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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Design and Technology: Product Design (5551/6551)

Unit 1 (3D Design) PD1D

Mark Scheme

2006 examination – June series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Design and Technology: Product Design

3D Design Unit 1 (PD1D)

Quality of Written Communication

The following marks are allocated to the quality of the candidate's written communication. Make a separate assessment of the candidate's overall ability as demonstrated across the paper using the criteria given below.

Performance Criteria	Marks
The candidate will express complex ideas extremely clearly and fluently. Sentences and paragraphs will follow on from one another smoothly and logically. Arguments will be consistently relevant and well structured. There will be few, if any, errors of grammar, punctuation and spelling.	4
The candidate will express moderately complex ideas clearly and reasonably fluently, through well-linked sentences and paragraphs. Arguments will be generally relevant and well structured. There may be occasional errors of grammar, punctuation and spelling.	3
The candidate will express straightforward ideas clearly, if not always fluently. Sentences and paragraphs may not always be well connected. Arguments may sometimes stray from the point or be weakly presented. There may be some errors of grammar, punctuation and spelling, but not such as to suggest a weakness in these areas.	2
The candidate will express simple ideas clearly, but may be imprecise and awkward in dealing with complex or subtle concepts. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling may be noticeable and intrusive, suggesting weaknesses in these areas.	1

NB This mark scheme is intended as a guide to the type of answer expected but is not intended to be exhaustive or prescriptive. If candidates offer other answers which are equally valid **they must be given full credit.**

Many responses at this level are assessed according to the **quality** of the work rather than the number of points included. The following level descriptors are intended to be a guide when assessing the quality of a candidate's response.

(low mark range)
The candidate has a basic but possibly confused grasp of the issues. Few correct examples are given to illustrate points made. Description may be unclear.
(mid mark range)
The candidate has some knowledge but there will be less clarity of understanding. Some correct examples given to illustrate points made. Description better but unclear or confused in parts.
(high mark range)
The candidate has a thorough understanding of the issues and has provided relevant examples to support the knowledge shown. This candidate's answer shows clear evidence of understanding.

PD1D

1 (a) (i)

- **Play house**

Accept any suitable softwood, e.g. Red Deal, Pine, tannelised pine, beech, teak, oak, etc

- **Food Packaging**

Accept any suitable thermoplastic, e.g. PET, Polypropylene (PP), Low Density Polyethylene (LDPE), High Impact Polystyrene (HIPS).
Do not accept Acrylic or PVC.
1 mark for Polythylene

- **Drinks can**

Accept aluminium, aluminium and coated steel combination, coated steel.

(1 mark for 'steel')
(1 mark for tin)
(1 mark for mild steel)

(2 × 2 marks) (4 marks)

(ii) Suitable explanation, linking the properties of the material to the product function or manufacture.

- **Wooden play house**

Softwoods e.g. pine are grown in managed forests, having less impact on the environment than hardwoods taken from rain forests etc.
Pine trees grow much faster than hardwoods and so are more readily available and economical to use.
Softwood can be seasoned faster than hardwood e.g. by kiln drying. This ensures a steady supply at an economical price.
Softwood is available in the UK and Europe, keeping transport costs down compared to more exotic hardwoods.
Softwood can be joined with screws, nails, etc and can be finished with preservatives, paints etc to enhance appearance and prevent decay.

- **Plastic food packaging**

Thermoplastics such as Polypropylene are used as this is an ideal material for vacuum forming/thermo forming.
P.P/PET are food grade polymers and are therefore safe to contain food, eat from etc.
Thermoplastics can be formed into shape rapidly, reducing costs of production compared to other materials.
Waste from the manufacturing process with thermoplastics can be recycled.
PET/HIPS/LDPE is available in transparent which is needed to show the contents of the packaging for retail use.
Thermoplastics can be recycled which is good for the environment given the short life cycle of the product.

- **Metal drinks can**

Aluminium/coated steel will not corrode as readily as other metals, making it safe to drink from.
Such sheet metals are malleable and ductile so they can be cupped and deep drawn/press formed into the desired shape.
Aluminium/coated steel is non permeable so the drink stays fresh – it won't leak, air can't get in and the gases in the can can't escape until the ring-pull is opened.
Aluminium is soft, so is ideal for the opening of ring pull as the aluminium is pierced more easily than say stainless steel or a coated steel.
Aluminium has a low melting point making it easy to recycle when the can is disposed of.

