative Design Project'. To ensure it is delivered appropriately the following should be considered:

- all learners must develop a unique design brief that responds to their own interpretation of the chosen 'context'
- learners should have prior awareness of their centre's facilities and resources to fully consider the implications of their own approach
- if changes need to be made to a learner's design brief at a later stage, this must be fully justified by the learner in response to their iterative design process and remain true to their chosen 'context'.

Outlining requirements

Learners are required to follow iterative design processes determined by the opportunities, requirements and problems they encounter. Whenever **stakeholder requirements** or **technical requirements** are identified that cover specific needs, wants and interests, they should be outlined and presented accordingly to support the thinking within the design process.

Generating initial ideas

There are various techniques and design approaches that can be taken to conceive initial ideas, but all ideas should be focused on responding to identified problems and requirements and offering innovative challenge. Designing starts from a position of many initial ideas that quickly communicate and capture thinking appropriately within the design process. When initial ideas have been generated through interaction with others, learners should:

- acknowledge who generated the idea and when
- use ideas generated by others only when supported by a reflection of why they are considered appropriate.

Design developments

When developing designs, the focus is on narrowing down and improving ideas through more detailed iterations that give deeper consideration to resolving identified requirements technically, conceptually and commercially.

It is likely that technical and design problems may be identified, some of which may be seen as mistakes. Recognising and solving these issues through the demonstration of thought processes and practical activity should be clearly evidenced.

Design developments are assessed through the level of detail offered and the quality and range of skills used to find suitable solutions. Therefore, the quantity of developments is very much dependent on this level of thinking. Two design developments should always be considered a minimum regardless of the quality of the outcome.

Developing a final design solution

When developing a design solution to be made into a final prototype(s), learners should consider the solution as it would look and function if sold as a commercial or industrial product. This should include experimentation of processes and techniques through modelling and testing.

Digital design and manufacture **must** be used either through the development of the final design solution or when making the final prototype(s).

Delivering a technical specification

Learners are required to justify and present their final design solution through a **technical specification** that delivers specific written and graphical information to outline how the final design solution meets the stakeholder requirements and will support accurate production. The specification should offer justification and a suitable level of information so that a third party would know what the intentions are for manufacturing the design solution as a commercial product, but also exactly how the design solution would be made into a final prototype(s) to present it to the stakeholders.

Producing a final prototype

When learners are producing their final prototype(s) this must be completed under the required level of **guidance and supervision** within the centre (see opposite). This is to ensure that each learner is witnessed producing their own outcome(s) so it can be authenticated and the learner's safety can be assured.

It is possible that the most suitable materials or machinery are not available in the centre's workshop. It is permissible to use the most suitable alternative materials in order to clearly demonstrate the intentions of the final prototype(s) and to deliver high quality outcomes.

Analysing validity of the final prototype

In order to make an appropriate evaluation of the final prototype(s), analysing stakeholders' opinions will be required. This should be sought from meaningful sources rather than superficially within the teaching group. It may be necessary to analyse the final prototype(s) in the situation or with the user group it is designed for. Centres **must** ensure that:

- the required photographic and/or video evidence **must** be taken prior to the prototype(s) being taken from the centre to ensure a valid assessment can be made should anything happen to the prototypes(s) whilst out of the centre.

3

Guidance and supervision requirements

Authenticating the making of the learner's final prototype(s) is of great importance as this is the only activity that cannot be fully recorded in the design process.

It is expected that the production of the final prototype(s) will take place during normal lesson time, using workshop and IT facilities as appropriate. Learners must be under direct teacher and/or technician supervision during this time. They must complete all of their work under these supervised conditions and the teacher must set the tone for this element of the NEA.

To make best use of supervised time, it is important that learners are prepared for and plan their activity in advance. It is also important for learners to write a report of their progress through the making process to evidence the on-going activity in their e-portfolio. The writing of this report does not need be under direct supervision.

Another reason for this supervised activity is so that the teacher can authenticate the level of guidance and support given through the making of the learner's final prototype(s). Any support that is given to assist a learner during production should be recorded by the supervisor concerned, whether it is direct assistance or due to health and safety requirements in the centre. The level of assistance given should be reflected in the assessment of the learner's NEA.

At A Level the learner can make arrangements to produce component parts outside of the centre, but for these to be recognised as the learner's work, they must, at all times, be under immediate guidance and supervision from a member of staff or by an industry professional who can be trusted to authenticate that the component was solely manufactured by the learner.

All practical work should be securely stored in the centre throughout the design and make process and distributed to the learner at the start of any supervised time. If for any reason practical work needs to be taken outside of the normal workshop or IT facilities before it is fully complete, the learner and final prototype(s) should at all times be accompanied by a suitable supervisor and this activity should be relevant to the design process and explained in the learner's e-portfolio.

Learners may wish to have access to their work between timetabled supervised sessions. This access can only be given if a suitable supervisor is available to authenticate the work being undertaken. Once the NEA has been submitted for assessment learners should not have access to their work. It should be securely retained within the centre until results are issued and it is certain that no Result Enquiry or Appeal procedure is required.

Teacher marking and feedback

Although the 'Iterative Design Project' is to be assessed internally once the project has been submitted, there may be requirements in some centres for learners to receive feedback and/or grades during the project to inform them of their progress. Therefore, it is important to consider what is acceptable.

Teachers can only give generic feedback on learners' work in progress and return it for re-drafting. Once handed in for final assessment, teachers may not return any work to learners for further adjustment. Any feedback given by the teacher must be framed in such a way as to enable the learner to take the initiative in developing their own work further.

Teachers cannot give detailed advice and specific suggestions as to how the work may be improved in order to meet the marking criteria. This includes indicating errors or omissions and personally intervening to improve the content of the work.

Teachers must reflect any assistance given throughout the 'Iterative Design Project' when marking learners' work. Provided that advice remains at a general level, this does not constitute intervention.

Both the teacher and learner will be required to confirm the authentication of the learners' work using the Candidate Declaration Form as outlined in Section 4d.

Required Evidence

There are **three** forms of evidence required to support the authentication of learners' work and enable the consideration of each learner's level of attainment against the marking criteria, which is set out to differentiate between each learner's performance.

Portfolio of evidence

Learners should produce a chronological e-portfolio (refer to Section 4d) supported by real-time evidence that demonstrates their complete 'Iterative Design Project'. This evidence should clearly demonstrate the design brief that the learner has written. It should also be in the order each activity is undertaken, outlining iterations as they occur or are developed rather than as they may be best presented.

Portfolio evidence can be supported by different digital files (see Section 5f), photographs, video and audio recordings. All evidence must be contained in a single digital folder for each learner, clearly labelled and signposted by the learner to indicate when evidence was completed and to ensure everything is easily identifiable through both internal marking and external moderation. Learners should complete a Candidate Content Sheet to support this.

Final Prototype

The final prototype(s) based on the learner's design brief must be clearly evidenced by the learner in their e-portfolio through the use of photography and video. All moving parts and perspectives should be appropriately visible to ensure it offers suitable evidence to any third party, enabling accurate assessment without the artefact being present.

The final prototype(s) must be kept securely in the centre during production. Photographs and videos should be taken as soon as production is complete to ensure all evidence is captured before any risk of damage or loss.

Observations

Teachers are the most appropriate individuals to evidence a learner's progress and the level of support given or independence demonstrated. Evidence of this nature can only be accepted in conjunction with the e-portfolio and final prototype(s).

Observed evidence is supporting evidence that should be recorded on the 'Candidate Record Form' and should reflect the wider evidence and support the internal marking.

Authenticity

Learners must clearly and unambiguously indicate work which is not their own and distinguish it from their own. Only the work of the learner, which can include managing the input from others and other sources, must be assessed.

It is a requirement of the iterative project that all references and sources of information/assistance must be indexed and acknowledged in a bibliography and must be clearly identifiable at the appropriate point in the e-portfolio of evidence submitted for assessment. This includes websites, books, digital sources, and help given by teachers, technicians, and others. This should also be acknowledged on their Candidate Declaration Form.

3

3b. Assessment objectives (AO)

There are four Assessment Objectives in the A Level in Design and Technology. These are detailed in the table below.

Learners are expected to demonstrate their ability to:

Assessment Objective	
AO1	Identify, investigate and outline design possibilities to address needs and wants.
AO2	Design and make prototypes that are fit for purpose.
AO3	Analyse and evaluate – • design decisions and outcomes, including for prototypes made by themselves and others • wider issues in design and technology.
AO4	Demonstrate and apply knowledge and understanding of – • technical principles • designing and making principles.

The assessment objectives AO1, AO2 and AO3 relate directly to iterative processes of 'explore/create/evaluate' as follows: AO1 = Explore, AO2 = Create, AO3 = Evaluate.

AO weightings in A Level in Design and Technology

The relationship between the assessment objectives and the components are shown in the following table:

Component	% of OCR A Level in Design and Technology (H404-H406)			
	AO1	AO2	AO3	AO4
Principles of... (component 01 of each endorsed title)	0	0	5%	21.7%
Problem Solving in.... (component 02 of each endorsed title)	0	0	7%	16.3%
Iterative Design Project (component 03 or 04 of each endorsed title)	12.5%	25%	12.5%	0
Total	12.5%	25%	24.5%	38%

3c. Assessment availability

There will be one examination series available each year in May/June for **all** learners.

All components must be taken in the same examination series at the end of the course.

This specification will be certificated from the June 2018 examination series onwards.

3d. Retaking the qualification

Learners can retake the qualification as many times as they wish. Learners must retake all examined components but they can choose to either retake the non-exam assessment (NEA) or carry forward (re-use) their most recent result (see Section 4d).

3e. Assessment of extended response

The assessment materials for this qualification provide learners with the opportunity to demonstrate their ability to construct and develop a sustained line of reasoning which is coherent, relevant, substantiated and logically structured. Marks for extended responses are integrated into the marking schemes.

3f. Internal assessment of non-exam assessment (NEA)

There are different stages in the production of the NEA, the task setting, task taking and required evidence are outlined in Section 3a, this section outlines the marking and final submission of the centre's entries.

Internal Assessment

Marking should be positive, rewarding achievement rather than penalising failure or omissions. The awarding of marks must be directly related to the marking criteria.

Teachers should use their professional judgement in selecting the band descriptors that best describes the work of the learner to place them in the appropriate band.

Teachers should use the full range of marks available to them and award all the marks in any mark band for which work fully meets that descriptor.

To select the most appropriate mark in the band descriptor, teachers should use the following guidance to locate the best-fit:

- where the learner's work *convincingly* meets the statement, the highest mark should be awarded
- where the learner's work a*dequately* meets the statement, the most appropriate mark in the middle of the range should be awarded
- where the learner's work *just* meets the statement, the lowest mark should be awarded.

The statements in each mark band are balanced in terms of their significance to help assessors judge the overall 'best-fit' within an assessment strand.

There should be clear evidence that work has been attempted and some work produced. If a learner submits no work for a component then the learner should be indicated as being absent from that component. If a learner completes any work at all for the component then the work should be assessed according to the marking criteria and the appropriate mark awarded, which may be zero.

As learners can deliver their e-portfolios using a variety of formats, there are no specific limits to the amount of evidence produced; however, any iterative design process should remain relevant to the context and brief of the project. It is essential that marking fully reviews and considers all material. It is the learner's responsibility to ensure all files function properly. If files do not open or function properly, this work cannot be considered in evidence.

It is essential that marking fully reviews and considers all material. It is the learner's responsibility to ensure all files function properly. If files do not open or function properly, this work cannot be considered in evidence.

Teachers must clearly show how the marks have been awarded in relation to the marking criteria on the Candidate Record Form.

The following approaches to indicate how marks have been awarded should be adopted:

- be clear and unambiguous
- be appropriate to the aims and objectives of the work
- facilitate the standardisation of marking in the centre
- enable the moderator to check the application of the marking criteria to the marking.

There are 'Candidate Record Forms' for individual learners that can be found on the qualification page on the OCR website.

Final Submission

Teachers should ensure that the standard applied in marking a learner's work in each endorsed title within the Design and Technology specification is the same standard as that expected and assessed for a learner following an individual specialist title, e.g. Design Engineering.

Work submitted for A level components should reflect the standard expected for a learner after a full A level course of study. The work presented for assessment in an A level qualification shows greater depth of study than that presented for an AS qualification. This might, for example, be achieved by:

- a greater depth of understanding and skill in design and/or areas of production

- extended development of design thinking and communication through higher level skills in thinking and presentation

- deeper levels of exploration with more support through stakeholder engagement

- an increased requirement to demonstrate understanding and project progress through informative communication

- higher level skills demonstrated in complex and sophisticated design solutions and prototypes

- more rigorous testing and analysis of design solutions and their viability as a marketable product.

