



General Certificate of Education

AS Design and Technology Product Design 5551

PD1D Materials and Components

Mark Scheme

2008 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 le.g.islated 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.

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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.

<i>Performance Criteria</i>	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

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. This candidate does not have a clear idea of what s/he is writing about.
(mid mark range)
The candidate has some knowledge but there will be less clarity of understanding. Some correct examples given to illustrate points made. This candidate knows what s/he is writing about but is confused in part.
(high mark range)
The candidate has a thorough understanding of the issues and has provided relevant examples to support the knowledge shown. This candidate knows what s/he is writing about and provides clear evidence of understanding.

- 1 (a) (i)
- **Wooden chair**
Accept plywood, aero ply, beech/birch or similar veneers, laminated hardwood veneers, Flexiply, flexible MDF, Bendywood.
 - **Plastic vase**
Accept acrylic/PMMA, or specific varieties of acrylic e.g .light gathering cast acrylic, laser acrylic, High Impact Polystyrene (HIPS), Polycarbonate (PC), Rigid/UPVC, Polypropylene (PP).
 - **Metal bottle opener**
Accept aluminium, aluminium alloy, stainless steel, mild steel, duralium, titanium, brass. NOT pewter.

Breakdown

1 mark for correct specific material.

(2 × 1 mark)

- 1 (a) (ii) Candidates are expected to link the properties of the materials identified in (i) to the function/use, manufacture serviceability, environmental considerations, etc of their **two** selected products.

- **Wooden chair**

Plywood (etc) can be steamed to make pliable enough to be bent in a mould without fracture.

Plywood (etc) can be cut and drilled to take mechanical fixings such as screws, KD fittings, etc.

Plywood (etc) can be stained, waxed, etc, for improved aesthetics

Plywood and wood veneers available in long, wide -sheets to remove need for joining smaller pieces together.

Stable. Once dried, the board will not change shape, warp, twist etc.

Available with attractive grain pattern/colours.

Etc

- **Plastic Vase**

Acrylic available in a wide range of colours, transparent, opaque etc to suit variety of tastes.

Can be cut using a CNC laser cutter or CNC router, etc.

Can be cut using a jig-saw/hole saw or bandsaw to make shapes of the components.

Can be filed and have edges polished with abrasive paper etc if required.

Accept PMMA is waterproof.

Can be joined with an acrylic solvent cement e.g. Tensol.

Not affected by water/plant contents.

- **Metal bottle opener**

Aluminium has a good aesthetic appearance which can be enhanced by anodising.

Aluminium doesn't corrode which is important in a kitchen or bar item.

Aluminium is Lightweight – easy to carry in pockets, on keys etc.

Aluminium has sufficient hardness when anodised to function as an opener, capable of pressing into alloy bottle tops.

Aluminium can be pierced and blanked- required to manufacture.

Aluminium can be cast into the required shape- low melting point.

Can be milled relatively easily.

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)

- 1 (b) Candidates will use notes and diagrams to explain the manufacture of their **two** chosen products.

- **Wooden chair**

Accept laminating of veneers/plywood **or** steam bending solid timber or thicker sheets of ply to manufacture cantilever legs.

Process includes manufacture of former(s)

Steaming of veneers or plywood unless flexibly used.

Clamping in between formers or using a bag press and former.

Allowing time to dry. Sand off excess and finish with stain, wax, etc.

AWARD MAXIMUM OF 5 MARKS IF ONLY A DESCRIPTION OF STRETCHER JOINT OR ASSEMBLY OF SEAT TO FRAME.

- **Plastic vase**

Accept description of using a jig-saw, hegner/vibrating saw, hole saw or even coping saw to cut components out.

Accept reference to **specific** CAD/CAM equipment such as a CNC laser cutter, router or milling machine.

Candidates may describe use of software e.g. 2D Design to draw object in CAD. Setting of 'pen' or cutter speeds and power settings (for laser) e.g. set cutter to low speed and maximum power with raster tool 'off' and vector tool 'on' to cut acrylic.

In the case of routers, may describe use of fixture to hold the plastic on the machine bed or double sided tape on an MDF base. Use of specific router cutters, slot drills, etc. Setting of speed and feed rates.

Candidates may describe 'capillary' bonding using solvent cement such as Tensol. (Some may describe use of masking tape to protect acrylic from cement spills, etc).

Credit use of files, wet and dry abrasive, buffer & polish to clean up edges if required.

- **Metal bottle opener**

Accept laser or plasma cutting

Accept piercing and blanking

Accept drop forging of a pre-cast 'preform'

Accept die casting.

Accept milling from a plate

Accept piercing saw/abra file etc.

Give **max 3** marks for sand casting.

Credit reference to finishing processes such as anodizing for aluminium, zinc plating for mild steel, etc.

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 most points labelled and some explanatory notes. (4 – 6 marks)
 - Detailed diagram with all points labelled and a good explanation of the process (7 – 10 marks)
- (2 × 10 marks)

- 1 (c) Candidates will describe three different procedures adopted for the safe use of materials in a workshop environment. The materials will be named.

e.g. Bonding acrylic with liquid solvent cement (Tensol). This must be kept in a clearly labelled container displaying the correct health and safety information.