Breakdown

1 – 2 marks per relevant point. (2 marks where point or statement is qualified i.e. property is linked to product function etc).

Max 3 marks if generic list of properties.

(2 × 6 marks) (12 marks)

(iii) Candidates will use notes and diagrams to explain the manufacture of their two chosen products.

Wooden playhouse

Expect diagrams of mortice and tenon, housing joints etc.
Tongue and groove panelling or similar fixed to frame.
Better candidates may make reference to use of jigs/fixtures to ensure frame is square.
Use if nail/staple gun in industrial manufacture.
Use of acrylic or polycarbonate for windows-safety.
Possible reference to finishing method e.g. use of pressure treated timber, dipping, spraying timber with preservative, etc.
If assembly of a flat-pack discussed, look for joining method to award marks.

Plastic food packaging

Accept vacuum forming.
Accept thermoforming (similar to vacuum forming but with additional mould over the top that presses down to make sharper detail, embossed lettering, etc.)
Accept injection moulding
"Not extrusion or blow moulding" but **accept** blow moulding/dome forming with a vacuum former.
If thermoset polymer given in (i), accept compression moulding in (iii)

Metal drinks can

Body and base:
Punched or pierced and blanked from stock sheet material.
Metal cupped and then deep drawn. (accept press forming).
Accept rolling and seam welding as an alternative.

Top:
Punched or pierced and blanked from stock material.
Edge rolled to make safe and provide crimping for attachment to base.
Material lacquered on inside to prevent corrosion.
Outer decorated with offset lithography. (Probably done when material still flat stock sheet).

Breakdown

- Basic diagram of a suitable manufacturing process with a few points labelled.

(1 mark for stating correct process)

(1 – 3 marks)

- Better diagram of a suitable manufacturing process with all points labelled and some explanatory notes.

(4 – 6 marks)

- Detailed diagram with all points labelled and a good explanation of the process

(7 – 9 marks)

(2 × 9 marks) (18 marks)

(b) Reasons why blow moulding is used to make plastic drinks bottles:

- Process produces hollow objects necessary to make drinks container.
- Mould produces sharp detail such as thread on neck, grips on bottle body, etc.
- Fast process necessary for volume production
- Process suitable for thermoplastics which can be extruded into mould cavity and cool quickly – again necessary for volume production.
- Process ideal for thin walled product.
- The most logical method of making the bottle.

Breakdown

Basic answer. Mostly refers to speed of production. May use generic terms e.g. 'inexpensive', 'easy to make bottle shape'

(1 – 2 marks)

Better answer. Refers to volume of production required, speed of production required and possible reference to hollow nature of product.

(3 – 4 marks)

Good understanding of speed and volume of production, nature of product, reference to how the product will be formed/how process works, etc.

(5 – 6 marks) (6 marks)

Total 40 marks

2 (a) Suitable definition of the term 'smart material' e.g.

"A Smart Material is a material whose physical properties change in response to an input, e.g. the application of heat to the material".

(Input could be cold, light/dark, water/moisture, etc).

(4 marks) (4 marks)

Breakdown

- Incorrect or no definition given

(0 marks)

- Definition is incomplete e.g. no reference to changes in the material but partly correct.

(1 – 2 marks)

- Definition is correct with reference to changes in material in response to an input or change in immediate environment.

(3 – 4 marks)

(b) Candidates will be expected to make reference to the properties of each smart material and how they are utilised in the function/use, etc of each product given. It is not necessary but candidates may give specific examples of a suitable smart material and should be credited.

(i) **Shape Memory Alloy**

Shape memory alloys are metals that have been heat treated to give the material a 'memory'. At a 'designed' temperature, such alloys can be plastically deformed (will change shape and can be held in this shape while held at this temperature), but will return to their original shape when the temperature is removed.

In green house windows, an alloy of copper-zinx-aluminium is made into a coiled spring which opens and closes a window on a hinge in response to changes in temperature.
Can be used in the same way as a solenoid to operate a motor.

