GCE MARKING SCHEME

SUMMER 2016

DESIGN & TECHNOLOGY
DT3 – PRODUCT DESIGN
1113/01

INTRODUCTION

This marking scheme was used by WJEC for the 2016 examination. It was finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conference was held shortly after the paper was taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about this marking scheme.

GCE DESIGN & TECHNOLOGY
DT3 - PRODUCT DESIGN

SUMMER 2016 MARK SCHEME

SECTION A

Answer **three** *questions from this section.*
This section is designed to demonstrate your **breadth** *of knowledge in Product Design.*
Each question carries 8 marks.

1. (a) Explain the term market segmentation.

(b) State the reasons why designers should be aware of market segmentation when designing specific products.

(a) Market segmentation is the process of dividing a broad target market into subsets of consumers. The consumers may have similar needs and priorities so that designers and researchers can then implement strategies to target them. **[4]**

(b) The designers should be aware of the market segment that they are designing for:

- so that they are aware of the possible market size;
- what the share of that market is likely to be;
- who are the potential purchasers;
- what are the expectations of the market,
- positioning to achieve a marketing plan objective;
- develop product differentiation strategies;
- involving specific products or product lines depending on the specific demand of the target segment.

Note: the response here should relate to specific named products. **[4]**

2. Describe how specific jigs and fixtures are used to increase speed and ensure accuracy when manufacturing products.

JIGS
'This is a device used to control the location and/or motion of another tool'. A jig is a device provided with one or more guides (for cutting tools) in which the work is located and held in position in relationship to the guides. Jigs are commonly associated with drilling operations where the holes to be drilled are in one plane, of little else than a flat plate in which are housed the tool guides. Jigs may also be made for reforming plastics.

There are many types of jigs, and each one designed to do a specific job - some to increase productivity, to do repetitious activities and to do a job more precisely.

Their primary purpose is to provide repeatability, accuracy, and speed in the production process.

FIXTURES
A fixture is a work-holding device pure and simple, and is intended to provide a means of mounting work on a machine for the purpose of performing an operation, in correct relationship to a previously machined surface, or surfaces (or even forming).

It basically holds the work in a fixed location in order to perform a machining or forming operation.

[8]

3. The use of ICT has a significant effect on the design and manufacture of products.

(a) Explain the benefits of ICT in pre-production prototyping.

(b) Explain the benefits of ICT within stock control.

Benefits: Pre-production prototypes
Discussion based on the following.

(a) Identification of design flaws.
Testing hypotheses – will a particular mechanism work.
Speed of creating an accurate 3D prototype.
Plan for part or component production.
Illustration when discussions with a client.
Test the market in order to gather opinions/data.
Enabling a shorter lead in time for the product to market.
Testing ergonomic features.
Carry out materials test.
The designer can visualise scale, evaluating form and location (also the use of animated images).
Calculate production methods or the best way to manufacture. **[4]**

Benefits: ICT within Stock Control

(b) If a manufacturing business does not manage its stock well, it will start to lose money, or lose profits. Benefits therefore:
An item of stock will not run out and the whole manufacturing process can carry on.
Customers continue to be able to buy, and the company able to sell.
Not too much of a stock item is allowed to build up, which wastes the money used to make or buy the item, and costs money to store the item. (JIT)
There will be the minimum amount of stock waiting to be used in the production process. **[4]**

4. Explain how quality standards, which are developed by the BSI (British Standards Institute) and ISO (International Organisation for Standardisation), have a positive effect on specific named products.

Quality standards are an agreed, repeatable way of doing something. It is a published document that contains a technical specification or other precise conditions designed to be used consistently as a rule, guideline, or definition.

Standards help to make life simpler and to increase the reliability and the effectiveness of many goods and services in use. Standards are created by bringing together the experience and expertise of all interested parties such as the producers, sellers, buyers, users and regulators of a particular material, product, process or service.

Positive Effects:

They are based around consumer confidence by the display of the 'kite mark' or specific certification labels relating to child safety, electrical or the construction of products.

A CE mark is a manufacturer's claim that its product meets specified essential safety requirements set out in relevant European directives.

The following categories of products require CE marking if sold within the EU and responses may make reference to these:

- toys
- electrical products
- construction products
- pressure vessels
- telecommunications equipment
- medical devices
- machinery, equipment and safety components
- personal protective equipment
- satellite station equipment
- gas appliances
- pressure equipment
- appliances
- non-automatic weighing instruments and equipment
- measuring instruments
- recreational craft
- lift machinery
- equipment and protective systems for explosive atmospheres
- marine equipment
- safety components and subsystems for incorporation into cableway installations.

[8]

5. Describe in detail, using diagrams where appropriate, a permanent and non-permanent method of joining specific materials.

