A Level Product Design Exam Revision Checklist

Topic Tiles:

1	**Designing and innovation**
(a)	Principles of designing
(b)	Research techniques
(c)	Analysis of the problem
(d)	Problem solving strategies
(e)	Quantitative and qualitative testing
(f)	Ergonomics and anthropometrics
(g)	Computer systems for designing
(h)	Innovation
(i)	Consider issues when designing
(j)	Research, plan and evaluate
(k)	Generate and develop ideas
(l)	Develop proposals
(m)	Detail design
(n)	Communicate ideas & information
2	**Materials and components**
(a)	Materials and their application
(b)	Working characteristics of materials
(c)	Materials with specific properties
(d)	Modern material technology
(e)	Materials for specific requirements
(f)	Choice of finishes
(g)	Components and their application
(h)	Safe working practices
(i)	Work with materials & components
3	**Processes**
(a)	Hand methods
(b)	Machine methods
(c)	Combining/forming materials
(d)	Computer-aided manufacture
(e)	Work with tools and equipment
(f)	Work with materials, components

4	**Industrial & commercial practice**
(a)	Manufacturing industry
(b)	Manufacturing systems
(c)	Stages of production
(d)	Detailed manufacturing methods
(e)	Management systems
(f)	Safe working practices
(g)	Industrial methodology
5	**Product analysis and systems**
(a)	Design and production
(b)	Form and function
(c)	Trends & influences on design
(d)	Intellectual Property & Standards
(e)	Systems and sub-systems
(f)	Control systems
(g)	The use of ICT
(h)	Issues when designing
(i)	Systems analysis
(j)	ICT when planning
(k)	ICT when designing and making
6	**Human responsibility**
(a)	Service to the customer
(b)	Regulatory frameworks
(c)	Risk assessment procedures
(d)	Values in design solutions
(e)	Forms of energy
(f)	Responsibilities when designing
(g)	Quality (of the product)
(h)	Quality (human processes)
7	**Public interaction**
(a)	Innovation in the market
(b)	Researching the market
(c)	Selling the product
(d)	Diffusion of products
(e)	Researching market/client needs
(f)	Determine product marketability
(g)	Evaluate products

Further content explanation:

Product design	1. Designing and innovation	
	This section is concerned with learners developing their ability to design and enhance their basic design skills in order to solve problems. Learners should also develop an understanding of a range of external influences and demands which affect the work of product designers.	
	Content	Amplification
	(a) 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; • user centred design: the investigation and analysis of a problem within a context, the needs wants and values of users to define a design opportunity or problem that could lead to the production of a design brief and specification; • 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.
	(b) 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.
	(c) Analysis of the problem	• Effective analysis and synthesis of material to guide development of innovative and creative ideas; • investigate and analyse a problem, consider the needs, wants and values of users, leading to the production of design briefs, specifications, to inform, direct and evaluate the end product; • reflection on the problem.
	(d) Problem solving strategies	• Investigation, team work (including brainstorming), research, modelling, prototyping and trialling; • how skills and knowledge from other subject areas (including mathematics, science, computer science) will support problem solving including the application of technology; • the process of innovation – collaborative and commercial approaches; • key concepts in innovation such as the impact of product champions and entrepreneurs; • innovation techniques such as inversion (turning the problem around), morphological analysis (evaluating possible solutions in a table or matrix), analogy and lateral thinking; • analysis and exploration of the needs of users.

Product design	(e)	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; • feasibility studies on proposed solutions.
	(f)	Ergonomics and anthropometrics	• Relevant use of human and environmental measurements and statistics to inform design and production.
	(g)	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.
	(h)	Innovation	• Appreciate the importance of innovation in both designing and making.
	(i)	Consider a range of issues when designing	• Take into account design strategies when designing, be innovative and open to creative ideas at the start of the process.
	(j)	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.

Product design	(k)	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, iteration, 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.
	(l)	Develop proposals	• Model detailed aspects of ideas and proposals, using ICT as appropriate and use a systems approach to solve problems.
	(m)	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; • carry out feasibility studies on the practicability of the proposed solution to meet the needs of the market place.
	(n)	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 and writing reports.

Product design

2. Materials and components

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 NEA work.

