Version 2
This version confirms that there will be no further January assessments.

GCE

Examinations from 2009

First AS Award: Summer 2009

First A Level Award: Summer 2010

Design & Technology

Contents

WJEC AS GCE in Design and Technology
WJEC A Level GCE in Design and Technology

First AS Award - Summer 2009
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GCE DESIGN & TECHNOLOGY

Subject/Option Entry Codes		*English medium*	*Welsh medium*
Advanced Subsidiary (AS) "Cash in" entry			
Product Design	*2111*	01	51
Food Technology	*2111*	02	52
Systems and Control Technology	*2111*	03	53
Advanced Level (A) "Cash in" entry			
Product Design	*3111*	01	51
Food Technology	*3111*	02	52
Systems and Control Technology	*3111*	03	53
DT1 : Examination: Product Design	1111	01	51
DT1: Examination: Food Technology	1111	02	52
DT1: Examination: Systems and Control Tech.	1111	03	53
DT2 : Design & Make Tasks: Product Design	1112	01	51
DT2 : Design & Make Tasks: Food Technology	1112	02	52
DT2 : Design & Make Tasks: Systems and Control Tech.	1112	03	53
DT3 : Examination: Product Design	1113	01	51
DT3 : Examination: Food Technology	1113	02	52
DT3 : Examination: Systems and Control Tech.	1113	03	53
DT4 : Major Project - Product Design	1114	01	51
DT4 : Major Project - Food Technology	1114	02	52
DT4 : Major Project - Systems and Control Tech.	1114	03	53

Availability of Assessment Units			
Unit	**January 2009**	**May/June 2009**	**May/June 2010 and each subsequent year**
DT1	✓	✓	✓
DT2		✓	✓
DT3			✓
DT4			✓

Advanced Subsidiary: 500/3256/2
Advanced: 500/2604/5

SUMMARY OF ASSESSMENT

This specification is divided into a total of 4 units, 2 AS units and 2 A2 units. Weightings noted below are expressed in terms of the full A level qualification.

AS

DT1 20% 2 hours
Examination Paper This paper will contain two sections which will asses candidates' knowledge and understanding drawn from the subject content for one focus area listed under: *4.1.1 Designing and innovation;* *4.1.2 Product analysis;* *4.2.1 Materials and components;* *4.2.2 Industrial and commercial practice.* Section A questions require short answers: Section B questions require open-ended essay type responses. This component is externally assessed by the WJEC.
DT2 30% (approximately 40 hours)
Design and Make Task Candidates will submit one design and make task which will satisfy the AS assessment criteria. This component is marked by the centre and moderated by the WJEC.

A Level (the above plus the following A2 units)

DT3 20% 2½ hours
Examination Paper This paper consists of three sections and will assess candidates' knowledge and understanding drawn from the whole subject content of one focus area. Section A and B questions require short answers and Section C questions require open-ended essay type responses and will specifically address the subject specification content listed under: *4.1.1 Designing and innovation;* *4.1.2 Product analysis;* *4.1.3 Human responsibility;* *4.1.4 Public interaction;* *4.2.1 Materials and components;* *4.2.2 Industrial and commercial practice.* *4.2.3 Processes;* *4.2.4 Production systems and control* This component is externally assessed by the WJEC.
DT4 30% (approximately 60 hours)
Major Project Candidates will undertake a single substantial project. Each year the WJEC will set eight themes for the project, though candidates may also submit their own proposals for approval. The project requires candidates to demonstrate the integration of designing and making skills and knowledge and understanding. Candidates will submit a major project which will satisfy the A level assessment criteria. This component is marked by the centre and moderated by the WJEC.

DESIGN AND TECHNOLOGY

1 INTRODUCTION

1. 1 Criteria for AS and A Level

This specification has been designed to meet the general criteria for GCE Advanced Subsidiary (AS) and Advanced (A) and the subject criteria for AS/A Design and Technology as issued by the regulators [2006]. The qualifications will comply with the grading, awarding and certification requirements of the Code of Practice for 'general' qualifications (including GCE).

The AS qualification will be reported on a five-grade scale of A, B, C, D, E. The A level qualification will be reported on a six-grade scale of A*, A, B, C, D, E. The award of A* at A level will provide recognition of the additional demands presented by the A2 units in term of 'stretch and challenge' and 'synoptic' requirements. Candidates who fail to reach the minimum standard for grade E are recorded as U (unclassified), and do not receive a certificate. The level of demand of the AS examination is that expected of candidates half way through a full Advanced course.

The AS assessment units will have equal weighting with the second half of the qualification (A2) when these are aggregated to produce the Advanced award. AS consists of two assessment units, referred to in this specification as DT1 (Examination Paper) and DT2 (Design and Make Task). A2 also consists of two units and these are referred to as DT3 (Examination Paper) and DT4 (Major Project).

Assessment units may be retaken prior to certification for the AS or Advanced qualifications, in which case the better result will be used for the qualification award. Individual assessment unit results, prior to certification for a qualification, have a shelf-life limited only by the shelf-life of the specification.

The specification and assessment materials are available in English and Welsh.

1.2 Prior learning

There is no specific requirement for prior learning, although many candidates will have already gained a knowledge and understanding of Design and Technology through their study of a GCSE or GCSE (Short Course) specification in Design and Technology or a GNVQ qualification in Manufacturing or Engineering.

This specification may be followed by any candidate, irrespective of their gender, ethnic, religious or cultural background.

1.3 Progression

The four part structure of this specification (2 units for AS, and an additional 2 for the full Advanced) allows for both staged and end-of-course assessment and thus allows candidates to defer decisions about progression from AS to the full Advanced qualification.

This specification provides a suitable foundation for the study of Design and Technology or a related area through a range of higher education courses (e.g.); progression to the next level of vocational qualifications (e.g.); or direct entry into employment. In addition, the specification provides a coherent, satisfying and worthwhile course of study for candidates who do not progress to further study in this subject.

1.4 Rationale

A course in Design and Technology offers an unique opportunity in the curriculum for candidates to identify and solve real problems by designing and making products or systems in a wide range of contexts relating to their personal interests. Design and Technology develops candidates' interdisciplinary skills and their capacity for imaginative, innovative thinking, creativity and independence.

The AS specification has been designed to source both as the first half of a full A level course and also a discrete course for those wishing to follow just one type of study.

This AS/AL specification:

(a) is intended to be of interest to a wide range of candidates including those intending to directly follow a higher education course or career in Design and Technology or an associated area. Those with other interests and aspirations can also benefit from the many transferable skills inherent in the study of Design and Technology;

(b) builds upon the knowledge, understanding and skills established by the National Curriculum and GCSE, whilst at the same time, accommodating the needs of candidates who have not studied Design and Technology at GCSE level;

(c) promotes progression through the AS and A level and provides a suitable foundation for the study of Design and Technology, or a related area of study, at further or higher education and / or preparation for future employment and the world of work;

(d) provides opportunities for candidates to gain a broad understanding of the skills, understanding and knowledge inherent in Design and Technology and to specialise in one focus area;

(e) encourages candidates to develop their critical thinking, to see the relationships between designer, manufacturer and user and to perceive Design and Technology within the world in which we live;

(f) provides opportunities to develop their Key Skills, particularly those in problem solving, use of IT and communication. They will also have opportunities to develop their skills in application of number, working with others and improving own learning and performance;

(g) is available through the medium of English and Welsh.

1.5 The Wider Curriculum

Spiritual, moral, ethical, social and cultural issues

This specification provides opportunities for candidates, through the study of their chosen focus area, to develop an understanding of spiritual, moral, ethical, social and cultural issues as they relate to the designer, manufacturer or user, for example in Section 3.1.1 *Designing and innovation, part (viii) [part (ix) for Systems and Control] research, plan and evaluate.*

The specification provides a framework and includes specific content through which individual courses may address these issues. Project work may serve to extend understanding of these issues in order that a balanced appreciation of the conflicts and dilemmas involved in the design and manufacture of products or systems may be encouraged. Section 3.1.2 *Product analysis,* includes content on …*social, moral, political and ethical influences on the design, production and purpose of products.* Other sections of specification content, such as Product Design 3.1.4 (i) *innovation in the market,* requires an understanding of *needs and demands of consumers, technology-push and market-pull,* while (iii) *selling the product,* includes reference to *the product life cycle.* Environmental issues are considered in 3.1.1 *Designing and innovation,* Health and safety is specifically mentioned in 3.2.2 *Industrial and commercial practice.* Candidates would also be expected to consider these factors when designing and making their own products (in DT2 and DT4).

1.6 Prohibited combinations and overlap

Every specification is assigned a national classification code indicating the subject area to which it belongs. Centres should be aware that candidates who enter for more than one GCE qualification with the same classification code will only have one grade (the highest) counted for the purpose of the School and College Performance Tables. The classification code for this specification are:

Design and Technology:	Product Design	9080
Design and Technology:	Food Technology	9020
Design and Technology:	Systems and Control Technology	9060

1.7 Equality and Fair Assessment

AS/A levels often require assessment of a broad range of competences. This is because they are general qualifications and, as such, prepare candidates for a wide range of occupations and higher level courses.

The revised AS/A level qualification and subject criteria were reviewed to identify whether any of the competences required by the subject presented a potential barrier to any disabled candidates. If this was the case, the situation was reviewed again to ensure that such competences were included only where essential to the subject. The findings of this process were discussed with disability groups and with disabled people.

In *GCE Design & Technology,* candidates with a visual impairment may find this subject difficult to access fully.

Reasonable adjustments are made for disabled candidates in order to enable them to access the assessments. For this reason, very few candidates will have a complete barrier to any part of the assessment. Information on reasonable adjustments is found in the Joint Council for Qualifications document *Regulations and Guidance Relating to Candidates who are eligible for Adjustments in Examinations.* This document is available on the JCQ website (www.jcq.org.uk).

Candidates who are still unable to access a significant part of the assessment, even after exploring all possibilities through reasonable adjustments, may still be able to receive an award. They would be given a grade on the parts of the assessment they have taken and there would be an indication on their certificate that not all of the competences have been addressed. This will be kept under review and may be amended in future.

2 AIMS

The aims set out below describe the educational purposes of following a course leading to an AS or AL qualification in Design and Technology. Some of these aims are reflected in the assessment objectives; others are not because they cannot be readily translated into measurable objectives. All are, however, aims of this course. The order in which the aims are presented does not indicate priority.

AS and A level specifications in design and technology should encourage students to:

(a) make use of tacit knowledge and reflective practices in order to work with tasks that are challenging and often require definition;

(b) develop and sustain their creativity and innovative practice;

(c) recognise and overcome challenges and constraints when working towards the production of high-quality products;

(d) develop a critical understanding of the influences of the processes and products of design and technological activities from a contemporary and historical perspective;

(e) draw on a range of skills and knowledge from other subject areas;

(f) draw on and apply knowledge, understanding and skills of production processes to a range of design and technology activities;

(g) develop an understanding of contemporary design and technology practices;

(h) use digital technologies and information-handling skills to enhance their design and technological capability;

(i) recognise the values inherent in design and technological activities and develop critical evaluation skills in technical, aesthetic, ethical, economic, environmental, sustainable, social, cultural and entrepreneurial contexts.

3 ASSESSMENT OBJECTIVES

The assessment objectives and the associated weightings for AS and A level are the same.

Knowledge, understanding, skills and their applications are closely linked. AS and A level specifications should require that all candidates demonstrate the following assessment objectives in the context of the content and skills prescribed.

The assessment objectives are to be weighted in all specifications as indicated.

Assessment objectives	
AO1	Candidates should demonstrate specific knowledge and understanding and be able to apply that knowledge and understanding in combination with appropriate skills in their designing; and should communicate ideas and outcomes and demonstrate strategies for evaluation.
AO2	Candidates should be able to demonstrate and apply skills, knowledge and understanding of relevant materials, processes and techniques, and use materials and equipment to produce suitable and appropriate outcomes; and should communicate ideas and outcomes and demonstrate strategies for evaluation.

The assessment objectives apply to the whole specification for AS and A level.

Unit	%	AO1%	AO2%
Unit 1	20	10	10
Unit 2	30	16	14
Unit 3	20	10	10
Unit 4	30	16	14
Total	100	52	48

4 SPECIFICATION CONTENT

Advanced Subsidiary

UNIT 1 – Examination Paper

UNIT 2 – Design and Make Task

Advanced Level

UNIT 3 – Examination Paper

UNIT 4 – Major Project

Specification Content

Design and Technology is about the *application* of skills, knowledge and understanding. It is recommended therefore that the specification content is delivered in a practical way to enable candidates to recognise the purpose of knowledge and to be able to draw on it in practical situations.

The specification content is presented under the two assessment objectives of *designing (AO1)* and *making (AO2)* as follows:

4.1 Designing

4.1.1	Designing and innovation	*(AS)*
4.1.2	Product analysis	*(AS)*
4.1.3	Human responsibility	*(A2)*
4.1.4	Public interaction	*(A2)*

4.2 Making

4.2.1	Materials and components	*(AS)*
4.2.2	Industrial and commercial practice	*(AS)*
4.2.3	Processes	*(A2)*
4.2.4	Production systems and control	*(A2)*

The first two sub-sections listed under *Designing* and the first two sub-sections listed under *Making*, i.e., *4.1.1 Designing and innovation; 4.1.2 Product analysis; 4.2.1 Materials and components* and *4.2.2 Industrial and commercial practice* form the AS subject content. The AS examination paper (unit DT1) will assess this subject content. However, the holistic nature of Design and Technology means that AS candidates are likely to address aspects listed under the content of the remaining (A2) units during the AS design and make task and the published schemes of assessment give credit for this.

Under each sub-heading the specification content is listed in the left-hand column, grouped as *knowledge and understanding* and *skills* with corresponding amplification shown on the right. The *skills* groups indicate areas where candidates are given opportunities to apply their *knowledge and understanding* in practical design and make situations. Some aspects of content appear in more than one sub-section: in these cases the content is repeated, but with amplification appropriate to the sub-section in question.

It is important to note that the content sections describe the knowledge and understanding which may be examined in the written papers DT1 and DT3. However, centres are encouraged to build upon their own expertise by developing specialist knowledge and understanding over and above the minimum requirement presented in these sections.

Candidates may address the specification content through any **one** of the three focus areas:

- Product Design;
- Food Technology;
- Systems and Control Technology.

The specification content for Product Design is listed on pages 13 to 26.
The specification content for Food Technology is listed on pages 27 to 40.
The specification content for Systems and Control Technology is listed on pages 41 to 57.

In each case the amplification of the essential knowledge and understanding has been tailored, where appropriate, to the specific focus area.

PRODUCT DESIGN

4.1 DESIGNING

4.1.1 Designing and innovation (AS)

This section is concerned with candidates developing their ability to design and enhance their basic design skills in order to solve problems. Candidates should also develop an understanding of a range of external influences and demands which affect the work of product designers.