The container must have a lid that is airtight and leak proof to prevent fumes escaping.

Eye protection must be worn to prevent injury from splashes.

Tensol should be used in a well ventilated room.

Tensol should be applied in a small syringe or with a fine brush to minimise splashes.

Etc

Breakdown

- Material(s) may or may not be named followed by a list of list of personal protective clothing e.g. goggles, gloves, mask with very little else (1 – 2 marks)

e.g. "When using MDF, wear goggles, a dust mask and overalls"=1 mark

- Material(s) named and precaution given but no explanation (3 – 4 marks)

e.g. "When welding metals such as mild steel, protective clothing and equipment such as gauntlets and goggles should be worn and it should be carried out in a ventilated area. You should also remove flammable materials from the welding area" = 4 marks

- 3 procedures given for one or more materials with explanation (5 – 6 marks)

(6 marks)

2 Candidates will explain why the materials are suitable for the products listed:

Breakdown

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

Max 2 marks for generic/basic list.

Material	Product
<p>(a) Stainless steel</p>	<p>Drinks flask Toughness – resists sudden impacts from being dropped. Hard material- resists impacts from being dropped (compared to polymer & glass flasks) Good aesthetic appearance of stainless steel makes it a desirable product for retail purposes Stainless steel doesn't corrode so it can be cleaned in a dishwasher, used outdoors, etc. Etc “waterproof, non toxic, good aesthetics, durable “ = 2 marks</p>
<p>(b) Pewter</p>	<p>Jewellery Low melting point makes it relatively easy to cast into jewellery item Doesn't corrode so can be worn against skin and clothes without marking or causing any harmful effects. Can be polished to enhance aesthetic appeal. Lower cost alternative to silver which is commonly used in jewellery. Etc “good appearance, lightweight, low cost, easy to make” = 2 marks</p>
<p>(c) Carbon Fibre Composite</p>	<p>Tennis racket High mechanical strength but extremely lightweight means it can resist impacts from use, whilst reduce fatigue in the player compared to aluminium, etc. Can be moulded into shape, speeding up manufacture, etc. Easy to mould than traditional wooden racket. Can be combined with titanium mesh or other materials to increase mechanical strength. Add a colour pigment for improved aesthetics and no need to apply a finish. Etc Good impact resistance- frame doesn't break if you hit the floor or in high speed serves. “carbon fibre is lightweight, good impact resistance, easy to mould, shock resistant”= 2 marks</p>

<p>(d) Laminated glass</p>	<p>Gives good optical clarity necessary for driving Good mechanical strength (windscreens form part of the structure of the vehicle) Resists minor impacts from flying debris etc Cracks but does not shatter in the event of a large/sudden impact. This prevents sharp glass fragments entering the passenger space. Can be formed by automated processes suitable for volume production. Can be cast and pretensioned. Widely available material which is necessary for volume production of this key replaceable component. Can be tinted with a colour pigment added to the polymer interlayer.</p> <p>“it is clear, you can see through it, doesn’t break easily, durable”= 2 marks</p>
<p>(e) Thermochromic pigment</p>	<p>Thermometer Changes colour in response to heat so can be used in an easy to read temperature scale. Non toxic and doesn’t need to be contained in glass- a significant weakness of traditional thermometers. Different pigments respond to different temperatures so simple to read temperature bands can be indicated. Can be combined with thin polymer film to make a flexible strip thermometer which is easy to use on a child. Etc</p> <p>“ changes colour, easy to use, widely available” = 2 marks</p>
<p>(f) Corrugated polypropylene sheet</p>	<p>Art Carry folders Can be cut and scored to make necessary folds, tabs etc for construction. Waterproof to keep the contents dry. Comes in a variety of colours for improved aesthetics, etc. Can be joined using snap fixings for speedy assembly Lightweight, easy to carry. Very flexible so it can be folded on the hinge many times. It is not brittle so it doesn’t break if folder dropped Etc</p> <p>“lightweight, waterproof, cheap, it looks good” = 2marks</p>

<p>(g) Expanded polystyrene</p>	<p>Take- away food containers Good thermal insulator will keep food warm/not burn the user carrying item. Can be injection moulded to quickly form the complex shape required with minimum of waste. Food grade polymer which is necessary to prevent contamination. Thermoplastic which can be recycled – important in a short lifecycle disposable item for environmental performance. Can be printed on with corporate graphics Can be pigmented to suit different produce. Lightweight, reduces transport costs and carbon emissions for volume producers “non toxic, light, cheap and disposable”</p>
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(7 × 4 marks)

- 3 (a) (i) Accept mild steel rod or bar. Accept aluminium and stainless steel.
Accept steel welding rod or brass brazing rod.
(1 mark for 'steel' or welding rod/brazing rod) (2 marks)

- 3 (a) (ii) Candidates will explain why the material is suitable

e.g.

