AQA

AS
Design and Technology: Product Design

7551/W-Paper 1 Written Paper
Mark scheme

June 2018

Version/Stage: 1.0 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' 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.

Further copies of this mark scheme are available from aqa.org.uk

Level of response marking instructions

Level of response mark schemes are broken down into levels, each of which has a descriptor. The descriptor for the level shows the average performance for the level. There are marks in each level.

Before you apply the mark scheme to a student's answer read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1 Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer. With practice and familiarity you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

When assigning a level you should look at the overall quality of the answer and not look to pick holes in small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level and then use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 3 with a small amount of level 4 material it would be placed in level 3 but be awarded a mark near the top of the level because of the level 4 content.

Step 2 Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this. The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do not have to cover all of the points mentioned in the Indicative content to reach the highest level of the mark scheme.

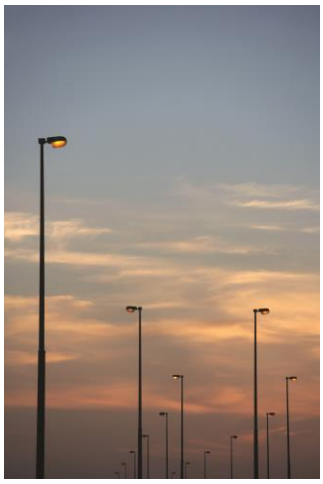
An answer which contains nothing of relevance to the question must be awarded no marks.

Section A

<table>
<tr><th>Qu</th><th>Part</th><th>Marking Guidance</th><th>Total marks</th><th>AO</th></tr>
<tr><td>1</td><td></td><td>Figure 1 shows low carbon steel streetlights.

Select the most appropriate applied finish for the streetlight.

Figure 1

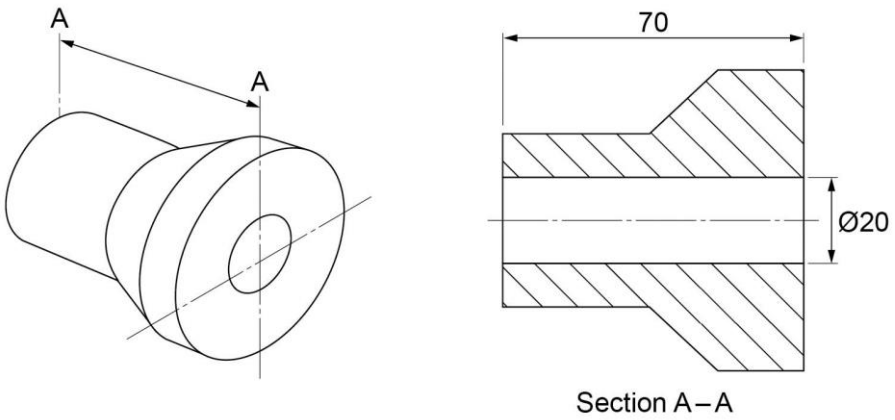
Answer: Galvanising.</td><td>1 mark</td><td>AO41c</td></tr>
<tr><td>2</td><td></td><td>Categorise the following materials:

<table>
<tr><th>Metal</th><th>Ferrous metal or ferrous alloy</th><th>Non-ferrous metal</th><th>Non-ferrous alloy</th></tr>
<tr><td>Stainless steel</td><td>✓</td><td></td><td></td></tr>
<tr><td>Copper</td><td></td><td>✓</td><td></td></tr>
<tr><td>Bronze</td><td></td><td></td><td>✓</td></tr>
<tr><td>Low carbon steel</td><td>✓</td><td></td><td></td></tr>
</table>
</td><td>4 marks</td><td>AO41a</td></tr>
<tr><td>3</td><td></td><td>Define each of the following material working characteristics:

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.</td><td>2 x 1 mark</td><td>AO41a</td></tr>
</table>

4		Name a ferrous metal and give **two** reasons why hardening has been used to improve its function in a specific product. 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 marks	AO41c

5		**Figure 2** shows a 70 mm long turned aluminium component. The component has a volume of 200 000 mm^3. The diameter of the through hole is increased from 20 mm to 25 mm. Work out how much aluminium is removed as waste as a percentage of the original component. Give your answer to two decimal places. Show your working out. **Figure 2 – all dimensions in mm**  Note Values for π can be used in the range [3.14, 3.142]	5 marks	AO4 1c