	CONTENT	AMPLIFICATION
	Knowledge and understanding	
(i)	Principles of designing.	*The generation, development and expression of ideas; development of aesthetic values; fitness for purpose;* *the understanding and application of design processes in a logical and creative manner;* *knowledge of writing appropriate and effective specifications;* *the generation of specific, measurable performance criteria to inform designing and evaluating;* *use of sketchbooks in design development* *communication of ideas and solutions in appropriate contexts using a variety of media, such as freehand sketching, formal working and presentation drawings, 2D and 3D modelling, ICT generated images.*
(ii)	Research techniques.	*The discerning use of reference material from a variety of sources such as libraries, Internet, databases, magazines and exhibitions, to produce valid and reliable information.*
(iii)	Analysis of the problem	*Understanding effective analysis and synthesis of material to guide effective development of innovative and creative ideas;* *reflection on the problem.*
(iv)	Problem solving strategies.	*Investigation, team work (including brainstorming), research, modelling, prototyping and trialling;* *the process of innovation – collaborative and commercial approaches; the development of innovative product solutions. Key concepts in innovation such as the impact of product champions and entrepreneurs;* *innovation techniques such as inversion (turning the problem around, for example instead of considering 'how do I get to work?' thinking about 'how can work get to me?', morphological analysis (evaluating possible solutions in a table or matrix and considering all possible combinations), analogy and lateral thinking;* *analysis and exploration of the needs of users*

(v)	Quantitative and qualitative testing.	*Techniques of evaluating performance against specific measurable criteria such as comparative testing of materials for a specific application; devising fair tests for materials;* *2D/3D modelling and prototyping to evaluate proposals;* *identification of criteria for value judgements such as ratings charts for aesthetics, function, user-friendliness.*
(vi)	Ergonomics and anthropometrics.	*Relevant use of human and environmental measurements and statistics to inform design and production.*
(vii)	Computer systems for designing.	*Use of CADD both in formative and summative stages of designing, Internet, CD-ROM, databases, spreadsheet, word processing/DTP and control programs, as appropriate to the task undertaken;* *understand the principles of concurrent engineering;* *product data management – using software to manage and monitor production.*
(viii)	Innovation	*Appreciate the importance of innovation in both designing and making.*
Skills		***Candidates should be able to:***
(ix)	Consider a range of issues when designing.	*take into account manufacturing, maintenance and product life when designing.*
(x)	Research, plan and evaluate.	*investigate, organise and manage time and resources effectively, responding to changing circumstances;* *exercise entrepreneurial, collaborative and team working skills as appropriate;* *identify and apply relevant external standards, such as BSI, IEE, to their design tasks;* *achieve optimum use of materials and components by taking into account the complex relationship between: material, form and manufacturing processes; the scale of production; the environmental factors affecting disposal of waste, surplus and by-products; and the cost;* *evaluate outcomes by devising quality assurance procedures, assessing the impact of actions and regularly reviewing and establishing the best approach. Review the way the work plan is followed after considering its effectiveness in order to achieve improvements;* *use and select methods of testing the performance of products against specified criteria and act on their findings. Ensure, through testing, modification and evaluation, that the quality of products is suitable for the intended user.*

(xi)	Generate and develop ideas.	*use a range of design methods and strategies to originate ideas and possible solutions which are appropriate to the problem, for example brainstorming, disassembly of existing products, inversion, morphological analysis, analogy and lateral thinking; design strategies – mood, lifestyle or theme boards;* *in the light of thorough analysis and the specifications, use knowledge and understanding to develop and refine alternative designs and/or design detail, demonstrating creativity and innovation; critically evaluate all ideas against the specification.*
(xii)	Develop proposals.	*model detailed aspects of ideas and proposals, using ICT as appropriate and use a systems approach to solve problems.*
(xiii)	Detail design.	*use knowledge and understanding of the working characteristics of materials and components (such as tensile and/or compressive strength, shear, stiffness, density, insulation properties) and restrictions imposed by tools, equipment and processes to prepare detailed design proposals to meet specifications;* *technical factors – maintenance, safety and how the product is used? take into account information gained during research, from manufacturers or suppliers, the Internet, experimentation etc.;* *carry out feasibility studies on the practicability of the proposed solution to meet the needs of the market place.*
(xiv)	Communicate ideas and information.	*present ideas and design possibilities in appropriate formats such as word processing/DTP, freehand sketching, formal working or presentation drawings, CAD/ICT generated images; solid modelling;* *record and explain design decisions;* *communicate information unambiguously to enable others to interpret design intentions using appropriate conventions and technical language, sketching, presentation drawings, ICT generated graphs, drawings, spreadsheet printouts, digital or conventional pictures/images*.

4.1.2 Product analysis (AS)

This section is about understanding the requirements a product must satisfy, critical assessment of existing products and visualising new products in a context of past, present and future possibilities.

	CONTENT	AMPLIFICATION
Knowledge and understanding		
(i)	The processes involved in the design and production of a range of manufactured products.	*Reverse engineering, to include historical influences, technological performance and components, functional success and aesthetic detailing, or other techniques for product analysis;* *performance modelling and prototyping;* *the influence of equipment on product manufacture in a range of materials;* *interaction of new technologies and design needs especially on material and fabric development.*
(ii)	Form and function of different products.	*Aesthetic detailing, functional and marketing constraints such as maintenance and cost of a range of manufactured products;* *stylistic and engineering design;* *considerations of 'above the line' (visible and consumer required characteristics) and 'below the line' (invisible, operational characteristics) assessment;* *appreciate the relationship between products and human form and environment (ergonomics and anthropometrics) to ensure suitability and ease of use.*
(iii)	Trends, styles, new technical capabilities, and social, moral, political and ethical influences on the design, production and purpose of products.	*Candidates should have an understanding of the historical influences on selected products;* *comparison of 'new' products with existing types; cultural trends and differences and their effect on new product development; ethical, moral and social considerations;* *the development of products through time – recognising 'design classics' or' icons'* *development of a design consciousness in society;* *levels of technological development (including new materials and technologies) and their influence on designing and products.*

(iv)	Intellectual Property and International Standards	*The implications of Intellectual Property - Patents, Registered Designs, Design Right, Registered Trade Marks, Copyright;* *the importance and effect of international standards on the design of products – BSI and ISO Standards.*
Skills		***Candidates should be able to:***
(v)	Consider a range of issues when designing.	*take into account the characteristics and features of existing products when designing.* *– structural, aesthetic and functional characteristics*

4.1.3 Human responsibility (A2)

This section is about acquiring the knowledge and understanding needed to support design activities through an increased awareness of the designer's social, moral, ethical and legal responsibilities. It also allows candidates to explore the environmental and consumer factors which impact on designers and which might affect the final nature of a product.

	CONTENT	**AMPLIFICATION**
Knowledge and understanding		
(i)	Service to the customer, including legal requirements, availability of resources.	*Appreciate the need to offer product support and customer services;* *take account of consumer group opinions in a competitive market;* *understand the effect of legislation/regulations related to product design;* *consumer protection.*
(ii)	How to find information on the regulatory and legislative frameworks related to product design.	*Candidates should know how to find relevant information related to a product's design and use, from documents such as Health and Safety legislation, BS and COSHH.*
(iii)	Standard risk assessment procedures in product design.	*The identification of risks to the consumer in using a product, making risk assessments, reduction of risks.*

(iv)	The values (technical, economic, aesthetic, social, environmental and moral) implicit in product design solutions.	*Needs, wants and acceptability to consumers; Maslow's hierarchy of needs* *concept of quality by designers and to consumers;* *client profiles;* *identifying target markets;* *the effect of product life cycles;* *sustainable design issues when making design choices;* *manufacturing and the environment;* *conservation of raw materials;* *intermediate technology.*
(v)	The forms of energy used by industry, its impact on design, manufacturing and the environment.	*The benefits and limitations of various sources of energy, to include, fossil fuels, nuclear fuels, solar, hydro and wind generation;* *the efficient use of energy in manufacturing* *green/environmental issues (implications of the industrial/technological age)* *sustainability issues- influencing the future, resource management.* *energy conservation, including re-cycling/green issues;* *the effect of energy costs on the final product;* *appropriate technology.*
Skills		***Candidates should be able to:***
(vi)	Consider appropriate issues and responsibilities when designing.	*design for economic and environmentally friendly manufacture;* *consider product maintenance and life cycle when designing;* *design for safe use by the consumer;* *appreciate the needs of specific consumers, such as young children, the elderly or those with special physical needs.*
(vii)	Quality in terms of the product: • fitness for purpose; • meeting the criteria of the specification; • accuracy of production; • appropriate use of technology; • aesthetic aspects.	*manage and use control systems in quality assurance and quality control.*
(viii)	Quality in terms of the human process of designing and making.	*recognise the importance of quality in the personal processes of designing and making, production systems, attention to detail.*

4.1.4 Public interaction – marketing and research (A2)

This section is about product design and its place in the market, for example how a design idea may be transformed into a marketable product. It is concerned with producing reliable and quantifiable performance specification following a detailed consideration of the users of the product (the target audience). It seeks to examine the many factors influencing product design, such as *market-pull* versus *technology-push* models of innovation and the four Ps *(Product life cycle, Price, Place and Promotion).* Market research techniques and their influence on producing innovative products will also be considered as part of human responsibility within the process of designing. Candidates should develop an appreciation of the effects of social, economic, cultural and ethical issues in addition to material and manufacturing technologies.

	CONTENT	**AMPLIFICATION**
Knowledge and understanding		
(i)	Innovation in the market.	*Needs and demands of consumers, technology-push and market-pull;* *the totally new (radical) product and the product which has been subjected to improvements over time (incremental);* *marketing strategies and how market research is conducted.*
(ii)	Researching the market,	*The process of market research and its place in the process of innovation;* *the market environment, who buys, lifestyle changes, market segmentation;* *technological trends and how market research is conducted;* *the importance of the target audience and market trends.*
(iii)	Selling the product.	*The four Ps:* • *Product life cycle;* • *Price and how it is determined;* • *Place and how products are distributed;* • *Promotion, which considers different ways in which products are presented to their market.*

(iv)	Diffusion of products.	*Factors influencing the success of products such as criteria which are important in purchasing decisions made by consumers (target audience; market penetration, who buys products).*
(v)	Trends, styles, new technical capabilities, and social, political and ethical influences on design, production and sale of products.	*History and impact of Twentieth Century design movements and designers to include developments in design from the 70's onward;* *cultural trends and differences and their effect on new product development including retailing strategies; product life cycle; fashion cycles;* *ethical, moral and social considerations;* *development of a design consciousness in society;* *consumer society – an awareness of over use of natural resources, the consequences of pollution, over production;* *global manufacturing.*
Skills		***Candidates should be able to:***
(vi)	Clarify tasks, by analysing and researching market/client needs: producing quantifiable performance specifications.	*identify user needs, the nature of the problem to be solved and the target audience. Adopt strategies to produce design specifications which inform and guide decision making, seeking specialist advice and information as appropriate;* *develop initial design briefs for performance manufacturing, maintenance and product life.*
(vii)	Use appropriate measurements to determine product marketability.	*assess the success of existing products; the effectiveness of a product using social, economic and moral parameters.*
(viii)	Evaluate products.	*use personal sources and external sources – target audience, specialists, when evaluating products against performance specification.*

4.2 MAKING

4.2.1 Materials and components (AS)

This section is about developing a general appreciation of the wide range of materials and components available to designers and manufacturers. This general appreciation should be supported by a more detailed knowledge of a range of materials, partly developed through use in specialist project work in units DT2 and DT4.

	CONTENT	AMPLIFICATION
Knowledge and understanding		
(i)	Materials, components and their potential application.	*Classification, general characteristics and uses of:-* *natural materials and elements to include, cotton, copper, hardwoods, linen, silk, silver, softwoods, wool;* *plastic/pure synthetic to include, acrylic, cellophane, epoxy resin, kevlar, polyamide (nylon), polyester, PTFE, polypropylene, PVC;* *regenerated materials to include, blockboard, cellulose-based boards (cards), chipboard, MDF, paper, viscose;* *alloys and composites to include, aluminium alloy, brass, pewter, bronze, carbon fibre, GRP, low and medium carbon steels;* *stock forms of the above materials to include, bonded, knitted, laminated, profiled, sheet and woven forms, availability and comparative costs.*
(ii)	Working characteristics of materials: physical, chemical and composite.	*The physical, working and chemical properties of range of materials, to include conductivity, relative hardness, density, toughness, ductility, tensile and compressive strength, malleability, as appropriate to the material in question;* *appreciation of the complex interrelationships between material, form and manufacturing process and consideration of how the material affects the structure of the product.*

(iii)	Methods of creating materials with specific properties.	*To include compositing, combining, laminating and reforming;* *awareness of current developments of new materials and alloys together with their application, e.g. SMART materials;* *foams, rubbers, wood-based composites, microfibres, performance fabrics and metallicised materials.*
(iv)	Awareness of modern material technology.	*An appreciation of how product development is influenced by modern materials, to include an understanding of a range of composites, functional (SMART) materials, which change their shape or properties in response to various stimuli.*
(v)	The choice of materials for specific service requirements.	*To include resistance to abrasion, weathering and fire, suitability for embossing, cold working, dimensional integrity;* *quantitative and qualitative testing of materials.*
(vi)	The choice of finishes for specific service requirements.	*Finishing techniques, including both self-finished and applied-finishing processes to improve aesthetic and/or physical characteristics, such as coating, painting, varnishing, laminating, anodising and holographic finishes.*
(vii)	Components and their potential application.	*A broad understanding of the availability and use of a wide range of bought-in components and fittings appropriate to the material(s) and application;* *a knowledge of temporary means of joining/fastening a broad range of materials, such as rivets, knock-down fittings, screws, velcro, zips.*
Skills		***Candidates should be able to:***
(viii)	Work with materials and components.	*work accurately, creatively, innovatively and imaginatively with materials, components, appropriate technologies, tools, processes and resources to achieve high quality products which match their specification;* *demonstrate an appreciation of the working properties and functions of a variety of materials (as identified in section (i) above), and components/fasteners (as identified in (vii) above), and use these with confidence.* *(This general appreciation should be supported by a more detailed knowledge of a range of materials partly developed through use in specialist project work in units DT2 and DT4.)*

4.2.2 Industrial and commercial practice (AS)

This section is about understanding various methods of production and being able to apply appropriate commercial practices in practical projects.

	CONTENT	AMPLIFICATION
Knowledge and understanding		
(i)	The main features of manufacturing industry, including employment and commercial practices.	*Principles of industrial manufacturing systems across a range of scales and levels of production to include: mass, batch, one-off and different product types;* *staffing needs, allocation of costs, 'Just in Time' manufacture and commercial liability;* *bought-in, standardised part assembly, sub-contracting. the effect of production across manufacturing sites*
(ii)	Manufacturing systems, including one off, batch, high volume, bought-in parts.	*The use of different levels of production taking into account economic decisions;* *unit/one-off (including prototyping), modular/batch and high volume production.*
(iii)	Stages of production.	*Primary and secondary processing;* *Sourcing of materials, the buying cycle, forward ordering, storage, processing, assembly, finishing, packaging/ labelling and transportation.*
(iv)	Detailed manufacturing methods, when preparing, combining, manipulating or processing materials.	*Comparison of hand and commercial methods of preparing, shaping, cutting/wasting, joining materials, such as casting and sintering, fabrication and injection moulding, cutting textiles by hand and laser.* *the influence of the above on the time taken to produce the product, its quality and final cost;* *knowledge of manufacturing through the analysis of products.*
(v)	Management systems for production, quality assurance, organisation of equipment and people.	*Internal Quality Control (QC) and external Quality Assurance (QA) requirements;* *project management systems including flow charts, GANTT charts and critical path analysis;* *modern methods of labour organisation to include single craft, progressive bundle and cell. Total quality manufacturing principles.*
(vi)	Safe working practices, including identifying hazards and making risk assessments.	*Commercial working practices and responsibilities and their application to project work;* *five-step risk assessment. (Identify hazard, who might be harmed & how, evaluate potential for risk, record, review if details change); provision of equipment, signage etc.*
Skills		***Candidates should be able to:***
(vii)	Industrial methodology and approaches.	*use an awareness of industrial methods and approaches in their own work to design, manufacture and implement quality control procedures.*

4.2.3 Processes (A2)

This section is about developing a detailed knowledge and understanding of a broad range of processes leading to the acquisition of associated skills through practical activity .

