



A-level
**DESIGN AND TECHNOLOGY:
PRODUCT DESIGN
7552/1**

Paper 1 Technical Principles

Mark scheme

June 2023

Version: 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 Examiner.

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

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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.

Glossary for maths

If a student uses a method which is not explicitly covered by the mark scheme the same principles of marking should be applied. Credit should be given to any valid methods. Examiners should seek advice from their senior examiner if in any doubt.

[a, b]	Accept values between a and b inclusive.
For π	Accept values in the range [3.14, 3.142]
Their	Accept an answer from the candidate if it has been inaccurately calculated but is subsequently used in a further stage of the question.

Questions which do not ask students to show working

As a general principle, a correct response is awarded full marks.

Qu	Part	Marking Guidance	Total marks	AO
01		<p>Figure 1 shows a labelled diagram of a hardwood drawer.</p> <p>For both of the joints labelled, state an appropriate traditional wood joint.</p> <p>Do not use any traditional wood joint more than once.</p> <p>1 mark for each correct answer to a maximum of 2 marks.</p> <p>Indicative content</p> <p>Joint A</p> <ul style="list-style-type: none"> • Dowel joint. • Housing joint. <p>Joint B</p> <ul style="list-style-type: none"> • Dovetail. • Dowel joint. • Comb joint. 	2 marks	AO4 1a

Qu	Part	Marking Guidance	Total marks	AO
02	1	<p>Describe how a piezo electric material functions.</p> <p>1 mark for a simple description:</p> <ul style="list-style-type: none"> piezo electric materials generate a small electrical charge when the material is compressed or deformed. <p>or</p> <ul style="list-style-type: none"> piezo electric materials change shape slightly when an electrical current is applied to the material. <p>2 marks for a detailed description:</p> <p>Piezo electric materials generate a small electrical charge when the material is compressed or deformed. The process is also reversible so they can also change shape slightly when exposed to an electric current.</p>	2 marks	AO4 1a

Qu	Part	Marking Guidance	Total marks	AO
02	2	<p>Give a specific example of where piezo electric material may be used.</p> <p>1 mark for a correct example.</p> <p>Piezo electric material:</p> <ul style="list-style-type: none"> musical greetings cards pressure sensors ignition units for lighters, gas stoves and grills ink jet printers car air bags buzzer applications <p>This list is not exhaustive. Accept any other valid responses.</p>	1 mark	AO4 1a

Qu	Part	Marking Guidance	Total marks	AO
03		<p data-bbox="320 338 1070 405">Figure 2 shows a dimensioned orthographic drawing of a component.</p> <p data-bbox="320 439 839 472">Calculate the volume of the component.</p> <p data-bbox="331 539 1166 707"> Volume of component corner $= 10 \times 5 \times 50 + 5 \times 5 \times 50$ 1 mark (A1) $= 2500 + 1250$ $= 3750$ </p> <p data-bbox="331 819 1166 1010"> Volume of semi-circular flanges $= \pi r^2$ 1 mark (M1) $= \pi \times 25^2$ $= [1962.50, 1963.75]$ </p> <p data-bbox="655 1043 687 1077">or</p> <p data-bbox="655 1111 959 1267"> $2 \times \frac{1}{2} \pi r^2$ $= [1962.50, 1963.50]$ </p> <p data-bbox="655 1301 959 1335">× 5 to calculate volume</p> <p data-bbox="655 1368 927 1402">$= [9812.50, 9819.75]$</p> <p data-bbox="655 1435 799 1469">or 3125π</p> <p data-bbox="331 1503 1166 1693"> Volume of holes $= \pi r^2$ 1 mark (A1) $= \pi \times 9^2 \times 2$ $= [254.34, 254.50] \times 2$ $= [508.68, 509]$ </p> <p data-bbox="655 1794 959 1827">× 5 to calculate volume</p> <p data-bbox="655 1861 927 1895">$= [2543.40, 2545.02]$</p> <p data-bbox="655 1928 783 1962">or 810π</p>	4 marks	AO4 1c

