

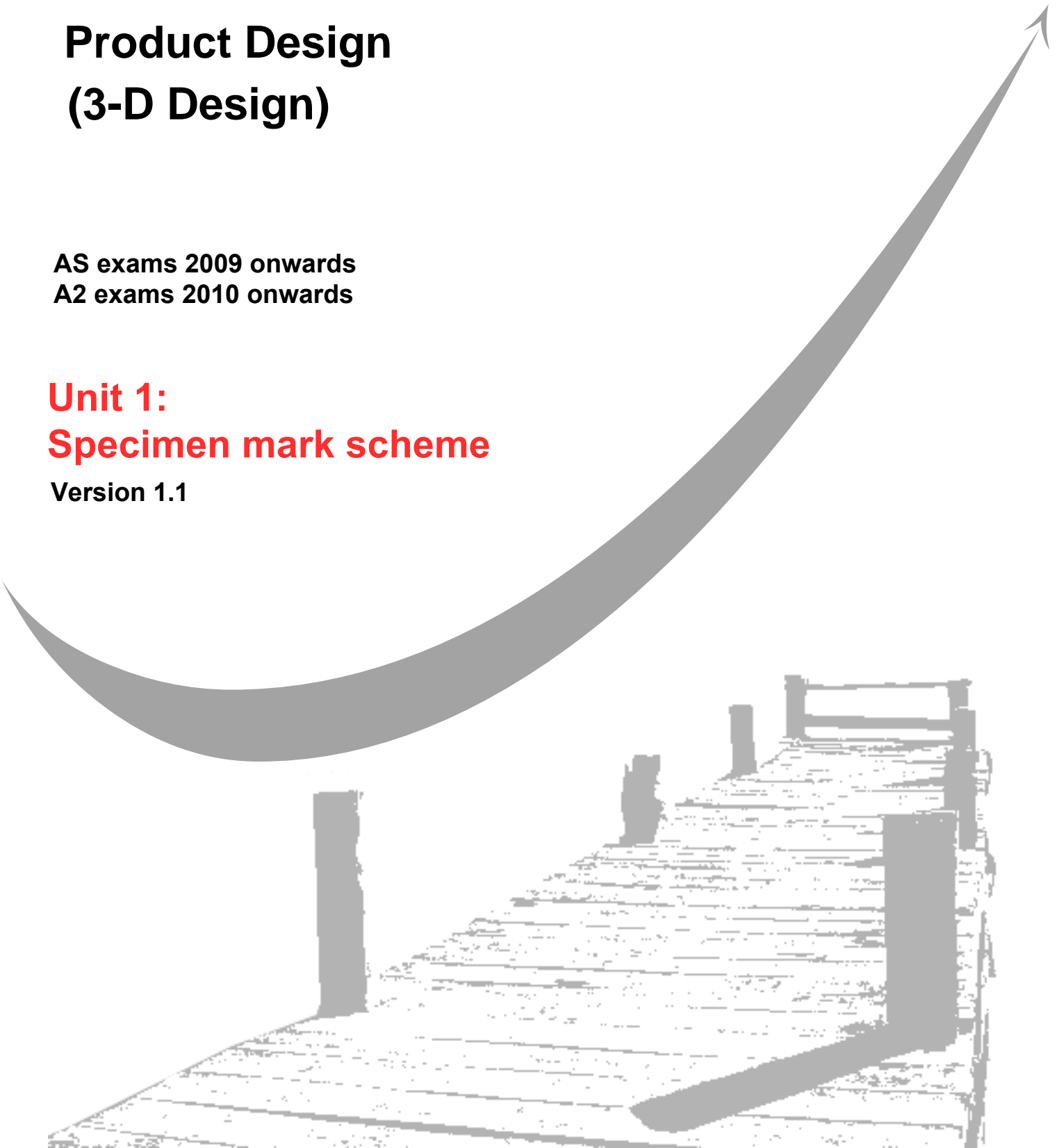
GCE
AS and A Level

Product Design
(3-D Design)

AS exams 2009 onwards
A2 exams 2010 onwards

Unit 1:
Specimen mark scheme

Version 1.1



Version 1.1



General Certificate Education

**Design and Technology:
Product Design (3-D Design)**

Mark Scheme – PROD1

Specimen Paper

The specimen assessment materials are provided to give centres a reasonable idea of the general shape and character of the planned question papers and mark schemes in advance of the first operational exams.