Current volume of hole A	$\pi \times 10^2 \times 70$ or [21980, 21994] or 7000 π	1 mark
Volume of hole A with increased diameter	$\pi \times 12.5^2 \times 70$ [34343, 34366] or 21875 π /2	1 mark
Difference in volume between the holes	their [34343, 34366] – their [21980, 21994] [12349, 12386]	1 mark
Difference as a percentage of the original component volume	their [12349, 12386] ÷ 200 000) × 100 = [6.1745, 6.193] (%)	1 mark
Their answer to 2 decimal places	6.17 (%) or 6.18 (%) or 6.19 (%)	1 mark

<table>
<tr>
<td>6</td>
<td></td>
<td>
A logo is to be applied to a gift box using either foil blocking or embossing. Evaluate the suitability of these two processes in terms of:

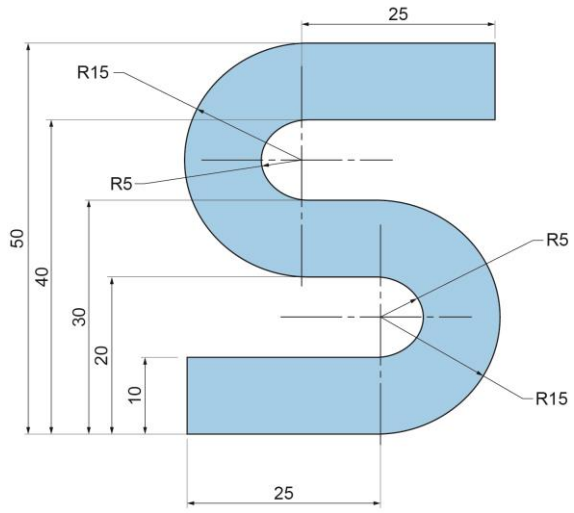
• aesthetics
• cost
• environmental issues.

<table>
<tr><th>Level</th><th>Marks</th><th>Description</th></tr>
<tr><td>3</td><td>5-6 marks</td><td>A detailed evaluation of the suitability of both finishing techniques in relation to the gift box context. All three points are addressed.</td></tr>
<tr><td>2</td><td>3-4 marks</td><td>A clear evaluation of both finishing processes in relation to the gift box context referring to at least two of the points.</td></tr>
<tr><td>1</td><td>1-2 marks</td><td>A basic evaluation of the finishing processes with little or no reference to the gift box context. At least one of the points is referred to.</td></tr>
<tr><td></td><td>0 marks</td><td>No response worthy of credit.</td></tr>
</table>

Indicative content:

Aesthetics:
• Foil blocking adds high quality appearance and contrast to the package.
• Embossing can have ink applied or be left as a ‘blind embossing’.
• Embossing gives a subtle aesthetic only visible in certain lighting due to single colour package.
• Embossing gives a tactile effect to the packaging.
• Foil blocking is available in metallic and holographic finishes adding to the quality of the product.
Cost:
• Embossing uses a single material and manufacturing process as it can be done during die cutting, reducing costs.
• Foil blocking adds cost due to adding a second material and adhesive, but this can be offset by the increased retail cost of the product.
Environmental issues:
• Embossed packages can be easily recycled due to the single material use.
• Embossing can be performed on FSC certified papers, and cards.

This list is not exhaustive. Accept any other valid responses.
</td>
<td>6 marks</td>
<td>AO32a
AO32b</td>
</tr>
</table>

7	1	**Figure 3** shows a letter to be foil blocked onto packaging. The outline of the letter has straight lines and semi-circular arcs. Calculate the surface area of the letter shown in **Figure 3**. Show your working out. **Figure 3 – all dimensions in mm** Not drawn to scale  Note Values for π can be used in the range [3.14, 3.142]	2 marks	AO41c

Area of curved sections	$\pi \times 15^2 - \pi \times 5^2$ or [706, 707] – [78.5, 79] or [627, 628.5] or 200 π	1 mark
Total surface area	25 × 10 + 10 × 10 + 25 × 10 + [627, 628.5] or 600 + [627, 628.5] = [1227, 1228.5] (mm^2)	1 mark

<table>
<tr>
<td>7</td>
<td>2</td>
<td>
The dimensions of the letter shown in Figure 3 are all increased by 50%

Work out the surface area of the enlarged letter.

Give your answer to two decimal places. Show your working out.