		<p>Volume of component</p> <p>= 3750 + [9812.50, 9819.75] – [2543.40, 2545.02]</p> <p>= [11 017.5, 11 026.4] mm³</p>	<p>1 mark (A1)</p>		
		<p>Volume of component</p> <p>Where no working has been shown but final answer is accurate.</p>	<p>= [11 017.5, 11 026.4] mm³</p> <p>4 marks</p>		

Qu	Part	Marking Guidance	Total marks	AO										
04		<p>Compare and evaluate the suitability of Acrylonitrile Butadiene Styrene (ABS) and Polylactic Acid (PLA) for the manufacture of a 3D printed component.</p> <table border="1" data-bbox="331 465 1225 1301"> <thead> <tr> <th data-bbox="331 465 475 521">Marks</th> <th data-bbox="475 465 1225 521">Description</th> </tr> </thead> <tbody> <tr> <td data-bbox="331 521 475 875">5–6 marks</td> <td data-bbox="475 521 1225 875">The response includes detailed analysis, and compares the two materials in detail with reference to factors such as the materials’ properties and the suitability for 3D printing. The response provides detailed evaluation of the suitability of each material to manufacture a 3D printed component. There may be some minor irrelevant points made but this will not detract from the overall quality of the response. Not all indicative content is required to be able to access the top mark band.</td> </tr> <tr> <td data-bbox="331 875 475 1093">3–4 marks</td> <td data-bbox="475 875 1225 1093">The response includes good analysis and evaluation of both materials and draws some comparison with reference to factors such as the materials’ properties and the suitability for 3D printing. There may be some irrelevant points made or a lack of clarity but this will not detract from the overall quality of the response.</td> </tr> <tr> <td data-bbox="331 1093 475 1245">1–2 marks</td> <td data-bbox="475 1093 1225 1245">The response includes basic analysis and tends to be descriptive rather than evaluative with little or no reference to the 3D printed component. At the lower end of the mark band statements will be largely generic.</td> </tr> <tr> <td data-bbox="331 1245 475 1301">0 marks</td> <td data-bbox="475 1245 1225 1301">No response or nothing worthy of credit.</td> </tr> </tbody> </table> <p data-bbox="331 1335 587 1368">Indicative content</p> <p data-bbox="331 1402 395 1435">ABS</p> <ul data-bbox="331 1435 1225 1760" style="list-style-type: none"> • ABS is a crude oil-based polymer which comes from a finite resource. • ABS is a tough material that can be used to create a 3D printed component with good resistance to impact. • ABS can be pigmented to produce a filament with a wide range of bright and bold colour options. • 3D printing often creates waste material in the form of rafts and supports. Although ABS can be recycled, it would more than likely be disposed of and contribute to landfill. <p data-bbox="331 1861 395 1895">PLA</p> <ul data-bbox="331 1895 1225 2040" style="list-style-type: none"> • PLA is a bio polymer that is engineered from natural and renewable resources. • PLA is a brittle material so may create a component with poor impact resistance. 	Marks	Description	5–6 marks	The response includes detailed analysis, and compares the two materials in detail with reference to factors such as the materials’ properties and the suitability for 3D printing. The response provides detailed evaluation of the suitability of each material to manufacture a 3D printed component. There may be some minor irrelevant points made but this will not detract from the overall quality of the response. Not all indicative content is required to be able to access the top mark band.	3–4 marks	The response includes good analysis and evaluation of both materials and draws some comparison with reference to factors such as the materials’ properties and the suitability for 3D printing. There may be some irrelevant points made or a lack of clarity but this will not detract from the overall quality of the response.	1–2 marks	The response includes basic analysis and tends to be descriptive rather than evaluative with little or no reference to the 3D printed component. At the lower end of the mark band statements will be largely generic.	0 marks	No response or nothing worthy of credit.	6 marks	AO3 2a AO3 2b
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	<ul style="list-style-type: none"> • PLA is becoming increasingly available in a wider range of colour options in line with ABS. • Rafts and support material in PLA will eventually biodegrade and have a reduced environmental impact when disposed of. <p>General</p> <ul style="list-style-type: none"> • ABS has a higher melting point than PLA which means it requires more energy to print in ABS than PLA. • ABS can give off toxic fumes when heated and can often require extraction and filtration. • ABS requires a 3D printer to have a heated bed to improve adhesion when printing whereas PLA is generally an easier material to work with. • The lower melting point of PLA makes it unsuitable for the manufacture of a component that may be exposed to friction or higher working temperatures. <p>This list is not exhaustive. Accept any other valid responses.</p>		
