## Mark schemes

**1.** Answer: Galvanising.

**[1]**

**2.**

| Metal | Ferrous metal or ferrous alloy | Non-ferrous metal | Non-ferrous alloy |
|---|---|---|---|
| Stainless steel | ✓ | | |
| Copper | | ✓ | |
| Bronze | | | ✓ |
| Low carbon steel | ✓ | | |

**[4]**

**3.** 1 mark: Hardness is the ability of a material to resist abrasion / scratching / indentation.

1 mark: Toughness is the ability of a material to withstand impact.

**[2]**

**4.** (a) Stainless steel, aluminium alloy, etc. *(1 mark)*

(b) Stainless steel has good aesthetic properties - looks appropriate for a modern kitchen interior.

Stainless steel is a malleable material so it can be press formed into the required shape.

Stainless steel does not corrode. Therefore it maintains a good, clean / hygienic finish, etc.

*Accept 'easily shaped'.*
*Accept high melting point.*
*Not affected by heat.*
*(6 marks)*

**[7]**

**5.** Mild steel is a ferrous metal. It contains iron therefore it is classed as ferrous.

Aluminium is a non ferrous metal. It does not contain iron, etc.

**[2]**

**6.** (a) E.g. Acetyl Polymer, PMMA (acrylic), ABS, HDPE, PP, polycarbonate (PC), (not thermoset). *(1 mark)*

(b) E.g.
Acrylic is a durable plastic which will withstand wear and tear from daily use.
Acrylic is a thermoplastic which is ideal for injection moulding into the complex shape.
Acrylic like all polymers is an insulator. It is safe to use with electricity and will not overheat from the heat of the hairdryer.

**Mark breakdown:**
*Three reasons required*.
*1 – 2 marks per relevant point. Award additional mark(s) for detail in explanation up to maximum*.

*(6 marks)*

(c) E.g. Chrome plated mild steel.
Accept aluminium or stainless steel.
No marks for tin, galvanized mild steel, silver / silver plate.

*1 mark for 'steel' or mild steel . (2 marks)*

(d) E.g. Mild steel is a malleable material which can be rolled into shape or extruded into a tube.
Mild steel is a hard material and will withstand being dropped and the wear & tear of daily use.
or
Chrome plating protects the steel from corrosion and gives the product an aesthetically pleasing appearance. Etc.

**Mark breakdown:**
*Two reasons required*.
*1 – 2 marks per relevant point. Two marks where point is explained. Award additional mark for further detail.*
*(4 marks)*