	CONTENT	AMPLIFICATION
Knowledge and understanding		
(i)	Hand methods of preparing, processing and manipulating materials.	*Methods of testing, conditioning, cutting/wasting, forming and finishing a variety of materials;* *the use of templates, patterns and guides.*
(ii)	Machine methods of preparing, processing and manipulating materials.	*Methods of cutting/wasting, industrial forming. (a range of materials) joining and finishing a variety of materials such as casting, laminating, injection moulding, bonding;* *the use of jigs and fixtures to increase speed of production and help ensure consistency.*
(iii)	Combining/forming materials to enhance their properties.	*Joining and forming of a wide range of materials within modern industry for different levels of production;* *laminating, combining, jointing, folding and other methods of reinforcing.*
(iv)	Computer aided manufacture.	*Knowledge of software applications and the transfer of information to CAM machines, e.g. laser cutters, microrouters, CNC Lathes and milling machines;* *the benefits and limitations of computer controlled machines, to include CADD,CAM, CIM, digital media.*
Skills		***Candidates should be able to:***
(v)	Work with tools and equipment.	*select an appropriate range of tools, equipment and processes in order to make quality products;* *make safe use of power tools and machinery;* *experiment with techniques in order to improve and refine intended methods of realising a design;* *demonstrate care, precision and attention to detail in the use of tools and equipment;* *work to a plan in order to achieve the desired objective.*

(vi)	Work with materials, components and appropriate technologies.	*select appropriate materials, components and methods in order to make quality products;* *experiment with techniques in order to improve and refine intended methods of realising a design;* *demonstrate care, precision and attention to detail in the use of materials and components.*

4.2.4 Production systems and control (A2)

This section is about applying knowledge of production systems and control techniques to provide valid, reliable data and information in order to manufacture quality products.

	CONTENT	AMPLIFICATION
Knowledge and understanding		
(i)	The use and detailed design of systems and sub-systems for manufacturing and management.	*The fundamental characteristics of a system in terms of Input, Process and Output;* *the applications of systems for manufacture and management;* *designing and making of systems;*
(ii)	Detailed design of control systems: loops, feedback, control functions to achieve desired purposes.	*The extension of simple systems, using feedback and loops, to enhance the system's performance;* *the importance of reliable data in feedback.*
(iii)	The use of ICT by industry in the design and manufacture of products.	*Examining the current use of ICT by industry in designing and manufacturing including:-* *CADD - Computer Aided Drawing and Design;* *CAM - Computer Aided Manufacture;* *CIM – Computer Integrated Manufacture;* *PPC – Production Planning and Control – production plans, quantity planning, quality assurance, ordering;* *CAA – Computer Aided Administration – personnel, marketing, sales, order processing, procurement, stock control, costing, accounting;* *retail stock control, distribution scheduling, customer / supplier relationships - JIT - 'Just in Time'.*

Skills		***Candidates should be able to:***
(iv)	Systems Analysis.	*use a systems approach to analyse problems;* *identify key features of a problem;* *devise strategies to meet the needs and model detailed aspects of a solution.*
(v)	Use ICT when planning.	*produce block, flow and systems diagrams to formulate solutions;* *use ICT appropriately for planning and data handling;* *work to devised plans.*
(vi)	Use ICT when designing and making.	*use ICT appropriately for communicating, modelling, controlling and manufacturing.*
(vii)	Communicate ideas and information to others in the production system.	*use ICT where appropriate to evaluate, cost, communicate within and across systems and present proposals.*

FOOD TECHNOLOGY

4.1 DESIGNING

4.1.1 Designing and innovation (AS)

This section is concerned with candidates developing their ability to design and enhance their basic design skills in order to solve problems. Candidates should also develop an understanding of a range of external influences and demands which affect the work of food technologists.

	CONTENT	AMPLIFICATION
Knowledge and understanding		
(i)	Principles of designing.	*The generation, development and expression of ideas;* *development of aesthetic values;* *the understanding and application of design processes in a logical and creative manner;* *knowledge of writing appropriate and effective specifications;* *use of sketchbooks in design development;* *the generation of specific performance criteria to inform designing and evaluating;* *communication of ideas and solutions in appropriate contexts using a variety of media.*
(ii)	Research techniques.	*Primary and secondary research – including the discerning use of a variety of sources such as the consumer, libraries, Internet, magazines/journals and retail outlets to produce valid and reliable information.*
(iii)	Analysis of the problem	*Understanding effective analysis of material to guide effective development of innovative and creative ideas; reflection on the problem.*
(iv)	Problem solving strategies.	*Investigation, team work (including brainstorming), research, modelling, prototyping and trialling.* *analysis and exploration of the needs of users.*
(v)	Quantitative and qualitative testing.	*Techniques of evaluating performance against specific measurable criteria such as a range of sensory evaluation procedures, nutritional analysis and food material/ packaging performance;* *devising fair tests for materials;* *identification of criteria for value judgements such as ratings charts for aesthetics, function, user-friendliness.*

(vi)	Ergonomics and anthropometrics.	*Relevant use of human and environmental measurements and data to inform design and production.*
(vii)	Computer systems for designing.	*Appropriate use of CADD (for example, 2D/3D modelling of products/packaging, computer modelling of sensory attributes, imaging, flow charts for production schedules, GANTT charts for developing, production and launching of new products), Internet, CD-ROM, databases for nutritional analysis, spreadsheets for costing.*
(viii)	Innovation	*product data management - using software to manage and monitor production.* *Appreciate the importance of innovation in both designing and making.*
(ix)	Consider of a range of issues when designing.	*take into account consumer needs, market trends, manufacturing and product life when designing.*
(x)	research, plan and evaluate.	*organise and manage time and resources effectively, responding to changing circumstances;* *exercise entrepreneurial, collaborative and team working skills as appropriate;* *identify and apply relevant external standards to their design tasks such as EC standards and legislation;* *achieve optimum use of materials and components by taking into account the complex relationship between: material, form and manufacturing processes; the scale of production; the environmental factors affecting disposal of waste, surplus and by-products; and the cost;* *evaluate outcomes by devising quality assurance procedures, assessing the impact of actions and regularly reviewing and establishing the best approach. Review the way the work plan is followed after considering its effectiveness in order to achieve improvements;* *use and select methods of testing the performance of products against specified criteria and act on their findings. Ensure, through testing, modification, and evaluation, that the quality of products is suitable for the intended user.*
(xi)	Generate and develop ideas.	*use a range of design methods and strategies to originate ideas and possible solutions which are appropriate to the problem, for example brainstorming, disassembly of existing products, inversion, morphological analysis, analogy and lateral thinking; design strategies - mood, lifestyle or theme foods boards;* *demonstrating creativity and innovation; critically evaluate all ideas against the specification.*
(xii)	Develop proposals.	*prototype ideas and proposals and use a systems approach to solve problems.*

(xiii)	Detail design.	*use knowledge and understanding of the working characteristics and properties of materials and components, and restrictions imposed by equipment/resources and processes to prepare detailed design proposals to meet specifications;* *carry out feasibility studies on the suitability of the proposed solution to meet the needs of the market place.*
(xiv)	Communicate ideas and information.	*present ideas / design possibilities in appropriate formats;* *record and explain design decisions;* *communicate information unambiguously to enable others to interpret design intentions using technical language, sketching, drawings, spreadsheet printouts, digital or conventional pictures/images.*

4.1.2 Product analysis (AS)

This section is about understanding the requirements a product must satisfy, critical assessment of existing products and developing new products in a context of past, present and future possibilities.

	CONTENT	AMPLIFICATION
Knowledge and understanding		
(i)	The processes involved in the design and production of a range of manufactured food products.	*Concept and product development – how ideas for food products are conceived and developed;* *understanding of major stages of design and production to include: market research, concept development, concept screening, design/product/manufacturing specification, prototypes, product formulation, test production runs, modification, product launch.* *the influence of equipment on product manufacture in a range of materials;* *interaction of new technologies and design needs especially on material development.*
(ii)	Influences of past and present food designers and inventors.	*Escoffier, Elizabeth David, Clarence Birdseye, Mossiman, and also the influence of "celebrity chefs" – Gary Rhodes, Delia Smith, Jamie Oliver etc.*
(iii)	Form and function of different products.	*Strategies for understanding, analysing and evaluating food products, and the systems used to produce them;* *analysis of existing products and systems in relation to specified criteria e.g. nutritional, sensory, physical, economic, technical developments. Using a variety of strategies such as disassembly, sensory analysis, nutritional and material analysis, qualitative and quantitative tests.*

(iv)	Product life cycle.	*To include product development stage, introduction, growth, maturity, decline and replacement rate of take-up. Case study of a range of products such as Cadbury's Spira;* *planned obsolescence of food products, such as novelty / seasonal products.*
(v)	Trends, styles, new technical capabilities, and social, moral, political and ethical influences on the design, production and purpose of products.	*The historical influences on major milestones of technical development in food – fermentation, milling, canning, freezing;* *an understanding that products are developed by companies for a number of reasons e.g. product orientated or market orientated;* *influences on new product design to include:* • *dietary trends and influence of dietary guidelines* • *development of new materials – food / packaging;* • *development of new techniques and processes;* • *socio-economic factors on meal pattern and employment trends;* • *cultural trends and differences and their effect on new product development – influence of foreign foods on the product market today;* • *global perspective – availability of food materials / out of season foods, cost of transportation / effect on the home market;* • *environmental issues.* *levels of technological development (including new materials and technologies) and their influence on designing and products.*
(vi)	Intellectual Property and International Standards.	*The implications of Intellectual Property - Patents, Registered Designs, Design Right, Registered Trade Marks, Copyright;* *the importance and effect of international standards on the design of products – BSI and ISO Standards.*
Skills		***Candidates should be able to:***
(vii)	Consider a range of issues when designing.	*take into account the characteristics and features of existing food products when designing.*

4.1.3 Human responsibility (A2)

This section is about acquiring the knowledge and understanding needed to support design activities through an increased awareness of the designer's social, moral, ethical and legal responsibilities. It also allows candidates to explore the environmental and consumer factors which impact on designers and which might affect the final nature of a food product.

	CONTENT	AMPLIFICATION
	Knowledge and understanding	
(i)	Service to the customer, regulatory and legislative framework related to materials and equipment.	*Commercial procedures for ensuring safe food production;* *1990 Food Safety Act;* *General Food Hygiene Regulations, 1995;* *European Union Food Hygiene Directive 93/94/EEC;* *legal requirements regarding food labelling.*
(ii)	The values (technical, economic, aesthetic, social, environmental and moral) implicit in food technology solutions.	*Consumer choice and preference in relation to:* • *dietary needs, including special dietary needs;* • *environmental / moral issues (fair trading / organic / animal welfare / green revolution, recycling, disposal of waste – domestic / industrial) / food miles;* • *technical development - genetically modified foods / quorn;* • *agricultural issues, use of antibiotics / growth promoters / factory farming / organic / animal welfare / BSE, pesticides;* • *social – change of employment patterns, loss of culinary skills;* • *cost - packaging, advertising and marketing;* • *fortified foods;* • *probiotic foods;* • *nutraceutical foods.* *the effect of product life cycles;* *manufacturing and the environment;* *Change acceptance and adaptability - the need to find new, novel, and authentic food products constantly to satisfy customer demand and maintain market sales.*
(iii)	The forms of energy used by industry, its impact on design and manufacturing and environmental impact.	*Consideration of cost and type of energy and the effect on the final product and product quality;* *the efficient use of energy in manufacturing;* *green/environmental issues (implications of the industrial/ technological age);* *sustainability issues - influencing the future, resource management;* *energy conservation, including re-cycling/green issues.*

(iv)	Consider appropriate issues and responsibilities when designing.	*design for economic and environmentally friendly manufacture / food production / transportation / retailing;* *appreciate the needs of specific consumers, such as young children, the elderly or those with special dietary needs.*
(v)	Quality in terms of the product: • suitability for target group; • meeting the criteria of the specification; • accuracy of production; • appropriate use of technology; • aesthetic factors.	*use qualitative tests with statistical and procedural accuracy and against specific quality standards – e.g. material testing, nutritional analysis, colour charts and sensory analysis;* *generate criteria and specifications required to judge quality;* *apply quality assurance procedures appropriate for different contexts and scales of production. Working to tolerances which define and control quality standards.*
(vi)	Quality in terms of the human process of designing and making.	*consider socio-economic, cultural and ethical factors involved in food choice, availability and distribution.*

4.1.4 Public interaction – marketing and research (A2)

This section is about product design and its place in the market, for example how a design idea may be transformed into a marketable food product. It is concerned with producing reliable and quantifiable performance specification following a detailed consideration of the users of the product (the target audience). It seeks to examine the many factors influencing product design, such as *market-pull* versus *technology-push* models of innovation and the four Ps *(Product life cycle, Price, Place and Promotion).* Market research techniques and their influence on producing innovative products will also be considered as part of human responsibility within the process of designing. Candidates should develop an appreciation of the effects of social, economic, cultural and ethical issues in addition to food material and manufacturing technologies.

	CONTENT	**AMPLIFICATION**
Knowledge and understanding		
(i)	Trends, styles, new technical capabilities, and social, political and ethical influences on design, production and sale of products.	*Development of food products in relation to influences from the consumer market, dietary theories, health issues, obesity concerns and guidelines, cultural trends and differences, design consciousness;* *impact of new and developing materials, processing equipment, socio-economic factors, changing nature of society;* *extension of new product lines as a result of foreign travel / revived interest in regional / historical foods;* *development of new products as a result of technical advancements e.g. processing (extrusion of chocolate), storage;*
(ii)	Innovation in the market.	*Needs and demands of consumers, technology-push and market-pull;* *the totally new (radical) product and the product which has been subjected to improvements over time (incremental);* *marketing strategies and how market research is conducted.*
(iii)	Researching the market.	*The process of market research and its place in the process of innovation;* *the market environment, who buys, lifestyle changes, socio-economic, target audience and market research methods.*
(iv)	Selling the product.	*Main methods of marketing food products;* *the four Ps:* • *Product life cycle;* • *Price and how it is determined;* • *Place and how products are distributed;* • *Promotion, which considers different ways in which products are presented to their market.* *marketing food products to children.*

(v)	Image and value of trade names.	*Importance of brands, logos, trade names and corporate identity.*
(vi)	Diffusion of products	*Factors influencing the success of products such as criteria which are important in purchasing decisions made by consumers (target audience; market penetration, who buys products).*
(vii)	Marketing potential of packaging.	*Packaging design – development of packaging as a direct marketing tool – e.g. tetra pak, tubular crisps;* *use of colour, size, shape, image and typography in packaging products to target specific groups;* *development of consumer led demands e.g. tamperproof, minimal cost packaging, minimal packaging, environmentally friendly packaging, smart codes.*
(viii)	Retailing.	*Basic techniques to produce prototypes;* *packaging products for functional and marketing personnel;* *layout of retail outlets - retail psychology and pressure;* *methods of retailing – Internet ordering, cable television.*
Skills		***Candidates should be able to:***
(ix)	Clarify tasks, by analysing and researching market/client needs: producing quantifiable performance specifications.	*identify a wide range of user needs and explore the nature of problems to be solved, carrying out in-depth research and seeking specialist advice and information;* *develop initial design briefs for performance, manufacturing, maintenance and product life;* *produce design specifications or performance criteria which inform designing and making.*
(x)	Use appropriate measurements.	*determine how effectively the product meets the pre-determined specification or criteria.*
(xi)	Evaluate products.	*use personal and external sources - target audience, specialists, when evaluating products against performance specification.*

4.2 MAKING

4.2.1 Materials and components (AS)

This section is about developing a wide appreciation of the range of food materials and packaging available for manufacturing and an ability to *use an appropriate selection in project work.* The choice should be supported by evidence of exclusions of possible alternatives as a result of research / knowledge and testing.