Note
Values for π can be used in the range [3.14, 3.142]

<table>
<tr><td>Area of new rectangular sections
or area of curved sections</td><td>(1.5 × 25) × (1.5 × 10) + (1.5 × 10) × (1.5 × 10) + (1.5 × 25) × (1.5 × 10)
or 37.5 × 15 + 15 × 15 + 37.5 × 15
or 562.5 + 225 + 562.5
or 1350

or 600 × 1.5^2
or 1350

or $\pi \times 22.5^2 - \pi \times 7.5^2$
or [1589, 1591] – [176, 177]
or [1412, 1415]

or [627, 628.5] × 1.5^2
or [1412, 1415]</td><td>1 mark</td></tr>
<tr><td>Total surface area</td><td>1350 + [1412, 1415] = [2762, 2765]

or [1227, 1228.5] × 1.5^2 = [2762, 2765]</td><td>1 mark</td></tr>
</table>

or

<table>
<tr><td>Alternative method
Calculate scale factor</td><td>Scale factor = 1.5^2</td><td>1 mark</td></tr>
<tr><td>Calculate new surface area</td><td>1.5^2 x their area from 7.1
2.25 x [1227.95,1228.4] = [2762.89, 2763.9]</td><td>1 mark</td></tr>
</table>
</td>
<td>2 marks</td>
<td>AO41c</td>
</tr>
</table>

<table>
<tr>
<td>8</td>
<td></td>
<td>
Explain how the use of Just In Time manufacture can improve efficiency within production.
<table>
<tr><th>Level</th><th>Marks</th><th>Description</th></tr>
<tr><td>3</td><td>5-6 marks</td><td>A detailed understanding of the concept of Just in Time production with clear examples of improvements in efficiency.</td></tr>
<tr><td>2</td><td>3-4 marks</td><td>A clear understanding of the concept of Just in Time production with some explanations of how efficiency can be improved.</td></tr>
<tr><td>1</td><td>1-2 marks</td><td>A basic understanding of Just in Time production with reference made to generic efficiency savings.</td></tr>
<tr><td></td><td>0 marks</td><td>No response worthy of credit.</td></tr>
</table>
Responses may make reference to comparisons with alternative production methods, but this is not essential.

Indicative content:

Explanation:
• Just in Time production refers to a system of manufacture where components and materials are delivered to the production/assembly line just as they are needed.
Possible improvement in efficiency:
• Just in Time production improves efficiency as excess stock is not kept on site reducing associated costs such as; warehouse rental, security, heating etc.
• Just in Time production improves efficiency by only producing stock to order removing the risk of stored products going out of date.
• Just in time production reduces the risk of stored goods being damaged while in storage.
• Just in time production allows manufacturers to react quickly to changes in customer demand as no excess stock is held, which may then need to be sold at a reduced price.
• Just in Time production also increases flexibility in production due to production to specific customer order.

This list is not exhaustive. Accept any other valid responses.
</td>
<td>6 marks</td>
<td>AO41b</td>
</tr>
</table>

9		**Figure 4** shows an armchair. The chair arms shown in **Figure 4** could be produced either from solid hardwood or from laminated veneers. Compare the suitability of both materials for the chair arms shown. **Figure 4**  	4 marks	AO41c

Level	Marks	Description
4	4 marks	A thorough comparison of the stated materials related to the production of the arms of the chair. Responses should make reference to aspects such as relevant performance characteristics of the materials and appropriate manufacturing techniques.
3	3 marks	A detailed comparison of how the stated materials may be suitable for the arms of the chair. Responses should make reference to aspects such as relevant performance characteristics of the materials or appropriate manufacturing techniques.
2	2 marks	A clear description of how the stated material may be suitable for the arms of the chair. Responses should make reference to aspects such as material performance characteristics or manufacturing techniques with some generalisations.

1	1 mark	A basic description of how the materials may be suitable for the arms of the chair. Responses may cover only a single material option with very limited technical detail.
	0 marks	No response worthy of credit.

Indicative content:

- Solid hardwood could be formed into the arm shape using steam bending. The laminated veneers would be glued together over a former and left to dry.
- Steam bending uses a single piece of timber and no adhesive, whereas the laminating process requires many layers and adhesive meaning after drying the arm will need cutting and sanding to shape.
- The use of veneers in laminating reduces the risk of faults in the timber, such as knots, which may be present in solid hardwood.
- Solid hardwood is more likely to split/splinter after forming than laminated veneers due to the continuous grain structure.
- Laminated veneer components can be produced more cheaply than solid hardwood by using cheaper veneers in the middle layers to reduce material cost.
- Laminated veneers are less susceptible to warping etc. due to alternating grain structure.
- Solid hardwood arms may be more suitable for external environment conditions due to the lack of adhesives.