Mark schemes are prepared by the Principal Examiner. Alternative answers not already covered by the mark scheme are legislated for and will receive credit if appropriate.

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| Side bars indicate changes that have been made to the previous version.

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Unit 1- Materials, Components and Application

Section A

Question 1

- (a) Explain in detail what the term ‘thermoset polymer’ means. You should refer to the molecular structure of the polymer in your answer.

“Thermoset polymers can not be reformed by applying heat. They can’t be recycled”.- 1 mark

“Thermoset polymers can not be reformed by applying heat. They can’t be recycled because cross linking has taken place between the monomer chains”- 2 marks

(2 marks)

- (b) Name a thermoset polymer often used in the manufacture of electrical fittings.

Urea Formaldehyde (UF)

(1 mark)

- (c) Explain in detail what the term ‘thermoplastic’ means. You should refer to the molecular structure of the polymer in your answer.

“Thermoplastics can be re formed by the application of heat. They can be recycled”- 1 mark

“Thermoplastics have long chain monomers that are not inter- connected. They can be reshaped by applying heat and therefore recycled”. – 2 marks

(2 marks)

- (d) Name a thermoplastic used in the manufacture of mobile phones.

ABS or Polycarbonate (PC)

(1mark)

Question 2

- (a) Define what is meant by the term ‘alloy’ and using examples explain the general advantages of alloys.

“An alloy is a mixture of two or more metals, it gives them superior properties to pure metals”- 1 mark

“ An alloy is a mixture of two or more metals, it gives them superior properties to pure metals such as improved corrosion resistance, increased hardness and so on”-2 marks

(2 marks)

- (b) Name an alloy that is often used in kitchen utensils.

Stainless steel

(1 mark)

- (c) Define what is meant by the term ‘Smart material’. In your answer name a specific smart material and describe a useful physical or mechanical property it has.

“Smart materials such as shape memory alloys are materials that change in response to an input e.g. heat.”- 1 mark

“ Smart materials such as the shape memory alloy Nitinol are materials that change in response to an input e.g. heat. Nitinol will bend in response to changes in temperature” -2 marks

(2 marks)

- (d) Name a specific smart material and an application for that smart material.

Nitinol (Accept others)- muscle wires, spectacle frames, switch actuator, cable connectors, etc

Piezo electric device- musical greetings cards, etc

Thermo chromic pigment- baby feeding products, thermometers, etc.

Phosphorescent pigment- emergency exit signs, etc.

(1 mark)

Question 3

- (a) Define what is meant by the term 'composite material' and using examples, describe the general advantages of composites over traditional materials.

"A combination of two or more materials to make a material with superior properties to traditional materials e.g. composites might be lighter, stronger, etc"- 1 mark

"A combination of two or materials e.g. carbon fibre and epoxy/polyester resin to make an improved material. CFRP is often used in the manufacture of sports cars because it is lighter than metals but has good mechanical strength"-2 marks

(2 marks)

- (b) Explain how the structure of plywood gives the material strength.

"Wood veneers are laminated with their grain at right angles to each other. This gives the board good strength" - 1 mark

"Wood veneers are laminated with synthetic resin with their grain running at right angles to each other. This gives the board uniform strength- i.e. all parts of the board are equally as strong"- 2 marks

(2 marks)

- (c) Name the materials that are combined to make Medium Density Fibreboard and briefly describe the useful properties of MDF.

"Resin and wood dust/shavings. MDF has good stability and comes in long wide boards. It is economical to use" – 1 mark

"Urea Formaldehyde and particles/ fibres of wood. MDF is stable (it doesn't warp or twist, it is easy to machine with saws, drills, routers, etc). MDF is made from waste materials and is therefore cheaper than natural timber"- 2 marks

(2 marks)

- (d) Name the materials that are combined to make Glass Reinforced Plastic and briefly describe the useful properties of GRP

“Polyester Resin, glass fibres and catalyst- makes the material easy to mould into a variety of shapes It comes in different sizes and forms which is useful for different jobs” – 1 mark

“Polyester Resin, glass fibres and catalyst. The glass fibre comes in matting which can be built up in layers making it easy to vary the thickness of components or make simple modifications. It is easy cut with scissors and mould with simple tools such as rollers and brushes. This makes it easy to mould into complex shapes.”

(2 marks)

Total (20 marks)

Section B

Answer **one** of the following two questions.