(ii) **Phosphorescent pigment**

Phosphorescent pigments are a ceramic material that will absorb light energy and will re-emit this light energy over a period of time. The pigments are available in a powder form and can be mixed with acrylic paints or inks and painted onto signs, or they can be mixed with a polymer in the moulding process. The pigments allow the signs to be illuminated without the need for electricity.

Breakdown

- Little or no understanding of the properties of the smart material listed. Possible reference to generic properties that may have some relevance to product function.

(0 – 2 marks)

- Candidate understands what the material is and the main properties. Candidate links properties of the material to how the product functions in a basic way.

(3 – 4 marks)

- Candidate clearly understands the use of the smart material listed and makes good reference to the properties of the material and how it enhances product function/use etc.

(5 – 6 marks)

(2 × 6 marks) (12 marks)

(c) Candidate will choose a product from the list and draw it to show where thermochromic pigments **could be** used. Candidates will add notes to describe how thermochromic pigments are used to enhance the product.

Breakdown

- Product named e.g. 'kettle'
  Basic sketch of the product with basic/limited description

(1 – 4 marks)

- Product named with better diagram with some notes describing features where smart material is used to enhance product.

(5 – 8 marks)

- Product named with good quality diagram and description clearly explaining where smart material is used to enhance product.

(9 – 12 marks)

A good written description without diagrams can achieve top marks.

Possible examples may include: **Note not exhaustive**!

Electronic jug kettles e.g. Russell Hobbs Thermocolour 'Pink' kettle. (The body of the kettle turns pink when the kettle boils), indicating the kettle is hot – both functional and an unusual, attractive aesthetic feature. May improve safety as it shows when kettle is hot to touch.
Saucepans e.g. Tefal 'Red spot' pans. Coloured spot in the middle of the pan turns red when saucepan is hot enough to cook. Ensures food is cooked at correct temperature, energy saving as it shows when sufficient heat has been used on the pan, etc.

Baby feeding products e.g. spoons, cups, bowls made by manufactures such as Tommy Tippee. Thermochromic pigments change colour with temperature of food/drink to indicate if it is too hot – functional/hygienic safety feature that is clearly visible. (No need to put fingers in food or taste it). May make reference to colour association, e.g red for hot and blue for cold, etc.

Children's toys such as 'Barbie Make-up toys' or McDonalds Happy Meal toys may be finished with thermochromic pigments to enhance play value. E.g. when cold or warm water is applied to toy, 'skin' changes colour to give impression of adding say lipstick, etc.
Accept other relevant examples, e.g. toothbrush, etc.

(12 marks)

Total 28 marks

3 Candidates are required to explain why each material is suitable for the products listed. Reference should be made to the material properties and their influence on function/use or manufacture of the products. Answers may include:

(a) Teak – Outdoor furniture

- Attractive colour and grain enhances aesthetics for retail purposes
- Natural 'oils' in teak help to preserve timber from decay. Hardwood resistant to splitting so ideal for machining and joining with mechanical fixings
- Excellent finish free from splinters etc so clothes won't snag etc
- Topical hardwood but can be grown in managed forests so plentiful supply
- Easily maintained with application of teak oil or similar
- Etc

(b) Foam board – models

- Soft material – very easy to cut with craft knives
- Easily joined with PVA/Hot glue or plastic 'snap fasteners'
- Laminated with a paper surface which can be coloured with paints, markers
- Flat surface – ideal for mounting computer printouts to apply graphics to model
- Laminated construction makes sheet stiff and adds strength. Model can be handled/used
- Etc

(c) Polycarbonate – CD cases

- Reasonable impact resistance so protects CD and will withstand some misuse
- Transparent so CD sleeve can be displayed
- Thermoplastic so can be injection moulded (Necessary for level of detail and complexity in case)
- Etc

(d) Low density polyethylene – Carrier bags

- Thermoplastic so can be made by calendaring to make thin film required
- Thermoplastic so can recycled to limit effects on the environment with packaging waste
- Good tensile strength for thickness of material. Resists handles breaking under weight of shopping with minimum use of material
- Can be printed on via screen – printing or offset lithography
- Etc