**[13]**

**7.**

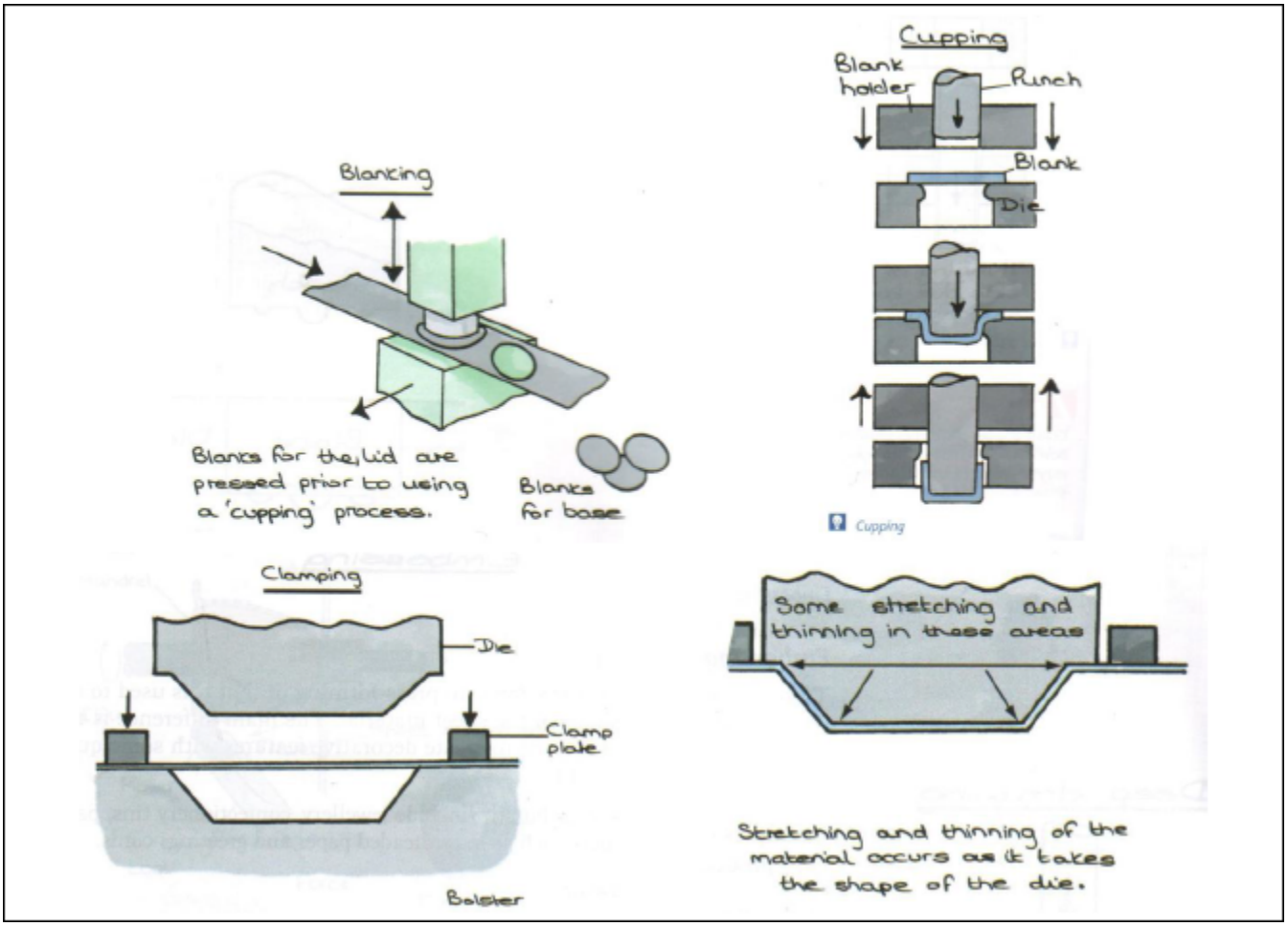
(a) Stainless steel / aluminum / aluminum alloy only. *(1 mark)*

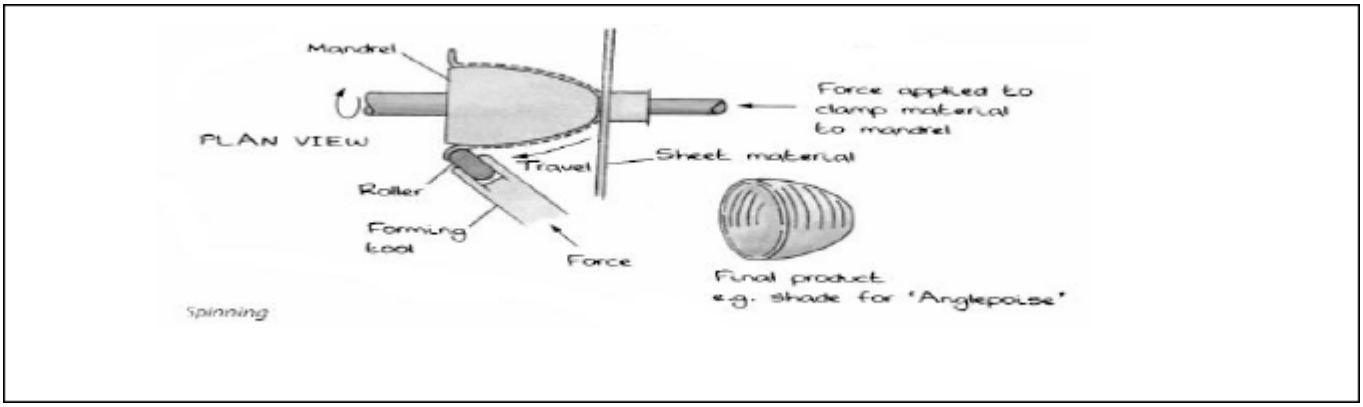
(b) Stainless steel is a tough metal, therefore it withstands impact from being dropped accidentally.
Stainless steel does not corrode. This makes it aesthetically pleasing and pleasant to drink from. Consumers would be put off if the cup was rusty.
Stainless steel can be formed by compressive forces because it is malleable. The processes of spinning or press forming need this property.
– Strength
– Lightweight
– Hard / not scratch easily.