	CONTENT	AMPLIFICATION
Knowledge and understanding		
(i)	Working and nutritional characteristics of food materials.	*Nutrients - composition, source, properties and function –* • *protein - amino acids, animal and vegetable protein, biological value;* • *carbohydrates;* • *fats - saturated and unsaturated fats;* • *vitamins - sources, function, deficiency – loss through processing;* • *minerals;* • *nutritional theories – underlying principles of current theories – Healthy Eating guidelines, Health of the Nation Targets, etc.;* • *the utilisation of DRVs to produce targeted products.*
(ii)	Physical, chemical and composite characteristics and properties.	*Classification of food materials, food and components by commodities – grouping of foods by commodity e.g. – fats /oil, cereals, fish/meat, fruit/vegetables, egg, milk, sugar;* *fats/oils – shortening, plasticity, lubrication, aeration, emulsification;* *cereals – gelatinisation, dextrinisation, bulking, gluten formation;* *sugars - caramelisation, moisture retention, preservation, aeration;* *fish/meat/milk/eggs – coagulation, gelatinisation, foam formation and denaturation;* *fruit/vegetables – enzymic browning, pectin formation.*
(iii)	Sensory characteristics.	*Organoleptic qualities – aroma, flavour, texture, mouthfeel, visual consistency, sound.*

(iv)	Manipulation and combination of materials to enhance their properties.	*To manipulate foods in appropriate amounts - ratio/proportion to achieve design criteria in relation to:- volume, palatability, appearance, texture, strength, shelf life, economic factors, nutritional content.*
(v)	Experimental investigations.	*Experimentation will be of key importance to enable the understanding of how materials react at certain temperatures and under certain processing conditions. Candidates will need to record data, interpret this and draw up conclusions.*
(vi)	Methods of creating new materials with specific properties.	*Origin, manufacture and utilisation of quorn, single cell protein, T.V.P., tofu;* *packaging materials;* *SMART materials.*
(vii)	Packaging materials.	*Properties and function of materials used in present day in primary / secondary packaging;* *consideration of the needs of the product, the consumer, manufacturer, retailer.*
Skills		***Candidates should be able to:***
(viii)	Work with materials and components.	*work accurately, creatively, innovatively and imaginatively with food / packaging materials, components, appropriate technologies, tools / equipment, processes and resources to achieve high quality products which match the specification;* *demonstrate a detailed knowledge of the working properties and functions of a variety of food / packaging materials and components and use these with confidence.*

4.2.2 Industrial and commercial practice (AS)

This section is about understanding various methods of production and being able to apply appropriate commercial practices in practical projects

	CONTENT	AMPLIFICATION
Knowledge and understanding		
(i)	The main features of food processing and manufacturing methods and applications.	*Primary – study of a range of foods that are processed this way – processing of wheat grain into flour etc.;* *secondary – study of secondary processing – mixing, blending, cutting etc.;* *utilisation by the food industry of sub-assembly foods to produce composite products;* *standardised components bought in / supplied for food manufacture.*
(ii)	Stages of production.	*Primary and secondary processing;* *key areas of production of food products - sourcing, buying, preparing, making, assembling, handling, packaging.*
(iii)	Manufacturing systems.	*Production systems:- one off, batch, continual flow, repetitive flow, mass production;* *selection of systems in relation to food product, scale of production and identified criteria;* *advantages and disadvantages of listed systems;* *consideration of scaling up of formulation – e.g. trial modification of seasoning, viscosity.*
(iv)	Employment of human resources.	*Role of personnel in the food industry ranging from the product development team to assembly line worker.*
(v)	Detailed manufacturing methods, when combining or processing materials.	*Application of :* • *heat – heat transference;* • *mixing / combining – emulsification (liquid in liquid) colloids (sols – solid in liquid, gel – liquid in solid,) foams (gas in solid / liquids) , suspensions;* • *cutting – hand and various mechanical methods;* • *extrusion;* • *forming / shaping – moulding (chocolate), extrusion (crisps), sheeting, rotary moulding;* • *filling – sandwich, injection;* • *enrobing products e.g. biscuits, fish fingers.* *Total quality manufacturing principles.*

(vi)	Industrial equipment.	*Knowledge of main industrial equipment used in food manufacture e.g. Rack / deck ovens, checkweigher, gyro-blast chiller, rotary cutters, vertical spindle mixer, flow wrapper, breakrollers, dollies, metal detector, Bratt pans etc.*
(vii)	Safe working practices, including identifying hazards and making risk assessments.	*Personal hygiene, food handling, storage and distribution. HACCP.*
Skills		***Candidates should be able to:***
(viii)	Industrial methodology and approaches.	*use an awareness of industrial methods and approaches to design, manufacture and implement quality control in different volumes of production.*

4.2.3 Processes (A2)

This section is about developing a detailed knowledge and understanding of a broad range of processes used in food manufacturing, leading to the acquisition of associated skills through practical activity.

	CONTENT	**AMPLIFICATION**
Knowledge and understanding		
(i)	Principles of preservation and prolonging shelf life of food products.	*Underlining principles in preservation – high / low temperature, removal of moisture, change of pH, control of oxygen.* *Main methods of preservation – further reference to:* • *application of heat / removal of heat including chilling, freezing, freeze drying, canning, pasteurisation, dehydration, irradiation, UHT, sterilisation. The resulting effect of heat treatment on the physical, sensory and nutritional properties of the food materials;* • *chemicals – to prolong shelf life and preserve food products – antioxidants, preservatives, emulsifiers – function in food products;* • *advantages and disadvantages of additives to the manufacture and retailer;* • *main materials used in food packaging related to shelf life – MAP.*

(ii)	Application of biological processes.	*Use of biological processes for different levels of production.- the role of enzymes / yeast / micro-organisms in food products e.g. cheese, yoghurt, bread, soya sauce - reference to underlying scientific principles.*
(iii)	Types of micro-organisms.	*Classification of bacteria, yeasts, pathogens and moulds, factors affecting growth and control.*
(iv)	Main types of food poisoning.	*Reasons for food poisoning – control of Salmonella, Staphylococcus, E coli, Clostridium etc. related to sources of infections, spread to food and prevention;* *cross-contamination.*
Skills		***Candidates should be able to:***
(v)	Work with tools and equipment.	*select an appropriate range of equipment and processes to generate quality food / packaging products;*
(vi)	Work with materials, components and appropriate technologies.	*experiment with techniques in order to improve and refine intended methods of realising a design;* *demonstrate care, precision and attention to detail in the use of tools and materials;* *produce a work plan to achieve the desired objective.*

4.2.4 Production systems and control (A2)

This section is about applying knowledge of production systems and control techniques to provide valid, reliable data and information in order to manufacture quality products.

	CONTENT	**AMPLIFICATION**
Knowledge and understanding		
(i)	Management systems for production, quality assurance, organisation of equipment and people.	*Role and function of systems in food manufacture to include – CAMM / CAD / CIM;* *main methods of controlling systems e.g. sensors, gauges, tests etc. The use of CAM in relation to control of time / heat / weight, and stock rotation / reordering;* *utilisation of systems control to assist quality assurance QA-ISO – 9000 and quality control systems for safer food production;* *new developments in systems control e.g. ARP – automatic replenishment package.*

(ii)	The use and detailed design of systems and sub-systems; inputs, process(es) and output(s).	*The main characteristics of a system – Input, Process and Output, the application of systems for manufacture and management, designing, trialling and evaluating production systems;* *differences between open and closed systems and their importance in achieving control. Selection of system in relation to product and function required.*
(iii)	Detailed design of control systems: loops, feedback, control functions to achieve desired purposes.	*Devise and develop systems to ensure food products are made to specific tolerances or quality specifications.* *Control of – weight, rate of flow of food materials, temperature, pressure, formulation / recipe, equipment, time processing, storage, skill;* *use of systems diagrams and schematic layouts indicating human and electronic feedback within industry.*
(iv)	The use of ICT by industry in the design and manufacture of products.	*Research, investigation, information handling (nutritional handling), modelling, prediction, generation, imaging and creation of designs, planning and organisation, communication / presentation, monitoring, control of safety, hygiene, quality and processes, stock control, distribution and marketing;* *use of CAD (Computer Aided Design), CAM (Computer Aided Manufacture), CIM (Computer Integrated Manufacture), CAA (Computer Aided Administration) PPC (Production Planning Control) and 'Just in Time' in food manufacture and packaging;* *CAA - Computer Aided Administration - personnel, marketing, sales, order processing, procurement, stock control, costing, accounting;*
(v)	Use ICT when planning.	*use ICT appropriately for planning and data handling;*
(vi)	Use ICT when designing and making.	*use ICT appropriately for communicating, modelling, controlling and manufacturing;*
(vii)	Plan (using a systems approach).	*carry out solutions working to devised plans which identify and seek agreement on resources needed, making use of different planning approaches and setting realistic deadlines;*
(viii)	Develop proposals.	*model detailed aspects of ideas and proposals and use a systems approach to solve problems;*
(ix)	Communicate ideas and information.	*use ICT where appropriate to evaluate, cost, communicate and present proposals;*

SYSTEMS AND CONTROL TECHNOLOGY

4.1 DESIGNING

4.1.1 Designing and innovation (AS)

This section is concerned with candidates developing their ability to design and enhance their basic design skills in order to solve problems. Candidates should also develop an understanding of a range of external influences and demands which affect the work of product and systems designers.

	CONTENT	AMPLIFICATION
Knowledge and understanding		
(i)	Principles of designing.	*The generation, development and expression of ideas;* *development of aesthetic values;* *fitness for purpose;* *the understanding and application of design processes in a logical and creative manner;* *knowledge of writing appropriate and effective specifications;* *the generation of specific, measurable performance criteria to inform designing and evaluating;* *use of sketchbooks in design development;* *communication of ideas and solutions in appropriate contexts using a variety of media, such as freehand sketching, formal working and presentation drawings, 2D and 3D modelling, ICT generated images.*
(ii)	Research techniques.	*The discerning use of reference material from a variety of sources such as libraries, Internet, databases, magazines, trade literature (such as RS Components or Maplin) and exhibitions, to produce valid and reliable information.*
(iii)	Analysis of the problem	*Understanding effective analysis and synthesis of material to guide effective development of innovative and creative ideas;* *reflection on the problem.*

(iv)	Problem solving strategies.	*Investigation, team work (including brainstorming), research, modelling, prototyping and trialling;* *the process of innovation - collaborative and commercial approaches; the development of innovative product solutions. Key concepts in innovation such as the impact of product champions and entrepreneurs;* *innovation techniques such as inversion (turning the problem around, for example instead of considering 'how do I get to work?' thinking about 'how can work get to me?', morphological analysis (evaluating possible solutions in a table or matrix and considering all possible combinations), analogy and lateral thinking;* *analysis and exploration of the needs of users.*
(v)	Quantitative and qualitative testing.	*Techniques of evaluating performance against specific measurable criteria such as comparative testing of materials and control systems for a specific application;* *devising fair tests for materials;* *2D/3D modelling and prototyping to evaluate proposals; identification of criteria for value judgements such as ratings charts for aesthetics, function, user-friendliness.*
(vi)	Ergonomics and anthropometrics.	*Relevant use of human and environmental measurements and statistics to inform design and production for control systems and, where appropriate, housings / casings.*
(vii)	Systems design techniques.	*Flow charts, ladder logic, circuit diagrams, block diagrams.*
(viii)	Computer systems for designing.	*Use of CADD both in formative and summative stages of designing for circuit and pcb layout, Internet, CD-ROM, databases, spreadsheets, word processing/DTP and control programs, as appropriate to the task undertaken;* *understand the principles of concurrent engineering;* *product data management - using software to manage and monitor production.*
(ix)	Innovation	*Appreciate the importance of innovation in both designing and making.*
Skills		***Candidates should be able to:***
(x)	Consider a range of issues when designing.	*take into account manufacturing, maintenance and product life when designing.*

(xi)	Research, plan and evaluate.	*investigate, organise and manage time and resources effectively, responding to changing circumstances;* *exercise entrepreneurial, collaborative and team working skills as appropriate;* *identify and apply relevant external standards, such as BSI, IEE, to their design tasks;* *achieve optimum use of materials and components by taking into account the complex relationship between: material, form and manufacturing processes; the scale of production; the environmental factors affecting disposal of waste, surplus and by-products; and the cost;* *evaluate outcomes by devising quality assurance procedures, assessing the impact of actions and regularly reviewing and establishing the best approach. Review the way the work plan is followed after considering its effectiveness in order to achieve improvements;* *use and select methods of testing the performance of products against specified criteria and act on their findings. Ensure, through testing, modification and evaluation, that the quality of products is suitable for the intended user.*
(xii)	Generate and develop ideas.	*use a range of design methods and strategies to originate ideas and possible solutions which are appropriate to the problem, for example brainstorming, disassembly of existing products, inversion, morphological analysis, analogy and lateral thinking;* *in the light of thorough analysis and the specifications, use knowledge and understanding to develop and refine alternative designs and/or design detail, demonstrating creativity and innovation - critically evaluate all ideas against specification.*
(xiii)	Develop proposals.	*model detailed aspects of ideas and proposals, using ICT as appropriate and use a systems approach to solve problems.*
(xiv)	Detail design.	*use knowledge and understanding of the working characteristics of materials and components (such as tensile and/or compressive strength, shear, stiffness, density, insulation properties) and restrictions imposed by tools, equipment and processes to prepare detailed design proposals to meet specifications in order to design reliable products and/or prototypes;* *technical factors - maintenance safety and how the product is used? Take into account information gained during research, from manufacturers or suppliers, the Internet, experimentation etc.* *carry out feasibility studies on the practicability of the proposed solution to meet the needs of the market place.*

(xv)	Communicate ideas and information.	*present ideas and design possibilities in appropriate formats such as word processing/DTP, freehand sketching, formal working or presentation drawings, CAD/ICT generated images; solid modelling;* *record and explain design decisions;* *communicate information unambiguously to enable others to interpret design intentions using appropriate conventions and technical language, sketching, presentation drawings, ICT generated graphs, drawings, spreadsheet printouts, digital or conventional pictures/images*.

4.1.2 Product analysis (AS)

This section is about understanding the requirements a product must satisfy, critical assessment of existing products, and visualising new products in a context of past, present and future possibilities.

	CONTENT	AMPLIFICATION
	Knowledge and understanding	
(i)	The processes involved in the design and production of a range of manufactured products.	*Reverse engineering, to include historical influences, technological performance and components, functional success and aesthetic detailing, or other techniques for product analysis;* *circuit modelling, prototype production of mechanisms / structures;* *performance modelling and prototyping;* *the influence of equipment on product manufacture in a range of materials;* *interaction of new technologies and design needs especially on material and fabric development.*
(ii)	Form and function of different products.	*Aesthetic detailing, functional and marketing constraints such as maintenance and cost of a range of manufactured products;* *stylistic and engineering design;* *considerations of 'above the line' (visible and consumer required characteristics) and 'below the line' (invisible, operational characteristics) assessment;* *appreciate the relationship between products and human form and environment (ergonomics and anthropometrics) to ensure suitability and ease of use.*
(iii)	Trends, styles, new technical capabilities, and social, moral, political and ethical influences on the design, production and purpose of products.	*Candidates should have an understanding of the historical influences on selected products which rely on control systems;* *comparison of 'new' products with existing types, such as flat LCD and CRT computer monitors;* *the effect of new technologies on products;* *ethical, moral and social considerations;* *the development of products through time - recognising 'design classics' or 'icons'* *development of a design consciousness in society; levels of technological development (including new materials and technologies) and their influence on designing and products.*

Skills		***Candidates should be able to:***
(iv)	Intellectual Property and International Standards.	*The implications of Intellectual Property - Patents, Registered Designs, Design Right, Registered Trade Marks, Copyright;* *the importance and effect of international standards on the design of products – BSI and ISO Standards.*
(v)	Consider a range of issues when designing.	*Take into account the characteristics and features of existing products and systems when designing - structural, aesthetic and functional characteristics.*

4.1.3 Human responsibility (A2)

This section is about acquiring the knowledge and understanding needed to support design activities through an increased awareness of the designer's social, moral, ethical and legal responsibilities. It also allows candidates to explore the environmental and consumer factors which impact on designers and which might affect the final nature of a product or system.

