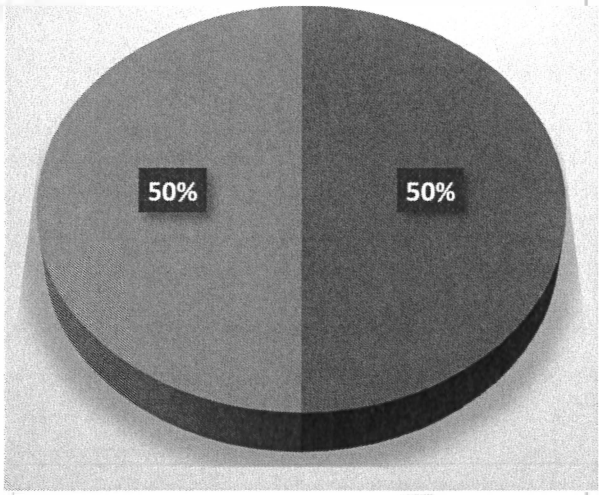
Name: .....

AQA Yr 13 Product Design Checklist SFH6

THE SYDENHAM & FOREST HILL 6TH FORM

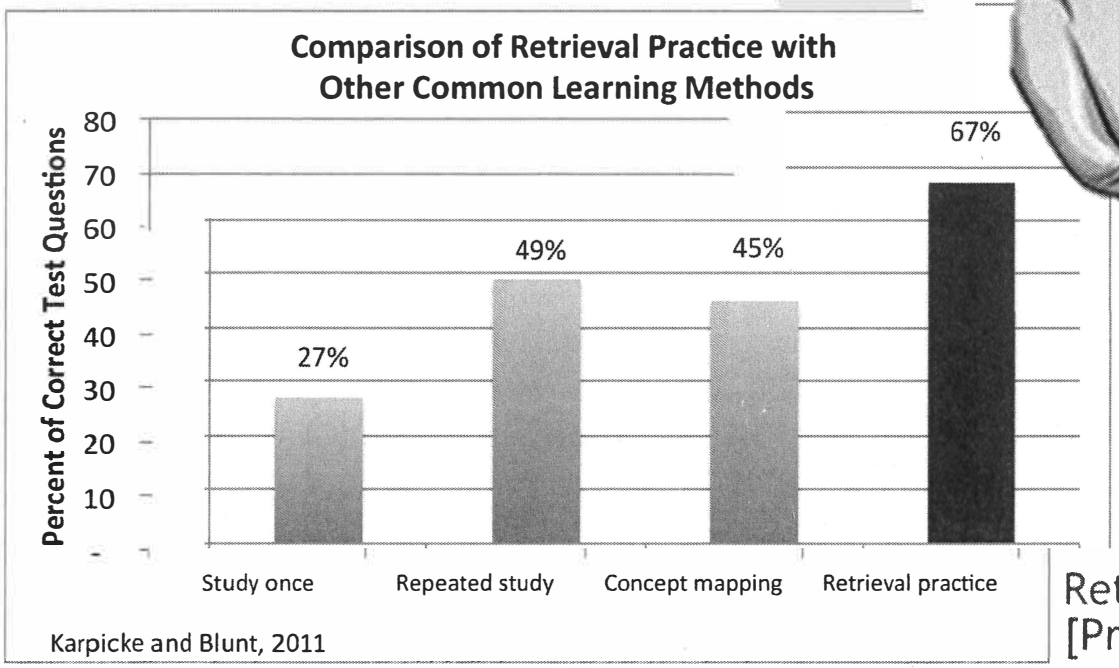
This booklet contains details of the various components of your final year on the A-Level Product Design course. It has all of the theory content you will be expected to know in order to achieve well by the end of the two-year course. Use this knowledge to identify your **areas** of **ignorance** and **areas of strength**, both of which are essential to know if you are to carry out efficient, well-planned, well-aimed studying.

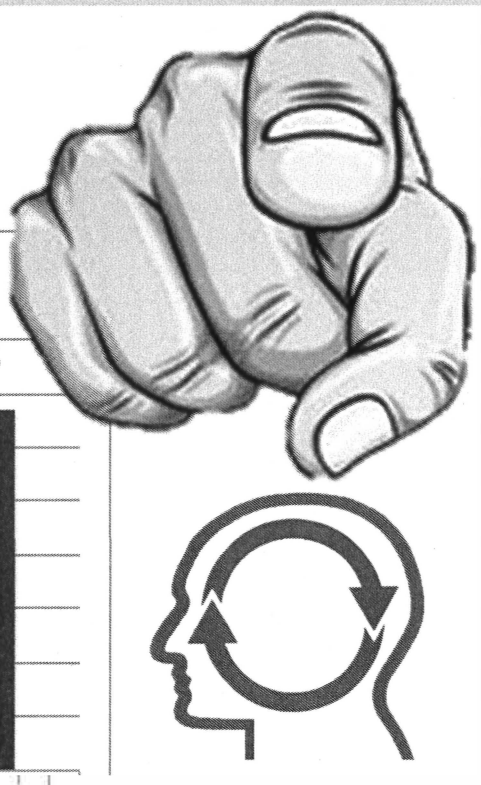
Remember that the course is a 50/50 balance of exams and design-and-make project (NEA). Always balance these two out!