Content	Amplification
(a) Materials, components and their potential application	Classification, general characteristics and uses of:- • natural materials and elements to include, copper, hardwoods, silver, softwoods, wool; • plastic/pure synthetic materials 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; • 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, laminated, profiled, sheet and woven forms, availability and comparative costs.
(b) 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.
(c) 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, including SMART materials; • foams, rubbers, wood-based composites and metallised materials.
(d) Awareness of modern material technology	• An appreciation of how product development is influenced by modern materials, to include an understanding of the application of functional (SMART) and modern materials

Product design	(e)	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.
	(f)	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, sealants, preservatives, anodising, holographic finishes, plating, galvanizing and cathodic protection.
	(g)	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; • the use of adhesives, permanent and semi-permanent fixings to join similar or dissimilar materials; • a knowledge of temporary means of joining/fastening a broad range of materials.
	(h)	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.
	(i)	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 (a) above).

Product design

3. Processes	
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
(a) 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.
(b) 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 ,stamping, laminating, milling, turning, injection moulding, extrusion, bonding; CAD/CAM and prototyping; • the use of jigs and fixtures to increase speed of production and help ensure consistency.
(c) 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.
(d) Computer aided manufacture	• Software applications and the transfer of information to CAM machines, e.g. laser cutters, micro -routers, CNC lathes, milling machines and 3D printers. • the benefits and limitations of computer controlled machines, to include CADD,CAM, CIM, digital media.
(e) Work with tools and equipment.	• Selection of 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
(f) Work with materials, components and appropriate technologies.	• Selection of 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.

Product design

4. Industrial and commercial practice	
This section is about understanding various methods of production and being able to apply appropriate commercial practices in practical projects.	
Content	Amplification
(a) 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; • modular/cell production systems; • 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.
(b) 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 rapid prototyping), modular/batch and high volume production.
(c) Stages of production.	• Primary and secondary processing; • Sourcing of materials, the buying cycle, forward ordering, storage, processing, assembly, finishing, packaging/ labelling and transportation.
(d) 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; • the influence of the above on the time taken to produce the product, its quality and final cost;
(e) 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.
(f) 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.
(g) Industrial methodology and approaches	• Use an awareness of industrial methods and approaches in their own work to design, manufacture and implement quality control procedures

Product design

5. Product analysis and systems	
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
(a) 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.
(b) Form and function of different products	• Aesthetic detailing, functional and marketing constraints such as maintenance and cost of a range of manufactured products; • appreciate the relationship between products and human form and environment (ergonomics and anthropometrics) to ensure suitability and ease of use.
(c) Trends, styles, new technical capabilities, and social, moral, political and ethical influences on the design, production and purpose of products.	• Design theory, including key historic movements/figures and their methods; • 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 • global manufacturing;
(d) 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.

Product design	(e)	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;
	(f)	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.
	(g)	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'.
	(h)	Consider a range of issues when designing	• Take into account the characteristics and features of existing products when designing.
	(i)	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.
	(j)	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.
	(k)	Use ICT when designing and making	• Use ICT appropriately for communicating, modelling, controlling and manufacturing.

Product design

6. Human responsibility	
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 learners to explore the environmental and consumer factors which impact on designers and which might affect the final nature of a product.	
Content	Amplification
(a) 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.
(b) How to find information on the regulatory and legislative frameworks related to product design	• How to find relevant information related to a product's design and use, from documents such as Health and Safety legislation, BS and COSHH.
(c) Standard risk assessment procedures in product design	• The identification of risks to the consumer in using a product, making risk assessments, reduction of risks.
(d) The values (technical, economic, aesthetic, social, environmental and moral) implicit in product 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; • sustainable design issues when making design choices; • manufacturing and the environment; • conservation of raw materials.

Product design	(e)	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.
	(f)	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.
	(g)	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; • generate criteria and specifications required to judge quality: material testing.
	(h)	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.

Product design

7. Public interaction – marketing and research	
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 seeks to examine the many factors influencing product design, market research techniques and their influence on producing innovative products. Learners should develop an appreciation of the effects of social, economic, cultural and ethical issues in addition to material and manufacturing technologies.	
Content	Amplification
(a) 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.
(b) 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.
(c) 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. • how the digital world affects the four P's; • enterprise and how products are brought to the market place.
(d) 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).
(e) 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.
(f) Use appropriate measurements to determine product marketability.	• Assess the success of existing products; the effectiveness of a product using social, economic and moral parameters.
(g) Evaluate products.	• Use personal sources and external sources – target audience, specialists, when evaluating products against performance specification.