CONTENT		**AMPLIFICATION**
Knowledge and understanding		
(i)	Service to the customer, including legal requirements, availability of resources.	*Appreciate the need to offer product support and customer services, take account of consumer group opinions in a competitive market;* *understand the effect of legislation / regulations related to product design.*
(ii)	How to find information on the regulatory and legislative frameworks related to product design.	*Candidates should know how to find relevant information related to a product's design and use from documents such as Health and Safety legislation, BS and COSHH (for example, microwaves generated by ovens and mobile phones).*
(iii)	Standard risk assessment procedures in product design.	*The identification of risks to the consumer in using a product, making risk assessments, reduction of risks.*

(iv)	The values (technical, economic, aesthetic, social, environmental and moral) implicit in product/system design solutions.	*Needs, wants and acceptability to consumers;* *concept of quality by designers and to consumers;* *client profiles;* *identifying target markets;* *the effect of product life cycles;* *manufacturing and the environment;* *conservation of raw materials;* *intermediate technology.*
(v)	The forms of energy used by industry, its impact on design, manufacturing and the environment.	*The benefits and limitations of various sources of energy, to include, fossil fuels, nuclear fuels, solar, hydro and wind generation;* *the efficient use of energy in manufacturing* *green/environmental issues (implications of the industrial/technological age)* *sustainability issues - influencing the future, resource management* *energy conservation, including re-cycling / green issues;* *the effect of energy costs on the final product;* *appropriate technology.*
Skills		***Candidates should be able to:***
(vi)	Consider appropriate issues and responsibilities when designing.	*design for economic and environmentally friendly manufacture;* *consider product maintenance and life cycle when designing;* *design for safe use by the consumer;* *appreciate the needs of specific consumers, such as young children, the elderly or those with special physical needs.*
(vii)	Quality in terms of the product: • fitness for purpose; • meeting the criteria of the specification; • accuracy of production; • appropriate use of technology • aesthetic aspects.	*manage and use control systems in quality assurance and quality control.*
(viii)	Quality in terms of the human process of designing and making.	*recognise the importance of quality in the personal processes of designing and making, production systems, attention to detail.*

4.1.4 Public interaction – marketing and research (A2)

This section is about product and control systems design and their place in the market, for example how an electronic system may be transformed into a marketable product. It is concerned with producing reliable and quantifiable performance specification following a detailed consideration of the users of the product (the target audience). It seeks to examine the many factors influencing product and control systems design, such as *market-pull* versus *technology-push* models of innovation and the four Ps *(Product life cycle, Price, Place and Promotion).* Market research techniques and their influence on producing innovative products will also be considered as part of human responsibility within the process of designing. Candidates should develop an appreciation of the effects of social, economic, cultural and ethical issues in addition to material and manufacturing technologies. It is important to remember that some systems and control outcomes do not become mass produced retail products.

	CONTENT	**AMPLIFICATION**
Knowledge and understanding		
(i)	Innovation in the market.	*Needs and demands of consumers, technology-push and market-pull;* *the totally new (radical) product and the product which has been subjected to improvements over time (incremental);* *marketing strategies and how market research is conducted.*
(ii)	Researching the market.	*The process of market research and its place in the process of innovation;* *the market environment, who buys, lifestyle changes, market segmentation;* *technological trends and how market research is conducted;* *the importance of the target audience and market trends.*
(iii)	Selling the product.	*The four Ps:* • *Product life cycle;* • *Price and how it is determined;* • *Place and how products are distributed;* • *Promotion, which considers different ways in which products are presented to their market.*
(iv)	Diffusion of products.	*Factors influencing the success of products such as criteria which are important in purchasing decisions made by consumers (target audience; market penetration, who buys products).*

(v)	Trends, styles, new technical capabilities, and social, political and ethical influences on design, production and sale of products.	*History and impact of Twentieth Century design movements and designers to include developments in design from the 70's onward;* *cultural trends and differences and their effect on new product development including retailing strategies; product life cycle; fashion cycles;* *ethical, moral and social considerations;* *development of a design consciousness in society.* *consumer society - an awareness of over use of natural resources, the consequences of pollution, over production;* *global manufacturing.*
Skills		***Candidates should be able to:***
(vi)	Clarify tasks, by analysing and researching market/client needs: producing quantifiable performance specifications.	*identify user needs, the nature of the problem to be solved and the target audience. Adopt strategies to produce design specifications which inform and guide decision making, seeking specialist advice and information as appropriate;* *develop initial design briefs for performance manufacturing, maintenance and product life.*
(vii)	Use appropriate measurements to determine product marketability.	*assess the success of existing products; the effectiveness of a product using social, economic and moral parameters.*
(viii)	Evaluate products.	*use personal sources and external sources – target audience, specialists, when evaluating products against performance specification.*

4.2 MAKING

4.2.1 Materials and components (AS)

This section is about developing a wide appreciation of the range of materials and components available for manufacturing and an ability to *use an appropriate selection in project work.* The choice should be supported by evidence of exclusions of possible alternatives as a result of research / knowledge and testing. Although a working experience of all materials and components is not expected, a candidate should have an awareness of the range available to designers and manufacturers.

	CONTENT	AMPLIFICATION
Knowledge and understanding		
(i)	Materials and their potential application.	*To understand the nature and working characteristics of a range of materials suitable for constructing control systems and, if appropriate, marketable products for example, pcb boards, HIPS, conductors and insulators;* *materials suitable for producing cases for electronic systems, such as polystyrene, ABS;* *the structural and mechanical properties of a range of common timbers, metals and plastics sufficient to manufacture reliable products and / or prototypes.*
(ii)	Systems components.	*Materials used to produce components;* *semi-conducting materials;* *specific material properties related to their function in a component for example, gold in connectors, gallium arsenide in semi-conductors, ceramics in transducers, piezzo crystals.*
(iii)	Application of components in control systems.	*Understanding how to use components to design and assemble control systems;* *appreciation of the properties and characteristics of components which make them suitable for particular applications or purposes for example, that capacitors store electrical charge, the switching characteristics of an AND gate, that bevel gears transmit drive through 90 degrees, the importance of air pressure regulation in pneumatics.*

(iv)	Electronic components used in input, control and output blocks.	*Basic components to include: resistors (fixed and variable), transistors, capacitors and diodes (including LEDs);* *input devices to include: switches, reactive switches (LDRs and thermistors) and variable resistors;* *control devices to include: operational amplifiers, timers and logic gates;* *output devices to include: relays; lamps, LEDs, motors, buzzers and displays, solenoid valves.*
(v)	Microprocessor control - a basic understanding of a range of control systems to select the most appropriate to solve the problem.	*The use of microprocessor and smart cards, microprocessor modelling systems, computer interface devices, to design, model and make microprocessor controlled products and/or systems, including mechatronics. Including the interfacing of basic electronic input and output components.*
(vi)	Mechanical control - a basic understanding of a range of control systems which transmit force and motion to select the most appropriate to solve a problem.	*Basic components to include: spur and bevel gears in simple and compound trains, belts and pulleys, sprocket and chains, rack and pinion, worm and worm wheel, ratchet and pawl;* *calculation of MA and VR of gear and pulley systems;* *the use of plain, ball and roller bearings;* *rack and pinion, crank and slider mechanisms;* *simple clutch systems used to transmit drive;* *cams and followers;* *the application of shafts and couplings in specific mechanical control systems;* *classification of levers, application of load, effort and fulcrum to systems involving levers;* *the use of the above components in the design of 'black box' systems to achieve desired relationships between input and output motion.*

(vii)	Pneumatic control - a basic understanding of a range of control systems to select the most appropriate to solve the problem.	*Single and double acting cylinders, valves, restrictors and reservoirs;* *sequential and cascade systems;* *application of simple pneumatic circuits to control mechanical systems;* *use of restrictors and reservoirs to create time delay in pneumatic systems;* *health and safety issues relating to the use of pneumatics.*
(viii)	Methods of creating materials with specific properties.	*To include compositing, combining, laminating and reforming;* *awareness of current developments of new materials and alloys together with their application, e.g. SMART materials;* *metallics, foams, rubbers, wood-based composites, microfibres and performance fabrics;* *finishes – to improve aesthetic and / or physical characteristics, such as coating or painting, varnishing, laminating and holographic finishes.*
(ix)	Awareness of modern material technology.	*An appreciation of how product development is influenced by modern materials, to include functional (SMART) materials, which change their shape or properties in response to various stimuli and modern composites.*
Skills		***Candidates should be able to:***
(x)	Work with materials and components.	*work accurately, creatively, innovatively and imaginatively with materials, components, appropriate technologies, tools, processes and resources to achieve high quality products which match their specification;* *demonstrate a detailed knowledge of a range of components and sub-systems to assemble control devices that function;* *use appropriate numeracy skills to calculate values in the design of circuits, mechanical and pneumatic systems.*

4.2.2 Industrial and commercial practice (AS)

This section is about understanding various methods of production and being able to apply appropriate commercial practices in practical projects

	CONTENT	AMPLIFICATION
	Knowledge and understanding	
(i)	The main features of manufacturing industry, including employment and commercial practices.	*Principles of industrial manufacturing systems across a range of scales of production to include: mass, batch, one-off;* *staffing needs, allocation of costs, JIT manufacture and commercial liability;* *bought-in, standardised part assembly, sub-contracting.*
(ii)	Manufacturing systems, including one off, batch, high volume, bought-in parts.	*The use of different levels of production taking into account economic decisions;* *unit / one-off (including prototyping), modular / batch and high volume production.*
(iii)	Stages of production.	*Primary and secondary processing;* *Sourcing of materials, the buying cycle, forward ordering, storage, processing, assembly, finishing, packaging, labelling and transportation.*
(iv)	Detailed manufacturing methods, when preparing, combining, manipulating or processing materials.	*Comparison of hand and commercial methods of preparing, shaping, cutting / wasting, joining materials, circuit board production, population and soldering;* *the influence of the above on the time taken to produce the product, its quality and final cost;* *knowledge of manufacturing through analysis of products.*
(v)	Management systems for production, quality assurance, organisation of equipment and people.	*Internal Quality Control (QC) and external Quality Assurance (QA) requirements;* *project management systems including flow charts and critical path analysis;* *modern methods of labour organisation to include single craft, progressive bundle and cell. Total quality manufacturing methods.*

(vi)	Safe working practices, including identifying hazards and making risk assessments.	*Commercial working practices and responsibilities and their application to project work;* *five-step risk assessment. (Identify hazard, who might be harmed & how, evaluate potential for risk, record, review if details change);* *provision of equipment, signage etc.;* *the safe operation of electrical, mechanical and pneumatic systems.*
Skills		***Candidates should be able to:***
(vii)	Industrial methodology and approaches.	*use an awareness of industrial methods and approaches in their own work to design, manufacture and implement quality control procedures.*

4.2.3 Processes (A2)

This section is about developing a detailed knowledge and understanding of a broad range of processes leading to the acquisition of associated skills through practical activity.

	CONTENT	**AMPLIFICATION**
Knowledge and understanding		
(i)	Hand methods of preparing, processing and manipulating materials.	*Methods of testing, conditioning, cutting / wasting, forming and finishing a wide variety of materials;* *the use of templates, patterns and guides.*
(ii)	Machine methods of preparing, processing and manipulating materials.	*Methods of cutting / wasting, forming, joining and finishing a variety of materials such as casting, laminating, injection moulding, bonding;* *the use of jigs and fixtures to increase speed of production and help ensure consistency;*
(iii)	Combining/forming materials to enhance their properties.	*Joining and forming of a wide range of materials for different levels of production.* *laminating, combining, jointing, folding and other methods of reinforcing.*
(iv)	Computer aided manufacture.	*Knowledge of software applications and the transfer of information to CAM machines, e.g. laser cutters, microrouters, CNC Lathes and milling machines;* *the benefits and limitations of computer controlled machines, to include CADD, CAM, CIM, digital media.*

(v)	Principles and techniques of testing.	*Control of variables and measurement, testing for quality, safety and specification;* *VIR, pneumatic pressure and forces.*
(vi)	Structural systems: to provide support, force transfer and other functions.	*Process and stability of whole system in achieving its specified function.*
(vii)	Switching, monitoring and interfacing.	*Switching, counting, timing and sequencing power supplies, matching different electronic sub-systems and the need for signal conditioning and interfacing.*
(viii)	Knowledge for application to the design of products and control systems.	• *Quantitative analysis of structural and mechanical systems, including energy transfer. Efficiency and methods for maximising efficiency;* • *logic control – combinational and sequential: computer control and the use of an interface; matching of sub-systems;* • *electronic and microprocessor control of electro-mechanical sub-systems;* • *analogue and digital signal processing (filtering, conversion, amplification, conditioning).*
Skills		***Candidates should be able to:***
(ix)	Work with tools and equipment.	*select an appropriate range of tools, equipment and processes in order to make quality products;* *experiment with techniques in order to improve and refine intended methods of realising a design;* *demonstrate care, precision and attention to detail in the use of tools and equipment;* *work to a plan in order to achieve the desired objective.*
(x)	Work with materials, components and appropriate technologies.	*select appropriate materials, components and methods in order to make quality products and systems;* *experiment with techniques in order to improve and refine intended methods of realising a design;* *demonstrate care, precision and attention to detail in the use of materials, components and sub-systems;* *use appropriate assembly and prototype systems to include stripboard, pcb and wire wrapping techniques.*

4.2.4 Production systems and control (A2)

This section is about applying knowledge of production systems and control techniques to provide valid, reliable data and information in order to manufacture quality products.

	CONTENT	AMPLIFICATION
Knowledge and understanding		
(i)	The use and detailed design of systems and sub-systems for manufacturing and management.	*The fundamental characteristics of a system in terms of Input, Process and Output;* *the applications of systems for manufacture and management;* *designing and making of systems;* *systems diagrams and their use to explain systems and sub-systems and their relationship to each other.*
(ii)	Detailed design of control systems: loops, feedback, control functions to achieve desired purposes.	*The extension of simple systems, using feedback and loops, to enhance the system's performance;* *the importance of reliable data in feedback.*
(iii)	The use of ICT by industry in the design and manufacture of products.	*Examining the current use of ICT by industry in designing and manufacturing including:-* *CADD - Computer Aided Drawing and Design;* *CAM - Computer Aided Manufacture;* *CIM – Computer Integrated Manufacture;* *PPC – Production Planning and Control – production plans, quantity planning, quality assurance, ordering.* *CAA – Computer Aided Administration – personnel, marketing, sales, order processing, procurement, stock control, costing, accounting;* *retail stock control, distribution scheduling, customer / supplier relationships - JIT - 'Just in Time'.*

Skills		***Candidates should be able to:***
(iv)	Systems Analysis.	*use a systems approach to analyse problems;* *identify key features of a problem;* *devise strategies to meet the needs and model detailed aspects of a solution.*
(v)	Use ICT when planning.	*produce block, flow and systems diagrams to formulate solutions;* *use ICT appropriately for planning and data handling;* *work to devised plans.*
(vi)	Use ICT when designing and making.	*use ICT appropriately for communicating, modelling, controlling and manufacturing.*
(vii)	Communicate ideas and information to others in the production system.	*use ICT where appropriate to evaluate, cost, communicate and present proposals.*

5 SCHEME OF ASSESSMENT

AS and A level qualifications are available to candidates following this specification.

Advanced Subsidiary

The AS is the first half of an Advanced course. It will contribute 50% of the total Advanced marks. Candidates must complete the following **two units** in order to gain an AS qualification.

		Weighting Within AS	Weighting Within A level
UNIT 1	Examination Paper	40%	20%
UNIT 2	Design and Make Task	60%	30%

DT1: EXAMINATION PAPER 40% (20% AL)

DT1 – Written Paper

The examination paper DT1 will examine candidates on the following four blocks of specification content:

4.1.1 Designing and Innovation
4.1.2 Product Analysis
4.2.1 Materials and Components
4.2.2 Industrial and Commercial Practice

The blocks of content include specific knowledge and understanding, which are set out in the specification, and which will form the basis for setting the examination paper. Much of this knowledge and understanding will, of course, be directly relevant to many aspects of the AS coursework elements. It is anticipated that the content of the specification will be presented to candidates in practical designing and making sessions as well as in more formal theoretical lessons.