Retrieval Practive

The best revision method for **YOU!**





Retrieval Practice [Practice Testing]

WHAT DO WE MEAN BY 'RETRIEVAL PRACTICE'?

Traditional revision methods may result in lovely posters or beautiful pages of highlighted notes and flashcards, but how do you **know** that you know the content? Simple... You TEST yourself by setting up challenges to remember how much you remember. Doing this at regular intervals will cement that knowledge into your memory like no other method and will also help identify your areas of ignorance. After all, how else do you know what areas you need to spend more time on if you can't identify your weaknesses? Thinking that you know more than you actually do is dangerous!

The act of information retrieval, or calling information to mind, leads to that memory being strengthened and it builds automatic recall in the future. Retrieval practice is a powerful tool for improving learning without more technology, money, or class time. It's not easy, but it is proven to work!

How is the A-Level Product Design Course (7552) Assessed?

NEA (50% of your final result)

Started at the end of Year 12. It is vital that NEA deadlines are met so that time is not stolen from exam preparation.

Non-exam assessment (NEA)
What's assessed Practical application of: • Technical principles • Designing and making principles • Specialist knowledge

How it's assessed
• Single substantial design and make task
• 100 marks
• 50 % of A-level
• Approximately 40 hours in duration
• Written or electronic portfolio with photographic evidence of final outcome
• Assessment criteria to include:
  • exploration
  • designing
  • making
  • analysis and evaluation.
The above will be assessed in a holistic way.

Task(s) Students will undertake a substantial design and make task and produce a final prototype. The context of the task will be determined by the student.

Written Exams (50% of your final result)

Two exams written at the end of Year 13 in June.

Paper 1 is 2½ hours long and Paper 2 is 1½ hours long.

Paper 1

What's assessed

- Technical principles
- Designing and making principles
- Specialist knowledge

How it's assessed

- Written exam: 2½ hrs
- 100 marks
- 25 % of A-level

Questions

Mixture of short answer, multiple choice and extended response questions.

Paper 2

What's assessed

- Technical principles
- Designing and making principles
- Specialist knowledge

How it's assessed

- Written exam: 1½ hrs
- 100 marks
- 25 % of A-level

Questions

Section A: Product analysis

- 40 marks available.
- Up to six short answer questions based on visual stimulus of product(s).

Section B: Commercial manufacture

- 60 marks.
- Two extended response questions worth a total of 30 marks each.

3.1 Technical principles

3.1.1 Materials and their applications

Content	Potential links to maths and science
Students are expected to be able to name specific materials for a wide range of applications. They must also be able to provide detailed and justified explanations of why specific materials and combinations of materials are suitable for given applications, with reference to: • physical and mechanical properties (working characteristics) • product function • aesthetics • cost • manufacture and disposal.	Understand the appropriate use of materials including polymers, composites, woods and metals based on their physical and working characteristics such as: • malleability • toughness • hardness • resistance to corrosion and degradation • thermal conductivity • electrical conductivity. Calculation of quantities of materials sizes and costs.

Classification of materials

Content	Potential links to maths and science
Students should know and understand the classifications of the following materials and be able to name examples that belong to each category: • metals (ferrous, non-ferrous, alloys) • woods (hardwoods, softwoods, manufactured boards) • polymers (thermoplastics, thermoset polymers, elastomers) • papers and boards • composites • smart materials • modern materials.	

Methods for investigating and testing materials

Content	Potential links to maths and science
Students should be able to describe how workshop and industrial tests are set up and what will be tested, measured and compared, including: • tensile strength • toughness • hardness • malleability • corrosion • conductivity.	Analysis of data obtained from testing.

3.1.2 Performance characteristics of materials

Performance characteristics of papers and boards

Content	Potential links to maths and science
Students should be able to name different types of papers and boards. Students should be able to describe the performance characteristics of papers and boards, including: • the ability to be scored • cutting • folding • surface qualities for printing • impact resistance • recyclability and/or biodegradability. Students should be able to explain why different papers and boards are suitable for different applications, including: • layout paper: sketch pads • cartridge paper: printing • tracing paper: copying images • bleed proof paper: marker rendering • treated paper: photographic printing • watercolour paper: painting • corrugated card: packaging • bleached card: greeting cards and high quality packaging • mount board: modelling • duplex card: food packaging • foil backed and laminated card: drinks packaging • metal effect card: gift packaging • moulded paper pulp: eco-friendly packaging.	Efficient use of materials in the construction of containers through 2D net design. Effective selection of materials to allow for recyclability, biodegradability and stability.

Performance characteristics of polymer based sheet and film

Content	Potential links to maths and science
Students should be able to name different types of polymer based sheet and film. Students should be able to describe the performance characteristics of polymer based sheet and film, including: • the ability to be scored • cutting • folding • moulding • transparency • translucency • flexibility • recyclability and/or biodegradability.	
Students should be able to explain why different polymer based sheet and film are suitable for different applications, including: • foam board: model making • fluted polypropylene: signs and box construction • translucent polypropylene sheets: packaging • styrofoam: modelling and formers • low density polyethylene sheet: wrapping, packaging and bags • plastazote foam: protective packaging • cellulose acetate: packaging • polyactide sheet and film: biodegradable packaging.	