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

10		State a specific application for a UV hardening adhesive. Give **two** reasons why it is suitable for the application you have named. For a UV adhesive to work the bonding area must be accessible to the UV light source. 1 mark for appropriate application. Accept: bonding lenses into glasses frames, glass furniture, etc. dentist tooth fillings, acrylic fingernails. 1 mark for **each** appropriate reason. Possible reasons depend on the application, but the list below gives a range. • Reduced curing times. • One part adhesive removing risk of mixing ratio errors. • Joints can be tested for strength with fluorescent light (non-destructive). • Transparent adhesive improving aesthetics. • Solvent free adhesives for Health and Safety. • Only sets when exposed to UV light source so excess can be cleaned away easily prior to exposure. **This list is not exhaustive. Accept any other valid responses.**	3 marks	AO41b

11		Evaluate the environmental impact of the two coffee packages shown in **Figures 5** and **6**.	6 marks	AO32a AO32b

Figure 5
Glass coffee jar with polymer screw lid

Figure 6
Foil based coffee refill pouch

Level	Marks	Description
3	5-6 marks	The response shows a detailed analysis and evaluation of both packages discussing the environmental impact of each product considering several stages of the product life.
2	3-4 marks	The response clearly evaluates the environmental impact of both products considering more than one stage of the product life.
1	1-2 marks	The response makes a basic evaluation of the environmental impact of both products.
	0 marks	Nothing worthy of credit

Indicative content:

The following are some examples of points candidates may refer to in their comparisons.

NOTE: Students may have interpreted the product in Figure 6 as a coffee pouch that is made exclusively from foil and that can be refilled. Valid analysis and evaluation of the environmental impact of this product in response to this assumed material and function should be credited. See red underlined text for additions that have been made to the mark scheme to ensure that credit is awarded to students who have interpreted Figure 6 in this way.

Raw materials:

Figure 5:
- The glass jar is produced from readily available raw ingredients, with a high percentage of recycled glass.
- The polymer lid is produced from non-renewable resources (crude oil).
- The label is printed on paper, which could be from FSC sources.

Figure 6:
- The pouch is manufactured from a single foil / foil polymer coated sheet, this has a low volume of material per pouch with integrated labelling.

Processing:

Figure 5:
- The forming of the glass requires a lot higher temperature than the forming of the foil pouch.
- The lid is injection moulded requiring heat.
- The label is printed and attached with adhesive adding cost and other raw materials.

Figure 6:
- The pouch would be formed using calendaring requiring heat and pressure / rolling for a foil product
- Printing is added to the pouch in a one phase process requiring no additional components.

Transportation and use:

Figure 5:
- The glass jar and lid adds weight to the contents.
- The glass jar is larger than the foil pouch and rigid in form making transportation more costly due to tessellation issues.

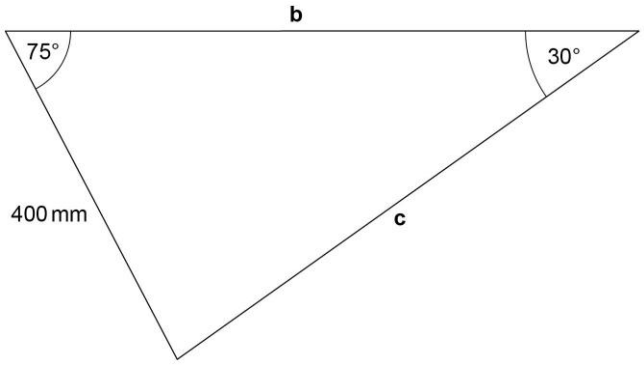
Disposal (end of life):

- The glass jar can be easily recycled, although the components must be separated and the label will be burnt away with the adhesive during reforming.
- The foil & polymer pouch is not easily recycled, as it is a combination of materials that can't be easily separated.
- The foil can be recycled as it is a single material product.