Unit DT1 consists of three separate papers – one for each focus area. Candidates attempt only one paper, which will consist of two sections:

Section A: This will contain eight short answer questions out of which **the candidate will be required to answer 5 questions**. It is expected that each answer would be approximately 150 words (with sketches where appropriate) or half a side of A4 and would address the knowledge and understanding contained within the four DT1 units of study. This section is intended to examine the candidates' breadth of knowledge and answers in this section could be in standard prose or in the form of a comparative table or chart, depending on the nature of the question. Each question will be worth eight marks, giving a total of 40 marks for Section A

Section B: This section will contain three questions which will examine the depth of knowledge and understanding gained over the duration of the Advanced Subsidiary course. **Candidates will be required to produce one longer essay type response** to these questions which will be allocated 30 marks, including credit for quality of written communication.

DT2: DESIGN AND MAKE TASK 60% (30% AL)

This unit should represent about 40 hours of supervised time. However, as with all other AS subjects, candidates will need to work independently and outside of supervised time to complete the work to an appropriately high standard.

The work must demonstrate the candidate's ability to:

1. Analyse a problem, product or range of products and its place in the market and use this information to design a new product for an identified target audience.

2. Design and make high quality innovative product which is tested and evaluated.

3. Apply relevant knowledge and understanding including key skills to a range of technological activities.

4. Relate their work to relevant industrial and commercial practices.

5. Communicate to relevant audiences their ideas, understanding and decision-making processes.

6. Use ICT appropriately in designing and making.

The purpose of this unit is two-fold. On the one hand it is intended to provide an opportunity to examine a selected product in depth, which centres may tailor to the specific needs, interests and abilities of candidates, whilst providing a valuable preparation ahead of the major project (Unit DT4).

Candidates are required to submit a single, substantial project for assessment in DT2. The project is to consist of a design folio, supported by a sketchbook and the associated product.

On the other hand the unit stands alone as a worthwhile experience, providing candidates who do not progress beyond AS the opportunity to demonstrate high quality designing and making skills.

Product Design

The design study for the AS project should begin with a design problem or a product analysis of a product or a range of products identified by the candidate. The analysis should be of sufficient depth for the candidate to have a thorough understanding of the problem or, in the case of a product analysis the product's user interfaces (above the line) as well as any technologies incorporated (below the line) into the product. Design a new product based on the product analysis for an identified target audience. Whilst not requiring the depth or complexity expected within the AL project, candidates are expected to demonstrate achievement and abilities appropriate for the first year of an AL course. They will be expected to present evidence of their competence and ability in all facets of product analysis, the design problem and its realisation, in the selection and use of materials, tools/equipment and techniques.

The choice of the product analysis is left to the candidate, in consultation with the teacher. The final choice should be appropriate for the suggested timescale identified above and allow the candidate to work in one of the focus areas of product design, food technology or systems and control technology.

The design experience should provide the candidate with an opportunity to demonstrate achievement in a wide range of materials and processes and the whole design process. This work will also provide candidates with opportunities for generating evidence for Key Skills *PS3.1, PS3.2, PS3.3, WO3.1, WO3.2, WO3.2, WO3.3* along with *LP3.1, LP3.2 and LP3.3.*

Advanced

The Advanced specification consists of two parts: Part 1 (AS) and Part 2 (A2).

Part 1 (AS) may be taken separately and added to A2 at a further examination sitting to achieve an Advanced qualification, or alternatively, both the AS and A2 may be taken at the same sitting.

Candidates must complete the AS units outlined above plus a further two units to complete A level Design and Technology. The A2 units will contribute 50% of the total Advanced marks.

		Weighting within A2	**Weighting within Advanced**
DT3	Examination Paper	40%	20%
DT4	Major Project	60%	30%

*Includes synoptic assessment

DT3: EXAMINATION PAPER (2½ Hours) (20% Advanced)

Examination paper DT3 will examine candidates on **all eight blocks** of specification content: i.e. the four AS blocks;

4.1.1 *Designing and Innovation*
4.1.2 *Product Analysis*
4.2.1 *Materials and Components*
4.2.2 *Industrial and Commercial Practice*

and the four A Level (A2) blocks;

4.1.3 *Human Responsibility*
4.1.4 *Public Interaction*
4.2.3 Processes
4.2.4 *Production Systems and Control*.

The blocks of content include specific knowledge and understanding, which are set out in the specification, and which will form the basis for setting the examination paper. Much of this knowledge and understanding will, of course, be directly relevant to many aspects of the AS and A2 coursework elements. It is anticipated that the content of the specification will be presented to candidates in practical designing and making sessions as well as in more formal theoretical lessons.

Unit DT3 consists of three separate papers – one for each focus area. Candidates attempt only one paper, which will consist of three sections:

Section A: This will contain five short answer questions out of which **the candidate will be required to answer 3 questions**. It is expected that each answer would be approximately 150 words (with sketches where appropriate) or half a side of A4 and would address the knowledge and understanding contained within the four A2 units of study (3.1.3, 3.1.4, 3.2.3, 3.2.4). This section is intended to examine the candidates' breadth of knowledge and answers in this section could be in standard prose or in the form of a comparative table or chart, depending on the nature of the question. Each question will be worth eight marks, giving a total of 24 marks for Section A

Section B: This will contain five short answer questions out of which **the candidate will be required to answer 3 questions**. It is expected that each answer would be approximately 150 words (with sketches where appropriate) or half a side of A4 and would address the knowledge and understanding across the whole specification (i.e. it is synoptic in nature). This section is also intended to examine the candidates' breadth of knowledge and answers in this section could be in standard prose or in the form of a comparative table or chart, depending on the nature of the question. Each question will be worth eight marks, giving a total of 24 marks for Section B

Section C: This synoptic section will contain five questions which will examine the depth of knowledge and understanding gained over the duration of the whole course. **Candidates will be required to produce two longer essay type responses** to these questions which will be allocated 26 marks each, including credit for quality of written communication, giving a total of 52 marks for Section C.

DT4: MAJOR PROJECT (30% Advanced)

This project should represent about 60 hours of supervised time, however as with all other Advanced Level subjects, candidates will need to work independently and outside of supervised time to complete the work to an appropriately high standard. **In terms of time, demands and complexity, this project is very similar to that required by the previous A Level syllabus.** The work presented for DT4 will be distinctly different and separate from that submitted for DT2, whether the submissions are made in the same or different examination sessions.

DT4 project work must demonstrate the candidate's ability to:

1. Analyse, research and evaluate existing products and their place in the market.

2. Design and make innovative, high quality products which can be tested and evaluated.

3. Apply relevant knowledge and understanding including key skills to a range of technological activities.

4. Relate their work to relevant industrial and commercial practices.

5. Communicate to relevant audiences their ideas, understanding and decision-making processes.

6. Use ICT appropriately in designing and making.

These competencies at Advanced Level would demonstrate a greater depth and maturity to candidates' designing and making skills, appropriate to an A Level qualification.

Candidates are required to submit a single, substantial project for assessment in DT4. The project is to consist of a design folio, supported by a sketchbook and the associated product.

Each year the WJEC will set eight themes for the project, which will allow candidates to work in one of the focus areas of product design, food technology or systems and control technology. Candidates may, if they wish, submit their own proposals (question 9) for the approval of the Chief Examiner providing they are based within one of these focus areas and reflect the spirit and content of the specification. **These submissions should be made on form DT4 and sent to the WJEC by 30th September at the latest, in the year preceding the examination.**

Question 9 exists to allow candidates equality of opportunity for undertaking interesting, motivating project work should they not be inspired by the eight set themes. Considerable care should be taken when advising candidates with regard to their own submission, which should be derived from their own analysis of a design situation. Experience has shown that simply allowing candidates to work on previous year's set questions, with access to previous research/investigation/resources is not conducive to the production of innovative, high scoring work.

Candidates must respond using ICT in their work in DT4 as required in the assessment criteria, as appropriate to their requirements, providing the published assessment criteria for these components are met.

Synoptic Assessment

Synoptic assessment, testing candidates' understanding of the connections between the different elements of the subject and their holistic understanding of the subject, is a requirement of all A level specifications.

Candidates must be able to demonstrate that he/she can:

- Conceptualise a problem, identify the most appropriate technique for addressing different problems.
- Make decisions about what information is required and when to use the appropriate information in dealing with a problem.
- Be able to show independent thinking.

Design and practical work is considered to be inherently synoptic due to the bringing together of knowledge to be applied to a specific brief and the use of a variety of acquired skills.

Quality of Written Communication

Candidates will be required to demonstrate their competence in written communication in all assessment units where they are required to produce extended written material: [Refer to Units] as appropriate Mark schemes for these units include the following specific criteria for the assessment of written communication.

- legibility of text; accuracy of spelling, punctuation and grammar; clarity of meaning;
- selection of a form and style of writing appropriate to purpose and to complexity of subject matter;
- organisation of information clearly and coherently; use of specialist vocabulary where appropriate.

Availability of Units

Availability of Assessment Units			
Unit	**January 2009**	**May/June 2009**	**May/June 2010 and each subsequent year**
DT1	✓	✓	✓
DT2		✓	✓
DT3			✓
DT4			✓

Awarding, Reporting and Re-sitting

The overall grades for the GCE AS qualification will be recorded as a grade on a scale from A to E. The overall grades for the GCE A level qualification will be recorded on a grade scale from A* to E. Results not attaining the minimum standard for the award of a grade will be reported as U (Unclassified). Individual unit results and the overall subject award will be expressed as a uniform mark on a scale common to all GCE qualifications (see table below). The grade equivalence will be reported as a lower case letter ((a) to (e)) on results slips, but not on certificates:

	Max. UMS	A	B	C	D	E
Units 1 and 3 (weighting 20%)	80	64	56	48	40	32
Units 2 and 4 (weighting 30 %)	120	96	84	72	60	48
AS Qualification	200	160	140	120	100	80
A Qualification	400	320	280	240	200	160

At A level, Grade A* will be awarded to candidates who have achieved a Grade A in the overall A level qualification and 90% of the total uniform marks for the A2 units.

Candidates may re-sit units prior to certification for the qualification, with the best of the results achieved contributing to the qualification. Individual unit results, prior to certification of the qualification have a shelf-life limited only by the shelf-life of the specification.

6 KEY SKILLS

Key Skills are integral to the study of AS/Advanced Design and Technology and may be assessed through the course content and the related scheme of assessment as defined in the specification. The following key skills can be developed through this specification at level 3: [Delete as necessary]

- Communication
- Application of Number
- Problem Solving
- Information and Communication Technology
- Working with Others
- Improving Own Learning and Performance

Mapping of opportunities for the development of these skills against Key Skills evidence requirement is provided in 'Exemplification of Key Skills for Design and Technology, available on the WJEC website.

7 PERFORMANCE DESCRIPTIONS

Introduction

Performance descriptions have been created for all GCE subjects. They describe the learning outcomes and levels of attainment likely to be demonstrated by a representative candidate performing at the A/B and E/U boundaries for AS and A2.

In practice most candidates will show uneven profiles across the attainments listed, with strengths in some areas compensating in the award process for weaknesses or omissions elsewhere. Performance descriptions illustrate expectations at the A/B and E/U boundaries of the AS and A2 as a whole; they have not been written at unit level.

Grade A/B and E/U boundaries should be set using professional judgment. The judgment should reflect the quality of candidates' work, informed by the available technical and statistical evidence. Performance descriptions are designed to assist examiners in exercising their professional judgment. They should be interpreted and applied in the context of individual specifications and their associated units. However, performance descriptions are not designed to define the content of specifications and units.

The requirement for all AS and A level specifications to assess candidates' quality of written communication will be met through one or more of the assessment objectives.

The performance descriptions have been produced by the regulatory authorities in collaboration with the awarding bodies.

AS performance descriptions for design and technology

	Assessment objective 1	**Assessment objective 2**
Assessment objectives	Candidates should demonstrate specific knowledge and understanding and be able to apply that knowledge and understanding in combination with appropriate skills in their designing and should communicate ideas and outcomes and demonstrate strategies for evaluation.	Candidates should be able to demonstrate and apply skills, knowledge and understanding of relevant materials, processes and techniques and use materials and equipment to produce suitable and appropriate outcomes, and should communicate ideas and outcomes and demonstrate strategies for evaluation.
A/B boundary performance descriptions	Candidates characteristically: a) demonstrate specific knowledge and understanding of the working characteristics of materials, ingredients, components and their uses and/or systems and control • develop an appropriate brief and specification • understand quality issues • use correct technical language relevant to the task b) research and communicate a broad range of ideas and information effectively in a creative and innovative way through some recognition of values issues or uniqueness (for the candidate) or connections with other ideas • demonstrate that they understand the main features of industrial and commercial practices related to manufacturing systems including the use of ICT and stages of production • show that they understand health and safety issues through the regulatory and legislative framework c) demonstrate clear strategies for testing and evaluating by taking into account form and function of a product, trends and styles of products reflecting environmental, cultural and ethical/ moral issues as well as stylistic and engineering considerations • analyse and assess information and ideas in appropriate ways, including ICT, enabling others to interpret them.	Candidates characteristically: a) apply skills that demonstrate understanding of the working characteristics and potential application of a range of materials, ingredients, components and/or systems and control including preparation and processing • demonstrate that they understand the principles of testing materials and/or components b) demonstrate that they understand and can carry out appropriate making processes during product development/manufacture • understand and use safe working practices • use appropriate skills in the development of a practical outcome c) communicate ideas and outcomes • refine and/or modify products and/or manufacturing methods • use a range of criteria, for example social, economic, environmental, cultural, and ethical/moral considerations d) demonstrate clear strategies for testing and evaluating by analysing the planning, production and manufacturing methods.
E/U boundary performance descriptions	Candidates characteristically: a) demonstrate some understanding of how their knowledge and understanding of materials, ingredients, components and their uses meet general design criteria • develop an outline brief and specification b) communicate ideas and information appropriately • demonstrate that they understand at least one feature of industrial and commercial practices, a relevant manufacturing system and some stages of production c) demonstrate some strategies for testing and evaluating by taking into account form and function of a product and the need for appropriate modifications.	Candidates characteristically: a) demonstrate that they understand the application of a limited range of materials, ingredients and components including their uses • demonstrate some knowledge of testing a material or component b) demonstrate that they understand and can carry out a limited range of making processes safely during product development • demonstrate that they understand how to plan for production c) communicate ideas and outcomes through a suitable development process and manufacturing method d) demonstrate the ability to test and evaluate a limited range of manufacturing methods.