'A permanent joint is one that is intended to last the life time of a product whereas a temporary joint is one which is intended to hold the item together but is removable easily at any stage without causing too much damage to the main product'

Permanent Method

Adhesion – the use of a variety of specific glues (to join similar and dissimilar materials).
Cohesion – a method of joining materials permanently using heat (welding – gas, mig, arc, friction) or without heat (solvents).
Mechanical – a method of joining both similar and dissimilar materials mechanically (rivets, pins Joining steel sheet by riveting giving full description of the preparation of the joint, marking out and drilling, type of rivet used, and the tools and processes used to form the joint.

Non-permanent Method

Mechanical – a method of joining both similar and dissimilar materials mechanically (nuts and bolts, screws, pins Joining steel) including the tools and processes used to form the joint. Knock down fittings, double sided tape, Velcro fasteners.

Snap fasteners (also called **press studs**) are often used in children's clothing, as they are relatively easy for children to use.

[8]

SECTION B

Answer **three** *questions from this section.*
This section is designed to demonstrate your **breadth** *of knowledge in Product Design.*
Each question carries 8 marks.

6. Explain what you understand by qualitative and quantitative testing in the selection of materials when developing products.

Qualitative testing *of materials are used primarily to define a problem and generate hypotheses. They can be better than quantitative testing - understanding what drives and motivates behaviour.*

They are very valuable for exploring an issue and are used by almost all researchers at various points during large research campaigns.

Qualitative testing will reflect the intended quality of certain defined aspects of a material's specification. They are a more subjective form of criteria.
Marks allocated with a full description with any of the following examples:

The material must be aesthetically pleasing…
Material used must be recyclable….
The material must be bright……

Quantitative testing *of materials involves using some form of calibrating device to ascertain the response of materials to a particular force or range of forces*.

This can be undertaken by using scientific measuring instruments such as a tensometer or a hardness tester. Materials may also be subjected to qualitative testing by devising 'fair' tests that ascertain the ability of a particular component or the product to be able to perform reliably.

Quantitative testing are objective, measurable criteria, which can be assessed against specific performance measurable objectives.
Marks allocated with a full description with any of the following examples:

The material must weigh no more than…..
The material used must be light enough to….
Related to material hardness, malleability, ductility…..

[8]

7. Describe the important features of a design process that are used to design and make successful products.

A description of the features from initial design brief to the completion of a problem solving task. Responses need to refer clearly to a successful process utilised which may be structured into definitive steps or stages in solving problems i.e.

Identify a Need ……..through to the summative evaluation.

Discover – identify the design need.
Discover – identification of the design problem/opportunity. How is it identified? Consumer pull.
Define – understand the issues through detailed research.
Define – through detailed research and identification of the problem. Responses will need to make reference to how the designer defines the problem and reaches a possible specification which clearly defines the problem. Also allow reference to target market.
Develop – developing the product to a successful conclusion.
Develop – all the associated systems which will be used in developing the product to a successful conclusion i.e. types of modelling systems (physical and computer generated) running in parallel with idea generation and their subsequent development.
Deliver – manufacturing the product for a specific market.
Deliver – will involve the delivery of the product to the specified market (the diverse markets available from the product). JIT (Just In-time)

Responses will need to refer to the principles of a design process and the development of products.

[8]

8. Describe a five step risk assessment plan appropriate for a named manufacturing process.

I. Look for the hazard (being anything which may cause harm).
II. Decide who/what may be harmed and how?
III. Evaluate the risks and decide whether existing precautions are adequate or whether more needs to be done. Risk is the chance, high or low, that somebody will be harmed by the hazard.
IV. Record the findings.
V. Review the assessments and revise if necessary.

The 5 stages in the **incorrect** order gain a maximum 5 marks
Single words or very short phrases can be given credit – up to a maximum of 4 marks.

[8]

9. Describe a specific process of forming a product or component in a named plastic.

Description of blow moulding, compression moulding, calendaring, injection moulding, rotational moulding etc.

Example:

Blow moulding - PET bottle.

The Process
The process is divided into three areas:

A. Injection

The injection blow moulding machine is based on an extruder barrel and screw assembly which melts the polymer. The molten polymer is fed into a manifold where it is injected through nozzles into a hollow, heated pre-form mould. The pre-form mould forms the external shape of the pre-form. The pre-form consists of a fully formed bottle/jar neck with a thick tube of polymer attached, which will form the body.

B. Blowing

The pre-form mould opens and the core rod is rotated and clamped into the hollow, chilled blow mould. The core rod opens and allows compressed air into the pre-form, which inflates it to the finished article shape.

C. Ejection

After a cooling period the blow mould opens and the core rod is rotated to the ejection position. The finished article is stripped off the core rod and leak-tested prior to packing The pre-form and blow mould can gave many cavities, typically three to sixteen depending on the article size and the required output. There are three sets of core rods, which allow concurrent pre-form injection, blow moulding and ejection.