Performance characteristics of woods

Content	Potential links to maths and science
Students should be aware of the different stock forms of timber, including: • rough sawn • planed square edge (PSE) • planed all round (PAR) • natural timber • manufactured boards • mouldings.	

Content	Potential links to maths and science
Students should be able to describe the performance characteristics of woods, including: • grain pattern • grain direction • surface defects • warpage • shrinkage • splitting • joining • forming • steam bending • laminating • machining qualities • resistance to decay • moisture resistance • toxicity.	

Students should be familiar with the following woods and wood products:
• softwoods:
  • pine
  • spruce
  • Douglas fir
  • redwood
  • cedar
  • larch
• hardwoods:
  • oak
  • ash
  • mahogany
  • teak
  • birch
  • beech
• manufactured boards:
  • plywood
  • marine plywood
  • aeroply
  • flexible plywood
  • chipboard
  • medium density fibreboard (MDF)
• veneers and melamine formaldehyde laminates.	

Performance characteristics of metals

Content	Potential links to maths and science

Students should be aware of the different stock forms of metals, including:
• sheet
• plate
• bar:
  • flat
  • round
  • square
  • hexagonal
• tube:
  • round
  • square
  • rectangular
  • hexagonal
• structural:
  • H beam
  • I beam
  • tee
  • channel
  • angle.	

Students should be able to describe the performance characteristics of metals, including: • hardness • toughness • malleability • elasticity • tensile strength • density • resistance to corrosion • thermal conductivity • electrical conductivity • melting points • ability to be alloyed • ability to be joined with heat processes • ability to take applied coatings and finishes.	

Content	Potential links to maths and science

Students should be familiar with the following metals:
• ferrous:
  • low carbon steel
  • stainless steel
  • high speed steel (HSS)
  • medium carbon steel
  • cast iron
• non-ferrous:
  • aluminium
  • copper
  • zinc
  • silver
  • gold
  • titanium
  • tin
• ferrous alloys:
  • stainless steel
  • die steel (tool steel)
• non-ferrous alloys:
  • bronze
  • brass
  • duralumin
  • pewter.	

Performance characteristics of polymers

Content	Potential links to maths and science
Students should be aware of the different stock forms of polymers, including: • sheet • film • granules • rod and other extruded forms • foam • powder.	

Content	Potential links to maths and science
Students should be able to describe the performance characteristics of polymers, including: • toughness • elasticity • insulation (thermal and electrical) • UV resistance • ability to be moulded • resistance to chemicals and liquids • melting points • suitability for food packaging applications • biodegradability • recyclability • self finishing • ability to be combined with other polymers and/or additives.	

Students should be familiar with the following polymers:
• thermoplastic:
  • low density polyethylene (LDPE)
  • high density polyethylene (HDPE)
  • polypropylene (PP)
  • high impact polystyrene (HIPS)
  • acrylonitrile butadiene styrene (ABS)
  • polymethylmethacrylate (PMMA)
  • nylon
  • rigid and flexible polyvinyl chloride (PVC)
  • Polyethylene terephthalate (PET)
• thermosets, with specific reference to their:
  • urea formaldehyde (UF)
  • melamine formaldehyde (MF)
  • polyester resin
  • epoxy resin.	

Elastomers

Content	Potential links to maths and science
Students should be able to explain the suitability of elastomers for given applications making reference to relevant physical and/or mechanical properties, including: • ability to be stretched and then return to original shape • texture • self finishing • non-toxic. Students should understand how elastomers are used to enhance products, for example in producing grips for improved ergonomics.	
Students should be familiar with the following elastomers: • natural rubber • polybutadiene • neoprene • silicone • Thermoplastic Elastomer (TPE).	

Biodegradable polymers

Content	Potential links to maths and science
Students should be able to explain the suitability of biodegradable polymers for given application making reference to relevant physical and/or mechanical properties, including: • ability to be moulded into 3D products or film • ability to degrade with the action of UV rays (sunlight), water or enzymes present in soil. Students should understand how biodegradable polymers degrade.	

Content	Potential links to maths and science
Students should be familiar with the following biodegradable polymers: • corn starch polymers • potatopak • biopol (bio-batch additive) • polyactide (PLA) • polyhdroxyalkanoate (PHA) • water soluble: lactide, glycolide (Lactel and ecofilm).	

Composites

Content	Potential links to maths and science
Students need to know and understand how materials are combined to make composites with enhanced properties. Students should be able to explain the suitability of composites for given application making reference to relevant physical and/or mechanical properties, including: • ability to be moulded into a variety of 3D forms • enhancement of physical and/or mechanical properties • ease of manufacture for some uses against traditional materials • improved product performance. Students should be familiar with the following composites: • carbon fibre reinforced plastic (CFRP) • glass reinforced plastic (GRP) • tungsten carbide • aluminium composite board • concrete, including reinforced concrete • fibre cement • engineered wood, eg glulam (glued laminated timber).	