**Mark breakdown:**
*1 – 2 marks per relevant point. 2 marks where point is explained or further detail given.*
*A list of points – max 3 marks.*
*(6 marks)*

(c) Accept either spinning or press forming / cupping / deep drawing.
Accept details of Blanking.

**Note:** Diagrams for illustration only. Dies may differ according to product shape. Do not expect same level of line accuracy.




**Stages:**
Sheet steel is unrolled from stock material
Material may be annealed to increase ductility
Material is punched to make a blank
Material clamped onto press former
Die moves down using hydraulic pressure and pushes into the material.
Material takes the shape of the dies
Product removed for de-burring and cleaning.

**Mark breakdown:**

- Basic diagram of a suitable manufacturing process with a few points labelled (***1 mark for stating 'spinning'*** ).
  E.g. Simple diagram of press forming dies. Generic die (doesn't resemble product) with little detail. Labels missing. Major points missing.
  *(0 – 3 marks)*

- Better diagram of a suitable manufacturing process with all points labelled and some explanatory notes.
  E.g. Die resembles product, some specific parts correctly labelled such as die, clamp, etc. Step by step process in note form but may have some steps missing or lacks clarity. *(4 – 6 marks)*

- Detailed diagram with all points labelled and a good explanation of the process.
  E.g. Die clearly resembles the product. Details of die / punch, bolster, clamping ring, etc. Step by step process is correct with few if any details missing for the top mark. *(7 – 10 marks)*

*7 marks max if no diagram*

(d) Polypropylene or LDPE / HDPE / ABS / HIPS.
Do not accept acrylic or polycarbonate. *(1 mark)*

(e) PP is a food grade polymer which will not contaminate the drink / non toxic.
PP is an insulator which helps to keep the drink warm and keeps the outer of the cup cool to touch.
PP is a thermoplastic and therefore can be injection moulded.
– Durable.
– Good chemical resistance.

**Mark breakdown:**
*1 – 2 marks per relevant point. 2 marks where point is explained or where additional detail is given*.
*If polymer given in part (d) is incorrect still award credit for appropriate points in part (e)*.
*If no polymer written in part (d) award zero marks in part (e)*.
*If generic list of points – max 3 marks.*
*(6 marks)*

**[24]**

**8.**

(a) **Carbon Fibre Reinforced Polymer (tennis racquet)**
CFRP is very lightweight which makes it easier to hold and swing than traditional alternatives.
CFRP can be moulded into a variety of shapes to make ergonomic grips, etc.
CRFP can be strong.

**Alternative answers:**
CFRP looks stylish and can be painted or have applied graphics printed on.
CFRP can be reinforced with alloy mesh to increase tensile strength.

**Mark breakdown:**
*1 – 2 marks per relevant point. 2 marks where point is explained or further detail given*.

If a list of generic points – *max 2 marks*.
E.g. It is lightweight, scratch resistant, etc.
*(4 marks)*

(b) **Concrete (Garden ornament)**
Concrete can be cast into a re-usable mould which is much easier than carving stone.
Concrete can be coloured with pigments to increase aesthetic qualities.