Question 4

- (a) For each of the following materials, explain in detail why they are suitable for the products listed. Your answers should make reference to the function, aesthetics or manufacture of the product.

Material	Product
(i) Aluminium	Drinks can
(ii) 'Plaswood'	Park bench
(iii) Biodegradable Polyethylene	Carrier bags
(iv) Metallised card	Takeaway meal container

(4 x 4 marks)

Candidates should state properties for each material and explain the relevance of each property by making reference to functional requirements of the product, method of manufacture, product lifecycle and so on.

2 marks per material awarded where property is stated and relevance explained (up to max 4 marks per material).

If a simple list of properties is given- maximum 2 marks per material

(i) Aluminium- Drinks can

Answers may include:

- *Aluminium is non toxic and therefore won't contaminate the drink*
- *Aluminium is malleable and can be cupped and press formed into the can shape*
- *Aluminium does not corrode and therefore the can will not rust which might spoil the drink and the appearance of the can.*
- *Aluminium has a low melting point and can be easily recycled. This is important in a short lifecycle product.*
- *Aluminium has a silver finish, often utilised for corporate branding/aesthetic purposes,*
- *Etc*

(ii) 'Plaswood'- Outdoor climbing frame

Answers may include:

- *Plaswood is self coloured by adding pigment to the polymer and therefore doesn't need any maintenance and provides an opportunity for different colours to suit different settings, etc.*
- *Plaswood can be cut and machined much like timber and joined using a variety of mechanical fixings or KD fittings for easy assembly.*
- *Plaswood is completely weatherproof and therefore doesn't need to be painted, etc.*
- *Plaswood makes use of post consumer waste and therefore is an ecologically sound alternative to using timber or virgin grade polymers.*
- *Etc*

(iii) Biodegradable polyethylene- carrier bags

Answers may include

- *Carrier bags have a short lifecycle and often go to landfill. Non biodegradable plastics will remain intact for hundreds of years contaminating the ground in the future.*
- *As it is a thermoplastic, polythene can be calendared and seam welded to make the sheet into a bag design.*
- *Recycling polymers is difficult as they have to be manually sorted into separate plastics. Biodegradable polymers remove the need to do this.*
- *Biodegradable polythene will begin to degrade in response to mechanical stress, moisture, temperature rise, etc. If stored properly and only used to take shopping home, or for a short period, the material is fit for purpose.*
- *Polythene can be printed on to display corporate graphics etc*
- *Etc*

(iv) Metallised card – Take away food container

Answers may include

- *Metallised card is non toxic and therefore suitable with foods*
- *Can be made from recycled aluminium and recycled card to minimise impact on the environment*
- *Metallised surface helps to reflect the heat back into the food whilst the card acts as an insulator keeping the food warm.*
- *Metallised surface prevents the card disintegrating when in contact with moist food.*
- *Etc*

- (b) Use an annotated diagram to critically analyse the function of aluminium drinks cans and explain how this has to some extent, determined their form. (4 marks)

Candidates will use a diagram with simple notes to explain how the function of the can has influenced the form of the can.

Breakdown:

- *Basic diagram with simple labels indicating obvious parts such as the ring pull, hole to dispense drink, etc. (0-2 marks)*
- *More detailed diagram with analytical notes and labels. Reference to details such as shaping of the rim and base to allow stacking, diameter of the can is within the optimum range for good grip, ring pull is of a suitable size to provide leverage and for size of finger. Rounded or rolled edges for safety. Overall size partly determined by standard 33CL volume of contents. (3-4 marks)*

Question 5

Study the photograph of the Juicy Salif Lemon squeezer by Philippe Stark (**figure 1** on the insert sheet) and answer the following questions;

- (a) Name a suitable specific material for the lemon squeezer (1 mark)

Suitable answers include:

- *Aluminium*
- *Stainless steel*

1 mark awarded for correct specific material.

- (b) Explain in detail why this material is suitable. You should make reference to the function of the product, aesthetics, and its manufacture.

(6 marks)

Candidates should state properties for aluminium or stainless steel and explain the relevance of each property by making reference to functional requirements of the product, method of manufacture, aesthetics and so on.