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

SECTION B

12		A manufacturer uses a jig when welding a bike frame together. Explain two reasons why a jig would be used. **Indicative content:** Below are a list of explained points (points are shown in bold) • Jigs can be used to hold components in place while joining/fabrication is undertaken reducing labour costs. • Jigs can be used to guide tools during fabrication reducing errors from slippage. • Jigs remove the risk of components moving during fabrication, this reduces errors and improves quality control. • Jigs increase speed of repeating a process as they aid simple line up of components. • Jigs increase accuracy of repeat components as they remove some of the need for measurements. **This list is not exhaustive. Accept any other valid responses.**	4 marks (2 x 2 marks)	AO42b

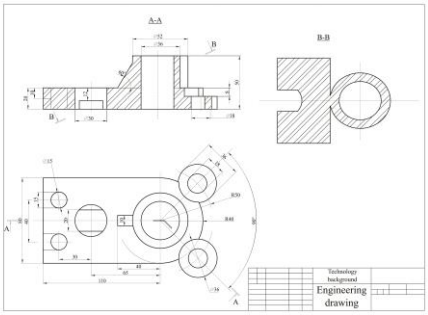
13		**Figure 7** shows three tubes that make the front section of a bike frame. Work out the total length of tube required to make the front section. Give your answer to the nearest mm. Show your working out. **Figure 7** Not drawn to scale  	3 marks	AO42c

		Alternative method 1 – Using isosceles triangle divided into 2 right-angled triangles		
		Setting up trigonometrical equation	$\sin 15 = \frac{200}{b}$ or $\cos 75 = \frac{200}{c}$ or $\sin 15 = \frac{200}{c}$ or $\cos 75 = \frac{200}{b}$	1 mark
		Rearranging the formula to calculate the length of b	$b = \frac{200}{\sin 15}$ or $b = \frac{200}{\cos 75}$ or $c = \frac{200}{\sin 15}$ or $c = \frac{200}{\cos 75}$ or [772, 773]	1 mark
		Total length to nearest mm	[772, 773] × 2 + 400 = 1944 or 1945 or 1946	1 mark
		Alternative method 2 – Using Sine rule		
		Setting up trigonometrical equation	$\frac{400}{\sin 30} = \frac{b}{\sin 75}$ or $\frac{400}{\sin 30} = \frac{c}{\sin 75}$	1 mark
		Rearranging the formula to calculate the length of b	$b = \frac{400 \sin 75}{\sin 30}$ or $c = \frac{400 \sin 75}{\sin 30}$ or [772, 773]	1 mark
		Total length to nearest mm	[772, 773] × 2 + 400 = 1944 or 1945 or 1946	1 mark

<table>
<tr>
<td>14</td>
<td></td>
<td>
Evaluate the impact of Kevlar fibres on the development of sporting products.
<table>
<tr><th>Level</th><th>Marks</th><th>Description</th></tr>
<tr><td>3</td><td>5-6 marks</td><td>The response gives a detailed evaluation of the impact of Kevlar fibres on specific sporting contexts.</td></tr>
<tr><td>2</td><td>3-4 marks</td><td>The response gives a clear evaluation of the impact of Kevlar fibres on sporting products in general.</td></tr>
<tr><td>1</td><td>1-2 marks</td><td>The response shows an understanding of Kevlar fibres and their using in sporting products.</td></tr>
<tr><td></td><td>0 marks</td><td>Nothing worthy of credit</td></tr>
</table>
Indicative content:

Kevlar fibres are used in bicycle tyres to replace standard rubber. These fibres prevent punctures due to the resistance to sharp objects, thus reducing risk for cyclists when travelling at high speed. This also reduces the time lost from punctures during races for cyclists who see the added cost of the tyres as worthwhile.
Kevlar fibres are used in personal protection equipment for motorcyclists and others as it protects against abrasion and cuts. It is much lighter than alternative materials, such as steel inserts and due to its thermal insulation properties the wearer is not at risk of burns through conduction.
Kevlar fibres are used in high end trainers as a replacement for nylon due to the reduced elasticity. This means the laces will remain tight as Kevlar fibres stretch by 1% in comparison to 30% associated with Nylon.

This list is not exhaustive. Accept any other valid responses.
</td>
<td>6 marks</td>
<td>AO31a
AO31b</td>
</tr>
</table>

15		**Figures 8** and **9** show two different design communication techniques. Discuss why a designer may use each technique to communicate information. **Figure 8** Exploded view of a product  **Figure 9** Sectional view of a product  	6 marks	AO42c