To ensure teachers are marking to the correct standard, teachers who are delivering A level and/or AS level should ensure they use the A level and AS level marking criteria, performance descriptors and reference exemplar work for each level. These are available on the OCR website, www.ocr.org.uk.

Centres must carry out internal standardisation to make sure that marks awarded by different teachers are accurate and consistent across all learners entered by the centre. To help set the standard of marking, centres should use exemplar material provided by OCR, and, where available, work from that centre from the previous year. Where work has been marked by more than one teacher in a centre, standardisation of marking should normally be carried out according to one of the following procedures:

- **either** a sample of work that has been marked by each teacher is re-marked by the teacher who is in charge of internal standardisation
- **or** all the teachers responsible for marking a component exchange some marked work (preferably at a meeting led by the teacher in charge of internal standardisation) and compare their marking standards.

Where standards are found to be inconsistent, the relevant teacher(s) should make adjustment to their marks or re-mark all learners' work for which they were responsible.

If centres are working together in a consortium, they must carry out internal standardisation of marking across the consortium. Centres should retain evidence that internal standardisation has been carried out.

Once the final e-portfolio is submitted by the learner for assessment it must not be revised. Adding any material to the work or removing any material from it after it has been presented by a learner for final assessment would constitute malpractice. If a learner has required additional assistance in order to demonstrate aspects of the assessment, the teacher must submit a mark which represents the learner's unaided achievement.

Where the learner's evidence of their final prototype(s) is insufficient to demonstrate the marks that have been submitted by the centre, it is permitted for additional photography and/or video evidence to be taken to support the marking. This evidence should remain separate from the learner's work.

Each learner's work should be stored in a folder on a secure area on the centre's network. Prior to submitting the work to OCR, the centre should add the Candidate Record Form'.

For further guidance on e-portfolios and how to submit work refer to Section 4d. Work should be saved using the candidate name and centre name as reference.

Exams directory: www.ocr.org.uk

Iterative Design Project (03, 04) – Marking criteria

The marking criteria are set out over the following pages to outline how learners are to be assessed following completion of their own iterative design process that reflects their thinking, creative and practical skills and abilities through designing and making a prototype(s). To ensure comparability of all learners undertaking the 'Iterative Design Project' component the marking criteria set out are to be used regardless of the endorsed title they have followed.

The marking criteria covers five mark bands to clearly differentiate learners' work and are delivered through five strands of assessment, rewarding two distinct considerations:

- the thinking and design **process** of the 'Iterative Design Project' through explore/create/evaluate is assessed in strands 1, 2 and 5
- the quality of design **outcomes** in relation to design communication and the final prototype(s) are assessed in strands 3 and 4.

These are outlined in more detail below.

Mark band 5 should be used to identify those learners whose level of work and outcome(s) is exceptional, in that it represents an expert understanding and application of iterative designing and is considered the highest standard expected in GCE qualifications.

The level of attainment is consistent with standards that could be seen in a professional environment. As a consequence Mark Band 5 is reserved for learners who meet this exceptional standard and evidence should be apparent.

The marking criteria follow a 'best fit' approach as outlined in more detail earlier in this section. The layout of the assessment strands is to support internal application of the criteria, using the statements and the marks along the bottom of each strand to support 'best-fit' allocation.

The marking criteria for the 'Iterative Design Project' should be considered together with the non-exam content (NEA) from Section 2h and the relevant endorsed title interpretation of the NEA 2i to 2k to ensure coverage of content.

Guidance on the delivery and required evidence for the 'Iterative Design Project' are set out in Section 3a.

When completing internal assessment, these marking criteria should be considered together with the administrative requirements of the NEA outlined in Section 4d.

Assessment of process

The three **process** strands (1, 2 and 5) of the marking criteria follow an iterative design process with strands that cover 'explore', 'create' and 'evaluate'. Effective management of the interrelationship between the strands of the iterative design process is also assessed within these strands.

The assessment of 'process' is the process that each individual learner has undertaken. The evidence of the process will be given through the learner's chronological e-portfolio.

Assessment of outcomes

The two **outcome** strands (3 and 4) of the marking criteria are an opportunity for assessment of the graphical and practical outcomes delivered throughout the learner's design processes. This is the assessor's judgement of:

- the quality of design communication
- the quality of the final prototype(s).

The assessment of 'outcomes' can only be made against what is evidenced in the learner's chronological e-portfolio.

Further guidance on the collection and presentation of evidence can be found earlier in this section, in Section 3a and Section 4d.

Strand 1 – Explore (AO1)

					Exceptional Level
	Mark Band 1 (1–6)	**Mark Band 2 (7–11)**	**Mark Band 3 (12–16)**	**Mark Band 4 (17–21)**	**Mark Band 5 (22–25)**
Investigations of the context and feasibility study of potential approaches	Superficial investigations identify little or no problems and/or opportunities for further consideration. Little or no consideration of market potential through the approaches taken.	Investigations are of sufficient quality to identify some problems and/or opportunities for further consideration. Some consideration of market potential through the approaches taken.	Investigations offer a good level of detail and identify a breadth of problems and opportunities for further consideration. Informed consideration of market potential through the approaches taken.	Comprehensive investigations identify a breadth and/or depth of challenging problems and opportunities for further consideration. Objective consideration of market potential through the approaches taken.	Exceptional investigations identify a breadth of highly challenging problems and opportunities for further consideration. Objective and innovative consideration of market potential through the approaches taken.
Design brief	Limited relevance to the context and little or no identification of a primary user or other stakeholders.	Some relevance to the context and identification of a primary user and/or other stakeholders.	Mostly has relevance to the context offering scope for challenge and identification of a primary user and other stakeholders.	Clear and fully relevant to the context offering scope for challenge and a focused identification of a primary user and other stakeholders.	Exceptional understanding that is fully relevant to the context offering scope for challenge and a fully focused identification of a primary user and other stakeholders.
Investigations of user and stakeholder needs and wants and the outlining of stakeholder requirements (non-technical specification)	Superficial consideration of primary user(s) needs and wants with little or no consideration of other stakeholders. Little or no requirements have been identified and are outlined with limited scope to support the future design process.	Some relevant consideration of primary user(s) needs and wants and some consideration of other stakeholders. Some requirements are identified that offer some scope to support the design process.	Informed consideration of primary user and other stakeholders needs and wants. A range of requirements with a good level of detail are identified that offer scope to support the design process.	Full and objective consideration of primary user and other stakeholders needs and wants. A range of comprehensive requirements are identified that offer scope to support the design process.	Exceptional consideration of primary user and other stakeholders needs and wants. A range of clearly defined and comprehensive requirements are identified that offer scope to support the design process.
Investigations of existing products and design practices	Little or no information or sources of inspiration are identified to offer support to design iterations and thinking.	Some information and/or sources of inspiration are identified that may not always be relevant but do offer some influence on design iterations and thinking.	Good amount of relevant information and sources of inspiration are identified to influence design iterations and thinking when required throughout the design process.	Comprehensive and relevant information and sources of inspiration are identified to influence design iterations and thinking when required throughout the design process.	Sophisticated, comprehensive and fully relevant information and sources of inspiration are identified to perceptively and skillfully influence design iterations and thinking when required throughout the design process.
Exploration of materials and possible technical requirements	Superficial consideration of materials and/or possible technical requirements.	Some relevant consideration of materials and possible technical requirements.	Informed consideration of relevant materials and possible technical requirements when required throughout the design process.	Full and objective consideration of relevant materials and possible technical requirements when required throughout the design process.	Exceptional consideration of relevant materials and possible technical requirements when required throughout the design process.
Technical specification	Inaccurate, outlines basic details and/or is incomplete making it difficult for a third party to understand.	Generally accurate, outlines details that communicate some requirements to a third party.	Good levels of accuracy, outlines details that communicate most requirements to a third party.	High levels of accuracy, outlines details that clearly communicate all requirements to a third party.	Exceptional levels of accuracy, outlines details that show requirements are convincingly communicated to a third party.
	1 2 3 4 5 6	7 8 9 10 11	12 13 14 15 16	17 18 19 20 21	22 23 24 25

0 marks – No response or no response worthy of credit

Strand 2 – Create: Design Thinking (AO2)

	Mark Band 1 (1–5)	Mark Band 2 (6–9)	Mark Band 3 (10–13)	Mark Band 4 (14–16)	Exceptional Level Mark Band 5 (17–19)
Generation of initial ideas	Limited use of different design approaches that lead to ideas that do not always reflect the requirements and may appear stereotypical.	Some different design approaches that lead to some ideas that avoid design fixation and generally reflect the requirements.	Different and relevant design approaches that lead to a ideas that mostly avoid design fixation, offer scope for challenge and reflect requirements.	Different and relevant design approaches that lead to ideas that fully avoid design fixation, offer excellent scope for challenge and fully reflect requirements.	Different, relevant and innovative design approaches that lead to non-fixated ideas, offering outstanding scope for challenge and fully reflect and meet requirements.
Design developments	Limited developments are superficial and/or are not iterative.	Iterative developments are generally progressive and respond to some identified next-steps of development.	Iterative developments are progressive, incorporating technical requirements and respond to most identified next-steps of development.	Iterative developments are comprehensive and progressive, incorporating all technical requirements and fully respond to identified next-steps of development.	Iterative developments are exceptional, incorporating all technical requirements and fully respond and meet identified next-steps of development.
Development of final design solution(s)	Little or no progression seen from earlier developments and little or none of the identified opportunities and requirements have been met.	Some progression seen from earlier developments and some of the identified opportunities and requirements have been met.	Clear progression from earlier developments and most of the identified opportunities and requirements have been met.	Clear and comprehensive progression from earlier developments and all of the identified opportunities and requirements have been met.	Exceptional progression from earlier developments and all of the identified opportunities and requirements have been met.
Critical thinking	Superficial responses when problems are identified. Little or no evidence of innovation* throughout the design process.	Effective responses to some identified problems. Some evidence of innovation* throughout the design process.	Effective responses to most identified problems. Clear evidence of innovation* throughout the design process.	Systematic and effective responses to all identified problems. Clear and systematic evidence of innovation* throughout the design process.	Clear, systematic and highly effective responses to all identified problems. Exceptional evidence of innovation* throughout the design process.
	1 2 3 4 5	6 7 8 9	10 11 12 13	14 15 16	17 18 19

0 marks – No response or no response worthy of credit

* Innovation in this context refers to learners considering new methods or ideas to improve and refine their design solutions and meet the needs of their intended market and/or primary user.

Strand 3 – Create: Design Communication (AO2)

	Mark Band 1 (1–3)	Mark Band 2 (4–6)	Mark Band 3 (7–9)	Mark Band 4 (10–11)	Exceptional Level Mark Band 5 (12–13)
Quality of chronological progression	Design iterations are not always clear and/or chronological, with little or no support from real-time evidence.	Design iterations are sometimes clear and predominantly chronological, some support from real-time evidence.	Design iterations are clear and chronological, mostly supported by real-time evidence.	Design iterations are clear, systematic and chronological, fully supported by real-time evidence.	Design iterations are highly professional, systematic and chronological, fully supported by exceptional real-time evidence.
Quality of initial ideas	Informal graphical and modelling skills are limited and rarely clear enough to appropriately communicate initial thinking.	Informal graphical and modelling skills are sufficient, but are not consistent in appropriately communicating initial thinking.	Informal graphical and modelling skills are good and are consistent in appropriately communicating initial thinking.	Informal graphical and modelling skills are excellent and are effective and consistent in appropriately communicating initial thinking.	Informal graphical and modelling skills are exceptional and are highly effective and convincing in appropriately communicating initial thinking.
Quality of design developments	The range of communication techniques* used are limited and rarely clear enough to appropriately develop or communicate design concepts.	The range of communication techniques* used are sufficient, but are not consistent in appropriately developing or communicating design concepts.	The range of communication techniques* used are good and are consistent in appropriately developing or communicating design concepts.	The range of communication techniques* used are excellent and are effective and consistent in appropriately developing or communicating design concepts.	The range of communication techniques* used are exceptional and are highly effective and convincing in appropriately developing or communicating design concepts.
Quality of final design solution(s)	Formal presentation of the final design solution(s) is limited making it difficult for a third party to understand.	Formal presentation of the final design solution(s) is sufficient and provides some clarity to a third party.	Formal presentation of the final design solution(s) is good and provides appropriate clarity to a third party.	Formal presentation of the final design solution(s) is excellent and provides impact and appropriate clarity to a third party.	Formal presentation of the final design solution(s) is exceptional and provides strong impact and appropriate clarity to a third party.
	1 2 3	4 5 6	7 8 9	10 11	12 13

0 marks – No response or no response worthy of credit

* Refer to Strand 4 when assessing digital design and manufacture.