Answers might include:

- *Aluminium can be easily die cast into the required shape because it has a low melting point.*
- *Aluminium will not react with citrus fruits and therefore won't contaminate the food etc*
- *Aluminium will not corrode and therefore the product will maintain a good aesthetic appearance, suitable for a kitchen. It can also be washed without fear of the metal rusting.*
- *Aluminium has an appealing silver finish when polished- in keeping with contemporary interiors.*
- *Aluminium does not need to be painted and therefore there is no worry about applied finishes coming off and contaminating food or spoiling the appearance of the product.*
- *Etc*

Breakdown:

- *Basic list of properties **not** clearly linked to the product function, method of manufacture, etc.
e.g.” Aluminium doesn’t rust. Aluminium has good aesthetic qualities. Aluminium is lightweight, Aluminium is non toxic” (0-3 marks **maximum 3 marks**)*
- *Properties given and relevance explained with reference to product function, manufacture etc*

e.g.” Aluminium doesn’t rust and therefore will not contaminate food used on the fruit squeezer”

“ Aluminium has a low melting point and therefore it can be cast easily”

“ Aluminium has a silver, metallic appearance and will fit the aesthetics of contemporary kitchen interiors”

*(2 marks per property and reason **up to a maximum of 6 marks**)*

(c) Use notes and diagrams to explain how the lemon squeezer could be manufactured.

(9 marks)

Candidates will be expected to use notes and diagrams to explain a suitable manufacturing process.

Acceptable processes include:

Pressure die casting

Gravity die casting

Investment casting

Sand casting

(Sand casting will be accepted as many candidates may not realise this product is made in relatively large batches and although not normally used for this product, sand casting would work).

Breakdown

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

(0 – 3 marks)

e.g. For sand casting- Simple diagram of a 'casting box' with a cavity –possibly not resembling the product with appropriate runners, channels & riser drawn and labelled. Only very brief notes e.g. "Metal is heated and melted, then poured into the mould. When set, it is opened up and the product is finished"

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

(4 – 6 marks)

e.g. For die casting- Clear diagram with a cavity resembling the product. Details of the mould (made from hardened die steel), labels for runner, riser, vent holes, etc. Split lines of mould drawn and some notes e.g. "Aluminium is melted and stored in a heated hopper. The mould, made from die steel is coated with a 'special powder' to prevent the aluminium sticking to it. The metal is poured into the runner until it is seen in the riser. It is then allowed to cool, the mould opened and the runner and riser broken off and the rough edges filed and buffed up with a polishing mop".

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

(7 – 9 marks)

e.g. For investment casting- Step by step diagrams & notes of the process-

- *making a wax pattern in a master die*
- *joining several wax patterns together to make a 'tree' by using a hot knife (for batch production)*
- *coating with a refractory clay slurry and firing in a kiln to harden and remove the wax.*
- *Melting the aluminium and pouring into the clay moulds.*
- *Allowing to cool & harden. Then removal of clay mould.*
- *Cutting off runner & machining/polishing.*

- (d) The Juicy Salif Lemon squeezer is often said to be more about aesthetics than its function. Provide justification why this is so. (4 marks)

Answers might include:

- *Aluminium legs might slip on work tops making it difficult to hold steady.*
- *3 legged design could make the lemon squeezer prone to tipping over when force is applied to the fruit.*
- *There is nothing to catch the fruit juice or to separate the pips from the juice – features normally provided in traditional juicers.*
- *Polished aluminium/stainless steel construction is unnecessary in a utility item.*
- *Etc*

Breakdown:

1 mark for relevant point. E.g. “ Aluminium legs look good but might slip”

2 marks for a relevant point explained up to a maximum of 4 marks

E.g. “Space age styling features such as the tear drop shape and the tapered legs are intended to give the product a sculptural appearance. It can be left out on display. A more typical, functional polymer product would not normally be suitable for display”.

Maximum 2 marks for a list of unexplained points.

Section C

Question 6

Study **figure 2** on the insert sheet provided. It shows a basic Computer Aided Design drawing of a mobile phone. The ergonomic and anthropometric features of the phone have not been considered.

Answer the following questions:

- (a) Explain why the designer of the phone might need to make a physical model. (2 marks)

Answers might include:

- *To test out ergonomic and anthropometric features with user groups.*
- *To check overall dimensions are suitable*
- *To use in a 3D scanner to capture machining geometry for mould making.*
- *Etc*

Breakdown

- **Basic point not explained**

e.g. “ To test out ergonomic features with user groups”- 1 mark

- **Point with explanation**

e.g. “ To test out ergonomic features with user groups. This will identify if the phone is comfortable to hold or the proportions of the phone to the average hand size are correct” – 2 marks

- (b) Name a material that the phone could be modelled from. (2 marks)

Answers could include:

Styrofoam

Model board/Modelling foam

Clay

Casting resin

Card

Starch or similar (for 3D printer)

ABS or similar (for stereo lithographic modeller or fused deposition modeller).

