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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

AS Design and Technology Product Design 5551

PD1D Materials and Components

Mark Scheme

2008 examination – January 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.

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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.

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

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.

No marks should be awarded for answers that simply state materials are "strong", "cheap", "easy to mass produce", "easy to manufacture / cheap to manufacture" or "readily available".

Question 1

(i)

- **Watering can**
  Accept any suitable thermoplastic such as:
  ABS-Acrylonitrile Butadiene Styrene
  HDPE- High Density Polyethylene
  LDPE- Low Density Polyethylene
  UPVC – Poly Vinyl Chloride
  PP- Polypropylene

  Not acrylic or PMMA

- **Alloy Wheel**
  Accept suitable metals such as:
  Aluminium
  Aluminium Alloy
  Magnesium/Aluminium Alloy
  Duralumin
  Not stainless steel
  Not titanium

- **Softwood Table**
  Accept suitable softwood such as:
  Pine, Scots Pine, Douglas Fir, etc.

(2 × 1 mark)

(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.

- **Plastic watering can**

Waterproof or impermeable. This is obviously necessary to hold water to function as a watering can.
Resistant to UV from sunlight and resistant to frost/freezing therefore prolonging the life of the product.
Thermoplastic required for injection moulding process- thermosets are not usually injection moulded.
Impact resistance of PP, etc. 'The product likely to be dropped or thrown around in the garden or shed during use'.
Polymers can include a colour for improved aesthetics (no need to paint, reducing manufacturing costs).
Etc

- **Alloy wheels**

Aluminium, aluminium alloy, etc have excellent strength to weight ratio. This reduces vehicle weight and therefore fuel consumption, whilst having good mechanical strength.
Aluminium etc, doesn't corrode- essential to maintain long product lifecycle especially if used in all weathers. Resistant to salts, etc used in road treatments
Aluminium, etc don't need to be painted (anodised or polished finish can save manufacturing costs).
Aluminium has a low melting point and is therefore ideal for die casting. Steel (having a higher melting point would reduce the lifetime of the dies)
Aluminium can be easily machined using milling cutters, lathe tools etc (if wheel is made from a solid billet- as in custom motorcycles etc)
Aluminium can be machined and polished to repair the wheel after surface damage/abrasion.
Etc

- **Softwood Table**

Attractive grain pattern for aesthetic quality
Lower cost than hardwoods such as oak.
Sustainable timber- can be grown in managed forest (better for environment, etc)
Can be turned to manufacture legs.
Can be cut, chiselled, glued, etc to create traditional joining methods.
Can be joined using wood screws, Knock-Down fittings etc –for joining of the top to the legs
Can be sanded to an acceptable finish and a number of finishes can be applied such as beeswax, wood stains, etc.
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).

E.g. "Pine is a sustainable timber"= 1 mark

"Pine can be sourced from managed forests in the UK and is therefore cheaper to transport than woods from overseas, keeping the cost of the material down" = 2 marks

Max 3 marks if generic list of properties.

(2 × 6 marks)

(b) Candidates will use notes and diagrams to explain the manufacture of two of the products from the list in part (a)

- **Plastic watering can**

Accept only **injection moulding,**. (1 mark for correct process)
Give credit for correct terminology used in labels such as 'Archimedean screw' (1 mark), ejector pins,
(1 mark) etc. UP TO A MAXIMUM OF 4 Marks. The remainder of the marks are awarded for the description of the process.

E.g. "Polymer powder, stabilisers, fillers and pigment are loaded into the hopper" (1 mark), "The Archimedean screw moves the polymer forward" (1 mark),"The heaters melt the polymer and when a sufficient charge has built up, the hydraulic ram pushes the screw forwards, injecting the polymer into the cavity" (1 mark) "The mould is water cooled, and when the product is set, the mould opens and the product is ejected" (1 mark).
Give credit for reference to removable cores for injection moulding,(1 mark), removal of flash (1 mark), etc.

Do not accept compression moulding, vacuum forming, etc.