**Alternative answers:**
Concrete or its constituent parts are more readily available than stone.
Concrete can have different aggregates added to give it the appearance of stone at a fraction of the cost.
Weather resistant.

**Mark breakdown:**
*1 – 2 marks per relevant point. 2 marks where point is explained or further detail given.*

If a list of generic points – *max 2 marks*.
E.g. It is lightweight, scratch resistant, etc.
*(4 marks)*

(c) **Liquid Silicon Rubber (mobile phone cover / skin)**

LSR provides impact resistance so the phone might be protected if accidentally dropped.
LSR is flexible and so will stretch over the phone to allow the cover to be put on or removed.
Pigments can be added / phosphoresent pigments (glow-in-the-dark).

**Alternative answers:**
LSR can be injection moulded over the top of other polymers to provide a textured grip.
LSR has a rubber like texture which is comfortable to hold.

**Mark breakdown:**
*1 – 2 marks per relevant point. 2 marks where point is explained or further detail given.*

If a list of generic points – *max 2 marks*.
E.g. It is lightweight, scratch resistant, etc.
*(4 marks)*

(d) **Beech (Chopping board)**

Beech is a close grained hardwood which is needed to help prevent food being absorbed into the chopping board.
Beech has good hardness which helps it to resist cutting from knives.
Aesthetic – suits modern kitchens.

**Alternative answers:**
Beech is non toxic and therefore will not contaminate food.
Beech does not leave a taste.

**Mark breakdown:**
*1 – 2 marks per relevant point. 2 marks where point is explained or further detail given.*

If a list of generic points – *max 2 marks*
E.g. It is lightweight, scratch resistant, etc.
*(4 marks)*

(e) **Titanium (wrist watch strap and casing)**
Titanium is a very hard metal which withstands scratching which will maintain the aesthetic appearance of the watch.
Titanium is a very lightweight metal which makes it very comfortable to wear.

**Alternative answers:**
Titanium has an attractive patina or colour which makes it appealing.
Titanium still has a 'prestige' which makes it desirable as a piece of jewellery.
– Recyclable.
– Strength – weight ratio good.

**Mark breakdown:**
*1 – 2 marks per relevant point. 2 marks where point is explained or further detail given.*

If a list of generic points – *max 2 marks.*
E.g. It is lightweight, scratch resistant, etc.
*(4 marks)*

**[20]**

**9.**

(a)

| | | | |
|---|---|---|---|
| Ferrous | Mild steel | Stainless steel | High carbon steel |
| Other Ferrous | Cast iron | Medium carbon steel | |
| Non Ferrous | Aluminium | Copper | Silver |
| Other Non Ferrous | Gold<br>Platinum | Lead<br>Titanium | Tin<br>Zinc |

No to steel
Low carbon steel – same as mild steel. *(6 marks)*

(b) (i) Metal: eg silver
Use: eg jewellery. *(1 mark)*

(ii) E.g. Silver can be soldered which is needed to make rings. When polished, silver has an attractive aesthetic appearance. *(2 marks)*

0 = No metal named.

**[9]**

**10.**

| Sheet mild steel waste bin for exterior use | Cast brass bathroom taps | Moulded polymer car bumper | Forged steel pliers |
|---|---|---|---|
| A | C | D | B |

*One mark for each correct answer.*
*If same answer given twice and both correct – ignore second response.*

**[4]**

**11.**

(a)

| Joining mild steel sheet to make a box | Joining tubular mild steel to make a frame for a chair | Joining 50mm x 50mm timber to make a frame section for a table | Joining 100 mm x 15mm timber to make a drawer |
|---|---|---|---|
| C | D | A | B |

*One mark for each correct answer.*
*If same answer given twice and both correct – ignore second response.*
*(4 marks)*

(b) Appropriate response for fabrication method chosen.
*2 marks for qualified response*.
*1 mark for very brief response*.
*(2 marks)*

**[6]**

**12.**

(a) E.g. Stainless steel.