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Qu	Part	Marking Guidance	Total marks	AO										
05		<p>Explain why High Impact Polystyrene (HIPS) is an appropriate material for the manufacture of the protractor shown in Figure 3.</p> <table border="1" data-bbox="331 434 1222 1196"> <thead> <tr> <th data-bbox="331 434 472 490">Marks</th> <th data-bbox="472 434 1222 490">Description</th> </tr> </thead> <tbody> <tr> <td data-bbox="331 490 472 741">5–6 marks</td> <td data-bbox="472 490 1222 741">The response includes detailed understanding of why HIPS would be a suitable material for a protractor. Response should be specifically related to the protractor context. There may be some minor irrelevant points made but this will not detract from the overall quality of the response. Not all indicative content needs to be referenced to access full marks.</td> </tr> <tr> <td data-bbox="331 741 472 992">3–4 marks</td> <td data-bbox="472 741 1222 992">The response includes good understanding of why HIPS would be a suitable material for a protractor. Response may refer to the physical or mechanical properties of HIPS and its suitability for the protractor context. There may be some irrelevant points made or a lack of clarity but this will not detract from the overall quality of the response.</td> </tr> <tr> <td data-bbox="331 992 472 1144">1–2 marks</td> <td data-bbox="472 992 1222 1144">The response offers a basic explanation of the material properties of HIPS with limited reference to the protractor application. At the lower end of the mark band statements will be largely generic.</td> </tr> <tr> <td data-bbox="331 1144 472 1196">0 marks</td> <td data-bbox="472 1144 1222 1196">No response or nothing worthy of credit.</td> </tr> </tbody> </table> <p>Indicative content</p> <ul data-bbox="331 1301 1222 1962" style="list-style-type: none"> • HIPS has excellent optical properties and can be translucent allowing for clear visibility through the product, essential for use. • HIPS has a good level of hardness allowing it to resist scratching when stored in a pencil case, and preventing the surface from being obscured. • HIPS is a rigid polymer that maintains the thin flat shape of the protractor so that it can be used to measure angles on drawings accurately. • HIPS is a shatter resistant polymer that prevents the product from cracking if exposed to impact such as a bag getting dropped. • HIPS has a low melting point which makes it particularly suitable for the injection moulding process used to manufacture the protractor. • HIPS can be easily injection moulded which is appropriate for the scale of the market. • HIPS can be easily printed on allowing for the application of the angle increments and text needed for the protractor. <p>This list is not exhaustive. Accept any other valid responses.</p>	Marks	Description	5–6 marks	The response includes detailed understanding of why HIPS would be a suitable material for a protractor. Response should be specifically related to the protractor context. There may be some minor irrelevant points made but this will not detract from the overall quality of the response. Not all indicative content needs to be referenced to access full marks.	3–4 marks	The response includes good understanding of why HIPS would be a suitable material for a protractor. Response may refer to the physical or mechanical properties of HIPS and its suitability for the protractor context. There may be some irrelevant points made or a lack of clarity but this will not detract from the overall quality of the response.	1–2 marks	The response offers a basic explanation of the material properties of HIPS with limited reference to the protractor application. At the lower end of the mark band statements will be largely generic.	0 marks	No response or nothing worthy of credit.	6 marks	AO4 1c
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06	1	<p>Figure 4 shows a side view representing a child’s art easel.</p> <p>The support bar is located 600 mm from the top of the easel.</p> <p>Calculate the length of the support bar.</p> <p>Show your working out.</p> <p>Where candidates have interpreted that the support bar is located 600mm vertical from the top of the easel.</p> <p>Length of support bar (x) $\tan 15 = x \div 2 \div 600$ 1 mark (M1)</p> <p>$x = \tan 15 \times 600 \times 2$</p> <p>$= [321.5, 321.54] \text{ mm}$ 1 mark (A1)</p> <p>Or</p> <p>$600 \div \sin 75 \times \sin 15$</p> <p>$= 160.76 \times 2$</p> <p>$= [321.5, 321.54] \text{ mm}$</p> <p>Or an alternative correct method used.</p> <p>Length of support bar (x) $= [321.5, 321.54] \text{ mm}$ 2 marks</p> <p>Where no working has been shown but final answer is accurate.</p> <p>Or</p> <p>Where candidates have interpreted that the support bar is located 600mm along the hypotenuse.</p>	2 marks	AO4 1c