Strand 4 – Create: Final Prototype(s) (AO2)

	Mark Band 1 (1–5)	Mark Band 2 (6–9)	Mark Band 3 (10–13)	Mark Band 4 (14–16)	Exceptional Level Mark Band 5 (17–18)
Quality of planning for making the final prototype(s)	Offers little or no support to the making process with little or no consideration of safety.	Generally supports the management of the making process with some relevant requirements and safety considerations identified from the technical specification.	Good level of detail and relevant, covering most requirements and safety considerations identified from the technical specification to manage the making process.	Comprehensive and relevant, covering all requirements and safety considerations identified from the technical specification to effectively manage the making process.	Exceptional and fully relevant, covering all requirements and safety considerations identified from the technical specification to convincingly manage the making process.
Quality of final prototype(s)	Inaccurate and/or basic standards demonstrated. Finishing may not be appropriate and/or the outcome would not present well to a stakeholder.	Sufficient standard demonstrated through a generally accurate outcome. Finishing is appropriate but the outcome could be better presented to stakeholders.	Good standard and levels of accuracy demonstrated. Finishing is appropriate and the outcome will present well to a stakeholder.	Excellent standard, demonstrating high levels of accuracy. Finishing is appropriate and the outcome will present well and provide impact to a stakeholder.	Exceptional standard, demonstrating outstanding levels of accuracy. Finishing is appropriate and the outcome will convince and provide strong impact when presented to a stakeholder.
Use of specialist techniques and processes	Limited and rarely appropriate to materials/components being used.	Sufficient, but are not consistently appropriate to materials/ components being used.	Good and are consistently appropriate to materials/ components being used.	Excellent and are effective and consistently appropriate to materials/components being used.	Exceptional, highly effective and consistently appropriate to materials/components being used.
Use of specialist tools and equipment	Use and selection of hand tools and/or machinery are limited and rarely appropriate. Digital design and/or manufacture* is limited and demonstrate little or no skills or knowledge.	Use and selection of hand tools and machinery are sufficient, but not always consistently appropriate. Digital design and manufacture* is not always used appropriately, but demonstrate sufficient skills and knowledge.	Use and selection of hand tools and machinery are good and consistently appropriate. Digital design and manufacture* are used appropriately to demonstrate good skills and knowledge.	Use and selection of hand tools and machinery are effective and consistently appropriate. Digital design and manufacture* are used effectively and appropriately to demonstrate excellent skills and knowledge.	Use and selection of hand tools and machinery are highly effective and consistently appropriate. Digital design and manufacture* are used highly effectively and appropriately to demonstrate exceptional skills and knowledge.
Viability of the final prototype(s)	Little or no links to the technical specification and demonstrates limited potential to become a marketable/industrial product.	Meets some of the technical specification and demonstrates some potential to become a marketable/industrial product.	Meets most of the technical specification and demonstrates good potential to become a marketable/industrial product.	Meets all of the technical specification and demonstrates excellent potential to become a marketable/industrial product.	Meets all of the technical specification and demonstrates exceptional potential to become a marketable/industrial product.
	1 2 3 4 5	6 7 8 9	10 11 12 13	14 15 16	17 18

0 marks – No response or no response worthy of credit

***It may not have been appropriate to use digital design and manufacture in the final prototype. Where this is the case, the statement should be assessed on the skill levels demonstrated when using digital design and manufacture through earlier modelling. This can equally be applied to the use of hand tools and machinery, all of which require appropriate evidence.

Strand 5 – Evaluate (AO3)

	Mark Band 1 (1–6)	Mark Band 2 (7–11)	Mark Band 3 (12–16)	Mark Band 4 (17–21)	Exceptional Level Mark Band 5 (22–25)
Analysis and evaluation of primary and/or secondary sources	Limited analysis and evaluation of investigated sources of information from stakeholders, existing products and/or wider issues, offering little or no support to inform the design process.	Sufficient analysis and evaluation of investigated sources of information from stakeholders, existing products and wider issues, offering some support to inform the design process.	Good level of analysis and evaluation of investigated sources of information from stakeholders, existing products and wider issues, offering clear support to inform the design process.	Comprehensive and systematic analysis and evaluation of investigated sources of information from stakeholders, existing products and wider issues, offering clear and focused support to inform the design process.	Exceptional analysis and evaluation of investigated sources of information from stakeholders, existing products and wider issues, offering clear and convincing support to inform the design process.
Ongoing evaluation to manage design progression	Superficial evaluations with little or no reflection on requirements or feedback. Little or no reviews to identify any problems and/or next-steps for future iterations resulting in limited support to design progression.	Some critical evaluations with sufficient reflection on requirements and feedback. Infrequent reviews to identify some problems and/or next-steps for future iterations that are not always consistent in supporting design progression.	Mostly critical evaluations with good reflection on requirements and feedback. Ongoing and clear reviews to identify problems and next-steps for future iterations to consistently support design progression.	Full and critical evaluations with focused reflection on requirements and feedback. Ongoing, clear and comprehensive reviews to identify problems and next-steps for future iterations to effectively and consistently support design progression.	Exceptional critical evaluations with focused reflection on requirements and feedback. Ongoing, perceptive and comprehensive reviews to identify problems and next-steps for future iterations and convincingly supports progression.
Risk Assessments	Little or no analysis and evaluation resulting in superficial considerations of health and safety risks.	Sufficient analysis and evaluation that result in some considerations of health and safety risks.	Good level of detail in analysis and evaluation that result in clear considerations of health and safety risks.	Comprehensive analysis and evaluation that result in clear and focused considerations of health and safety risks.	Exceptional analysis and evaluation that result in perceptive and appropriate considerations of health and safety risks.
Feasibility of the design solution	Limited with little or no methods used to appropriately analyse and test whether the design solution is fit for purpose.	Sufficient with some appropriate methods used to analyse and test whether the design solution is fit for purpose.	Good level of detail with mostly appropriate methods used to analyse and test whether the design solution is fit for purpose.	Comprehensive with fully appropriate methods used to analyse and test whether the design solution is fit for purpose.	Exceptional, with fully appropriate methods used to analyse and test whether the design solution is fit for purpose.
Evaluation of the final prototype(s)	Superficial evaluation of strengths and/or weaknesses with little or no suggestions for modification and/or consideration of possible design optimisation presented.	Sufficient critical evaluation of strengths and/or weaknesses with some suggestions for modification and/or consideration of possible design optimisation presented.	Good critical evaluation of strengths and weaknesses with detailed suggestions for modification and consideration of possible design optimisation presented.	Full and critical evaluation of strengths and weaknesses with comprehensive suggestions for modification and consideration of possible design optimisation presented.	Exceptional critical evaluation of strengths and weaknesses with perceptive and comprehensive suggestions for modification and consideration of clearly defined design optimisation presented.
	1 2 3 4 5 6	7 8 9 10 11	12 13 14 15 16	17 18 19 20 21	22 23 24 25

0 marks – No response or no response worthy of credit.

Iterative Design Project (03) – Assessment Objective Distribution

The table below demonstrates how the Assessment Objectives are attributed to each section of the non-exam assessmentand where evidence of mathematics can be assessed.

Strand of Marking Criteria	% of overall Iterative Design Project			Total % per strand	Use of Maths Skills
	AO1	AO2	AO3		
Explore	25	0	0	25	✔
Create – Design Thinking	0	19	0	19	✔
Create – Design Communication	0	13	0	13	✔
Create – Final prototype(s)	0	18	0	18	✔
Evaluate	0	0	25	25	✔
Total	**25%**	**50%**	**25%**	**100%**	✔

3g. Synoptic assessment

Synoptic assessment is the learner's understanding of the connections between different elements of the subject. It involves the explicit drawing together of knowledge, skills and understanding from across the full A Level course of study.

The emphasis of synoptic assessment is to encourage the understanding of Design and Technology as a whole discipline.

Synoptic assessment requires learners to make and use connections within and between all different areas of design and technology, for example, by:

- understanding how an iterative design process requires multiple considerations not only to 'explore/create/evaluate', but also through the application of knowledge and understanding of both 'core' and 'applied' designing, making and technical principles
- justifying thinking in relation to an iterative design process through the consideration of, say, the forces exerted on a joint or seam and what impact that has on the materials being used to demonstrate that it is effectively fulfilling its requirements, or the identification of stakeholder needs and fulfilling these needs through the delivery of a design solution
- stretching design challenges to not only demonstrate application of knowledge and understanding of design and technical principles, but also through the application of wider mathematical and scientific knowledge.

3h. Calculating qualification results

A learner's overall qualification grade for A Level in Design and Technology will be calculated by multiplying their marks for the NEA by 150% and then adding this to their marks for the two examined components taken to give their total weighted mark. This mark will then be compared to the qualification level grade boundaries for the entry option taken by the learner and for the relevant exam series to determine the learner's overall qualification grade.

4 Admin: what you need to know

The information in this section is designed to give an overview of the processes involved in administering this qualification so that you can speak to your exams officer. All of the following processes require you to submit something to OCR by a specific deadline.

More information about the processes and deadlines involved at each stage of the assessment cycle can be found in the Administration area of the OCR website. OCR's *Admin overview* is available on the OCR website at http://www.ocr.org.uk/administration.

4a. Pre-assessment

Estimated entries

Estimated entries are your best projection of the number of learners who will be entered for a qualification in a particular series. Estimated entries should be submitted to OCR by the specified deadline. They are free and do not commit your centre in any way.

Final entries

Final entries provide OCR with detailed data for each learner, showing each assessment to be taken. It is essential that you use the correct entry code, considering the relevant entry rules and ensuring that you choose the entry option for the moderation you intend to use.

Final entries must be submitted to OCR by the published deadlines or late entry fees will apply.

All learners taking an A Level in Design and Technology must be entered for one of the following entry options:

<table>
<tr><th colspan="2">Entry option</th><th colspan="3">Components</th></tr>
<tr><th>Entry code</th><th>Title</th><th>Code</th><th>Title</th><th>Assessment type</th></tr>
<tr><td rowspan="3">H404 A</td><td rowspan="3">Design and Technology: Design Engineering A</td><td>01</td><td>Principles of Design Engineering</td><td>External Assessment</td></tr>
<tr><td>02</td><td>Problem Solving in Design Engineering</td><td>External Assessment</td></tr>
<tr><td>03</td><td>Iterative Design Project (Repository)</td><td>Non-exam Assessment</td></tr>
<tr><td rowspan="3">H404 B</td><td rowspan="3">Design and Technology: Design Engineering B</td><td>01</td><td>Principles of Design Engineering</td><td>External Assessment</td></tr>
<tr><td>02</td><td>Problem Solving in Design Engineering</td><td>External Assessment</td></tr>
<tr><td>04</td><td>Iterative Design Project (Postal)</td><td>Non-exam Assessment</td></tr>
<tr><td rowspan="3">H404 C</td><td rowspan="3">Design and Technology: Design Engineering C</td><td>01</td><td>Principles of Design Engineering</td><td>External Assessment</td></tr>
<tr><td>02</td><td>Problem Solving in Design Engineering</td><td>External Assessment</td></tr>
<tr><td>80</td><td>Iterative Design Project (Carried Forward)</td><td>Non-exam Assessment</td></tr>
</table>

Entry option		Components		
Entry code	Title	Code	Title	Assessment type
H405 A	Design and Technology: Fashion and Textiles A	01	Principles of Fashion and Textiles	External Assessment
		02	Problem Solving in Fashion and Textiles	External Assessment
		03	Iterative Design Project (Repository)	Non-exam Assessment
H405 B	Design and Technology: Fashion and Textiles B	01	Principles of Fashion and Textiles	External Assessment
		02	Problem Solving in Fashion and Textiles	External Assessment
		04	Iterative Design Project (Postal)	Non-exam Assessment
H405 C	Design and Technology: Fashion and Textiles C	01	Principles of Fashion and Textiles	External Assessment
		02	Problem Solving in Fashion and Textiles	External Assessment
		80	Iterative Design Project (Carried Forward)	Non-exam Assessment
H406 A	Design and Technology: Product Design A	01	Principles of Product Design	External Assessment
		02	Problem Solving in Product Design	External Assessment
		03	Iterative Design Project (Repository)	Non-exam Assessment
H406 B	Design and Technology: Product Design B	01	Principles of Product Design	External Assessment
		02	Problem Solving in Product Design	External Assessment
		04	Iterative Design Project (Postal)	Non-exam Assessment
H406 C	Design and Technology: Product Design C	01	Principles of Product Design	External Assessment
		02	Problem Solving in Product Design	External Assessment
		80	Iterative Design Project (Carried Forward)	Non-exam Assessment

*Entry option H404 C, H405 C or H406 C should only be selected for learners who are retaking the qualification who want to carry forward their mark for the non-exam assessment.

4b. Special consideration

Special consideration is a post-assessment adjustment to marks or grades to reflect temporary injury, illness or other indisposition at the time the assessment was taken.