Smart materials

Content	Potential links to maths and science
Students should know and understand the term smart material. Students should be able to explain the suitability of smart materials for given applications making reference to how the material responds to external stimuli, including: • changes in temperature • changes in light levels • changes in pressure (force).	
Students should be familiar with the following smart materials: • shape memory alloys (SMA), eg Nitinol • thermochromatic pigment • phosphorescent pigment • photochromic pigment • electroluminescent wire • piezo electric material.	

Modern materials

Content	Potential links to maths and science
Students should know and understand the term modern material.	
Students should be able to explain the suitability of modern materials for given applications.	
Students should be familiar with the following modern materials: • kevlar • precious metal clay (PMC) • high density modelling foam • polymorph.	

3.1.3 Enhancement of materials

Content	Potential links to maths and science
Students are expected to be able to describe enhancement methods for given materials and explain their suitability for specific product applications.	Understand the appropriate use of materials, including polymers, composites, woods and based on their physical properties.

Polymer enhancement

Content	Potential links to maths and science
The use of additives to enhance properties, including: • UV stabilisers to prolong the life of polymers • bio-batch materials to encourage biodegradability. Students should be familiar with how additives are used in specific polymer products, eg patio furniture, food packaging and carrier bags.	

Wood enhancement

Content	Potential links to maths and science
The combining of natural timber with resins and lamination to give enhanced properties, eg increased strength and stability. Enhancing timber products with preservatives, finishes and coatings.	

Metal enhancement

Content	Potential links to maths and science
Students should be aware of heat treatment methods of enhancing metals, including: • case hardening • hardening and tempering.	

3.1.4 Forming, redistribution and addition processes

Paper and board forming processes

Content	Potential links to maths and science
Students should be aware of the ways that paper and board can be shaped into different products such as packaging. Specific process to include: • die cutting • laser cutting • creasing • bending.	

Polymer processes

Content	Potential links to maths and science
Students should be aware of how polymers can be formed into 3D products. They should be able to describe the different forming methods.	
They should be able to explain the suitability of the different forming methods for a range of specific products and scales of production. Specific process to include: • vacuum forming • thermoforming • calendaring • line bending • laminating (layup) • injection moulding • blow moulding • rotational moulding • extrusion • compression moulding.	

Metal processes

Content	Potential links to maths and science

Students should be aware of how metals can be shaped into 3D products.
 	
They should be able to describe the different forming methods.
 	
They should be able to explain the suitability of the different forming methods for a range of specific products and scales of production.
 	
Specific processes to include:
• press forming
• spinning
• cupping
• deep drawing
• forging
• drop forging
• bending
• rolling
• casting:
  • sand casting
  • die casting
  • investment casting
  • low temperature casting (pewter).	

Students should be aware of the different permanent and temporary joining methods for metals.
 	
They should be able to describe the different methods.
 	
They should be able to explain the suitability of the different joining methods for a range of specific products and scales of production.
 	
Including addition/fabrication processes:
• metal inert gas (MIG) welding
• tungsten inert gas (TIG) welding
• spot welding
• oxy-acetylene welding
• soldering (soft and hard)
• brazing
• riveting
• temporary joining methods and fasteners:
  • self tapping screws
  • machine screws
  • nuts and bolts.	

Content	Potential links to maths and science
Students should be aware of the different wasting processes. They should be able to describe the different processes. They should be able to explain the suitability of the different wasting processes for a range of specific components and products. Specific processes to include: • milling • turning • flame cutting • plasma cutting • laser cutting • punching/stamping.	

Wood processes

Content	Potential links to maths and science

Students should be aware of how timber can be joined to form different products.
 	
They should be able to describe the different methods.
 	
They should be able to explain the suitability of the different joining methods for a range of specific products and scales of production.
 	
Including:
 	
• addition/fabrication processes
• traditional wood jointing:
  • dovetail joint
  • comb joint
  • housing joint
  • half-lap joint
  • dowel joint
  • mortise and tenon
• component jointing:
  • knock down (KD) fittings
  • wood screws
  • nuts and bolts
  • coach bolts.	

Content	Potential links to maths and science

Students should be aware of how timber can be formed into 3D products.
 	
They should be able to describe the different processes.
 	
They should be able to explain the suitability of the different wasting processes for a range of specific products.
 	
Specific processes to include:
• laminating
• steam bending
• machine processes:
  • turning between centre
  • use of the chuck and faceplate
  • milling
  • routering to produce slots, holes and profiles.	

3.1.4.5 The use of adhesives and fixings

Content	Potential links to maths and science
• PVA • Contact adhesives • UV hardening adhesive • Solvent cements such as Tensol or acrylic cement • Epoxy resin	

Jigs and fixtures

Content	Potential links to maths and science
Students should be aware of how jigs and fixtures can be used to aid the manufacture of products. They should be able to describe them and explain their suitability for accurate and repeated manufacture of products.	Dimensions and angles in the design of jigs, fixtures and templates.