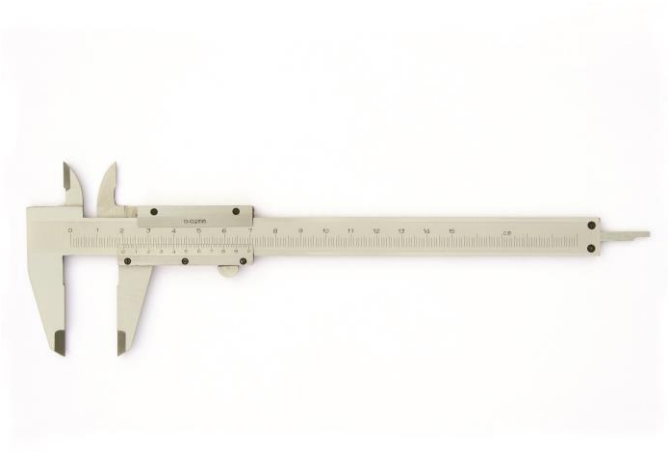
Level	Marks	Description
3	5-6 marks	A detailed discussion is presented which applies knowledge of both techniques to suggest distinctly different uses/reasons for use of each communication method.
2	3-4 marks	A clear discussion is presented which shows knowledge of both techniques. Responses give relevant reasons for use of each communication method.
1	1-2 marks	A basic discussion of at least one of the communication techniques is given.
	0 marks	Nothing worthy of credit.

Figure 8:

- Designers may use exploded views to produce assembly instruction booklets for flat pack furniture to assist the consumer.
- Exploded views allow the viewer to see all components within a product clearly.
- Exploded views can be used on assembly lines to assist during production.
- Exploded views may be used to communication information on internal assemblies to a client during a design meeting.
- Using CAD software allows a designer to create an exploded view on screen and re-assemble a product virtually when working with a client so all components can be seen.

		• Exploded views allow consumers to identify and order replacement parts. Figure 9: • Sectional views allow the viewer to see internal and hidden details within an assembly. • Using 2D sectional views allows dimensions of hidden components to be added onto engineering drawings. • Sectional views allow designers to visualise the interaction between separate hidden components. **This list is not exhaustive. Accept any other valid responses.**		

16		State **four** of the main concepts of a circular economy. **Indicative content:** 1 mark per point (max four) • the design of products for minimum impact on the environment including raw material extraction, consumption, ease of repair, maintenance, end of life, disposal and energy use • sustainable manufacturing including the use of alternative energy and methods to minimise waste • the impact of waste, surplus and by-products created in the process of manufacture • cost implications of dealing with waste • the impact of global manufacturing on product mile. • A circular economy aims to use materials in a way that ensures a continuous cycle of reuse and remanufacture **This list is not exhaustive. Accept any other valid responses.**	4 marks	AO42a

17		Name the measuring device shown in **Figure 10** and give a specific Quality Control application for it. **Figure 10**  1 mark for recognition of Figure 10 as a Vernier caliper / caliper 1 mark for a specific Quality Control application Example applications: • Checking or measuring the dimensional accuracy of an internal diameter. • Checking or measuring the dimensional accuracy of an external diameter. • Checking or measuring the dimensional accuracy of the depth of a blind hole. **This list is not exhaustive. Accept any other valid responses.**	2 marks	AO42a

18		Explain **four** reasons why third party feedback is important in the development of a product. 1 mark per relevant point (max 4) **Indicative content:** • You are able to gain a range of views on a product which is not possible from a single user • Designers are able to gain constructive criticism prior to production of the design • It saves costs as changes during the development stage are much cheaper than during production. • Focus groups can be held with specific demographics relevant to the product being assessed • If the product being designed is for a demographic group you are unfamiliar with it is essential to apply a User Centred Design approach. **This list is not exhaustive. Accept any other valid responses.**	4 marks	AO42b

19		**Figure 11** shows the control panel for a microwave oven. Evaluate how well the interface has been designed to be inclusive to all users. **Figure 11**  	6 marks	AO31a AO31b

Level	Marks	Description
3	5-6 marks	A detailed evaluation of the interface that recognises the needs of a range of users and relates these to the interface design. Responses show an understanding of possible issues faced by disabled users, children and the elderly
2	3-4 marks	A clear evaluation of the interface that recognises the limitations with the current controls for an inclusive product.
1	1-2 marks	A basic evaluation of the interface that makes limited attempt to address the suitability for a range of users, focussing on one demographic group.
	0 marks	Nothing worthy of credit

Indicative content:

- All buttons are the same colour making it hard to distinguish between them for visually impaired users.
- The control panel is flat for ease of cleaning, but this means the tactile interaction with buttons is lost making it harder to navigate around the panel for visually impaired users.
- The use of grey for all buttons makes it hard for children or visually impaired to distinguish between controls.
- As all buttons are the same rectangular shape distinguishing between them is very difficult.
- The black text on dark grey background means that it is hard to read for most users (not just the visually impaired).
- It is not clear how to change features such as power settings or length of time with the current buttons.
- The green LED screen is very clear on the black background.

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