Detailed information about eligibility for special consideration can be found in the *JCQ* publication *A guide to the special consideration process*.

Regulations governing examination arrangements are contained in the JCQ *Instructions for conducting examinations.*

4c. External assessment arrangements

Regulations governing examination arrangements are contained in the JCQ *Instructions for conducting examinations*.

4

4d. Admin of non-exam assessment

Regulations governing arrangements for internal assessments are contained in the JCQ *Instructions for conducting non-examination assessments*.

It should be made clear to learners that once the final portfolios have been submitted for assessment, no further work may take place.

Approval of tasks

The exploration of any context used in an A Level 'Iterative Design Project' is essentially down to the learner, as there are no OCR set tasks, and this forms an important part of the learner's non-exam assessment. Prior teaching and learning should ensure learners know how to explore contexts that offer possibilities for development through a project.

Learners should also be aware of how to modify their approach appropriately through an iterative design process, evidencing changes in the direction of a task is required.

Further information on task setting can be found in Section 3a.

Authentication of learners' work

Centres must declare that the work submitted for assessment is the learner's own by completing a centre authentication form (CCS160) for each internally-assessed component. This information must be retained at the centre and be available on request to either OCR or the JCQ centre inspection service. It must be kept until the deadline has passed for centres to submit an enquiry about results (EAR). Once this deadline has passed and centres have not requested an EAR, this evidence can be destroyed.

A copy of the Candidate Declaration Form, which forms part of the submission for each learner's work, can be found on the OCR website www.ocr.org.uk. It is important to note that **all** learners are required to sign and complete this form, and not merely those whose work forms part of the sample submitted to the moderator. Malpractice discovered prior to the learner signing the declaration of authentication need not be reported to OCR but must be dealt with in accordance with the centre's internal procedures.

Before any work towards the non-exam assessment is undertaken, the learner's attention should be drawn to the relevant JCQ *Notice to Learners*. This is available on the JCQ website www.jcq.org.uk and included in the *Instructions for Conducting Coursework/Portfolios*. More detailed guidance on the prevention of plagiarism is given in the *Plagiarism in Examinations.*

Learners' level of ability and each individual's work should be clearly identifiable and be taken under conditions which ensure that the evidence generated by each learner can be authenticated.

Investigation, exploration and design thinking can take place outside the centre as well as within the centre. Teachers need to ensure that the any work of this nature is only used to support the narrative of the NEA and that any work undertaken to present their final design solution(s) and prototype(s) is carried out under guidance and supervision.

When learners are producing their final prototype(s) this is required to be made under direct guidance or supervision to ensure authenticity (refer to Section 3a for requirements for guidance and supervision). The work should be securely stored within the centre throughout this part of the design and make process.

Head of centre annual declaration

The Head of Centre is required to provide a declaration to the JCQ as part of the annual NCN update, conducted in the autumn term, to confirm that all candidates at the centre have had the opportunity to undertake the prescribed course activities.

Please see the JCQ publication *Instructions for conducting non-examination assessments* for further information. Any failure by a centre to provide the Head of Centre Annual Declaration will result in your centre status being suspended and could lead to the withdrawal of our approval for you to operate as a centre.

Private candidates

Private candidates may enter for OCR assessments.

A private candidate is someone who pursues a course of study independently but takes an examination or assessment at an approved examination centre. A private candidate may be a part-time student, someone taking a distance learning course, or someone being tutored privately. They must be based in the UK.

OCR's A Level in Design and Technology requires learners to complete non-examined assessment. This is an essential part of the course and will allow learners to develop skills for further study or employment.

Private candidates need to contact OCR approved centres to establish whether they are prepared to host them as a private candidate. The centre may charge for this facility and OCR recommends that the arrangement is made early in the course.

Further guidance for private candidates may be found on the OCR website: http://www.ocr.org.uk

Internal Standardisation

Centres must carry out internal standardisation to ensure that marks awarded by different teachers are accurate and consistent across all learners entered for the component from that centre.

Moderation

The purpose of moderation is to bring the marking of internally-assessed components in all participating centres to an agreed standard. This is achieved by checking a sample of each centre's marking of learners' work.

Following internal standardisation, centres submit marks to OCR and the moderator. If there are fewer than 10 learners, all the work should be submitted for moderation at the same time as marks are submitted.

Once marks have been submitted to OCR and your moderator, centres will receive a moderation sample request. Samples will include work from across the range of attainment of the learners' work.

There are two ways to submit a sample:

Moderation via the OCR Repository – Where you upload electronic copies of the work included in the sample to the OCR Repository and your moderator accesses the work from there. Please refer to the OCR *Admin guide: 14–19 qualifications* for details about how to submit files using the OCR Repository.

Postal moderation – Where you post the sample of work to the moderator.

The method that will be used to submit the moderation sample must be specified when making entries. The relevant entry codes are given in Section 4a.

All learners' work must be submitted using the same entry option. It is not possible for centres to offer both options within the same series.

Centres will receive the outcome of moderation when the provisional results are issued. This will include:

Moderation Adjustments Report – Listing any scaling that has been applied to internally-assessed components

Moderator Report to Centres – A brief report by the moderator on the internal assessment of learners' work.

Preparing work for submission

Preparing work for submission can be a time consuming and stressful task if not planned properly. So as not to waste precious time, centres should make sure they are fully aware of the sample they are required to submit. Centres will have stored all of their learners' folders within a secure folder on their centre network.

Within each learner's folder from the sample being submitted, the following forms must be included:

1. Candidate Declaration Form
2. Candidate Record Form (CRF3).

The Candidate Record Form is used to mark learners' work with supporting evidence. This will offer centres an opportunity to share observations and evidence locations to justify how they arrived at the mark that was given and to add any additional evidence of the prototype(s) if the learners' evidence is not sufficient in demonstrating the marks awarded.

All forms for submission are available to download on the subject page on the OCR website.

E-Portfolios

In order to minimise software and hardware compatibility issues it will be necessary to save learners' work using an appropriate file format.

Learners must use formats appropriate to the evidence they are providing and appropriate to viewing for assessment and moderation purposes.

Open file formats or proprietary formats for which a downloadable reader or player is available are acceptable. Where a downloadable version is not available, the file format is not acceptable.

Evidence submitted can be through one or more formats, but it is essential that all formats are clearly labelled and signposted to offer a straightforward chronological review of the work.

Learners do not gain marks for using more sophisticated formats or for using a range of formats.

All portfolio evidence should be appropriate to the real-time activity being pursued. So long as evidence is clearly real-time, a learner who chooses or only has access to digital photography (as required in the specification) and word documents will not be disadvantaged by that choice.

To ensure compatibility, all files submitted must be in the formats listed in Appendix 5g. Where new formats become available that might be accepted, OCR will provide further guidance on the subject webpage. OCR advises against changing the file format that the document was originally created in. It is the centre's responsibility to ensure that the electronic work submitted for moderation is accessible to the moderator and fully represents the evidence available for each learner.

Carrying forward non-exam assessment (NEA)

Learners who are retaking the qualification can choose to either retake the non-exam assessment – Iterative Design Project (03, 04) or carry forward their most recent result for that component.

To carry forward the NEA component result, you must use the correct carry forward entry option (see table on page in Section 4a).

Learners must decide at the point of entry whether they are going to carry forward the NEA result or not.

The result for the NEA component may be carried forward for the lifetime of the specification and there is no restriction on the number of times the result may be carried forward. However, only the most recent non-absent result may be carried forward.

When the result is carried forward, the grade boundaries from the previous year of entry will be used to calculate a new weighted mark for the carried forward component, so the value of the original mark is preserved.

4e. Results and certificates

Grade Scale

A level qualifications are graded on the scale: A*, A, B, C, D, E, where A* is the highest. Learners who fail to reach the minimum standard for E will be Unclassified (U).

Only subjects in which grades A* to E are attained will be recorded on certificates.

Results

Results are released to centres and learners for information and to allow any queries to be resolved before certificates are issued.

Centres will have access to the following results information for each learner:

- the grade for the qualification
- the raw mark for each component
- the total weighted mark for the qualification.

The following supporting information will be available:

- raw mark grade boundaries for each component
- weighted mark grade boundaries for each entry option.

Until certificates are issued, results are deemed to be provisional and may be subject to amendment.

A learner's final results will be recorded on an OCR certificate. The H404, H405 and H406 endorsed titles will be shown respectively on the certificate as:

'OCR Level 3 Advanced GCE in Design and Technology: Design Engineering'

'OCR Level 3 Advanced GCE in Design and Technology: Fashion and Textiles'

'OCR Level 3 Advanced GCE in Design and Technology: Product Design'.

4f. Post-results services

A number of post-results services are available:

- **Enquiries about results** – If you are not happy with the outcome of a learner's results, centres may submit an enquiry about results.

- **Missing and incomplete results** – This service should be used if an individual subject result for a learner is missing, or the learner has been omitted entirely from the results supplied.

- **Access to scripts** – Centres can request access to marked scripts.

4g. Malpractice

Any breach of the regulations for the conduct of examinations and non-exam assessment work may constitute malpractice (which includes maladministration) and must be reported to OCR as soon as it is detected.

Detailed information on malpractice can be found in the JCQ publication *Suspected Malpractice in Examinations and Assessments: Policies and Procedures*.

5 Appendices

5a. Accessibility

Reasonable adjustments and access arrangements allow learners with special educational needs, disabilities or temporary injuries to access the assessment and show what they know and can do, without changing the demands of the assessment. Applications for these should be made before the examination series. Detailed information about eligibility for access arrangements can be found in the JCQ *Access Arrangements and Reasonable Adjustments.*

The A level qualification and subject criteria have been reviewed in order to identify any feature which could disadvantage learners who share a protected Characteristic as defined by the Equality Act 2010. All reasonable steps have been taken to minimise any such disadvantage.

5b. Overlap with other qualifications

This qualification allows for knowledge and understanding to be drawn on and applied from other qualifications such as Art and Design, Computer Science and Geography, but there is no significant overlap with these qualifications.

There is content in the specification that has some overlap with GCSE (9–1) mathematics and scientific specifications. This overlap is a requirement of the qualification and in particular the mathematical skills are set out as a condition of assessment by Ofqual.

Within the content in Sections 2e–2k of this specification the links to mathematics and science are highlighted using symbols.

= Maths

= Science

In addition, the mathematical skills are interpreted for each component alongside the content and further mapping is given in the next two sections to outline the links to respective GCSE (9–1) specifications in Mathematics and Combined Science.

In addition to the above, the endorsed title of Textiles within AS and A Level Art and Design can be seen to link directly to the textiles requirements in this qualification. It is, however, important to be aware that the two qualifications cover very different subjects. Learners considering taking either qualification should be made aware of these differences to ensure they are making the right choices for their futures. A review of the progression from GCE Design and Technology: Fashion and Textiles will support centres in understanding the available pathways into Higher and Further Education.

5c. Use of mathematics within Design and Technology

Through their work in design and technology, learners are required to apply relevant mathematical knowledge, skills and understanding equivalent to higher tier GCSE (9–1) learning.

The table below shows the requirements for mathematical skills to be covered within A Level Design and Technology. These are supported with examples to demonstrate application of each skill that could be assessed in examinations.

Learners following the Design Engineering endorsed title are required to additionally apply their mathematical skills to the scientific formulae outlined in Appendix 5d and specific engineering formulae as outlined below. Learners will be required to know these formulae and should be familiar with how to apply them through their teaching and learning. Formulae that fall within mathematical skills will be attributed to the 25% maths marks, formulae from science and engineering will not.

Within OCR's GCSE (9–1) in Mathematics the content is outlined at three different levels, the third column identifies the learning that is exclusive to higher tier GCSE (9–1). The first two columns identify content that is associates with foundation tier or lower. These are all shown in the table below to demonstrate how the GCSE (9–1) in Mathematics can support teaching and learning in Design and Technology.

The Maths content columns are indicated as appropriate using (1), (2) and (3) to clarify the standard. Where content is presented from the first two columns these will be assessed at a level of demand above the description of the statement to ensure they meet the requirements of higher tier GCSE (9–1).

With any mathematics within Design and Technology it is important that learners understand the standard application of metric units and other standard units of mass, length, time and money.