[8]

10. (a) Explain how concurrent engineering is used within product development.

(b) Explain how reverse engineering is used in the design and development of products.

Concurrent Engineering

[4]

Concurrent engineering, also known as simultaneous engineering, is a method of designing and developing products, in which the different stages run simultaneously, rather than consecutively. It decreases product development time and also the time to market, leading to improved productivity and reduced costs

- Employs simultaneous, rather than sequential, processes.
- Completing tasks in parallel.
- Product development can be accomplished more efficiently and at a substantial cost savings.
- Concurrent engineering allows for design and analysis to occur at the same time, and multiple times, prior to actual deployment.
- Emphasizes teamwork
- Allows for employees to work collaboratively on all aspects of a project from start to finish.
- Reduces the time required to bring a new product to the market.

Reverse Engineering **[4]**

Involves taking something (e.g., a mechanical device, electronic component, or software program) apart and analysing its workings in detail to be used in maintenance, or to try to make a new device or program that does the same thing.

Reverse Engineering

- The process of discovering the technological principles of a product, device or system.
- Analysis of its structure and form.
- Take something apart and analyse its workings (mechanical, electrical or software)
- Product development can be accomplished more efficiently and at substantial cost savings.

SECTION C

Answer **two** *questions from this section.*

Your answers should be substantial and show the **depth** *of your knowledge in Product Design*

Each question carries 26 marks.

Level 1 0-9	• Candidate has a simplistic knowledge of the issues associated with the question. • The use of terminology and technical language is basic. • The candidate has little understanding of the general elements of industrial and commercial practices, with little knowledge of ICT in manufacturing systems if appropriate to the question. • The candidate has limited knowledge of the form and function of products. • The candidate will express ideas clearly, if not always fluently. Answers may deviate from the question or not be relevant. • Grammar, punctuation and spelling may be weak impacting on effective communication.
Level 2 10-14	• The candidate has a basic understanding of the issues associated with the question. • The use of terminology and technical language is variable. • The candidate understands the general elements of industrial and commercial practices related to manufacturing systems and some aspects of ICT in production. • The candidate has some general knowledge of the form and function of a product, trends and styles of products. Environmental, cultural and/or ethical/moral. These aspects are not always considered. • The candidate will express straightforward ideas clearly, if not always fluently. Answers may deviate from the question or be weakly presented. • There may be some errors of grammar, punctuation and spelling but is still able to communicate the issues.
Level 3 15- 20	• The candidate demonstrates a clear understanding of the issues associated with the question. • The use of terminology and technical language is reasonably accurate. • The candidate understands the general elements of industrial and commercial practices related to manufacturing systems and is aware of aspects of ICT in production. • The candidate has demonstrated a knowledge of the form and function of a product, trends and styles of products reflecting environmental, cultural and/or ethical/moral issues. These aspects are considered. • The candidate will express moderately complex ideas clearly and fluently, through well linked sentences and paragraphs. Answers will be generally relevant and structured. • There may be occasional errors of grammar, punctuation and spelling.
Level 4 21-26	• The candidate demonstrates a specific ability to analyse questions, takes into account of a wide range of factors and has a clear understanding of the issues associated with the question. • Uses correct terminology and technical language. • The candidate understands the main feature of industrial and commercial practices related to manufacturing systems including the use of ICT and stages of production. • Candidate has developed a detailed knowledge of the form and function of a product, trends and styles of products. Environmental, cultural and/or ethical /moral issues. These aspects are considered where appropriate. • The candidate will express complex ideas extremely fluently. Sentences and paragraphs will follow on from each other smoothly and logically. Answers will be consistently relevant and structured. • There will be few, if any, errors of grammar, punctuation and spelling.

Marks are awarded according to the four levels within the assessment criteria. These criteria are best fit and if a candidate has most of the aspects within a level then the candidate can be considered for marks towards the higher end of the band. If there are some features that are weak or missing but overall the response matches many of the descriptors then the candidate could be considered for marks in the middle of the level. Candidates may be awarded marks at the bottom of the level if they have most of the descriptors in the previous level and one or two in the next level.

11. "Truly elegant design incorporates top-notch functionality into a simple, uncluttered form"

(David Lewis 2006)

Discuss how this statement is relevant to the work of a contemporary designer and the impact of the products that he/she has designed.

This question requires an answer in essay form which assesses the way a particular contemporary designer has impacted upon the design of the particular product (an elegant, simple and uncluttered form). Have the products influenced other developments/products?

The answer should seek to identify a specific product or range of products attributed to the chosen designer and to examine the development brought about by the designer. The candidate should go on to examine styling details and their development and comment upon the styling developments, form and design simplicity and how these elements have impacted on the overall design of the product.