3.1.5 The use of finishes

Paper and board finishing

Content	Potential links to maths and science
Students should be aware of the ways that paper and board can be finished to enhance their appearance or for improved function. Specific finishes to include: • laminating • embossing • debossing • varnishing, UV varnishing and spot varnishing • foil blocking.	Ensure products are designed to take account of potential corrosion due to environmental factors.

Paper and board printing processes

Content	Potential links to maths and science
Students should be aware of the different types of printing processes and their suitability for specific products and scales of production. Specific processes to include: • screen printing • flexographic and offset lithographic printing • digital printing.	

Polymer finishing

Content	Potential links to maths and science
Students should be aware of the ways that polymers can be finished to enhance their aesthetics or for improved function. Students should be aware that some polymers are self-finishing and that this should be considered as a polymer finish. Specific finishes to include: • acrylic spray paints • thermoplastic elastomer.	

Content	Potential links to maths and science
Students should understand how pigments can be added to polymers in the moulding process, including: • gel coats when laminating GRP • smart pigments such as thermochromic or phosphorescent.	

Metal finishing

Content	Potential links to maths and science
Students should be aware of the ways that metals can be finished to enhance their appearance or prevent corrosion. Including applied finishes: • cellulose paint • acrylic paint • electro-plating • dip coating • powder coating • galvanising • sealants • preservatives • anodising • plating • coating • cathodic protection.	

Wood finishing

Content	Potential links to maths and science

Students should be aware of the ways that woods can be finished to enhance their appearance or prevent decay.
 	
Specific finishes to include:
 	
• applied finished:
  • polyurethane varnish
  • acrylic varnish
  • water based paints
  • stains
  • colour wash
  • wax finishes
  • danish oil
  • teak oil
• pressure treating with chemical preservatives.	

3.1.6 Modern industrial and commercial practice

Scales of production

Content	Potential links to maths and science
Students should be aware of, and be able to describe, the different scales of production giving example products and specific manufacturing methods. Specific scales of production to include: • one-off, bespoke • batch production • mass/line production • unit production systems (UPS) • quick response manufacturing (QRM) • vertical in-house production.	

3.1.6.2 Efficient use of materials

Content	Potential links to maths and science
Students must develop an awareness of the relationship between material cost, form, and manufacturing processes, and the scale of production. • The development of designs which use materials economically and with regard to their characteristics. • The use of manufacturing processes which increase accuracy and reduce waste. • The savings to be gained when comparing bulk production with one-off production. • The advantages of Just In Time (JIT) manufacture.	Determining quantities of materials.

The use of computer systems

Content	Potential links to maths and science
Students should be aware of how computer systems are used to plan and control manufacturing, reduce waste and respond quickly to changes in consumer demand.	
Students should be able to explain specific industrial manufacturing systems and their use in the production of given products. Specific manufacturing systems to include: • modular/cell production • just in time (JIT) • quick response manufacturing (QRM) • flexible manufacturing systems.	
Students should be able to explain the use of computer controlled systems in production, distribution and storage. Students should be able to explain the use of standardised and bought-in components made by specialist manufacturers.	

Sub-assembly

Content	Potential links to maths and science
Students should be aware of, and able to explain, sub-assembly as a separate line of manufacture for certain parts of a product.	

3.1.7 Digital design and manufacture

Computer aided design (CAD)

Content	Potential links to maths and science

Students should be aware of, and be able to describe, the following:
• the advantages and disadvantages of using CAD compared to a manually generated alternative
• the use of CAD to develop and present ideas for products, including:
  • the use of 2D CAD for working drawings
  • the use of 3D CAD to produce presentation drawings
• how CAD is used in industrial applications.
	Use of datum points and geometry when setting out design drawings.
	The use of tolerances in dimensioning.

Computer aided manufacture (CAM)

Content	Potential links to maths and science
Students should be aware of, and be able to describe, how CAM is used in the manufacture of products. Specific processes to include: • laser cutting • routing • milling • turning • plotter cutting.	Calculating speeds and times for machining.

Virtual modelling

Content	Potential links to maths and science
Students should be aware of, and be able to describe, how virtual modelling/testing is used in industry prior to product production. Specific processes to include: • simulation • computational fluid dynamics (CFD) as used for testing aerodynamics and wind resistance, and flow of liquids within/ around products • finite element analysis (FEA) as used in component stress analysis.	Interpretation of data from CFD or FEA testing.

Rapid prototyping processes

Content	Potential links to maths and science
Students should be aware of, and be able to describe, rapid prototyping processes, including 3D printing. Students should understand, and be able to explain, the benefits to designers and manufacturers.	Calculating volumes of 3D printed products, calculating time/speed for 3D printing.

Electronic data interchange

Content	Potential links to maths and science
Students should be aware of, and able to describe, the use of electronic point of sales (EPOS) for marketing purposes and the collection of market research data, including: • the maintenance of stock levels • the capture of customer data, eg contact details.	

Production, planning and control (PPC) networking

Content	Potential links to maths and science
Students should be aware of, and able to describe, the role of PCC systems in the planning and control of all aspects of manufacturing, including: • availability of materials • scheduling of machines and people • coordinating suppliers and customers.	