Mathematical skills requirements for Design and Technology *Required skills*	*Examples of application in Design and Technology*	**OCR GCSE (9–1) Mathematics ref.**	**GCSE (9–1) Mathematics specification (J560)**
M1 Confident use of number and percentages	*All endorsed titles* • calculation of quantities of materials, components, costs and size with consideration of percentage profits and tolerances as appropriate. • substitute numerical values into and rearrange learnt formulae and expressions. • confident use of decimal and standard form.	3.01b 3.02a 4.01a 4.01c	• Calculate positive integer powers and exact roots. (1) • Interpret and order numbers expressed in standard form. Convert numbers to and from standard form. (1) • Round answers to an appropriate level of accuracy. (2) • Use inequality notation to write down an error interval for a number or measurement rounded or truncated to a given degree of accuracy. (2) Calculate the upper and lower bounds of a calculation using numbers rounded to a known degree of accuracy. (3)

Mathematical skills requirements for Design and Technology *Required skills*	 *Examples of application in Design and Technology*	OCR GCSE (9–1) Mathematics ref.	GCSE (9–1) Mathematics specification (J560)
		6.02a	Formulate simple formulae and expressions from real-world contexts. (1)
		6.02b	Substitute positive numbers into simple expressions and formulae to find the value of the subject (1) and into more complex formulae, including powers, roots and algebraic fractions. (2)
		6.02c	Rearrange formulae to change the subject, including cases where the subject appears twice, or where a power or reciprocal of the subject appears. (2)
		6.04a	Understand and use the symbols $<$, $\leq$, $>$ and $\geq$. (1) Solve linear inequalities in one variable. (2)
		10.01a	Use and convert standard units of measurement for length, area, volume/capacity, mass, time and money (1) and in algebraic contexts. (2)
		10.01b	Use and convert simple compound units (e.g. for speed, rates of pay, unit pricing) (1) (e.g. density, pressure) (2). Know and apply in simple cases: speed = distance ÷ time (1) and density = mass ÷ volume. Use and convert compound units in algebraic contexts. (2)
	Design Engineering only: • recall and application of engineering formulae in qualitative work and calculations when applying engineering to mathematical skills: ○ Young's modulus = $\frac{stress}{strain}$	6.02b 6.02e	Substitute positive numbers into simple expressions and formulae to find the value of the subject (1) or negative numbers into more complex formulae, including powers, roots and algebraic fractions. (2) Use $v = u + at$, $s = ut + \frac{1}{2}at^2$ and $v^2 = u^2 + 2as$ where a is constant acceleration, u is initial velocity, v is final velocity, s is displacement from position when $t = 0$ and t is time taken. (1)

Mathematical skills requirements for Design and Technology		OCR GCSE (9–1) Mathematics ref.	GCSE (9–1) Mathematics specification (J560)
Required skills	*Examples of application in Design and Technology*		
	○ Stress = $\frac{\textit{force}}{\textit{cross-sectional area}}$ ○ Strain = $\frac{\textit{extension}}{\textit{original length}}$ ○ Pressure = force/area ○ Wave frequency = 1/period ○ Turning effects, torque = Fd , or moment = Fx • recall and application of scientific formulae outlined in requirement S1 in Appendix 5d.	10.01b	Use and convert simple compound units (e.g. for speed, rates of pay, unit pricing (1)) (e.g. density, pressure) (2). Know and apply in simple cases: speed = distance ÷ time (1) and density = mass ÷ volume. Use and convert compound units in algebraic contexts. (2)
M2 Use of ratios	• understand and use ratios in the scaling of drawings and pattern grading • understand and apply fractions and percentages when analysing data, survey responses and user questionnaires given in tables and charts • calculate percentages e.g. with profit, waste saving calculations or comparing measurements.	2.01a 2.01c 2.03a 2.03b 2.03c 5.01a 5.01b 5.01c 5.01d 9.04c	Recognise and use equivalence between simple fractions and mixed numbers. (1) Calculate a fraction of a quantity. (1) Convert between fractions, decimals and percentages. (1) Calculate a percentage of a quantity, and express one quantity as a percentage of another. (1) Express percentage change as a decimal or fractional multiplier. Apply this to percentage change problems (including original value problems). (2) Find the ratio of quantities in the form *a* : *b* and simplify. Find the ratio of quantities in the form 1 : *n*. (1) Split a quantity into two parts given the ratio of the parts. Express the division of a quantity into two parts as a ratio. Calculate one quantity from another, given the ratio of the two quantities. (1) Interpret a ratio of two parts as a fraction of a whole. (1) Solve simple ratio and proportion problems. (1) Compare lengths, areas and volumes using ratio notation and scale factors. (1) Understand the relationship between lengths, areas and volumes of similar shapes. (3)

Mathematical skills requirements for Design and Technology *Required skills*	*Examples of application in Design and Technology*	OCR GCSE (9–1) Mathematics ref.	GCSE (9–1) Mathematics specification (J560)
M3 Calculation of surface areas and/or volumes	• determining quantities of materials by surface area • calculate the overall surface area of different shapes, such as cuboids, cylinders and spheres to determine quantities of material and feasibility analysis • calculate the volume of different shapes, such as, cuboids, cylinders and spheres to determine suitability of objects and products.	8.06a 10.04a 10.04b 10.04c	Recognise and know the properties of the cube, cuboid, prism, cylinder, pyramid, cone and sphere. (1) Calculate the surface area and volume of cuboids and other right prisms (including cylinders). (1) Calculate the surface area and volume of spheres, cones and simple composite solids (formulae will be given). (2) Calculate the surface area and volume of a pyramid (the formula area of base × height will be given). (2)
M4 Use of trigonometry	*All endorsed titles* • calculate the sides and angles of objects to determine structural integrity, marking out and direction of movement *Design Engineering only* • determining projectile motion and direction of movement • determining how to resolve force vectors using $F_x = F\cos\theta$ and $F_y = F\sin\theta$	8.04b 10.05a 10.05b 10.05c	Know the basic properties of the square, rectangle, parallelogram, trapezium, kite and rhombus. (1) Use these facts to find lengths and angles in rectilinear figures and in simple proofs. (2) Use these facts in more formal proofs of geometrical results. (3) Know, derive and apply Pythagoras' theorem $a^2 + b^2 = c^2$ to find lengths in right-angled triangles in 2D figures. (2) Apply Pythagoras' theorem in more complex figures, including 3D figures. (3) Know and apply the trigonometric ratios, $\sin\theta$, $\cos\theta$ and $\tan\theta$ and apply them to find angles and lengths in right-angled triangles in 2D figures. (2) Apply the trigonometry of right-angled triangles in more complex figures, including 3D figures. (3) Know the exact values of $\sin\theta$ and $\cos\theta$ for θ = 0°, 30°, 45°, 60° and 90°. Know the exact value of $\tan\theta$ for θ = 0°, 30°, 45° and 60°. (2)

Mathematical skills requirements for Design and Technology *Required skills*	*Examples of application in Design and Technology*	OCR GCSE (9–1) Mathematics ref.	GCSE (9–1) Mathematics specification (J560)
		10.05d	Know and apply the sine rule, $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$, to find lengths and angles. (3)
		10.05e	Know and apply the cosine rule, $a^2 = b^2 + c^2 - 2bc \cos A$, to find lengths and angles. (3)
M5 Construction, use and/or analysis of graphs and charts	*All endorsed titles* • representation of data used to inform design decisions and evaluation of outcomes • presentation of market data, user preferences, outcomes of market research as part of product design, fashion and textiles • interpret and extract appropriate data.	7.01a	Work with *x*- and *y*- coordinates in all four quadrants. (1)
		7.04a	Construct and interpret graphs in real-world contexts. (1) Recognise and interpret graphs that illustrate direct and inverse proportion. (2)
		12.02a	Interpret and construct charts appropriate to the data type; including frequency tables, bar charts, pie charts and pictograms for categorical data, vertical line charts for ungrouped discrete numerical data. Interpret multiple and composite bar charts. (1) Design tables to classify data. Interpret and construct line graphs for time series data, and identify trends (e.g. seasonal variations). (2)
		12.02b	Interpret and construct diagrams for grouped data as appropriate, i.e. cumulative frequency graphs and histograms (with either equal or unequal class intervals). (3)
		12.03a	Calculate the mean, mode, median and range for ungrouped data. Find the modal class, and calculate estimates of the range, mean and median for grouped data, and understand why they are estimates. Describe a population using statistics. Make simple comparisons. Compare data sets using 'like for like' summary values. Understand the advantages and disadvantages of summary values. (1) Calculate estimates of mean, median, mode, range, quartiles and interquartile range from graphical representation of grouped data. Draw and interpret box plots. Use the median and interquartile range to compare distributions. (3)

Mathematical skills requirements for Design and Technology		OCR GCSE (9–1) Mathematics ref.	GCSE (9–1) Mathematics specification (J560)
Required skills	*Examples of application in Design and Technology*		
		12.03c	Plot and interpret scatter diagrams for bivariate data. Recognise correlation. (1) Interpret correlation within the context of the variables, and appreciate the distinction between correlation and causation. Draw a line of best fit by eye, and use it to make predictions. Interpolate and extrapolate from data, and be aware of the limitations of these techniques. (2)
		12.03d	Identify an outlier in simple cases. (1) Appreciate there may be errors in data from values (outliers) that do not 'fit'. Recognise outliers on a scatter graph. (2)
	Design Engineering only • present and interpret velocity/time graphs, stress-strain and resistance-temperature graphs • representation of frequency, period, amplitude and phase.	7.04b	Calculate or estimate gradients of graphs, and interpret in contexts such as distance-time graphs, velocity-time graphs and financial graphs. Apply the concepts of average and instantaneous rate of change (gradients of chords or tangents) in numerical, algebraic and graphical contexts. (3)
		7.04c	Calculate or estimate areas under graphs, and interpret in contexts such as distance-time graphs, velocity-time graphs and financial graphs. (3)

Mathematical skills requirements for Design and Technology *Required skills*	*Examples of application in Design and Technology*	OCR GCSE (9–1) Mathematics ref.	GCSE (9–1) Mathematics specification (J560)
M6 Use of coordinates and geometry	• use of datum points and geometry when setting out design drawings, when setting out patterns and within engineering drawings • present accurate 2D and 3D graphics to communicate design solutions.	8.01g	Use *x*- and *y*- coordinates in plane geometry problems, including transformations of simple shapes. (1)
		8.06b	Interpret plans and elevations of simple 3D solids. (1) Construct plans and elevations of simple 3D solids, and representations (e.g. using isometric paper) of solids from plans and elevations.
		9.03a	Understand addition, subtraction and scalar multiplication of vectors. (2) Use vectors in geometric arguments and proofs. (3)
		10.01c	Construct and interpret scale drawings. (1)
M7 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 and sizes and dimensions of fashion products • understanding of dimensional variations in mass produced components • defects in batches and reliability linked to probabilities.	11.01a	Use the 0-1 probability scale as a measure of likelihood of random events, for example, 'impossible' with 0, 'evens' with 0.5, 'certain' with 1. (1)
		11.01b	Record, describe and analyse the relative frequency of outcomes of repeated experiments using tables and frequency trees. (1)
		11.01c	Use relative frequency as an estimate of probability. (1) Understand that relative frequencies approach the theoretical probability as the number of trials increases.
		11.02e	Use the addition law for mutually exclusive events. Use p(A) + p(not A) = 1. (1) Derive or informally understand and apply the formula p(A *or* B) = p(A) + p(B) − p(A *and* B) (2)
		11.02f	Use tree diagrams and other representations to calculate the probability of independent and dependent combined events. (2) Understand the concept of conditional probability, and calculate it from first principles in known contexts. Derive or informally understand and apply the formula p(A *and* B) = p(A *given* B)p(B). Know that events A and B are independent if and only if p(A *given* B) = p(A). (3).

5d. Use of science within Design and Technology

Through their work in design and technology, learners are required to apply relevant scientific knowledge, skills and understanding equivalent to Key Stage 4 learning in Combined Science.

The table below shows the requirements for science knowledge and skills to be covered within the endorsed titles for OCR's A Level in Design and Technology. These are supported with examples to demonstrate application of each requirement with a design and technology context.

Within OCR's GCSE (9–1) in Combined Science A the content outlines standard Key Stage 4 content and higher tier content in bold. This is shown in the table below to demonstrate how the GCSE (9–1) in Combined Science A can support teaching and learning in Design and Technology.

Scientific knowledge and skills requirements for Design and Technology		Design Engineering	Fashion & Textiles	Product Design	OCR Design and Technology specification ref.	OCR GCSE (9–1) Science section	GCSE (9–1) Combined Science A specification (J250)
Science requirements	*Examples applied to D&T*						
S1 Use scientific laws – Newton's laws of motion, Hooke's law, Ohm's law as appropriate to the design product	Use scientific laws appropriately to the design of products, such as: • Newton's laws of motion • Hooke's Law • Ohm's Law.	✔			**2e (6)** **2i (6)**	**P2.2**	• Contact and non-contact forces influencing the motion of an object.
						P2.2	• Newtons and that this is the measure of force. • Force arrows and have an understanding of balanced and unbalanced forces.
						P2.3	• Forces acting to deform objects and to restrict motion. • Understanding of force and extension for a spring covering Hooke's law.
						P3.2	• Measurement of conventional current and potential difference in circuits. • Assemble series and parallel circuits and of how they differ with respect to conventional current and potential difference. • Current and resistance and the units in which they are measured.
						P3.2	• Recall and apply Ohm's law the relationship between I, R and V.