		<p>Length of support bar (x)</p>	$\sin 15 = (x) \div 600$ $600 \sin 15$ $= 155.29 \times 2$ $= [310.4, 310.59] \text{ mm}$	<p>1 mark (M1)</p> <p>1 mark (A1)</p>		
		<p>Length of support bar (x) Where no working has been shown but final answer is accurate</p>	<p>Or an alternative correct method used.</p> $= [310.4, 310.59] \text{ mm}$	<p>2 marks</p>		

Qu	Part	Marking Guidance	Total marks	AO						
06	2	<p>Consumers have raised issues with the stability of the easel and the manufacturer has decided to increase the length of the support bar to 400 mm.</p> <p>The support bar remains at 600 mm from the top of the easel.</p> <p>Calculate the new angle of the apex of the easel.</p> <p>Give your answer to two decimal places.</p> <p>Where candidates have interpreted that the support bar is located 600mm vertical from the top of the easel.</p> <table border="1" data-bbox="320 824 1217 1850"> <tr> <td data-bbox="320 824 643 1850"> <p>Calculation of angle of apex</p> </td> <td data-bbox="643 824 1082 1850"> $\frac{400}{2} = 200$ $\tan x = \frac{200}{600}$ $x = \tan^{-1}\left(\frac{200}{600}\right)$ $= 18.4349 \times 2$ <p>Or</p> $\sqrt{a^2 + b^2} = \sqrt{200^2 + 600^2}$ $= 632.4555$ <p>Sin = opposite ÷ hypotenuse</p> $x = \sin^{-1}\left(\frac{200}{632.4555}\right)$ $= 18.4349 \times 2$ <p>Or an alternative correct method used.</p> </td> <td data-bbox="1082 824 1217 1850"> <p>1 mark (M1)</p> </td> </tr> <tr> <td data-bbox="320 1850 643 1948"> <p>New angle of apex</p> </td> <td data-bbox="643 1850 1082 1948"> <p>[36.8°, 36.87°]</p> </td> <td data-bbox="1082 1850 1217 1948"> <p>1 mark (A1)</p> </td> </tr> </table>	<p>Calculation of angle of apex</p>	$\frac{400}{2} = 200$ $\tan x = \frac{200}{600}$ $x = \tan^{-1}\left(\frac{200}{600}\right)$ $= 18.4349 \times 2$ <p>Or</p> $\sqrt{a^2 + b^2} = \sqrt{200^2 + 600^2}$ $= 632.4555$ <p>Sin = opposite ÷ hypotenuse</p> $x = \sin^{-1}\left(\frac{200}{632.4555}\right)$ $= 18.4349 \times 2$ <p>Or an alternative correct method used.</p>	<p>1 mark (M1)</p>	<p>New angle of apex</p>	<p>[36.8°, 36.87°]</p>	<p>1 mark (A1)</p>	2 marks	AO4 1c
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Qu	Part	Marking Guidance	Total marks	AO
06	3	<p>Calculate the new distance between the feet of the easel on the ground.</p> <p>Where candidates have interpreted that the support bar is located 600mm vertical from the top of the easel.</p> <p>Calculate the new distance between feet $\sin [\text{their } 18.43] = x \div 2 \div 1000$ 1 mark (M1)</p> <p>$x = \sin [\text{their } 18.43] \times 1000 \times 2$</p> <p>$= [631.29, 632.5] \text{ mm}$ 1 mark (A1)</p> <p>Calculate the new distance between feet $= [631.29, 632.5] \text{ mm}$ 2 marks</p> <p>Where no working has been shown but final answer is accurate.</p> <p>Or</p> <p>Where candidates have interpreted that the support bar is located 600mm along the hypotenuse.</p> <p>Calculate the new distance between the feet of the easel on the ground.</p> <p>Calculate the new distance between feet $\sin [\text{their } 19.47] = x \div 2 \div 1000$ 1 mark (M1)</p> <p>$x = \sin [\text{their } 19.47] \times 1000 \times 2$</p> <p>$= [666.62, 667] \text{ mm}$ 1 mark (A1)</p> <p>Calculate the new distance between feet $= [666.62, 667] \text{ mm}$ 2 marks</p> <p>Where no working has been shown but final answer is accurate.</p>	2 marks	AO4 1c