*(Accept mild steel or aluminium) duralumin*. *(1 mark)*

(b) E.g. Stainless steel is a very hard material and will withstand attempts at vandalism e.g. scratching.

E.g. Stainless steel does not corrode and therefore will withstand the effects of weather.

E.g. Stainless steel has an attractive silver colour which looks appealing in a modern street environment.

**Mark breakdown:**

- *1 – 2 marks per reason. Award second mark where explanation is given for relevance of the property*.
- *If no metal named in part (a), award zero for part (b)*.
- *If unsuitable metal award marks for relevant properties.*

*(6 marks)*

**[7]**

**13.** 1 mark for a ferrous metal which could be treated by hardening.
accept: medium and high carbon steel (do not accept low carbon steel unless case hardening is referred to).

1 mark for a relevant product: accept any appropriate product, such as screwdriver blades, chisels, drill bits, saw blades etc.

Two marks for reasons:

- reference to need to keep a sharp edge when working with the product
- resisting wear from abrasion.

**This list is not exhaustive. Accept any other valid responses.**

**[4]**

**14.**

*1 mark for accurate naming of material:* PP or HDPE for polymer bucket,
Galvanised mild steel for metal bucket accept stainless steel due to photograph.
*1 mark for stating injection moulding is the method for production of the polymer bucket.*
*1 mark for stating that rolling would be used to produce the sides of the metal bucket*.
*1 mark for stating that the 'mop holder' would be blanked and press formed* .
*Up to 3 marks per product for diagrams showing manufacturing processes related to the bucket ie injection moulding diagram with annotation, cross sectional drawings of joints etc*.
The metal bucket has been joined using seam joints to seal the edges.
The rolled edge around the top of the bucket increases rigidity and hides the raw edge of the metal from view.

The handle has been attached with rivets, candidates identifying this should be rewarded
Assembly:

- Injection moulding means assembly is simple with integral fixings and no extra components are required.
- The galvanised bucket has been joined using rivets and also spot welds (to attach the mop squeezer to the top plate after forming into a cone) which require extra machinery and set up time as well as meaning the product cannot be dis-assembled.
- As with all questions a relevant point is worth 1 mark and explanation of that point is worth a further mark.
- Bending the handle into shape is not sufficient for a mark unless reference is made to a former to bend round.
- Candidates describing the benefits of manufacturing with polymers versus the disadvantages of manufacturing with metals should be credited accordingly.

**[10]**

**15.**

Note: Values for $\pi$ can be used in the range [3.14, 3.142]

**Current volume of hole A**

$\pi \times 10^2 \times 70$
or [21980, 21994] or $7000\pi$

**1**

**Volume of hole A with increased diameter**

$\pi \times 12.5^2 \times 70$
[34343, 34366] or $21875\pi / 2$

**1**

**Difference in volume between the holes**

their [34343, 34366] – their [21980, 21994]
[12349, 12386]

**1**

**Difference as a percentage of the original component volume**

their [12349, 12386] ÷ 200 000) × 100
= [6.1745, 6.193] (%)

**1**

**Their answer to 2 decimal places**

6.17 (%) or 6.18 (%) or 6.19 (%)