3.1.8 The requirements for product design and development

Product development and improvement

Content	Potential links to maths and science
Through the study and critical analysis of existing products, students should develop an understanding of the requirements of the following: • the design, development and manufacture of products to meet specification criteria • fitness for purpose • accuracy of production • how the critical assessment of products can lead to the development of new designs. Students should develop the skills to critically assess products and develop new design proposals. Students should development their ability to work with a variety of materials, including two- and three-dimensional forms, to produce creative and original products which satisfy the demands of the target market, and consider accurate and efficient manufacture. When designing products Students should consider aesthetics, ergonomics and anthropometrics.	

Inclusive design

Content	Potential links to maths and science
Students should be aware of, and be able to explain, the development of products that are inclusive in their design so that they can be used by a wide range of users including the disabled, children and the elderly.	

3.1.9 Health and safety

Safe working practices

Content	Potential links to maths and science
Students should be aware of, and able to explain, health and safety procedures related to products and manufacturing, including: • knowledge of the Health and Safety at Work Act (1974), and how it influences the safe manufacture of products • control of Substances Hazardous to Health (COSHH) and safety precautions that should be taken with relevant materials • safe working practices and identifying potential hazards for the school or college workshop and industrial contexts • safety precautions that should be taken with specific manufacturing processes • the concept of risk assessment and its application to given manufacturing processes.	Understand why some materials, adhesives and finishes are hazards.

Safety in products and services to the customer

Content	Potential links to maths and science

Students should be aware of, and able to explain, how designers and manufacturers ensure products are safe for consumers to use, including:
• legislation used to protect consumers and its impact on product design, eg Consumer Rights Act (2015), Sales of Goods Act (1979)
• the British Standards Institute (BSI), and how specific products might be tested to meet safety standards
• measures to ensure the safety of toys, eg Lion Mark
• advice to consumers:
  • manufacturer's instructions
  • safety warnings
  • aftercare advice.	

3.1.10 Protecting designs and intellectual property

Content	Potential links to maths and science
Students should be aware of, and able to explain, the importance of the following to the designer: • copyright and design rights • patents • registered designs • trademarks • logos.	
Students should be aware of, and able to explain, the concept of 'open design'. Specifically referring to the development of products for the common good of society, including potential use. Students should be able to give examples of this in practice, eg humanitarian projects and file sharing for 3D printing.	

3.1.11 Design for manufacturing, maintenance, repair and disposal

Manufacture, repair, maintenance and disposal

Content	Potential links to maths and science

Students should be aware of, and able to explain, the need to modify designs to make them more efficient to manufacture, including:
• reducing the number of manufacturing processes
• how the choice of materials affects the use, care and disposal of products:
  • labelling of materials to aid separation for recycling
  • making products easy to disassemble or separate
• application of the six Rs of sustainability:
  • reduce the quantity of materials, of toxic materials, of damaging materials and associated energy use
  • reuse components and parts
  • rethink by using eco friendly alternative materials
  • recycle materials and/or components into new products
• maintenance:
  • temporary and integral fixings
  • use of standardised parts
  • allowing for service and repair/ replacement of parts
  • ability to upgrade with software downloads.	

Ease of manufacture

Content	Potential links to maths and science
Students should be aware of, and able to explain, the different ways in which a product can be designed to allow for more efficient manufacture, including: • ribs and webbing to reduce material thicknesses • snap fittings to remove the need for fixings/adhesives • internal moulded screw posts for use with self tapping screws • use of pre made components • use of standardised patterns and sizes • addition of texture in moulding to reduce number of manufacturing processes • self finishing.	

Disassembly

Content	Potential links to maths and science
Students should be aware of, and able to explain, how a product can be designed and manufactured with disassembly in mind, including integral fixings and active disassembly using smart materials such as SMA and biodegradable parts.	

3.1.12 Feasibility studies

Content	Potential links to maths and science
Students should be aware of, and able to explain, the use of feasibility studies to assess the practicality for production of proposed designs, including the testing of prototypes with potential consumers.	Interpret statistical analyses to determine user needs and preferences. Use data related to human scale and proportion to determine product scale and dimensions.

3.1.13 Enterprise and marketing in the development of products

Content	Potential links to maths and science
Students should be aware of, and able to explain, the importance of marketing and brand identity, including: • customer identification • labelling • packaging • corporate identification • concept of global marketing: • the promotion and advertisement of products including the use of new technologies, eg social media, viral marketing • product costing and profit • awareness of the role of entrepreneurs. Students should be aware of, and able to explain, the collaborative working of designers in the development of new and innovative products, including virtual and face-to-face collaborative working systems.	Interpretation of market research data, calculating costs and profit.

3.1.14 Design communication

Content	Potential links to maths and science
Students should be aware of, and able to explain and demonstrate the skills, in a range of communication and presentation techniques for conveying proposals and intentions to clients, potential users and manufacturers, including: • report writing • the use of graphs • tables and charts • 2D/3D sketching • the use of mixed media and rendering to enhance drawings • dimensioning and details for manufacture.	Scaling drawings. Use of datum points and geometry when setting out design drawings. Representation of data used to inform design decisions and evaluation of outcomes. Presentation of market data, user preferences and outcomes of market research.