- **Alloy wheel**

Accept **only** the following processes:

Gravity Die Casting Pressure Die Casting Die Casting Machine from a solid billet	IF INVESTMENT OR SAND CASTING DESCRIBED, CREDIT MACHINING SURFACE AND REMOVAL OF RUNNER / RISER AND REF TO MELTING ALLOY ETC ACCEPT PRESSING IF FERROUS METAL GIVEN IN (i)

Give credit for labels & details of mould- cavity resembling product, (1 mark) reference to mould material (hardened die steel/refractory coating) (1 mark) - split lines & ejector pins (1 mark), plunger or hydraulic ram (1 mark) UP TO A MAXIMUM OF 4 marks
The reminder of the marks are awarded for the description

E.g. Aluminium is melted and stored in a heated hopper (1 mark)
The mould closes and a charge of aluminium is introduced into the chamber (1 mark)
A hydraulic ram moves forward pushing the aluminium into the mould under pressure (1 mark)
The metal cools and the product is ejected (1mark)
Excess material of flash is removed with a file or grinder (1 mark)

- **Softwood table**

Candidates may describe any one, all or a combination of the following:
- Give 1 to 2 marks for details about converting the timber using quarter sawn method to enhance grain and give further stability to timber
- Give 1 to 2 marks for details about seasoning timber for interior use
- Manufacture of the top using butt jointing (alternating end grain), biscuit, dowel or tongue and groove jointing.
- Use of buttons or brackets to allow for expansion of timber to stop splitting.
- Manufacture of the legs using wood turning
- Fabrication of box frame under the top to connect legs to top

- Connection of the legs to the box frame/table top using brackets, or similar method
- Allow the following:
  Corner blocks
  Cam lock and metal dowel
  Captive nut and bolt
  Wood screw and corner blocks (not self tapping screws or nails)
  Leg/corner brackets
  Etc.
- Finishing process.

Nb. A detailed answer describing one part can access the top mark.
Do not accept 'screw', but check notes and diagrams for any credit worthy, feasible answers.

Breakdown

- Basic diagram of a suitable manufacturing process with a few points labelled
  (1 mark for stating correct process) *(0 – 3 marks)*

  E.g. simple diagram of injection moulder. Generic mould with little detail. Labels such as 'screw', 'plunger'. Major points missing.

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

  E.g. Mould resembles product, some specific parts correctly labelled such as Archimedean screw, hydraulic system, etc. Step by step process in note form but may have some steps missing or lacks clarity

- Detailed diagram with all points labelled and a good explanation of the process *(7 – 10 marks)*

  E.g. Mould clearly resembles the product. Details of spit lines, water cooling, possibly cores, etc. Specific correct terminology such as 'ejector pins, 'hydraulic ram'. Step by step process is correct with few if any details missing for the top mark.

  (2 × 10 marks)

(c) Candidates will explain why hardwoods are becoming less popular with designers and manufacturers today compared to softwoods.

Accept the following:

- Softwoods can be easier to work with than hardwoods
- Hard wood dust is more hazardous than softwood dust, therefore fewer H & S issues with softwoods.
- More widely available than hardwoods due to European/North American supply from managed forests. This reduces costs.
- Faster growing time for softwoods, helps to ensure ready supply.
- Seasoning times are much reduced for softwoods, reducing costs.
- Softwoods routinely grown in sustainable, managed forests.
- Negative image of using hardwood from unsustainable sources or valuable habitat e.g. rainforest.
- Credit ref to aesthetics/taste and fashion if specific hardwoods mentioned.

(6 marks)

Breakdown

1 – 2 marks per relevant point. (2 marks where point or statement is explained).
Candidates may pick up marks by covering fewer than three points but coverage is in greater depth or by a combination of coverage and points.

E.g. Hardwood takes longer to grow and to season.✓ This makes it more expenses to process than softwood✓
Hardwood generally produces hazardous dust when machined✓.
Hardwood often comes from rainforest which is not environmentally sound✓ and transport costs to Europe are expensive✓. Hardwood can be difficult to machine, blunting saws✓ = 6 marks

Question 2

(a) Candidates will name a suitable adhesive used to join each of the following materials together:

(i) **Acrylic to acrylic**
Accept acrylic cement, Tensol or solvent cement.
Cyanoacrylate Superglue. Accept Epoxy resin

(ii) **Softwood to softwood**
Accept PVA or Synthetic resin, Cascamite/Extramite, Evostik Resin –W, etc.
Accept Epoxy resin and Superglue

(iii) **Melamine formaldehyde to MDF**
Accept contact adhesive, Evostik, etc
Also accept Epoxy resin and Superglue

(iv) **Steel to nylon**
Accept Epoxy resin, Araldite, and Superglue etc

(4 × 1 mark)

(b) Candidates will use notes and diagrams to describe two knock down fittings of their choice and its application in joining materials together

Accept:

- Barrel and nut and bolt
- Cam fitting
- T-nut and bolt
- Screw socket
- Screw connector
- Corner plate
- Chipboard fastener
- Block connector
- Modesty block
- Nut and bolt
- Wood screws, self tapping screws, etc. MAX 5 marks

Breakdown

- Basic diagram of a suitable KD fitting with a few points labelled
  (1 mark for stating correct KD fitting)

  (0 –2 marks)

  e.g. Simple sketch of corner blocks & use of 'screws'.