Scientific knowledge and skills requirements for Design and Technology *Science requirements*	*Examples applied to D&T*	Design Engineering	Fashion & Textiles	Product Design	OCR Design and Technology specification ref.	OCR GCSE (9–1) Science section	GCSE (9–1) Combined Science A specification (J250)
	Knowledge of the function of mechanical devices to produce different sorts of movement, and the movement of objects under the influence of forces in order to solve problems around stress, strain and elasticity, including projectiles.	✔			**2e (6)** **2i (6)**	**P2.1**	• Relationship between speed, distance and time. • Represent information in a distance-time graph. • Relative motion of objects.
						P2.2	• Contact and non-contact forces influencing the motion of an object. • Newtons and that this is the measure of force.
						P2.2	• Force arrows and have an understanding of balanced and unbalanced forces.
						P2.3	• Forces acting to deform objects and to restrict motion. • Hooke's law and the idea that when work is done by a force it results in an energy transfer and leads to energy being stored by an object. • There is a force due to gravity.
	Knowledge of the electronic systems through an understanding of currents (I), resistance (R) and potential difference (V); explain the design and use of circuits – including for lamps, diodes, thermistors and LDRs.	✔			**2e (6)** **2i (6)**	**P3.1**	• Electron transfer leading to objects becoming statically charged and the forces between them. • Existence of an electric field.
						P3.2	• Measurement of conventional current and potential difference in circuits. • Assemble series and parallel circuits and how they differ with respect to conventional current and potential difference. • Current and resistance and the units in which they are measured.
	Calculate the currents, potential differences and resistances in DC series circuits; represent them with the conventions of positive and negative terminals, and the symbols that represent common circuit elements,					**P3.2**	• Recall and apply Ohm's law and the relationship between I, R and V.
						P3.3	• Magnets and the idea of attractive and repulsive forces. • Shape of the fields around bar magnets. • Magnetic effect of a current and electromagnets.
						P5.1	• Energy transfer in process of electrical circuits. • Conservation of energy and that it has a quantity that can be calculated.

Scientific knowledge and skills requirements for Design and Technology *Science requirements*	*Examples applied to D&T*	Design Engineering	Fashion & Textiles	Product Design	OCR Design and Technology specification ref.	OCR GCSE (9–1) Science section	GCSE (9–1) Combined Science A specification (J250)
	including diodes, LDRs and thermistors.					**P5.2**	• Transfer of energy into useful and waste energy stores. • Power and how domestic appliances can be compared. • Insulators and how energy transfer is influenced by temperature.
	Understanding of how to choose appropriate energy sources.	✔			**2e (6)** **2i (6)**	**B6.1**	• Ecosystems and the various ways organisms interact. • Gases of the atmosphere.
						C6.2	• Composition of the Earth, the structure of the Earth, the rock cycle, the carbon cycle, the composition of the atmosphere and the impact of human activity on the climate.
						P4.1	• How waves behave and how the speed of a wave may change as it passes through different media. • How sound is heard and the hearing ranges of different species.
						P4.2	• Uses of some types of radiation.
						P5.1	• Be able to approach systems in terms of energy transfers and stores. • That energy can be transferred in processes such as changing motion, burning fuels and in electrical circuits. • Idea of conservation of energy and that it has a quantity that can be calculated.
						P5.2	• Transfer of energy into useful and waste energy stores. • Power and how domestic appliances can be compared. • Insulators and how energy transfer is influenced by temperature. • Ways to reduce heat loss in the home.
						P6.2	• Renewable and non-renewable energy resources. • Understanding of how power stations work and the cost of electricity in the home. • Electrical safety features in the home.

Scientific knowledge and skills requirements for Design and Technology		Design Engineering	Fashion & Textiles	Product Design	OCR Design and Technology specification ref.	OCR GCSE (9–1) Science section	GCSE (9–1) Combined Science A specification (J250)
Science requirements	*Examples applied to D&T*						
	Application of scientific formulae and calculation of quantities when applying science to mathematical skills.	✔			**2e,f,g (7)** **2e,f,g (8)** **2h (7)** **2h (8)**	**5c**	• Scientific quantities and corresponding units. • Apply them in qualitative work and calculations.
						5d	• Apply skills in observation, modelling and problem-solving, with opportunities for these skills to be shown through links to specification content.
						P1.1e	• Explain the differences in density between the different states of matter in terms of the arrangements of the atoms and molecules.
						P1.1	• Apply the relationship between density, mass and volume to changes where mass is conserved. (covered as maths requirement)
						5f	• density (kg/m^3) = mass (kg)/volume (m^3) (covered as maths requirement) • distance travelled (m) = speed (m/s) × time (s) (covered as maths requirement) • acceleration (m/s^2) = change in velocity (m/s)/time (s) (covered as maths requirement) • kinetic energy (J) = 0.5 × mass (kg) × (speed (m/s))^2 • force (N) = mass (kg) × acceleration (m/s^2) • work done/energy (J) = force (N) × distance (m) (along the line of action of the force) • power (W) = work done (J)/time (s) • momentum (kgm/s) = mass (kg) × velocity (m/s) • force exerted by a spring (N) = extension (m) × spring constant (N/m) • gravity force (N) = mass (kg) × gravitational field strength, g (N/kg) (g = 9.81 N/kg)

Scientific knowledge and skills requirements for Design and Technology		Design Engineering	Fashion & Textiles	Product Design	OCR Design and Technology specification ref.	OCR GCSE (9–1) Science section	GCSE (9–1) Combined Science A specification (J250)
Science requirements	*Examples applied to D&T*						
							• (in a gravity field) potential energy (J) = mass (kg) × height (m) × gravitational field strength, g (N/kg) • charge flow (C) = current (A) × time (s) • potential difference (V) = current (A) × resistance (Ω) • energy transferred (J) = charge (C) × potential difference (V) • power (W) = potential difference (V) × current (A) = $(\text{current (A)})^2$ × resistance (Ω) • energy transferred (J, kWh) = power (W, kW) × time (s, h) • wave speed (m/s) = frequency (Hz) × wavelength (m) • efficiency = useful output energy transfer (J)/input energy transfer (J) • change in thermal energy (J) = mass (kg) × specific heat capacity (J/kg°C) × change in temperature (°C)
S2 Describe the conditions which cause degradation	Understanding of properties of materials and how they need to be protected from potential degradation and corrosion due to environmental factors.	✔	✔	✔	**2e,f,g (5)** **2e,f,g (7)** **2h (5)** **2h (7)**	**C2.3** **C3.4** **C6.1** **P1.2**	• Understanding of physical properties of elements and compounds considering the nature of their bonding affecting their properties. • Many useful materials that we use today are mixtures. • Demonstrate an understanding of electrolysis, ionic solutions and solids. • Describe a process where a material or product is recycled for a different use, and explain why this is viable. • Evaluate factors that affect decisions on recycling. • Describe the basic principles in carrying out a lifecycle assessment of a material or product. • Matter and the similarities and differences between solids, liquids and gases.

Scientific knowledge and skills requirements for Design and Technology		Design Engineering	Fashion & Textiles	Product Design	OCR Design and Technology specification ref.	OCR GCSE (9–1) Science section	GCSE (9–1) Combined Science A specification (J250)
Science requirements	*Examples applied to D&T*						
S3 Know the physical properties of materials and explain how these are related to their uses	Knowledge of properties of materials to be applied when designing and making.	✔	✔	✔	**2e,f,g (5)** **2e,f,g (7)** **2h (5)** **2h (7)**	**C2.2**	• Explain applications of chemistry that can be used to help humans improve their own lives and strive to create a sustainable world for future generations. • Properties of ceramics, polymers and composites. • The method of using carbon to obtain metals from metal oxides.
	Knowledge of the properties of materials based on their scientific constitution.	✔	✔	✔	**2e,f,g (5)** **2h (5)**	**C2.1** **C6.1** **P1.1**	• Explain that many useful materials are formulations of mixtures. • Explain the differences in density between the different states of matter in terms of the arrangements of the atoms and molecules. • Explain how modern life is crucially dependent upon hydrocarbons and recognise that crude oil is a finite resource. • Apply the relationship between density, mass and volume to changes where mass is conserved.
	Understand the appropriate use of materials, including polymers, composites, woods and metals, based on their physical properties.	✔		✔	**2e,f,g (5)** **2h (5)**	**C2.3** **C2.2**	• Explain how the bulk properties of materials (ionic compounds, simple molecules, giant covalent structures, polymers and metals) are related to the different types of bonds they contain, their bond strengths in relation to intermolecular forces and the ways in which their bonds are arranged. • Describe and compare the nature and arrangement of chemical bonds in: i. ionic compounds ii. simple molecules iii. giant covalent structures iv. polymers v. metals.
	Understand the appropriate use of materials, including technical textiles, fibres, polymers and metals, based on their physical properties.		✔				

5e. Data Source

OCR has supplied data to support centres with a consistent approach throughout their assessment. The data outlined in this section delivers the format and level of information that would be used within an exam.

Sources cover general data within an environment, anthropometric data and data to support clothes sizes a candidate will need to be able to use and understand.

General data within an environment

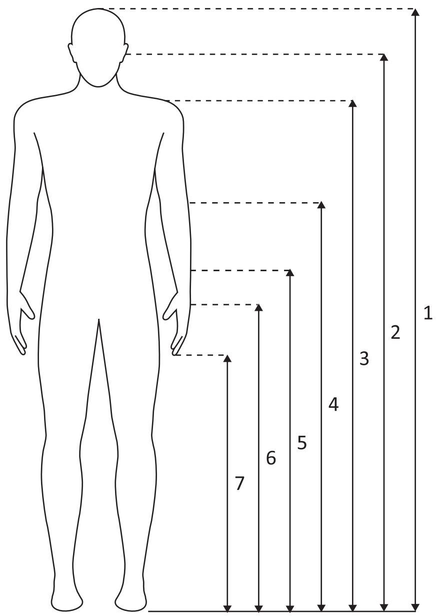
Architecture	(mm)
Width of passage	750
Body depth	450
Sitting body depth	600
Kneeling body depth	900
Vertical reach	1750

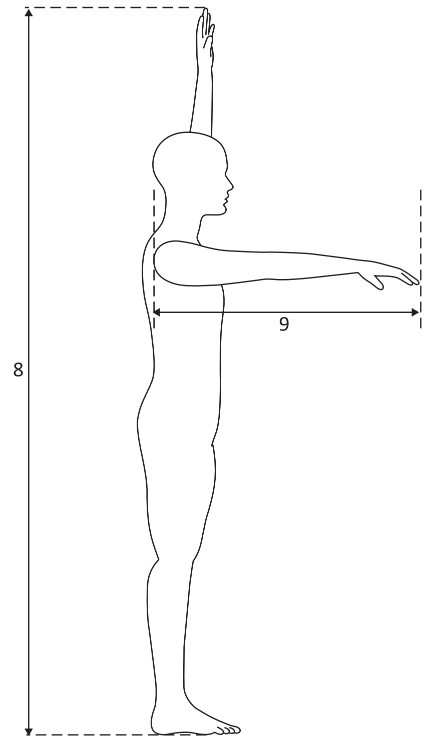
Wheelchair	(mm)
Width of passage	900
Vertical reach	1200
Turning radius	1500
Operating controls	900–1200
Supporting bar	850–900

Guidelines working heights	(mm)
Precise manipulative tasks	Elbow height + 5 total 100
Moderate force and precision	Elbow height – 5 total 100
Heavy manipulation, downward pressure	Elbow height – 10 total 250
Lifting and handling	Between fist and elbow height
Hand-operated controls	Between elbows and shoulders