Jelutong

Etc

2 marks for correct specific material or a list of correct materials.

- (c) Use notes and diagrams to explain how the phone could be modelled using the material named in part (b)

(9 marks)

Candidates will use notes and diagrams to explain the modelling process.

Answers might include:

- *Suitable marking out method- might include using templates.*
- *Shaping stock material using saws, hot wire cutter, spoke shaves, files, etc (according to material)*
- *Finishing methods e.g. sanding, applying primers & top coats, decals or components*

Alternatively, candidates may use notes and diagrams to describe specific CAD/CAM modelling equipment giving details of the software and hardware used, followed by finishing of the model.

Breakdown

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

(0 – 3 marks)

e.g. Simple diagram of Styrofoam block being marked out with a pencil and cut using a hot wire cutter. Basic notes describing sanding & painting (often non specific).

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

(4 – 6 marks)

e.g. Several steps drawn out including marking out, cutting, sanding, machining out details such as the screen. Specific tools and equipment correctly stated e.g. hot wire cutter, milling machine, etc. Possible reference to using primers and top coats for finishing.

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

(7 – 9 marks)

e.g. Clear drawings showing correct tools and equipment e.g. slot drills, router bits, etc. Possible reference to using different grades of glass paper for sanding. Specific primers and paints described e.g. Acrylic primer, cellulose, etc. Possible reference to using ICT to make simulated screen images, text, etc.

(d) Identify and elaborate upon the ways in which the ergonomic features of the mobile phone pictured in figure 2 could be enhanced. You should use notes and diagrams in your answer.

(9 marks)

Answers may include:

- *Shaping the body of the phone to fit the hand*
- *Making the screen larger to make text and images easier to read*
- *Spacing the keys to prevent incorrect dialling*
- *Use of colour on the phone keys to indicate send/receive*
- *Removal of external aerial to make a smoother profile.*
- *Etc*

Breakdown

- Basic diagram of a suitable ergonomic details with a few points labelled

(0 – 3 marks)

e.g. Simple diagram of a one feature. Basic notes describing how the phone could be shaped to fit the hand.

- Better diagram(s) of ergonomic details with all points labelled and some explanatory notes.

(4 – 6 marks)

e.g. Up to 2 features drawn with more analytical notes explaining the reasons for the changes.

- Detailed diagram of ergonomic details with all points labelled and a good explanation of the points drawn

(7 – 9 marks)

e.g. More than 2 features shown. Each feature explained in terms of their ergonomic benefits.

(e) Describe how the designers and manufacturers of the mobile phone would minimise the impact that the phone would have on the environment.

Your answer should make reference to:

- Selection of materials and components
- Method of manufacture
- Design for disposal

(3 x 6 marks)

Candidates might organise their answer under subheadings covering each area or combine them in one discursive answer.

Answers might include:

Selection of materials and components

- Use recycled polymers which require less energy than producing virgin grade polymers from processing oil.
- Re-use standardised components from recycled phones wherever possible such as batteries, power supply circuits, camera/internal aerial, etc.
- Use of replaceable covers to 'refresh' phone and extend life.
- Etc

Method of manufacture

- Minimise the number of processes required to make the phone, reducing energy consumption.
- Minimise the amount of waste in production by recycling, use of automation, etc.
- Use green energy sources to provide the power for running machines, etc.
- Do not paint or add pigments to polymers- reducing wasteful steps and saving energy.
- Etc

Design for Disposal

- Use shape memory alloys in fixings on the phone body, circuits, etc to aid separation of components for recycling.
- Use thermoplastic parts that can be recycled.
- Avoid using combined polymers or materials with painted or plated finishes which are difficult to separate for recycling.
- Use standardised components e.g. batteries, LCD screens etc that could be re-used to make a new phone.
- Etc

Breakdown

1-2 marks per relevant point. (2 marks where point is explained).

Maximum 3 marks for a simple list

E.g. "Use of thermoplastics would make it easier to recycle"- 1 mark

E.g. "Use of thermoplastics would make it easier to recycle. This is important as mobile phones have a short lifecycle, often being replaced every 12 months" - 2 marks