**1**

**[5]**

**16.**

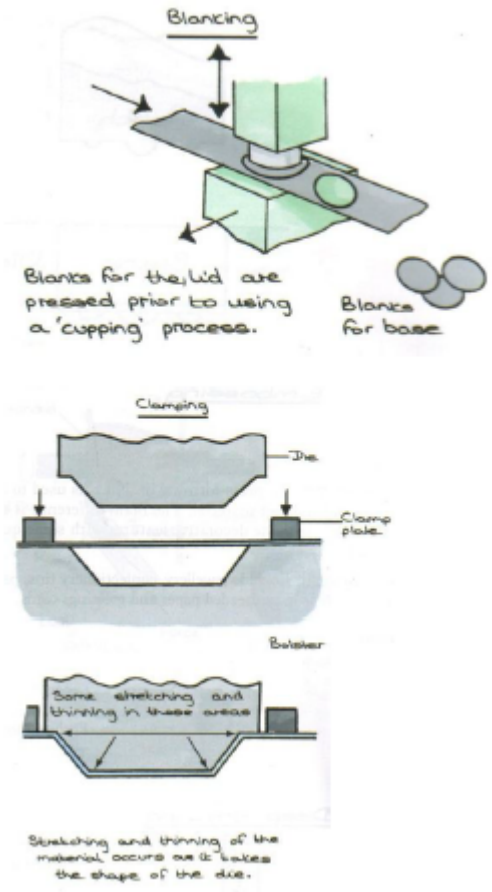
(a) Stainless steel, aluminium, aluminium alloy, duralumin.
*(1 mark)*

(b) E.g.
Stainless steel does not corrode when exposed to moisture and air. Corrosion would make the sink look unsightly.
Stainless steel is malleable / ductile so it can be press formed into the shape of the sink.
Stainless steel has an attractive silver appearance which makes it aesthetically pleasing and suitable for a modern setting.
Stainless steel is hard, which means it will resist scratching and indentation.
Stainless steel is chemical resistant which means it can be cleaned with bleach, etc.

**Mark breakdown:**
*1 – 2 marks per reason. Award second mark for explanation.*
*Max **three** marks for a simple list of properties without explanation.*
*If application is incorrect / inappropriate award zero marks.*
*No metal named in this part award zero. If material named is incorrect, award marks for relevant properties.*
*Do not double penalise.*

*(6 marks)*

(c)




Stainless steel sheet would be unrolled (from stock roll) and straightened.

The sheet would be punched into blanks.

The blanks are transferred to a press where they are clamped.

The press pushes the sheet into shape. There may be several pressings to achieve the shape and additional punching to remove the holes for the plug, taps and overflow.

Credit reference to cupping to create bowl shape.
Accept reference to spinning the bowl shape.
Ignore references to tap manufacture.

Candidates can answer with reference to the base and / or the bowl section.
Award marks for detailed description. E.g. If candidate gives a fully detailed descriptor of the square base section only, they can achieve max 8 marks.

**Mark breakdown:**

- *Very simple description. Diagrams maybe unclear. There may be several omissions. (0 – 3 marks)*
- *Better description. Diagrams are of better quality. Only minor omissions. (4 – 5 marks)*
- *Full answer. Clear diagrams. All points included. (6 – 8 marks)*

**[15]**

**17.**

| | | | |
|---|---|---|---|
| **Application** | Joining aluminium tube to aluminium tube to make a cycle frame | Joining copper to copper to make jewellery | Joining mild steel angle to mild steel angle to make a workbench frame |
| **Fabrication Method** | MIG welding | Soldering | Arc welding **or** MIG welding |

*(1 mark)*
*(1 mark)*
*(1 mark)*

*One mark for each correct answer.*
*Note If candidate uses same fabrication method more than once – only award the mark once.*

**[3]**

**18.** Answer may include notes and diagrams of the following:

- Cutting bar / tube to length with power hacksaw with a stop / in a cutting jig to remove need for measuring. Alternatively buy in steel cut to length.
- Bending of tube (in pipe bender), bar over a jig or fixture following heat treatment.
- Clamping of parts together. Possible use of jigs / fixtures / spacers to achieve consistent parallel parts.

May describe welding process but only award up to half marks if no ref to batch production. Ignore ref to manufacture of the bars eg extrusion.