- Better diagram of a suitable KD fitting process with all points labelled and some explanatory notes about function.

  e.g. Clearer diagram of a corner plate showing how it fits the leg to the frame. Some notes explaining how it works.

  (3 – 5 marks)

- Detailed diagram of a suitable KD fitting with all points labelled and a good explanation of the function of the fitting.

  *(6 – 7 mark*s)

(2 × 7 marks)

(c) Candidates will explain the benefits of using knock down fittings to join materials together. These may include:

- Allows manufacturer to flat-pack products
- Quicker to manufacture than using traditional wood joints
- KD fittings lend themselves to automation and volume production systems
- Manufacturer does not need skilled labour in the same way as manufacturers of traditional furniture would.
- Bought in component from specialist supplier- keeps costs for manufacturer down.
- Consumer can take the product home easily
- Can be assembled using simple hand tools
- Etc

Breakdown

- Answers are basic with no examples and limited explanation

(0 – 3 marks)

e.g. It is quicker than using traditional wood joints= 1 mark
It is quicker than using traditional wood joints because the manufacturer will not be assembling the product" = 2 marks

- Answers show some understanding of the benefits to either the manufacturer or consumer. Examples might be used to explain points

(4 – 6 marks)

e.g. KD fittings allow the manufacturer to supply the product in flat pack form- unassembled(1 mark). This speeds up manufacturing (1 mark) and makes it much easier to transport the product to retail outlets (1 mark). As the products take up less volume, they need less packaging (1 mark) to protect them in transit. This reduces manufacturing costs, (1 mark)

(d) Candidates will explain why self tapping screws are often used to assemble products. Answers might include:

- Allows the product to be maintained, repaired or recycled more easily.
- Allows speedy assembly using simple joining method
- Can be done with only semi skilled labour
- Uses a standard component that it widely available- keeps costs down
- Etc

Breakdown

- Answers are basic with no examples and limited explanation

(1 – 2 marks)

e.g. "Its quicker and cheaper to make things with self tapping screws"= 1 mark

"Assembly is speedy because pilot holes/internal screw posts, countersunk clearance holes (1 mark) etc can be moulded into the product (1 mark) and a self tapping screw simply driven in with a power screwdriver"(1 mark)= 3 marks

- Answers show some understanding of the benefits to either the manufacturer or consumer. Examples might be used to explain points

(3 – 4 marks)

Question 3

Candidates will explain why each of the materials given in the table is suitable for the products listed. Answers may include details concerning the function and/or manufacture of the product. Such answers may include:

Material	Product
(a) ABS	**Mobile phone** • ABS is lightweight so the overall weight is kept low. Good for ergonomics • Impact resistant so will withstand being dropped • Can be injection moulded into complex shapes required to hold circuits etc • Can be chrome plated for aesthetic purposes • Can be spray painted with acrylic/cellulose finishes for aesthetic purposes • Electrical insulator- prevent shock in the event of a fault with mains charger, etc • Can be coloured with a variety of pigments to make it appealing to different markets. • ABS is scratch resistant • Etc
(b) Acrylic	**CD Rack** • Good rigidity – needed for function • Acrylic can be laser cut or 'routered' to machine slots accurately. • Comes in a wide range of colours to suit different consumer tastes/trends • Can be glued with a variety of cements e.g. Tensol to make the joints permanent as necessary • Can be shaped on a strip heater to bend the edges in order to make it 3D and stand up, etc • Can be injection/vacuum formed • Etc
(c) MDF	**Storage unit** • Low cost – good for volume production • MDF is a stable material and doesn't warp or twist like natural timber.