- Mild steel is malleable so it can be bent into shape without fracture
- Mild steel can be brazed or welded together to join the parts.
- Mild steel is available in rod form as a standard stock form.
- Mild steel is relatively inexpensive compared to some metals which is good for a budget ornament like the one shown.
- 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)

- 3 (b) Candidates will use notes and diagrams to explain in detail how the ornament would be fabricated.

Accept MIG or TIG welding, Oxy-Acetylene welding or brazing (including aluminium brazing). Accept hard soldering/brazing using gas/air torch.

Accept using epoxy resin.

Credit details of cutting the bars to size, bending the bars, clamping, etc.

Credit, filing up and cleaning after welding operation.

Do not credit finishing details in this section.

Note: DO NOT PENALISE IF MANUFACTURING PROCESS IS DESCRIBED CORRECTLY BUT IT IS NOT SUITABLE FOR THE MATERIAL GIVEN IN (i).

Breakdown

- Basic diagram of a suitable fabricating process with a few points labelled
(1 mark for stating correct process) (1 – 4 marks)
- Better diagram of a suitable fabricating process with most points labelled and some explanatory notes. (5 – 7 marks)
- Detailed diagram with all points labelled and a good explanation of the process (8 – 10 marks)

(10 marks)

- 3 (c) Candidates will name a suitable specific finish for the ornament and describe how it would be applied.

Accept zinc/chrome plate

Accept powder coating.

Accept Polymer Dip Coating.

E.g. Cellulose /acrylic based paints.

Sharp edges removed with files/abrasives.

Firstly the metal maybe degreased and flux, etc, removed

A light 'key' might be created on the surface with wet & dry abrasive or in an acid pickle.

A primer coat of zinc based paint might be applied using a spray gun and allowed to dry for 24 hours.

A top coat of colour will be applied be and allowed to dry.

Breakdown

2 marks for specific paint finish. ("Paint it with Hammerite" = 2 marks)

Up to a further 2 marks for description of application.

(4 marks)

- 3 (d) Candidates will describe how the metal ornament could be batch produced. Diagrams maybe used to support their answer.

Answers might include:

- Answers may refer to division of labour
- Use of bending jigs to repeatedly form the tail, arms and feet
- Use of cutting stops on bench shears to cut materials to set lengths
- Use of welding jigs to hold components together at the correct spacing for joining e.g. legs to base washer
- Use of grit blasting or chemical pickle to remove residue prior to painting
- Dip or spray painting

(6 marks)

- 4 (a) Candidates will compare and contrast the two public benches shown in Figures 5 and 6.
Answers may be organised separately for each product or mixed together.
Maybe presented in a table format.

N.B record two marks in the right hand margin for the 2 × 12

Expect answers to discuss the following:

Polyethylene

- 4 (a) (i) Function of the product
- Teak and LDPE are rigid materials and therefore can withstand compressive/dynamic forces from people sitting on the bench
 - Teak is a relatively heavy wood which helps to prevent it blowing over in strong winds
 - Teak has a good surface grain which sands well. This resists splintering.
 - Teak can be oiled but this will discolour and need re application.
 - Teak has natural oils which help to preserve it-prevent rot and insect attack
 - Teak is a hardwood and resists scratching and surface indentation- preserving appearance
 - Teak can be cut, chiselled etc for jointing or KD fittings can be used as it resists splitting
 - TEAK can be sourced from Forest Stewardship Council certified suppliers and therefore is sustainable.
 - LDPE doesn't need any finishing and can be made to have a smooth finish from the mould and therefore good for ergonomics. Can be given a wood grain appearance from the mould.
 - LDPE can be made in a variety of colours to suit different applications. The colour goes throughout the polymer and so doesn't wear off.
 - LDPE doesn't need any maintenance other than an occasional cleaning
 - LDPE can be plastic welded or joined using KD fittings, screws, etc
 - LDPE is completely weatherproof but may eventually degrade with the effects of sunlight
 - Speed of manufacture through extrusion of individual polymer components and lack of finishing process.
 - Solid polymer components give density and weight which prevents the bench blowing over in strong winds.
 - LDPE can be cleaned with chemical detergents
 - Recycled LDPE makes good use of waste plastics.
 - Both materials can be recycled at end of life.
 - Etc

Breakdown:

1 – 2 Marks per relevant point. (2 marks where point is explained and made relevant to product function, manufacture or maintenance).

(2 × 12 marks)

IF CANDIDATE DESCRIBES OAK OR ANOTHER TIMBER, GIVE CREDIT FOR CORRECT, RELEVANT POINTS.

- 4 (b) Candidates will explain why it is necessary to add stabilisers to polymers used outdoors

Answers might include:

- Stabilisers help to prevent polymer from degrading from the effects of sunlight
- With exposure to UV over time, polymers can discolour and become brittle. E.g. budget UPVC patio furniture, GRP boats etc can crack, etc.

Breakdown

- Basic answer e.g. “It stops the polymer from fading in sunlight” (1 – 2 marks)
 - Good answer with supporting examples
e.g.
“Stabilisers help to prevent the polymer breaking down or degrading with the effects of sunlight. E.g. UPVC window frames can go yellow” (3 – 4 marks)
- (4 marks)