A2 performance descriptions for design and technology

	Assessment objective 1	**Assessment objective 2**
Assessment objectives	Candidates should demonstrate specific knowledge and understanding and be able to apply that knowledge and understanding in combination with appropriate skills in their designing and should communicate ideas and outcomes and demonstrate strategies for evaluation.	Candidates should be able to demonstrate and apply skills, knowledge and understanding of relevant materials, processes and techniques and use materials and equipment to produce suitable and appropriate outcomes, and should communicate ideas and outcomes and demonstrate strategies for evaluation.
A/B boundary performance descriptions	Candidates characteristically: a) demonstrate specific ability to analyse questions and/or contexts and select and explain relevant ways to proceed during in-depth study • take account of a wide range of factors and show knowledge and understanding of materials and manufacturing processes • combine distinct elements of technical information in their responses • develop an initial design brief, an outline specification and produce a design for manufacturing, considering maintenance and product life • clarify the task during designing and making activities identifying a wide range of user needs and carry out in-depth research including some relevant primary research b) originate a range of ideas and possible solutions when generating and developing proposals • apply knowledge and understanding to develop and refine their solutions, demonstrating evidence of creativity and innovation through recognition of values issues or uniqueness (for the candidate) or connections with other ideas c) research, analyse and communicate a broad range of ideas and information effectively • use technical language fluently and draw appropriate conclusions model aspects of their ideas when developing proposals d) demonstrate clear strategies for testing and evaluating by taking into account the working characteristics of materials and components; the product's impact on society; and the precise requirements of the brief and/or specification • confidently analyse ideas and outcomes and draw highly appropriate conclusions, enhancing interpretation by others.	Candidates characteristically: a) demonstrate their understanding of systems and control and/or products and applications by discriminating between aspects of a system or product that perform and those which could be improved after in-depth study • demonstrate understanding of reliable and quantifiable performances of a range of materials, components and production processes • demonstrate applied knowledge of the working properties and functions of materials and components • work safely, accurately and skilfully with materials, components, tools and processes including appropriate technologies to create high-quality products that match the specification b) plan, demonstrating an awareness of industrial methods and approaches during designing and making activities • select an appropriate range of tools, equipment and plan processes • manage time by anticipating potential problems and responding to changing circumstances • determine the degree of accuracy required for products to function as intended, and apply relevant external standards to their task • test the performance of their product against specified criteria and act on their findings by modifying their proposals if appropriate c) communicate ideas and outcomes using ICT appropriately for communicating, modeling, data handling, controlling or manufacture • work to devised plans and seek agreement on realistic deadlines • take account of the relationship between material, form and manufacturing processes d) demonstrate clear strategies for evaluating: • analyse information critically and objectively • assess the extent to which their work will meet genuine needs • devise quality assurance procedures and reviewing the way the work plan is followed using external sources for evaluating products.

E/U boundary performance descriptions	Candidates characteristically: a) demonstrate their ability to analyse questions and/or contexts and record some relevant information during in-depth study • take account of a limited range of factors • take account of requirements and demonstrate some knowledge and understanding of manufacturing processes during product analysis • develop a design brief and specification b) use technical language relevant to the task • clarify the task identifying user needs and carry out research during designing and making activities • generate ideas based on their own knowledge and understanding, satisfying most of the specification criteria • show awareness of manufacturing processes • develop their proposals and model at least one aspect • indicate at least one working characteristic of a material or component • demonstrate some strategies for testing and evaluating that refer to products and the need for modifications • evaluate ideas and outcomes in an appropriate way, including ICT, and draw conclusions enabling others to understand them.	Candidates characteristically: a) demonstrate a basic understanding of systems and control and/or products and applications during in-depth study b) demonstrate some understanding of a limited range of materials, ingredients, components and production processes c) work safely with materials, ingredients and components to create a product that meets their specification d) plan, demonstrating some awareness of industrial methods during making activities e) select some appropriate tools and resources f) carry out at least one test of their product g) work to an outline plan. h) use ICT appropriately for communicating, modelling, data handling, controlling or manufacture i) demonstrate strategies for testing and evaluating: • analyse information • assess the extent to which the product meets its specification.

8 INTERNAL ASSESSMENT GUIDELINES

8.1 Written communication

Written communication will be assessed in all AS/AL units within this specification. In both internal and external assessments, when answers and work in continuous prose are expected, candidates will be assessed on their ability to organise and present information, ideas, descriptions and arguments clearly and logically, taking into account their use of grammar, punctuation and spelling.

In the design and make tasks (unit DT2) and the project (DT4) the main opportunities for extended prose are likely to present themselves in the candidates' evaluation of their work, though evidence of written communication may also be found in the annotation of design ideas and investigative work.

In the externally assessed examination papers (DT1 and DT3) the longer essay type responses will include marks for assessment of written communication.

8.2 Definition and nature of the design and make tasks / project

At both AS and AL, candidates are required to integrate their knowledge and understanding with designing, making and Key Skills to produce high quality products which are appropriate for their intended purpose

Aspects of the designing process are given below. Designing is not necessarily a linear process; it can be cyclical, iterative, expanding or linear as appropriate to the particular circumstances.

When designing, candidates should:

analyse design situations, identifying appropriate research and research methods, developing a thorough understanding of the requirements to be met, identifying suitable starting points for work, and analysing and recording information, which includes the use of statistical and graphical analysis of information. Candidates should be able to draw on the work of others to inform their analysis;

develop and use specifications, including those prepared by others, which involve constraints and opportunities, functionality, aesthetics, ergonomics and usability, maintainability and ease of production and which suit the requirements of potential users;

use appropriate design methodology to generate and develop ideas in creative and practical ways, including identifying suitable sources of ideas, selecting and carrying out modelling techniques to develop and test design thinking or to promote further design activity. Modelling techniques should include, where appropriate, graphical, mathematical, and 3-D methods as appropriate, using ICT facilities where available;

develop a design solution which satisfies the specification and is sufficiently detailed for an accurate outcome to be produced;

evaluate all aspects of design thinking. This involves candidates making decisions/judgements at all stages from the inception of the work through to manufacturing. A summative evaluation is also required which identifies the strengths and weaknesses of the project and considers possible improvements;

communicate ideas, design proposals and evaluations using appropriate means for a range of audiences.

When making, candidates should:

select and use materials and components, processes and equipment to produce models, prototypes, products and systems, considering suitability, availability and the scale of production;

implement a design solution to the point where it can be fully evaluated in relation to the specification (including its function and appearance and within such constraints as cost etc. which may have been identified);

apply safety principles and safe working practices, including identifying hazards, making risk assessments and deciding how to minimise risks.

Candidates may present their written / design work on any size paper up to and including A2. The size should, however, be consistent throughout the folder.

8.3 Supervision and authentication

Malpractice

Before the course starts, the teacher is responsible for informing candidates of the WJEC's regulations concerning malpractice. Candidates must not take part in any unfair practice in the preparation of coursework required for assessment. They must understand that to present material copied directly from books or other sources *without acknowledgement* will be regarded as deliberate deception. Any candidate who uses, or is suspected of using or attempting to use, any unfair practice is to be reported to the WJEC immediately. If the Board is satisfied that a breach of the Regulations has occurred, the candidate may be disqualified from all subjects.

Supervision

Centres are responsible for providing sufficient supervision to be able to give an assurance that the assessments submitted are based on the work of the candidates concerned. As much work as possible must be undertaken under the direct supervision of teachers. If candidates undertake activities outside this supervision, some work associated with the activity must be undertaken under the direct supervision of teachers.

The teacher responsible for the supervision of the candidates' work will be required to certify that the marks submitted were awarded in accordance with the assessment criteria and that she / he is entirely satisfied that the work submitted is that of the candidate concerned.

It is accepted that certain parts of a candidate's coursework may be taken from other sources where these are relevant and appropriate. This is perfectly acceptable as long as all such cases are clearly identified in the text and fully acknowledged. Where phrases, sentences or longer passages are quoted directly from a source, it is important that candidates use quotation marks or acknowledge ideas and designs taken from the work of other designers.

8.4 Marking of internally assessed coursework and standardisation

Internal standardisation

Centres following this specification must apply a consistent standard of marking across different teachers and teaching groups. Where more than one teacher is involved in assessment, centres are responsible for standardising assessments in order to ensure a single rank order of candidates for the centre as a whole.

Annotation and supporting evidence

Centres are required to annotate coursework *"to show clearly how the marks have been awarded in relation to the marking criteria defined in the specification"* (paragraph 72, GCE / GCSE Code of Practice). This enables the moderator to check the centre's assessments against the Assessment Criteria.

Annotation should, therefore:

(a) highlighting those key aspects of work which have led to the award of a particular mark. Direct reference to the Assessment Criteria is particularly helpful;
(b) provide examples of starting points where specific work has been initiated by the teacher;
(c) include full details of the nature of any assistance given to particular candidates which is beyond that given to the group as a whole;
(c) facilitate the standardisation of assessment within the centre;
(d) include any other notes which will help the moderator to appreciate the reasons for the marks given or the background to work undertaken.

The centre is responsible for ensuring that all candidates' design work and practical outcomes are available for inspection by the visiting moderator.

Photographs, digital images or videos of practical work as it progresses are valuable resources for the centre and of great help to the moderator.

Moderation

It is necessary to provide some method of moderating internal assessments of candidates' work to ensure that no injustice occurs to candidates as a result of variation in the standards applied by different centres. For this specification, the internal assessment of units DT2 and DT4 will be moderated by inspection.

The moderator will visit the centre in May of the year of the examination. Where fewer than eleven candidates are entered, **all** outcomes will be reviewed. Where more than this number are involved a sample will be moderated in the first instance.

Adjustments to the assessments submitted by a centre will normally ensure that the rank order is unaltered, and will be made to bring centre's assessments into line with the national standard. The WJEC reserves the right to request that all submissions are seen if the exercise reveals problems which cannot be resolved by normal moderation procedures.

Problems with individual candidates

Where difficulties caused by illness or other special circumstances prevent appropriate coursework being submitted, the centre should use the standard WJEC procedures as soon as the difficulty becomes apparent.

Retention of evidence

It is appreciated that the storage of practical work can be difficult for centres entering a large number of candidates for this specification. However, provision must be made for the possibility of an enquiry upon results, so candidates' marked work must be kept under secure conditions until such a time as the centre is certain no enquiry is to be made. Case study reports and design folders must be retained at the centre, and ideally any practical outcomes as well. However, if the nature of the final product makes this impossible, candidates may remove these products from the centre providing:

(i) teachers keep evidence (documentary or photographic/videotaped) sufficient to support their marking of these internally assessed components;
(ii) all final products are made available to the Chief Examiner in the event of an enquiry upon results.

Teacher assistance

Design and make tasks (and project work) at both AS and A level are as much a vehicle for teaching as for assessment. It is therefore expected that the teacher will need to give advice and assistance to the candidate as part of normal teaching. This should be provided freely, in such a way that candidates have alternative possibilities to explore, and their own decisions to make about accepting or using the information or advice provided by the teacher. There will, of course, be occasions when direct teacher intervention is necessary to ensure safety, to prevent costly waste of materials or to provide positive assistance. In such cases, this should be done and the details recorded on the assessment sheets.

Candidates must respond using ICT in appropriate sections of their work in DT2, providing the published assessment criteria for this component are met.

The knowledge and understanding contained within the specification units should also be integrated into the DT2 project work, be it designing or making.

DT2 Design and Make task A/S

		Summary of Assessment Criteria	Marks
Designing	(a)	Product analysis and research	20
	(b)	Developing a specification	10
	(c)	Generating and developing ideas and proposals	20
	(d)	Detail designing	15
	(e)	Evaluating and decision making	10
	(f)	Communication / Key skills	10
Making	(g)	Planning for making	5
	(h)	Selecting and testing materials and processes	10
	(i)	Use of materials and processes	20
	(j)	Accuracy, quality and finish of the design solution	20
	(k)	Functionality and innovation of the design solution	10
		Total	**150**

Details of Assessment Criteria

DESIGNING		Mark Range
(a)	**Product analysis and research**	**20 marks**
	• No analysis or little analysis of a product or range of products which did not help to focus the research. • Analysis limited or inappropriate. • Major parameters for the product superficially outlined.	**0 – 4**
	• Some analysis of the product. • Some evidence of focused research activity with some important factors considered in the product analysis both 'above' and 'below the line'.	**5-10**
	• A product analysis which has led to a clear understanding of the major requirements to be met both 'above' and 'below the line'. • Research is appropriate and wide-ranging meeting the needs of the target audience.	**11 – 15**
	• Detailed product analysis has led to appropriate and well-focused research. • The intended product has been carefully analysed, 'above' and 'below the line'. • The candidate has demonstrated a thorough understanding of the task ahead and the requirements which have to be met, to satisfy the needs of the target audience.	**16 – 20**

(b)	**Develop a specification**	**10 marks**
	• Major parameters for the product superficially outlined from the product analysis.	**0 – 2**
	• A specification developed from the product analysis to a level of detail sufficient for the development of a solution but lacking a number of important performance criteria.	**3 – 5**
	• A specification developed from the product analysis to a level and range of detail sufficient for the development of an appropriate solution. • The specification displays a hierarchy of criteria, some of which are measurable.	**6 – 8**
	• A detailed and relevant specification developed from the product analysis. • The specification displays a hierarchy of criteria, some of which are measurable and which takes account of the relative importance of a wide range of factors.	**9 – 10**

(c)	Generating and developing ideas and proposals	20 marks
	• Basic designing skills within a sketch book which includes, idea generation including some relevant comments related to the design brief. • Appropriate idea generation and the use of ICT which demonstrates development of ideas which are derived from the sketchbook. • Modelling and testing is evident. • Some reference is made to the specification when developing ideas. • Initial ideas are used to build towards a proposal which is limited in breadth and depth. • Develop basic design details.	**0 – 4**
	• A limited range of appropriate designing skills, including relevant sketch book work, some quick idea generation and includes some evaluative comment related to the design brief. • Appropriate idea generation and the use of ICT which demonstrates creative development of innovative ideas and concepts that are derived from the sketchbook. • Modelling and testing aids decision making. • Reference is made to the specification through annotation when developing ideas. • Initial ideas are used to build towards a proposal that meets the previously identified specification but which are limited in breadth and depth. • Develop basic design details that identify factors in the evolution of the product.	**5 – 10**
	• A range of appropriate designing skills, including a well developed sketch book, annotation, quick idea generation and evaluative comment related to the design brief. • Appropriate idea generation and the use of ICT which demonstrates creative development of innovative ideas and concepts which are derived from the sketchbook. • Modelling and testing aids decision making. • Reference is made to the specification through annotation when analysing and developing ideas. • Initial ideas are used to build towards a proposal that meets the previously identified specification. • Develop design details that identify important factors in the evolution of the product.	**11 – 15**
	• A wide range of appropriate designing skills, including comprehensive sketch book work annotation, quick idea generation and evaluative comment related to the design brief. • Appropriate idea generation and the use of ICT which demonstrates creative development of innovative ideas and concepts that are derived from the sketchbook. • Modelling and testing aids innovative decision making. • Clear reference is made to the specification through annotation when analysing and developing ideas. • A diverse range of initial ideas are used to build towards a proposal that fully meets the previously identified specification. • Development and refinement of design details that identify important factors in the evolution of the product.	**16 – 20**

(d)	Detail designing	15 marks
	• The solution identifies the materials and essential manufacturing techniques to be used. • Some manufacturing dimensions and tolerances are presented which may assist the candidate to realise the solution. • The solution meets some of the requirements set out in the design specification.	**0 – 3**
	• A developed solution identifies materials and manufacturing techniques. • The developed solution identifies aesthetic details. • Manufacturing dimensions and tolerances are presented in an appropriate format which could be realised by a third party with some reference to the designer. • Presentation of the proposal communicates design intentions to prospective client/s. • The solution meets most of the requirements set out in the design specification; • Appropriate ICT skills have been used to present detailed dimensions.	**4 – 8**
	• A well developed quality solution that identifies appropriate materials and manufacturing techniques. • The developed solution identifies aesthetic details. • Manufacturing dimensions and tolerances are presented in an appropriate format which could be realised by a third party. • Presentation of the proposal communicates design intentions to prospective client/s using ICT where appropriate. • The solution meets the requirements set out in the design specification. • Appropriate ICT skills have been used to present detailed dimensions.	**9 – 12**
	• A fully developed quality solution that identifies appropriate materials and manufacturing techniques. • The developed solution identifies the aesthetic detailing to a high level of clarity. • Precise manufacturing dimensions and tolerances are presented in an appropriate format. • Effective presentation of the proposal which communicates design intentions to prospective client/s using ICT where appropriate. • The solution fully meets the requirements set out in the design specification. • Appropriate ICT skills have been used to present detailed dimensions and the final proposal.	**13 – 15**