Anthropometric Data – Standing

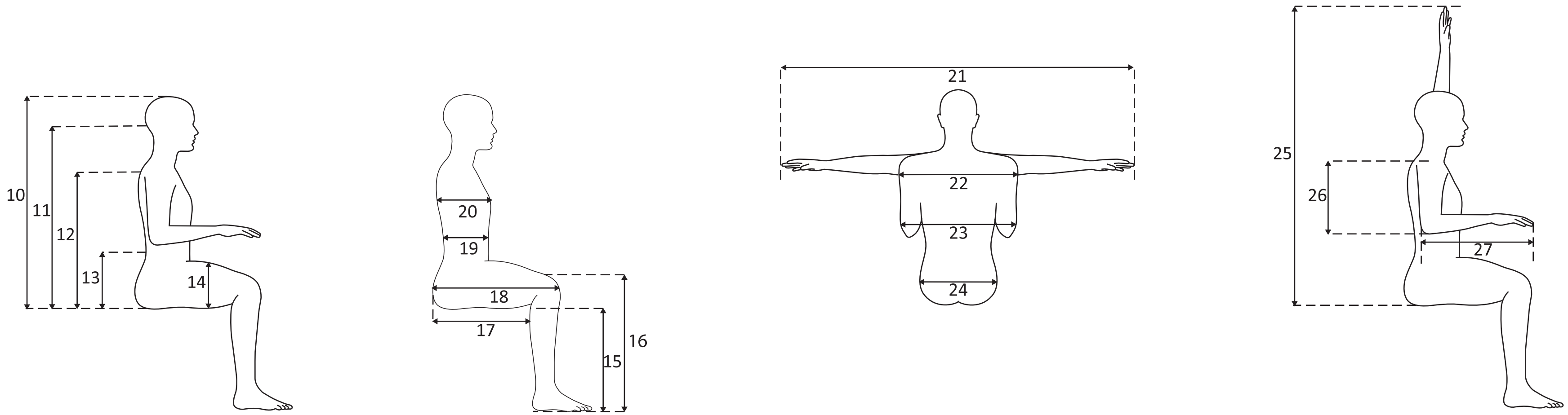
	Dimensions (mm)	Age Range 5–9 Combined (Percentiles)			Age Range 13–18 Combined (Percentiles)			Age Range 19–65 Men (Percentiles)			Age Range 19–65 Women (Percentiles)		
		5%	50%	95%	5%	50%	95%	5%	50%	95%	5%	50%	95%
1	Height	1058	1264	1483	1470	1685	1857	1630	1745	1860	1510	1620	1730
2	Eye level	895	1055	1180	1456	1570	1740	1520	1640	1760	1410	1515	1620
3	Shoulder height	843	1014	1198	1184	1352	1525	1340	1445	1550	1240	1330	1420
4	Elbow height	610	720	805	945	1005	1170	1020	1100	1180	950	1020	1090
5	Hip height	496	619	754	734	855	990	850	935	1020	750	820	890
6	Knuckle height (fist grip height)	375	480	565	690	720	815	700	765	830	670	720	770
7	Fingertip height	298	390	470	420	620	695	600	675	730	560	620	680
8	Vertical reach (standing position)	1241	1521	1820	1758	2033	2220	1950	2100	2250	1810	1940	2070
9	Forward grip reach (standing)	442	531	640	594	689	809	720	790	860	660	725	790





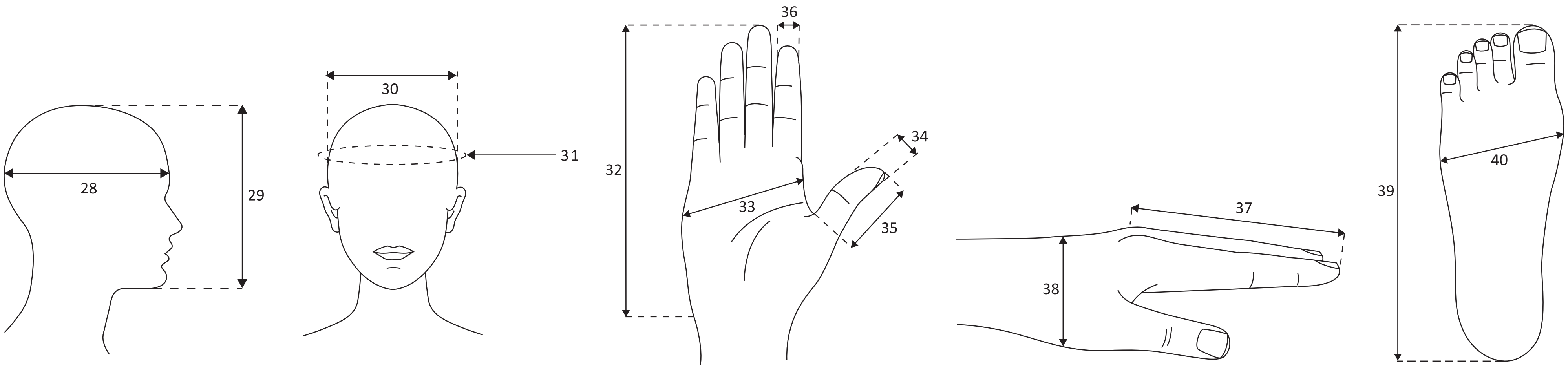
Anthropometric Data – Sitting

	Dimensions (mm)	Age Range 5–9 Combined (Percentiles)			Age Range 13–18 Combined (Percentiles)			Age Range 19–65 Men (Percentiles)			Age Range 19–65 Women (Percentiles)		
		5%	50%	95%	5%	50%	95%	5%	50%	95%	5%	50%	95%
10	Sitting height	594	694	797	774	908	968	860	915	970	800	855	910
11	Sitting eye height	446	570	648	640	759	834	740	800	860	700	750	800
12	Sitting shoulder	315	390	440	520	575	635	570	615	660	530	580	630
13	Sitting elbow height	120	160	205	185	232	285	210	250	290	190	235	280
14	Thigh thickness	81	116	169	116	153	178	130	155	180	120	150	180
15	Popliteal height (lower leg length)	220	295	340	360	435	485	410	450	490	370	410	450
16	Knee height	315	393	481	456	525	558	490	535	580	460	495	530
17	Buttock-popliteal length	230	300	350	430	480	545	450	510	570	440	500	560
18	Buttock-knee length	321	410	511	490	571	628	560	605	670	520	585	650
19	Abdominal depth	140	165	195	185	215	270	220	275	330	200	270	340
20	Chest depth	125	140	170	210	230	265	210	245	280	210	250	290
21	Lateral arm span	860	1160	1300	1505	1780	1935	1670	1810	1950	1520	1650	1780
22	Shoulder breadth	232	280	325	360	385	490	440	485	530	390	440	490
23	Elbow to elbow breath	212	260	305	340	365	470	420	465	510	370	420	470
24	Hip breadth	186	222	275	263	321	363	350	390	430	350	405	460
25	Vertical reach (sit)	650	780	905	1010	1225	1330	1220	1305	1390	1100	1190	1280
26	Shoulder-elbow length	188	259	316	302	352	396	330	365	400	300	330	360
27	Elbow fingertip length	276	333	404	390	450	509	440	475	510	400	430	460



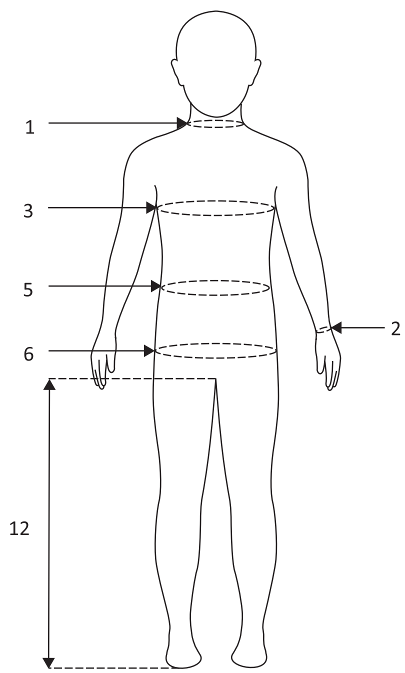
Anthropometric Data – Head, hand and feet

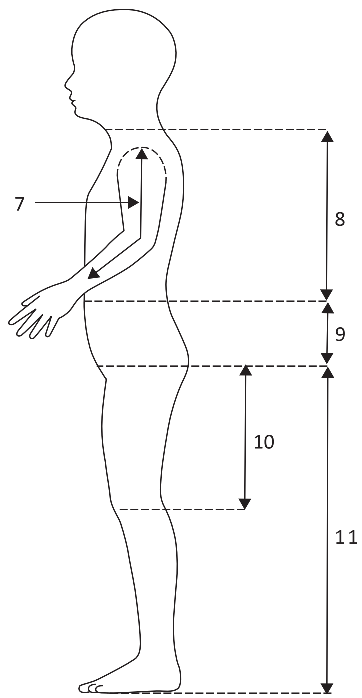
	Dimensions (mm)	Age Range 5–9 Combined (Percentiles)			Age Range 13–18 Combined (Percentiles)			Age Range 19–65 Men (Percentiles)			Age Range 19–65 Women (Percentiles)		
		5%	50%	95%	5%	50%	95%	5%	50%	95%	5%	50%	95%
28	Head depth	167	184	196	180	193	208	190	200	210	170	185	200
29	Head height	165	189	210	191	212	237	218	232	247	204	218	232
30	Head breadth	131	141	151	139	150	163	140	155	170	140	150	160
31	Head circumference	485	524	552	517	554	591	550	578	610	533	558	585
32	Hand length	115.0	137.0	164.0	157.0	179.0	202.0	170.0	190.0	210.0	160.0	175.0	190.0
33	Hand breadth	53.0	63.0	74.0	69.0	81.0	96.0	80.0	90.0	100.0	70.0	80.0	90.0
34	Thumb breadth (diameter)	12.2	14.9	17.3	15.8	19.0	21.4	20.0	23.0	26.0	16.0	19.0	22.0
35	Thumb length	37.0	48.0	60.0	51.0	64.0	74.0	44.0	51.0	58.0	40.0	47.0	53.0
36	Forefinger tip breadth (index finger)	9.5	11.5	13.5	12.1	14.6	17.1	18.0	21.0	24.0	15.0	18.0	21.0
37	Forefinger length (index finger)	42	53	66	61	71	80	64	72	80	60	67	74
38	Hand thickness (minimum hand clearance)							44.0	51.0	58.0	40.0	45.0	50.0
39	Foot length	162	197	236	220	249	287	240	265	290	220	240	260
40	Foot breadth	63	77	91	83	97	109	90	100	110	80	90	100



Clothing Size Data – Children

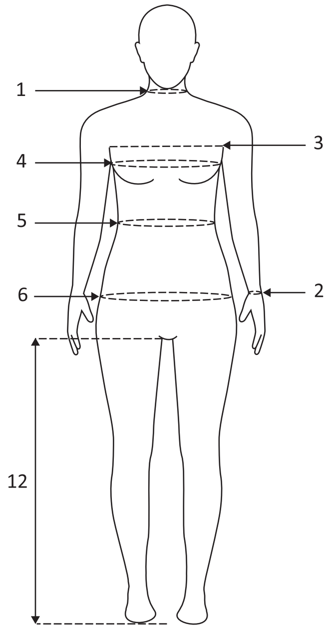
	Dimensions (cm)						Age Range 2–5–14 years Combined (Sizes)							
	Circumference	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Neck	25.00	–	26.00	27.00	28.00	29.00	30.00	31.00	32.00	33.00	34.00	35.00	35.00
2	Wrist	12.00	–	12.50	13.00	13.50	14.00	14.50	15.00	15.50	16.00	16.50	17.00	17.00
3	Chest	54.70	–	57.00	59.50	62.00	64.50	67.00	69.50	72.00	74.50	77.00	80.00	83.00
5	Waist	54.00	–	55.00	56.50	58.00	59.50	61.00	62.50	64.00	66.00	68.00	69.50	71.00
6	Hip	58.70	–	61.00	63.50	66.00	68.50	71.00	73.50	76.00	79.00	82.00	85.00	88.00
	Lengths													
7	Sleeve length	33.50	–	37.50	39.50	42.00	44.00	46.50	48.50	50.50	52.80	55.00	57.00	59.00
8	Back waist length	27.50	–	25.50	26.70	28.00	33.20	34.50	35.80	37.00	38.50	40.00	41.50	43.00
9	Hip depth	9.80	–	10.40	11.00	11.60	12.20	12.80	13.40	14.00	14.50	15.20	15.80	16.40
10	Knee length	15.00	–	30.60	32.60	34.50	36.30	38.40	40.20	42.20	43.80	45.70	47.60	49.60
11	Trousers length	61.00	–	60.60	64.80	69.00	73.10	77.40	81.50	85.20	89.00	92.90	96.70	100.70
12	Crotch length	17.80	–	14.60	15.30	16.00	16.60	17.40	18.00	18.70	19.50	20.40	21.20	22.20