**Mark breakdown:**

- *Very simple diagram with inaccurate and basic description eg hand cutting with 'saw', basic torch flame and generic 'welding' given, no reference to batch production . (0 – 3 marks)*

- *Better diagram showing some further detail eg clamps, welding rod and torch (if gas welding described). Possibly names 'electric arc', welding and may confuse between several different methods. (4 – 5 marks)*

- *Diagrams and notes make reference to batch production eg clamping over former / welding fixture. (6 – 7 marks)*

- *A more detailed answer with ref to cutting stops, bending fixture, comparing parts to drawing or 'standard parts', welding jig, spacers and so on . (8 – 9 marks)*

**[9]**

## Examiner reports

**1.** This question was generally well answered with the majority (59.3%) of students correctly selecting ‘galvanising’ as the most appropriate finish for the streetlight.

**2.** This question was well answered with a majority of students (51.9%) able to categorise all of the metals correctly, with only 5.8% of students failing to achieve a mark.

**3.** Responses to this question showed wide variation. 35.7% students correctly defined both of the material working characteristics and gained full marks. In responses that gained no marks (31.9% of responses), student definitions did not relate to the stated material working characteristics, or showed confusion between the two material working characteristics.

**4.**

(a) This was well answered with 93% of candidates who attempted this question, correctly giving a suitable metal for the toaster.

(b) Responses to this part were mixed. Some candidates made good use of relevant properties linked to the function or manufacture of the toaster, whilst others gave very weak responses with irrelevant properties such as ‘stainless steel is lightweight’ or vague terms such as ‘shiney’. 22% of candidates gained full marks and a similar percentage gained at least half marks.

**5.** This was very well answered with some good definitions of ferrous and non-ferrous metals being given.

**6.**

(a) and (b) Responses to part (a) were mixed with about half of the candidates giving thermosetting plastics such as UF. Where this was the case, candidates were not penalised in part (b). Reasons relating to product use were generally well linked.

(c) and (d) Aluminium or stainless steel were the most popular answers. Many candidates referred to the metal being a ‘heat insulator’, ‘non conductor so won’t get burnt / electrocuted’ or a ‘heat conductor so keeps the air in the dryer warm’. Some better responses included ‘chemical resistant, will not be affected by overspray from hair products such as hairspray’, ‘lightweight so does not add much extra weight to the product which is used with one hand and held above the head for some time’, ‘does not rust therefore will not be affected by long wet hair touching it’.

**7.**

(a) Most candidates gave a correct metal for the cup.

(b) Answers for this question were very mixed. The best answers referred to things like stainless steel being tough and resistant to impacts with such items being dropped, it does not corrode so it can be cleaned in a dishwasher and so on.
There were many confused answers with references to stainless steel or aluminium being a conductor ‘so users would not be burned‘.

(c) This question seemed to have either excellent or very poor responses. The best candidates described punching and then either spinning, or cupping followed by press forming / deep drawing. Diagrams were often very good. Unfortunately many candidates described either die casting or even sand casting, or suggested the cup might have been rolled and seem welded.

(d) There were good answers for this question with many candidates giving a suitable thermoplastic. Unfortunately many candidates described thermosets such as urea formaldehyde, melamine formaldehyde and even ‘Bakerlite’. Some candidates did not give a polymer but then proceeded to answer the next part.
This resulted in giving no marks for both this part and part (b).

**8.**

(a) Carbon Fibre Reinforced Polymer- Tennis Racquet

The most popular answer was ‘strong’ and ‘lightweight’. Most candidates explained that tennis racquets have to be strong to withstand continuous impacts from the ball; a little obvious but nevertheless correct. The explanation of the relevance of ‘lightweight’ was often very poor, with vague descriptions along the lines of ‘it makes it easier to play with’.

(b) Concrete- Garden Ornament

This was fairly well answered with lots of references to weather resistance and density / weight which helps to stop the product being blown over.

(c) Liquid Silicon Rubber (LSR)- Mobile Phone cover / skin

This was well answered with the majority of candidates describing the elastic properties and how this is needed to fit the cover to the phone and good references to texture for good grip, method of making, etc.

(d) Beech- Chopping board

Answers to this question were basic and obvious (‘strong because food will be constantly chopped on it’). Again, the terminology used by candidates was often vague.