3.2 Designing and making principles

3.2.1 Design methods and processes

Iterative design process

Content	Potential links to maths and science

Students should be aware of, and able to explain, different approaches to user centred design. That in approaching a design challenge there is not a single process, but that good design always addresses many issues, including:
• designing to meet needs, wants or values
• investigations to inform the use of primary and secondary data:
  • market research
  • interviews
  • human factors
  • focus groups
  • product analysis and evaluation
  • the use of anthropometric data and percentiles
  • the use of ergonomic data
• the development of a design proposal
• the planning and manufacture of a prototype solution
• the evaluation of a prototype solution to inform further development.
	Representation of data used to inform design decisions and evaluation of outcomes.
	The use of ergonomic and anthropometric data when designing products for humans and specific applications.

3.2.2 Design theory

Design influences

Content	Potential links with maths and science
Students should be aware of, and able to discuss, how key historical design styles, design movements and influential designers that have helped to shape product design and manufacture.	

Design styles and movements

Content	Potential links with maths and science
Students should be aware of, and be able to discuss, key design styles and movements and their principles of design, including: • arts and craft movement • Art Deco • Modernism, eg Bauhaus • Post modernism, eg Memphis.	

Designers and their work

Content	Potential links to maths and science
Students should be aware of, and be able to discuss, the work of influential designers and how their work represents the principles of different design movements, including: • Phillipe Starck • James Dyson • Margaret Calvert • Dieter Rams • Charles and Ray Eames • Marianne Brandt.	

3.2.3 How technology and cultural changes can impact on the work of designers

Socio economic influences

Content	Potential links to maths and science

Students should be aware of, and able to discuss, how socio economic influences have helped to shape product design and manufacture, including:
• post WW1: the Bauhaus and development of furniture for mass production
• WW2: rationing, the development of 'utility' products
• contemporary times:
  • fashion and demand for mass produced furniture
  • decorative design.	

Major developments in technology

Content	Potential links to maths and science
Students should be aware of, and able to discuss, how major developments in technology are shaping product design and manufacture, including: • micro electronics • new materials • new methods of manufacture • advancements in CAD/CAM.	An awareness of scientific advancements/ discoveries and their potential development.

Social, moral and ethical issues

Content	Potential links to maths and science

Students should be aware of, and able to discuss, the responsibilities of designers and manufacturers, including:
• products are made using sustainable materials and ethical production methods
• the development of products that are:
  • culturally acceptable
  • not offensive to people of different race, gender or religious belief
• the development of products that are inclusive
• the design and manufacture of products that could assist with social problems, eg poverty, health and wellbeing, migration and housing
• the impact of Fairtrade on design and consumer demand
• designing products to consider the six Rs of sustainability.	

3.2.3.4 Product life cycle

Content	Potential links to maths and science
Design introduction, evolution, growth, maturity, decline and replacement. Students should be familiar with examples of how designers refine and re-develop products in the lifecycle of specific products.	

3.2.4 Design processes

The use of a design process

Content	Potential links to maths and science
Students should be aware of, and able to discuss and implement, the stages of a range of design processes in order to apply personal judgement and relevant criteria in the appraisal of products and systems, including: • those used in the NEA • investigations and analysis • use of inspiration materials, eg mood boards • ideas generation • illustration • development of a design specification • modelling • planning • evaluating and testing.	

Prototype development

Content	Potential links to maths and science
Students should be aware of, and able to discuss and demonstrate, the development of a prototype from design proposals. This knowledge should influence the development of design ideas for the NEA so that students may make high quality products that meet the needs of identified users.	

The iterative design process in industrial or commercial contexts

Content	Potential links to maths and science
Students should be aware of, and able to discuss, how different design methodologies are used by designers in the corporate world when designing products including collaborative working and the cyclic nature of commercial design and manufacture.	

3.2.5 Critical analysis and evaluation

Content	Potential links to maths and science
Students should be aware of, and able to discuss, their own and commercial products leading to possible improvements/modifications of the original idea.	

Testing and evaluating products in commercial products

Content	Potential links to maths and science
Students should be aware of, and able to discuss, how products are required to undergo rigorous testing, and the testing methods used, before they become commercially available for sale.	

Use of third party feedback in the testing and evaluation process

Content	Potential links to maths and science
Students should be aware of, and able to discuss, how the use of feedback and testing informs the evaluation process, including: • informing future modification and development • the importance of ensuring the views of other interested parties in order to have objective and unbiased feedback.	

3.2.6 Selecting appropriate tools, equipment and processes

Content	Potential links to maths and science
Students should be aware of, and able to discuss and demonstrate, good and safe working practices, including: • the importance of using the correct tools and equipment for specific tasks • the importance of ensuring their own safety and that of others when in a workshop situation • how designs are developed from a single prototype into mass produced products • the effect on the manufacturing process that is brought about by the need for batch and mass manufacture • how to select the most appropriate manufacturing process to be able to realise their, or others', design proposals • the importance of health and safety in a commercial setting including workforce training and national safety standards.	