[26]

12. Describe the benefits and effects that composite materials have on the success of a particular product in terms of form, function and reliability.

A composite material is one which is composed of at least two elements working together to produce material properties that are different to the properties of those elements on their own. In practice, most composites consist of a bulk material (the 'matrix'), and a reinforcement of some kind, added primarily to increase the strength and stiffness of the matrix. This reinforcement is usually in fibre form.

- Polymer Matrix Composites (PMC's) ¬ These are the most common. Also known as FRP - Fibre Reinforced Polymers - these materials use a polymer-based resin as the matrix, and a variety of fibres such as glass, carbon, aramid and natural fibres as the reinforcement.
- Metal Matrix Composites (MMC's) - Increasingly found in the automotive industry, these materials use a metal such as aluminium as the matrix, and reinforce it with fibres such as silicon carbide.
- Ceramic Matrix Composites (CMC's) - Used in very high temperature environments, these materials use a ceramic as the matrix and reinforce it with short fibres, or whiskers such as those made from silicon carbide and boron nitride.

The composite material most commonly associated with the term "composite" is Fiber Reinforced Plastics. Responses may make reference to sporting equipment (golf shafts, tennis rackets, surfboards, hockey sticks, etc.), automotive components, wind turbine blades, body armour, building materials, water pipes.

Benefits of Composites

In comparison to common materials used today such as metal and wood, composites can provide a distinct advantage. The primary advantage in the adoption of composites is the lightweight properties. In transportation, less weight equates to more fuel savings and improved acceleration. In sporting equipment, lightweight composites allow for longer drives in golf, faster swings in tennis, and straighter shots in archery. While in wind energy, the less a blade weighs the more power the turbine can produce. Besides weight savings, the most important benefits of composites include:

- Non-corrosive
- Non-conductive
- Flexible, will not dent
- Low maintenance
- Long life
- Design flexibility **[26]**

13. Discuss the advantages of planned obsolescence within the life cycle of specific products to the consumer and to the manufacturer.

Planned obsolescence is when a product is deliberately designed to have a specific life span. This is usually a shortened life span. The product is designed to last long enough to develop a customer's lasting need. The product is also designed to convince the customer that the product is a quality product, even though it eventually needs replacing. In this way, when the product fails, the customer will want to buy another, up to date version.

Benefits to consumer: costs are usually low, easily replaced (no need for repairs), possible to keep up with developing technology.

Benefits to the manufacturer: cost of production is low, little or no repairs necessary, life cycle is short, known and secure market.

[26]

14. Discuss how manufacturing methods, product life and environmental factors relate to the design and manufacture of sustainable products.

Quantifying sustainability and as a result Carbon Foot printing or Life-Cycle Analysis (LCA) have become approaches adopted to identify the impact of a company and its activities in terms of the environment.

During product design, the environmental impact should be considered at every stage in the life-cycle, from the raw material extraction through to the end of the product's life.

Terms like eco-design, design for sustainability, carbon foot printing and life-cycle thinking are relevant when looking at the sustainability of a product, service or processes.

Responses must consider the three areas in relation to designing sustainable products.

(a) Manufacturing - demonstrating good awareness of manufacturing methods. Responses may also discuss the consideration of sustainable materials by the designer which match appropriate manufacturing of those materials.
(b) Product life - appropriate product life, energy, cost of manufacture, quality, fit for purpose.
(c) Environmental factors - a range of environmental issues highlighted (energy, cost, investment, environmental footprint). What are the alternatives?

[26]

15. Explain what you understand by quality control and quality assurance, and discuss their importance to the manufacturer, consumer and the environment.

Quality Control

Checks at points on the production line for accuracy and safety of product or components. Meet consumer and environmental expectations.

Importance to:

Manufacturer
Quality control methods: dimensional accuracy (tolerances), dimensional accuracy may be checked with a gauge or measuring tool (micrometer, vernier etc). Quality of materials (visual marks or blemishes) appearance and finish, durability. The use of CAD/CAM ensuring quality.

Candidates may refer to checks made on production machinery rather than a test on the product itself.

Consumer
Important to the consumer because of confidence in the product or manufacturer, aspects of safety important to the consumer, health aspects.

The Environment
Efficiency, producing little waste or emissions, recycling possibilities and consumer safety,

Quality Assurance
In developing products and services, quality assurance is any systematic process of checking to see whether a product or service being developed is meeting specified requirements.
Importance to:

Manufacturer
Principles included in Quality Assurance are: "Fit for purpose", the product should be suitable for the intended purpose; and "Right first time", mistakes should be eliminated.

Consumer
A quality assurance system is said to increase customer confidence and a company's credibility, to improve work processes and efficiency, and to enable a company to better compete with others.

The Environment
Monitoring emissions to air, land and water and encouraging manufacturing to manage their impact on the environment and reducing and managing waste.

[26]