(e) Titanium-Wrist watch strap and casing

Many candidates made reference to ‘aesthetically pleasing’ which is a fairly obvious point given the nature of the product. Better answers recognised properties such as hardness and the corrosion resistant qualities.

**9.**

(a) Answers to this question were very mixed with a significant number of candidates unable to correctly identify three ferrous and three non-ferrous metals. Often the answers to ferrous metals were generic ‘steel’ and ‘iron’.

(b) (i) Almost all candidates gave a correct application for one of the metals but again answers were sometimes not very specific e.g. “mild steel is used in buildings”.

(ii) Most candidates correctly gave two relevant properties to explain the suitability of the metal for the applications that they gave. The better answers offered a little explanation rather than just the basic properties.

**10.**

Responses to this question were quite mixed. Generally candidates gave either all correct answers or only two correct answers. Common errors were candidates choosing polymer dip coating for covering the car bumper.

**11.**

(a) Many candidates gave spot welding as a suitable process for joining tubular steel.

(b) Answers to this question were often quite basic and used generic phrases such as ‘spot welding makes a strong joint’. Only a minority were able to give quality answers such as describing how dovetail joints have a large gluing surface area and interlocking / directional strength.

**12.**

(a) The majority of candidates were able to suggest a suitable material for the bench, with stainless steel and aluminium being the most popular.

(b) Reasons were generally well linked to the original chosen material. ‘Strong’ is still a popular property proposed by candidates but few are able to define the specific strength property e.g. compressive strength required to take the weight of people.

**13.**

This question was poorly answered. 66.7% of students failed to achieve a mark on this question. In many cases, there was confusion in student responses between the process of ‘hardening’ and the material working characteristic of ‘hardness’. When student responses did show an understanding of hardening, there was often a lack of knowledge of which specific metals this process could be used for. This resulted in unsuitable specific products being named, along with reasons that did not relate to the expected references of maintaining sharp edges or resisting abrasion.

**14.**

This was a very popular question and when candidates were able to use diagrams to support their answers they performed well. Many candidates recognised the manufacturing processes for the metal bucket showing a good understanding of crimping and press forming techniques. The injection moulding process was well described with the better responses showing an understanding of how the high initial investment cost for injection moulding was less important as the scale of production increased. Where candidates recognised the reduced number of components used in the polymer bucket, and that due to the lack of joints leakage was very rare, they invariably accessed higher marks.

**15.** Student responses to this question were very varied. 8.1% of students failed to attempt the question, whilst 20.7% of students achieved the maximum mark available. When students struggled to answer this question, not being able to calculate the volume of a cylinder proved to be the biggest barrier to achievement. For students that were able to calculate the volumes, many were then unable to calculate the difference as a percentage of the entire component.

**16.**

(a) Almost all candidates were able to name a suitable metal for the sink with stainless steel being the most popular answer.

(b) Responses to this question were primarily well inked to product use and candidates made appropriate points such as ‘good chemical resistance to allow cleaning with detergent / so that the soap used did not react with the metal’ and ‘corrosion resistant so will not rust in the presence of the water’. The best answers also described how malleability was required for press forming the shape.

(c) Although the mark scheme allowed for a number of possible approaches, this question revealed a general lack of familiarity with metal processes. The best answers made good references to the use of sheet material, piercing and blanking and then either press forming or spinning to form the bowl shape. Many unsuitable processes such as die casting, sand casting and compression moulding were proposed and centres may consider the area of metal processing a focus for the future.

**17.** This was well answered with the majority of candidates able to get at least two correct answers. The mark scheme allowed for MIG welding to be accepted for joining either the aluminium bicycle frame or the mild steel angle. A fairly small number of candidates gave arc welding for aluminium or MIG welding for joining copper.

**18.** This question was generally answered very poorly. Many candidates described the manufacture of the stainless steel bars through extrusion, rather than the fabrication of the actual bench and, therefore, missing the point of the question altogether. Other low achieving answers focused on casting processes or the generic ‘CNC machine’, the bars being melted or soldered together.