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Qu	Part	Marking Guidance	Total marks	AO										
07		<p>Analyse and evaluate the suitability of rotational moulding for the manufacture of the child’s art easel shown in Figure 5.</p> <table border="1" data-bbox="331 436 1225 1167"> <thead> <tr> <th data-bbox="331 436 472 490">Marks</th> <th data-bbox="472 436 1225 490">Description</th> </tr> </thead> <tbody> <tr> <td data-bbox="331 490 472 741">5–6 marks</td> <td data-bbox="472 490 1225 741">The response includes detailed analysis and evaluation of the suitability of the manufacturing process. The response evaluates how appropriate the manufacturing process is with reference to the complexity of the design and intended use of the product. There may be some minor irrelevant points made but this will not detract from the overall quality of the response.</td> </tr> <tr> <td data-bbox="331 741 472 992">3–4 marks</td> <td data-bbox="472 741 1225 992">The response includes good analysis and evaluation of the manufacturing process. The response provides some evaluation of how appropriate the manufacturing process is and may reference the complexity of the design and intended use of the product. There may be some irrelevant points made or a lack of clarity but this will not detract from the overall quality of the response.</td> </tr> <tr> <td data-bbox="331 992 472 1111">1–2 marks</td> <td data-bbox="472 992 1225 1111">The response includes basic analysis and tends to be descriptive rather than evaluative. At the lower end of the mark band statements will be largely generic.</td> </tr> <tr> <td data-bbox="331 1111 472 1167">0 marks</td> <td data-bbox="472 1111 1225 1167">No response worthy of credit.</td> </tr> </tbody> </table> <p>Indicative content</p> <ul style="list-style-type: none"> • Rotational moulding would be a suitable process for producing a hollow component of the size and scale of the child’s art easel. • The complexity of the design is limited, with large radiused edges and minimal intricate detail making rotational moulding an appropriate manufacturing method. • Rotational moulding allows for a thicker wall thickness than other polymer redistribution processes meaning that the easel will be rigid and stable when in use. • Rotational moulding produces a lightweight hollow structure which allows the easel to be easily carried or moved and prevent an injury should the easel fall over. • Rotational moulding produces a one-piece structure that allows the easel to be manufactured out of a minimal number of parts, reducing assembly time. • Rotational moulding is suitable for large batch production which reflects the size of the consumer market for the child’s art easel. Rotational moulding allows for pigmentation to be added to the component at the point of manufacture. <p>This list is not exhaustive. Accept any other valid responses.</p>	Marks	Description	5–6 marks	The response includes detailed analysis and evaluation of the suitability of the manufacturing process. The response evaluates how appropriate the manufacturing process is with reference to the complexity of the design and intended use of the product. There may be some minor irrelevant points made but this will not detract from the overall quality of the response.	3–4 marks	The response includes good analysis and evaluation of the manufacturing process. The response provides some evaluation of how appropriate the manufacturing process is and may reference the complexity of the design and intended use of the product. There may be some irrelevant points made or a lack of clarity but this will not detract from the overall quality of the response.	1–2 marks	The response includes basic analysis and tends to be descriptive rather than evaluative. At the lower end of the mark band statements will be largely generic.	0 marks	No response worthy of credit.	6 marks	AO3 2a AO3 2b