	This makes it good for veneering. • Available in long wide boards so smaller pieces don't have to be joined- reducing costs • Accepts KD fittings to make it possible to flat - pack • Etc
(d) Laminated Plywood	**Cantilever chair** • Can be laminated over a mould to make curves required • Good compressive strength –will resist dynamic loads from person sitting on it. • Flexible so it can be bent over formers without breaking • Comes in a range of different face veneers to suit a variety of different tastes • Can be steamed and glued with synthetic resin which is necessary to make the chair. • Etc
(e) High Speed Steel	**Drill bit** • Stays hard/sharp at high temperature • High carbon content allow hardening and tempering to increase hardness and toughness • Sufficiently hard to cut low or medium carbon steels and non ferrous metals • Can be sharpened on a grinding wheel. (sharp edge has to be maintained with use) • Less expensive than tungsten carbide or diamond tipped tools. • Etc
(f) Aluminium sheet	**Car body panel** • Malleable material that allows the sheet to be press formed into shape. • Can be bonded with adhesives to join to other parts. • Can be tack MIG welded to frames/sub assemblies • Non Ferrous so will resist corrosion • Lightweight which improves fuel efficiency. Etc

(g) Foam board	**Architectural model** • Can be cut easily with simple blade and safety rule. • Can be laser cut to accurately manufacture model • Can be glued with PVA or contact adhesive • Can be finished with acrylic paints to colour parts of the model. • 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 2 marks if generic list of properties.
MAX 1 mark if points are basic/obvious but relevant.

Factually correct but not relevant = no marks

For example,

"Aluminium is silver coloured and has good aesthetics"
"ABS has a good strength to weight ratio"
"Acrylic is lightweight"
"MDF is made from woodpulp and resin"

(7 × 4 marks)

Question 4

(a) (i) Candidates will name a suitable material that could be used to make a model of the torch. Answers might include:

Styrofoam Plastacine or similar
Model Board (Dense modelling foam)
MDF
Clay
Jellutong or other suitable timbers
RPT powder substrates
ABS or similar (for FDM rapid prototyping)
4 sheet card
Acrylic
Etc

1 mark for generic "card". No marks for foam

ONLY ACCEPT ALUMINIUM IF IN (ii) A DESCRIPTION OF TURNING ON CENTRE LATHE OR CNC LATHE IS GIVEN.

(2 marks)

(ii) Candidates will use notes and diagrams to explain how a physical model of the torch could be made.

Breakdown

- Basic diagram of a suitable modelling process with a few points labelled

(0 – 4 marks)

- Better diagram of a suitable modelling process with most points labelled and some explanatory notes.

(5 – 7 marks)

- Detailed diagram(s) with all points labelled and a good explanation of the modelling process

(8 – 10 marks)

(10 marks)

N.b. If use of CAD/CAM described, award credit for naming of **specific equipment** e.g. use of 4 Axis CNC router with rotary table. Look for description of converting CAD drawings into STL files for machining. Candidates may sketch jig or clamps to hold work firmly and accurately, draw and describe use of specific cutting tools such as a bull nose slot drill and so on.

(b) (i) A suitable material for part A- (the body) might be:
ABS
High Impact Polystyrene (HIPs)
Polypropylene (PP)
HDPE
TPE (Thermoplastic Elasotmer) / Rubber
Aluminium
Etc

1 mark for 'steel' *(2 marks)*

(ii) Candidates will explain why this material would be suitable. Answers might include:

- Aluminium etc is impact resistant- Torch might be dropped
- Aluminium etc is lightweight making the torch easy to carry
- Aluminium etc is water proof and doesn't corrode (Important in a torch to be used outdoors)
- 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).

e.g. Aluminium is impact resistant= 1 mark
Aluminium is impact resistant. This is a useful product as torches are often dropped and if made from brittle materials such as acrylic, they might break. = 2 marks
Maximum 3 marks if generic list is given

(6 marks)

(iii) Candidates will name a suitable material for part B- (the lens cover). Answers might include:
Acrylic (PMMA)
Polycarbonate
Toughened glass
Laminated glass
High Impact Polystyrene (HIPs)

1 mark for simply "glass" *(2 marks)*

(iv) Candidates will explain why this material is suitable. Answers might include:

- Polycarbonate etc is impact resistant so will not break easily when dropped
- Polycarbonate etc is waterproof so will help to keep moisture out of the torch
- Polycarbonate has good optical clarity to allow the light to pass through.

Breakdown

1 – 2 marks per relevant point. (2 marks where point or statement is qualified i.e. property is linked to product function etc).
E.g. Polycarbonate is impact resistance so the lens has less chance of breaking = 1 mark

Polycarbonate is several times stronger than glass so is unlikely to break in normal use of a torch- thus extending the life of the torch.= 2 marks

Maximum 3 marks if generic list is given

(6 marks)