(e)	Evaluating, reflecting and decision making	10 marks
	• A limited on-going evaluation identifies some issues related to the specification. • Some limited suggestions for improvement. • Comments are sought from others. • A rudimentary summative evaluation.	**0 – 2**
	• An on-going evaluation identifies some issues related to the specification. • Use of a variety of appropriate evaluation methods and user trials resulting in a number of suggestions for possible improvements. • Objective comment is sought from others. • Summative evaluation which makes reference to the main criteria outlined in the specification.	**3 – 5**
	• A critical and objective on-going evaluation which is related to the specification. • Use of a variety of appropriate evaluation methods and user trials, resulting in a number of suggestions for possible improvements. • Objective comment is sought and analysed from those with commercial or specialist knowledge. • Summative and reflective evaluation which makes clear reference to the specification and the performance criteria.	**6 – 8**
	• A thorough, critical and objective on-going evaluation which is related to the specification and includes reflective comment. • Use of a variety of appropriate evaluation methods, and user trials, resulting in a number of suggestions for possible improvements / further design activity. • Objective comment is sought from those with commercial or specialist knowledge and critically analysed. • Summative well-written reflective evaluation which makes detailed reference to the specification and the performance criteria.	**9 – 10**

(f)	Communication / Key skills	10 marks
	• Little structure to designing. • A limited range of presentation techniques. • Limited written communication demonstrates a basic understanding. • Little use of ICT and numeracy.	**0 – 2**
	• A structured design approach to the portfolio supported by a sketchbook. • A limited range of presentation techniques which demonstrates some design ideas. • Written communication demonstrates some accuracy and basic understanding. • Some use of ICT and numeracy.	**3 – 5**
	• An organised and structured portfolio supported by good sketchbook work. • Skilful use of a range of presentation techniques demonstrating the candidate's thinking. • Flair shown in presenting some aspects of designing. • Written communication demonstrates clarity, accuracy and good understanding. • Good use of appropriate ICT and relevant helpful numeracy.	**6 – 8**
	• An organised and well structured portfolio supported by comprehensive sketchbook work. • Skilful use of a range of presentation techniques enabling a clear appreciation of the candidate's thinking. • Flair shown in presenting all aspects of designing. • Written communication demonstrates clarity, accuracy and depth of understanding. • Very good use of appropriate ICT, and relevant helpful numeracy.	**9 – 10**

MAKING	Mark Range
(g) Planning for making	**5 marks**
• Little evidence to support planning for production of the product. • Limited evidence of quality assurance and quality control measures.	**1**
• Some use made of project management systems for production of the product. • Some quality assurance and quality control measures are in place.	**2**
• Use made of appropriate project management systems for production of the product. • Quality assurance and quality control measures are in place.	**3 - 4**
• Thorough planning for production of the product using effective and appropriate project management systems. • Detailed quality assurance and quality control measures are in place.	**5**

(h) Selecting and testing materials and processes	**10 marks**
• Little or no evidence of the informed selection. • Materials and equipment selection and use based mainly on immediate availability and/or teacher direction.	**0 – 2**
• Some evidence of the consideration of alternative materials and equipment. • Selection based on a limited range of appropriate criteria.	**3 – 5**
• Good material and equipment selection based on the consideration of a broad range of appropriate criteria. • Clear reference made to relevant data and testing.	**6 – 8**
• Discerning selection of suitable materials and equipment using a broad range of appropriate criteria, with clear reference to relevant data and testing. • Selection within specified design constraints, including properties of materials, manufacturing processes and cost limitations.	**9 – 10**

(i)	**Use of materials and processes**	**20 marks**
	• Generally inappropriate use of materials and equipment. • Making techniques not suitable for the selected material in this context.	**0 – 4**
	• Evidence of some concern shown for the materials and manufacturing processes. • Some of the major material properties / characteristics not fully recognised.	**5 – 10**
	• Appropriate, use of materials and equipment demonstrating a good understanding of the relationship between material properties and the manufacturing techniques involved. • Creative use of materials and manufacturing processes including CAM where appropriate.	**11 – 15**
	• Sophisticated, innovative use of materials and equipment demonstrating sympathy for, and a good understanding of, the working properties and performance characteristics of the selected materials. • Creative use of materials and manufacturing processes including CAM where appropriate.	**16 –20**

(j)	**Accuracy, quality and finish of the design solution**	**20 marks**
	• A product demonstrating low levels of accuracy. • Low level of tolerances achieved. • Adequate quality of finish achieved with little attention to detail. • The candidate has worked with some support and demonstrates an ability to apply techniques.	**0 – 4**
	• A product demonstrating limited accuracy in construction. • Limited level of tolerances achieved. • Adequate quality of finish achieved with some attention to detail. • The candidate has worked with limited support and demonstrates an ability to apply techniques to requirements.	**5 – 10**
	• A well made product demonstrating accuracy in construction. • A high level of tolerances achieved. • Good quality of finish achieved, through care and attention to detail. • The candidate has worked unaided and demonstrated an ability to successfully adapt techniques to new situations.	**11 – 15**
	• A well made product demonstrating accuracy in construction. • A very high level of tolerances achieved. • Excellent quality of finish achieved, through care and attention to detail. • The candidate has worked unaided and demonstrated an ability to successfully adapt techniques to new situations.	**16 – 20**

(k) Functionality and innovation of the design solution	10 marks
• End product functions and meets some requirements of the design brief and specification.	**0 – 2**
• End product functions and meets the requirements of the design brief and specification but has few innovative features.	**3 – 5**
• End product meets most functional requirements of the design brief and specification and has some innovative features.	**6 – 8**
• Innovative end product functions very well and fully meets the requirements of the design brief and specification.	**9 –10**
Total	**150**

UNIT DT2 (40%) Extended task		
Designing	85 marks	
Making	65 marks	
Sub-Total	150 marks	**(30%)**

It is suggested that approximately 40 hours is devoted to the Design and Make task. Whilst not requiring the depth or complexity expected within the AL project, candidates are expected to demonstrate achievement and abilities appropriate for the first year of an AL course. They will be expected to present evidence of their competence and ability in all facets of the design problem and its realisation, in the selection and use of materials, tools / equipment and techniques.

DT4 MAJOR PROJECT

		Summary of Assessment Criteria	Marks
Designing and Making	(a)	Analysis, research and developing a design specification	10
	(b)	Generating and developing innovative ideas and proposals	30
	(c)	Detail designing	10
	(d)	Evaluating, reflecting and decision making	15
	(e)	Graphic communication and Key skills	10
	(f)	Planning for making	5
	(g)	Range and sophistication of making skills	30
	(j)	Accuracy, quality and finish of the design solution	25
	(k)	Functionality and innovation of the design solution	15
		Total	**150**

Details of Assessment Criteria

DESIGNING	Mark Range
(a) Analyse research and developing a design specification	**10 marks**
• No analysis or little analysis of the situation which does not help to focus the research. • Research limited or inappropriate. • Major parameters for the product superficially outlined.	**0 – 2**
• Some analysis of the situation. Some evidence of research activity with some important factors considered. • A specification developed to a level of detail sufficient for the development of a solution but lacking a number of important performance criteria which influences design decisions.	**3 – 5**
• Analysis which has led to a clear understanding of the task and the requirements to be met. • Research is appropriate and wide-ranging using ICT where appropriate. • A specification developed to a level and range of detail sufficient for the development of an appropriate solution. Some measurable performance criteria listed which will drive designing.	**6 – 8**
• Detailed analysis of the design situation has led to appropriate and well-focused research. • Research using ICT where appropriate has been carefully analysed, as a result of which the candidate has demonstrated a thorough understanding of the task and the requirements which have to be met. • Evidence of students' ability to reflect upon their research and analysis and make objective comment on the way forward. • A detailed and relevant specification which displays a hierarchy of measurable criteria which take account of the relative importance of a wide range of factors which will drive designing.	**9 – 10**

(b)	Generating and developing innovative ideas and proposals	30 marks
	• Basic designing skills within a sketch book which includes, idea generation including some relevant comments related to the design brief. • Appropriate idea generation and the use of ICT which demonstrates development of ideas which are derived from the sketchbook. • Modelling and testing is evident. • Some reference is made to the specification when developing ideas. • Initial ideas are used to build towards a proposal which is limited in breadth and depth. • Develop basic design details.	**0 – 7**
	• A limited range of appropriate designing skills within a sketch book which includes, quick idea generation and includes some evaluative comment related to the design brief. • Appropriate idea generation and the use of ICT which demonstrates creative development of innovative ideas and concepts which are derived from the sketchbook. • Modelling and testing aids decision making. • Reference is made to the specification through annotation when developing ideas. • Initial ideas are used to build towards a proposal that meets the previously identified specification but which are limited in breadth and depth. • Develop basic design details that identify factors in the evolution of the product.	**8 – 16**
	• A range of appropriate designing skills within a sketch book which includes, annotation, quick idea generation and evaluative comment related to the design brief. • Appropriate idea generation and the use of ICT which demonstrates creative development of innovative ideas and concepts which are derived from the sketchbook. • Modelling and testing aids decision making. • Reference is made to the specification through annotation when analysing and developing ideas. • Initial ideas are used to build towards a proposal that meets the previously identified specification. • Develop design details that identify important factors in the evolution of the product.	**17 – 22**
	• A wide range of appropriate designing skills within a sketch book which includes, annotation, quick idea generation and evaluative comment related to the design brief. • Appropriate idea generation and the use of ICT which demonstrates creative development of innovative ideas and concepts which are derived from the sketchbook. • Modelling and testing aids innovative decision making. • Clear reference is made to the specification through annotation when analysing and developing ideas. • A diverse range of initial ideas are used to build towards a proposal that fully meets the previously identified specification. • Develop and refine design details that identify important factors in the evolution of the product.	**23 – 30**

(c)	Detail designing	10 marks
	• The solution identifies the materials and essential manufacturing techniques to be used. • Some manufacturing dimensions and tolerances are presented which may assist the candidate to realise the solution. • The solution meets some of the requirements set out in the design specification.	**0 – 2**
	• A developed solution identifies materials and manufacturing techniques. • The developed solution identifies aesthetic details. • Manufacturing dimensions and tolerances are presented in an appropriate format which could be realised by a third party with some reference to the designer. • Presentation of the proposal communicates design intentions to prospective client/s. • The solution meets most of the requirements set out in the design specification.	**3 – 5**
	• A well developed quality solution that identifies appropriate materials and manufacturing techniques. • The developed solution identifies aesthetic details. • Manufacturing dimensions and tolerances are presented in an appropriate format which could be realised by a third party. • Presentation of the proposal communicates design intentions to prospective client/s. • The solution meets the requirements set out in the design specification.	**6 – 8**
	• A fully developed quality solution that identifies appropriate materials and manufacturing techniques. • The developed solution identifies the aesthetic detailing to a high level of clarity. • Precise manufacturing dimensions and tolerances are presented in an appropriate format. • Effective presentation of the proposal which communicates design intentions to prospective client/s including using ICT effectively where appropriate. • The solution fully meets the requirements set out in the design specification.	**9 – 10**

(d)	Evaluating, reflecting and decision making	15 marks
	• A limited on-going evaluation identifies some issues related to the specification. • Some limited suggestions for improvement. • Comments are sought from others. • A rudimentary summative evaluation.	**0 – 3**
	• An on-going evaluation identifies some issues related to the specification. • Use of a variety of appropriate evaluation methods, and user trials, resulting in a number of suggestions for possible improvements. • Objective comment is sought from others. • Summative evaluation which makes reference to the main criteria outlined in the specification.	**4 – 7**
	• A critical and objective on-going evaluation which is related to the specification. • Use of a variety of appropriate evaluation methods, and user trials, resulting in a number of suggestions for possible improvements. • Objective comment is sought and analysed from those with commercial or specialist knowledge. • Summative and reflective evaluation which makes clear reference to the specification and the performance criteria.	**8 – 11**
	• A thorough, critical and objective on-going evaluation which is related to the specification and includes reflective comment. • Use of a variety of appropriate evaluation methods, and user trials, resulting in a number of suggestions for possible improvements / further design activity. • Objective comment is sought from those with commercial or specialist knowledge and critically analysed. • Summative well-written reflective evaluation which makes detailed reference to the specification and the performance criteria.	**12 – 15**

(e) Graphic communication / Key skills	**10 marks**
• Little structure to designing. • A limited range of presentation techniques. • Limited written communication demonstrates a basic understanding. • Little use of ICT and numeracy.	**0 – 2**
• A structured design approach to the portfolio. • A limited range of presentation techniques which demonstrates some design ideas. • Written communication demonstrates some accuracy and basic understanding. • Some use of ICT and numeracy.	**3 – 5**
• An organised and structured portfolio. • Skilful use of a range of presentation techniques demonstrating the candidate's thinking. • Shows flair in presenting some aspects of designing. • Written communication demonstrates clarity, accuracy and good understanding. • Good use of appropriate ICT, numeracy relevant and helpful.	**6 – 8**
• An organised and well structured portfolio. • Skilful use of a range of presentation techniques enabling a clear appreciation of the candidate's thinking. • Shows flair in presenting all aspects of designing. • Written communication demonstrates clarity, accuracy and depth of understanding. • Very good use of appropriate ICT, numeracy relevant and helpful.	**9 – 10**

MAKING		Mark Range
(f)	**Planning for making**	**5 marks**
	• Little evidence to support planning for production of the product. • Limited evidence of quality assurance and quality control measures. • The candidate has made little use of project management systems.	**1**
	• Basic planning for production of the product. • Some quality assurance and quality control measures are in place. • The candidate has made some use of project management systems.	**2**
	• Appropriate planning for production of the product. • Quality assurance and quality control measures are in place. • The candidate has made use of appropriate project management systems. • Evidence of a journal of making intent.	**3 - 4**
	• Thorough planning for production of the product. • Detailed quality assurance and quality control measures are in place. • The candidate has made effective use of appropriate project management systems. • Evidence of a detailed journal of making intent.	**5**

(g)	**Range and sophistication of making skills**	**30 marks**
	• Evidence of a limited range of making skills. • Basic manufacturing processes used to make the final design. • Low level basic making skills with an incomplete the final solution.	**0 – 7**
	• Evidence of a range of making skills. • Appropriate manufacturing processes used to make the final design. • Adequate level basic making skills used to complete the final solution.	**8 – 16**
	• Evidence of a range of difficult making skills. • Appropriate manufacturing processes used to make the final design using CAM where appropriate. • Creative use of materials to manufacture the final product. • A good level of making skills, including some innovative characteristics, in the production of the final solution.	**17 – 22**
	• Evidence of a range of challenging making skills. • Sophisticated and appropriate manufacturing processes used to make the final design using CAM where appropriate. • Creative use of materials to manufacture the final product. • A high level of making skills, including key innovative characteristics, in the production of the final solution.	**23 – 30**

(h)	Accuracy, quality and finish of the design solution	25 marks
	• A product demonstrating low levels of accuracy. • Low level of tolerances achieved. • Adequate quality of finish achieved with little attention to detail. • The candidate has worked with some support and demonstrates an ability to apply techniques.	**0 – 6**
	• A product demonstrating limited accuracy in construction. • Limited level of tolerances achieved. • Adequate quality of finish achieved with some attention to detail. • The candidate has worked with limited support and demonstrates an ability to apply techniques to requirements.	**7 – 13**
	• A well made product demonstrating accuracy in construction. • A very high level of tolerances achieved. • Good quality of finish achieved, through care and attention to detail. • The candidate has worked unaided and demonstrated an ability to successfully adapt techniques to new situations.	**14 – 19**
	• A well made product demonstrating accuracy in construction. • A very high level of tolerances achieved. • Excellent quality of finish achieved, through care and attention to detail. • The candidate has worked unaided and demonstrated an ability to successfully adapt techniques to new situations.	**20 – 25**

(k)	Functionality and innovation of the design solution	15 marks
	• End product functions and meets some requirements of the design brief and specification.	**0 – 3**
	• End product functions and meets the requirements of the design brief and specification.	**4 – 7**
	• Innovative end product meets some functional requirements of the design brief and specification.	**8 – 11**
	• Innovative end product functions very well and fully meets the requirements of the design brief and specification.	**12 –15**
	Total	**150**