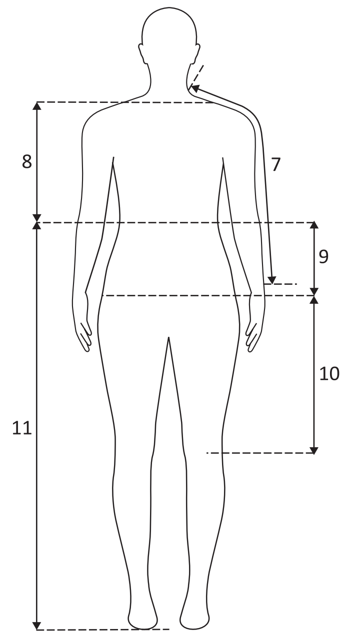




Clothing Size Data – Women

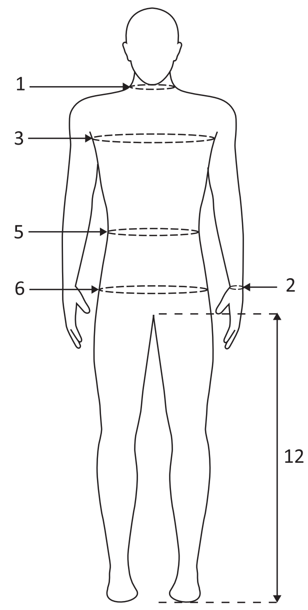
	Dimensions (cm)	Age Range 19–65 Women (Sizes)									
		8	10	12	14	16	18	20	22	24	26
	Circumferences	XS	XS	S	M	M	L	L	XL	2XL	3XL
1	Neck size	35.00	36.00	37.00	38.00	39.00	40.00	41.00	42.40	43.80	45.20
2	Cuff size for shirts	21.00	21.00	21.50	21.50	22.00	22.50	23.00	23.50	24.00	24.50
3	Chest	30.00	31.20	32.40	33.60	34.80	36.00	37.20	39.00	40.80	42.60
4	Bust	80.00	84.00	88.00	92.00	96.00	100.00	104.00	110.00	116.00	122.00
5	Waist	64.00	68.50	73.50	78.50	84.00	90.00	95.00	100.00	106.50	111.50
6	Hips/Seat	88.00	92.00	96.00	100.00	104.00	108.00	112.00	117.00	122.00	127.00
	Lengths										
7	Sleeve length	57.20	57.80	58.40	59.00	59.50	60.00	60.50	61.00	61.20	61.40
8	Nape to waist (neck to waist)	40.20	40.60	41.00	41.40	41.80	42.20	42.60	43.00	43.40	43.80
9	Waist to hip	20.00	20.30	20.60	20.90	21.20	21.50	21.80	22.10	22.40	22.70
10	Waist to knee	57.50	58.00	58.50	59.00	59.50	60.00	60.50	61.00	61.50	62.00
11	Waist to floor	102.00	103.00	104.00	105.00	106.00	107.00	108.00	109.00	110.00	111.00
12	Inside leg short length	76.20	76.20	76.20	76.20	76.20	76.20	76.20	76.20	76.20	76.20
12	Inside leg regular length	81.28	81.28	81.28	81.28	81.28	81.28	81.28	81.28	81.28	81.28
12	Inside leg long length	86.36	86.36	86.36	86.36	86.36	86.36	86.36	86.36	86.36	86.36

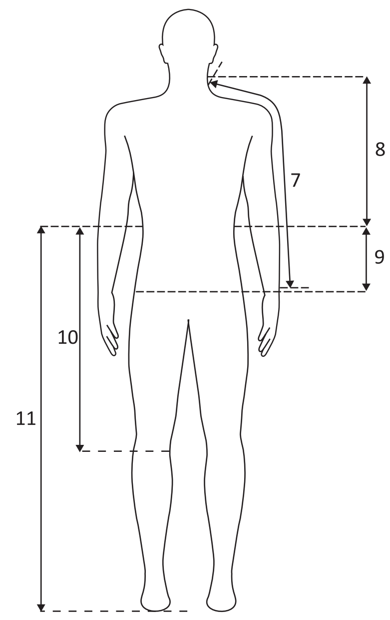




Clothing Size Data – Men

	Dimensions (cm)	Age Range 19–65 Men (Sizes)						
	Circumferences	XS	S	M	L	XL	2XL	3XL
1	Neck size	37.00	38.00	39.00	40.00	41.00	42.00	43.00
2	Cuff size for shirts	23.00	23.50	23.50	24.00	24.00	24.50	24.50
3	Chest	88.00	92.00	96.00	100.00	104.00	108.00	112.00
4	Bust	–	–	–	–	–	–	–
5	Waist	74.00	78.00	82.00	86.00	90.00	94.00	98.00
6	Hips/Seat	90.00	94.00	98.00	102.00	106.00	110.00	114.00
	Lengths							
7	Sleeve length	84.00	85.00	85.00	86.00	86.00	87.00	87.00
8	Nape to waist (neck to waist)	43.00	43.40	43.80	44.20	44.60	44.80	45.00
9	Waist to hip	21.30	21.60	21.90	22.20	22.50	22.80	23.10
10	Waist to knee	63.50	64.00	64.50	65.00	65.50	66.00	66.50
11	Waist to floor	111.00	115.00	119.00	123.00	127.00	131.00	135.00
12	Inside leg short length	76.00	76.00	76.00	76.00	76.00	76.00	76.00
12	Inside leg regular length	81.00	81.00	81.00	81.00	81.00	81.00	81.00
12	Inside leg long length	86.00	86.00	86.00	86.00	86.00	86.00	86.00





5f. Glossary of terms from the specification content

Circular economy	A circular economy is an alternative to a traditional linear economy (make, use, dispose) in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life. It aims to keep products, components and materials at their highest utility and value at all times.
Context	Circumstances that form a setting, surroundings, people, places, events that all form a setting for us to design within.
Creativity	Creativity is a phenomenon whereby something new and valuable is formed. The ability to transcend traditional ideas, rules, patterns, relationships, or the like to create meaningful new ideas, forms, methods, interpretations, etc. originality, progressiveness, or imagination.
Critique	Critique is a method of disciplined, systematic analysis of a written or oral discourse. Although critique is commonly understood as fault finding and negative judgment, it can also involve merit recognition, and in the philosophical tradition it also means a methodical practice of doubt. It is detailed evaluation.
Design optimisation	Product design and development requires that engineers consider trade-offs between product attributes in the areas of cost, weight, manufacturability, quality and performance. It is about determining how to arrive at the best overall design, making the right compromises and not sacrificing critical attributes like safety.
Design solution	A design solution is a generic term that can be used to outline any existing products or systems, or any design development that is offered as an answer to needs, wants and requirements. This can be a fully drawn up solution or a prototype one.
Digital design	Digital design is the use of computers, graphics tablets and other electronic devices to create graphics and designs for the web, television, print and portable electronic devices. Digital designers use creativity and computer skills to design visuals associated with electronic technology.
Disruptive technology	Disruptive technology is a new emerging technology that unexpectedly displaces an established one. Recent examples of disruptive technologies include smart phones and e-commerce retailing. Clayton Christensen popularised the idea of disruptive technologies in the book "The Innovator's Dilemma" in 1997.
Disassembly	To disconnect the pieces of (something), to take things apart into smaller pieces. Used within Design and Technology to analyse and test products.
Enterprise	Relating to a progressive approach that demonstrates initiative, resourcefulness and willingness to undertake new and challenging projects.
Fixation	The state of being unable to stop thinking about something, or an unnaturally strong interest in something. We talk about this in terms of design fixation, i.e. being fixated with an idea.

Global sustainable development	Sustainable development relates to the principle of sustaining finite resources that are necessary to provide for the needs of future generations of life on the planet.
Incremental Innovation	A series of small improvements to an existing product or product line that aims to improve its competitive position over time. Incremental innovation is regularly used within high-tech businesses to ensure products include new features that are desired by consumers.
Innovation	Innovation in the context of this qualification refers to learners considering new methods or ideas to improve and refine their design solutions and meet the needs of their intended market and/or primary user.
Iterative design	Iterative design is a design methodology based on a cyclic process of prototyping, testing, analysing and refining a product or process. Within the context of this specification we refine these processes to explore/create/evaluate. In iterative design, interaction with the product or system is used as a form of investigation for informing and evolving a project. Based on the results of testing the most recent iteration of a design, changes and refinements are made.
Just-in-time (JIT)	Just-in-time (JIT) manufacturing, also known as just-in-time production or the Toyota production system (TPS), is a methodology aimed primarily at reducing flow times within production as well as response times from suppliers and to customers. A strategy companies employ to increase efficiency and decrease waste by receiving goods only as they are needed in the production process, thereby reducing inventory costs.
Lean manufacturing	Lean manufacturing or lean production, often simply "lean", is a systematic method for the elimination of waste within a manufacturing system.
Lifecycle assessment (LCA)	Lifecycle assessment (LCA), also known as lifecycle analysis, eco-balance, and cradle-to-grave analysis is a technique to assess environmental impacts associated with all the stages of a product's life from cradle-to-grave (from raw material extraction through materials processing, manufacture, distribution, use during its life, repair and maintenance and end of life disposal or recycling).
Need	A need is a thing that is necessary for someone to live a healthy, safe and fulfilled life. A need can imply a want, a lack, or a demand, which must be filled.
Ongoing dialogue	An exchange of ideas or opinions on a particular issue, with a view to reaching an amicable agreement or settlement.
Practical activities	Practical activities enable the student to put into practice the theory and/or skills they are studying, in a practical environment. This will involve all stages of designing and making, but also investigative, testing and analytical activities.
Primary user	The primary user is that person or group of people that are intended to practically use a product or system in their lives. Many products may have primary users that use the same product in different ways or with different purposes.
Prototype	In the context of this qualification, the term 'prototype' refers to a functioning design outcome. A final prototype could be a highly finished product, made as proof of concept prior to manufacture, or working scale models of a system where a full-size product would be impractical.

Real-time evidence	Evidence that demonstrates design activity as it happens through whatever medium it is recorded in. Real-time evidence is gathered chronologically to tell a real story.
Requirement	In product development a requirement is a singular physical and functional need that a particular design, product or process must be able to perform. It is a statement that identifies a necessary attribute, capability, characteristic, or quality of a system for it to have value to a customer, user, or other stakeholder.
Sketch modelling	Sketch modelling enables you to study, visualise and understand the space in 3D because it looks more real than pen and paper sketches. It can involve modelling using cheap materials and help you work out your design ideas or sketching of parts to explore the parts of a design.
Social footprint	Social footprint is linked to the carbon footprint, implying that all human actions leave a trace and sometimes our lifestyle choices have negative consequences on the environment.
Solution	A solution is a way to solve a problem or resolve a bad situation.
Stakeholder	A stakeholder is a person, group or organisation with an interest in a project; for example, parents/schools when designing products for children; the manufacturer or retailer that has an interest in a product; a regulator who needs to ensure products meet required regulations within a jurisdiction.
Systems thinking	'Systems thinking' is a holistic approach to analysis that focuses on the way that a system's constituent parts interrelate and how systems work over time and within the context of larger systems.
Technical textiles	Technical textiles are materials meeting high technical and quality requirements, e.g. mechanical, thermal, electrical, durability etc., this gives them the ability to offer technical functions.
Upcycling	Upcycling, also known as creative reuse, is the process of transforming by-products, waste materials, useless and/or unwanted products into new materials or products of better quality or for better environmental value.
User-centred design	User-centred design (UCD) is a framework of processes (not restricted to interfaces or technologies) in which the needs, wants and limitations of end users of a product, service or process are given extensive attention at the stage of the design process.

5g. Accepted file formats

Further explanation of the use of formats for non-exam assessment can be found in Section 4d under 'E-portfolios'

Movie formats for digital video evidence
MPEG (*.mpg)
QuickTime movie (*.mov)
Macromedia Shockwave (*.aam)
Macromedia Shockwave (*.dcr)
Flash (*.swf)
Windows Media File (*.wmf)
MPEG Video Layer 4 (*.mp4)

Audio or sound formats
MPEG Audio Layer 3 (*.mp3)

Graphics formats including:
JPEG (*.jpg)
Graphics file (*.pcx)
MS bitmap (*.bmp)
GIF images (*.gif)

Animation formats
Macromedia Flash (*.fla)

Text formats
Comma Separated Values (.csv)
PDF (.pdf)
Rich text format (.rtf)
Text document (.txt)

Microsoft Office suite
PowerPoint (.ppt) (.pptx)
Word (.doc) (.docx)
Excel (.xls) (.xlsx)
Visio (.vsd) (.vsdx)
Project (.mpp) (.mppx)

5h. Acknowledgements

Designing Our Tomorrow

In developing this specification, we have consulted and drawn on the research and authentic practices of an initiative called Designing Our Tomorrow, from the University of Cambridge. In particular, the content and Figures related to the iterative processes, from, namely, Explore: Create: Evaluate: Manage, used throughout this specification and shown schematically in Fig. 1, Fig. 2 and Fig. 3.

For more information about their work visit:
www.designingourtomorrow.com

Summary of updates

Date	Version	Section	Title of section	Change
May 2018	1.1	Front cover	Disclaimer	Addition of Disclaimer
August 2018	1.2	3d 4d multiple	Retaking the qualification Admin of non-exam assessment	Update to the wording for carry forward rules Amendent to 'Centre Record form' Reference

5

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