3.2.7 Accuracy in design and manufacture

Content	Potential links to maths and science
Students should be aware of, and able to discuss and demonstrate, the importance of accuracy in manufacturing, whatever the scale of production, including: • how testing can eliminate errors • the value in the use of measuring aids, eg templates, jigs and fixtures in ensuring consistency of accuracy and the reduction of possible human error.	Determining quantities of materials. Calculation of sides and angles of products. Use of datum points and geometry when setting out design drawings. Use of geometry to create templates for designs.

3.2.8 Responsible design

Environmental issues

Content	Potential links to maths and science
Students should be aware of, and able to discuss, the importance environmental issues in design and manufacture, including: • the responsibilities of designers and manufacturers in ensuring products are made from sustainable materials and components • the environmental impact of packaging of products, eg the use of excessive packaging and plastics.	

Conservation of energy and resources

Content	Potential links to maths and science
Students should be aware of, and able to discuss, the concept of a circular economy, including: • how products are designed to conserve energy, materials and components • the design of products for minimum impact on the environment including raw material extraction, consumption, ease of repair, maintenance and end of life • sustainable manufacturing including the use of alternative energy and methods to minimise waste • the impact of waste, surplus and by-products created in the process of manufacture including reuse of material off-cuts, chemicals, heat and water • cost implications of dealing with waste • the impact of global manufacturing on product miles.	

3.2.9 Design for manufacture and project management

Planning for accuracy and efficiency

Content	Potential links to maths and science
Students should be aware of, and able to discuss and demonstrate, the importance of planning for accuracy when making prototypes and making recommendations for small, medium and large scale production.	

Quality assurance

Content	Potential links to maths and science
Students should be aware of, and able to discuss and demonstrate, the procedures and policies put in place to reduce waste and ensure manufactured products are produced accurately and within acceptable tolerances, including quality assurance systems including Total Quality Management (TQM), scrum, Six Sigma and their applications to specific industrial examples including critical path analysis.	

Quality control

Content	Potential links to maths and science
Students should be aware of, and able to discuss and demonstrate, quality control, including: • the monitoring, checking and testing of materials, components, equipment and products throughout production to ensure they conform to acceptable tolerances • specific quality control methods including the use of 'go-no go' gauges, laser or probe scanning and measuring • use of digital measuring devices such as vernier callipers and micrometers • non-destructive testing such as x-rays and ultrasound.	

3.2.10 National and international standards in product design

Content	Potential links to maths and science

Students should be aware of, and able to discuss, the importance of national and international standards in product design, including:
• British Standards Institute (BSI)
• International Organisation for Standardisation (ISO)
• Restriction of Hazardous Substances (ROHS) directive
• battery directive
• polymer codes for identification and recycling
• packaging directives
• WEEE directives
• energy ratings of products
• eco-labelling:
  • the Mobius Loop
  • the European Eco-label
  • NAPM recycled mark
  • the EC energy label
  • the Energy Efficient label and logo
  • Forest Stewardship Council (FSC)
  • EPA energy star.	

Command words

Command words are the words and phrases used in exams and other assessment tasks that tell students how they should answer the question.

The following command words are taken from Ofqual's official list of command words and their meanings that are relevant to this subject. In addition, where necessary, we have included our own command words and their meanings to complement Ofqual's list.

Analyse

Separate information into components to identify their characteristics (AO3)

Apply

Put into effect in a recognised way (AO4)

Argue

Present a reasoned case (AO3)

Calculate

Work out the value of something (AO4)

Compare

Identify similarities and differences (AO3)

Complete

Finish a task by adding to given information (AO4)

Consider

Review and respond to given information (AO3)

Contrast

Identify differences (AO3)

Define

Specify meaning (AO4)

Describe

Set out characteristics (AO4)

Discuss

Present key points about different ideas or strengths and weaknesses of an idea (AO3)

Evaluate

Judge from available evidence (AO3)

Examine

Investigate closely (AO3)

Explain

Set out purpose or reasons (AO4)

Give

Produce an answer from recall (AO4)

How (far)

Work out the correct answer (AO4)

Identify

Name or otherwise characterise (AO4)

Justify

Support a case with evidence (AO3)

Name

Give the correct title or term (AO4)

Outline

Set out main characteristics (AO4)

Repeat (the pattern)

Maths specific; repeat a given pattern (AO4)

State

Express clearly and briefly (AO4)

What (is)

Give the correct information (AO4)

Which

Select or give the correct information (AO4)

7 Appendix 1: Links to maths and science

All A-level specifications in design and technology must require students to demonstrate their application of knowledge, understanding and skills of maths and science in both theoretical and practical ways. Design and technology uses maths and science to support decisions made in the processes of designing and making

7.1 Maths

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

7.2 Science

Ref	Scientific knowledge and skills	Potential applications: fashion and textiles
a	Describe the conditions which cause degradation	Ensure products are designed to take account of potential corrosion due to environmental factors
b	Know the physical properties of materials and explain how these are related to their uses	Understand the appropriate use of materials, including glass and ceramics, polymers, composites, woods, and metals, based on their physical properties