(e) Laminated card – Drinks cartons

- Inside layer made from low grade (grey) card laminated with polyethene, foil or similar film on inside to prevent leakage
- White better quality outer card ideal for full colour printing to show off branding etc.
- Outer may be waxed or lacquered to give carton greater durability
- Crushable to minimise space in waste. Burns easily for waste disposal purposes
- Can be made from recycled materials but not recyclable
- Etc

(f) Silver – Jewellery

- Attractive colour/lustre ideal for jewellery
- Very ductile and malleable so can be shaped into rings, bracelets or drawn into wires for fine chain links etc.
- Low melting point enables casting of intricate jewellery items
- Can be soldered to join different parts together in making jewellery
- Etc

(g) Aluminium – Car engine parts

- Lightweight compared to alloy steels – reducing fuel consumption
- Low melting point allows die casting of parts
- Does not corrode so greater engine life compared to alternatives
- Low melting point allows easy recycling of engines
- Can be alloyed with other metals to enhance properties

(7 × 4 marks)

Breakdown

1 – 2 marks per relevant point. (2 marks where relevance of property explained).

Max 2 marks for generic list.

MAX 4 marks per section. (28 marks)

Total 28 marks

4 (a) Any suitable, specific metal e.g. Mild steel, stainless steel, aluminium.

Award 1 mark for 'steel'
1 mark for chrome. (2 marks)

(b) Candidates are expected to give reasons why the material given in (a) is suitable for the stool legs. Better answers will link the properties of the material to the function/use, manufacture of the product and so on. Answers may include:

- Malleability. Metals can be bent into shape to form leg structure.
- Available in tube form – keeping weight down but giving good mechanical strength.
- Can be welded to join the legs together.
- Readily available in a range of diameters to suit manufacture.
- Etc.

Breakdown

1 – 2 marks per relevant point. (2 marks where point or statement is qualified i.e. property is linked to product function etc).

Max 3 marks if generic list of properties. (6 marks)

(c) Candidates are expected to give a description of a suitable paint finish for the legs e.g.
2 marks for named specific paint, e.g. acrylic paint, cellulose paint, spirit based paint, oil based paint, "Hammerite".

Powder coating with cellulose paints or similar.
No marks for emulsion paints or "car paint".

- Steel is chemically cleaned to remove oils, fluxes, etc from manufacturing.
- Legs are dried, suspended and electronically charged.
- Powdered paint is sprayed onto the legs, electrical charge ensures powder sticks to legs.
- Legs are baked in a kiln to fuse the powder into a hard, moisture resistant finish.

Breakdown

- Generic finish e.g. 'paint' with very basic description e.g. "paint it on with a brush".

(0 – 1 marks)

- Specific finish named e.g. cellulose based paints with better description but maybe incomplete.

(2 – 4 marks)

- Specific finish named and detailed description.

(5 – 6 marks) (6 marks)

(d) Notes and diagrams to show suitable method of joining legs to seat. Answers may include:

- Clamp arrangement under legs, with screws into posts moulded under seat.
- Screws/machine screws going through holes drilled into legs into posts moulded into seat.
- Etc.

Breakdown

Basic diagram of a suitable manufacturing process with a few points labelled.
(1 – 3 marks)

Better diagram of a suitable manufacturing process with all points labelled and some explanatory notes.
(4 – 6 marks)

Detailed diagram with all points labelled and a good explanation of the process.
(7 – 9 marks) (9 marks)

(e) Suitable explanation why injection moulding is used to make seat. Answers may include:

- Seat requires reinforcing ribs and moulded details such as screw posts etc. Only really possible to make via injection moulding.
- High volume production required. Injection moulding is fast and accurate with little waste. Good mould design can produce multiple mouldings from one injection.
- Can be fully automated to ensure consistent quality.
- Etc.

Breakdown

- Explanation basic. Little understanding of reasons for injection moulding.
(1 – 2 marks)

- Better explanation with good reasons for selecting injection moulding.
(3 – 4 marks)

- Full explanation with clear understanding of why injection moulding is used.
(5 marks) (5 marks)

Total 28 marks