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08		<p>Figure 6 shows the results of a finite element analysis (FEA) simulation where a load has been placed on a bracket.</p> <p>Describe how a designer would interpret and use the information obtained from the results of the virtual modelling technique such as that shown in Figure 6.</p> <table border="1" data-bbox="331 568 1222 1234"> <thead> <tr> <th data-bbox="331 568 472 622">Marks</th> <th data-bbox="472 568 1222 622">Description</th> </tr> </thead> <tbody> <tr> <td data-bbox="331 622 472 842">5–6 marks</td> <td data-bbox="472 622 1222 842">The response shows a detailed understanding of how a designer may interpret the FEA diagram. The response may refer to a variety of different design improvements or developments that subsequently may occur. There may be some minor irrelevant points made but this will not detract from the overall quality of the response.</td> </tr> <tr> <td data-bbox="331 842 472 1061">3–4 marks</td> <td data-bbox="472 842 1222 1061">The response demonstrates a good understanding of how a designer may interpret the FEA diagram. The response may refer to some subsequent design improvements that may occur. There may be some irrelevant points made or a lack of clarity but this will not detract from the overall quality of the response.</td> </tr> <tr> <td data-bbox="331 1061 472 1178">1–2 marks</td> <td data-bbox="472 1061 1222 1178">The response offers a basic understanding of how the FEA diagram can be interpreted. At the lower end of the mark band statements will be largely generic.</td> </tr> <tr> <td data-bbox="331 1178 472 1234">0 marks</td> <td data-bbox="472 1178 1222 1234">No response worthy of credit.</td> </tr> </tbody> </table> <p>Indicative content</p> <p>Interpretation</p> <ul data-bbox="331 1406 1222 1839" style="list-style-type: none"> • The range of colours on the bracket represent the range of the average amount of stress that occurs throughout the component in response to a computer model of an applied force. • The blue areas of the diagram represent the lowest amount of stress and the red areas of the diagram represent the highest amount of stress. • The contour scale can be interpreted to indicate at what specific loading the bracket will yield or fail. • The image will provide a visual guide to the designer to allow them to identify weak areas of the design or the location at which yield or failure will occur and subsequently improve the bracket. <p>Use</p> <ul data-bbox="331 1951 1222 2049" style="list-style-type: none"> • The results can be used by a designer to compare and evaluate how alternative designs would perform under the same loading. 	Marks	Description	5–6 marks	The response shows a detailed understanding of how a designer may interpret the FEA diagram. The response may refer to a variety of different design improvements or developments that subsequently may occur. There may be some minor irrelevant points made but this will not detract from the overall quality of the response.	3–4 marks	The response demonstrates a good understanding of how a designer may interpret the FEA diagram. The response may refer to some subsequent design improvements that may occur. There may be some irrelevant points made or a lack of clarity but this will not detract from the overall quality of the response.	1–2 marks	The response offers a basic understanding of how the FEA diagram can be interpreted. At the lower end of the mark band statements will be largely generic.	0 marks	No response worthy of credit.	6 marks	AO4 1b
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		<ul style="list-style-type: none">• The results may prompt the designer to refine the design of the bracket such as increasing the radius of the fillets, increasing the width of the bracket section or reinforcing the bracket from below.• The results may prompt the designer to explore the options for manufacturing the bracket in an alternative material.• The result may confirm to the designer that the design of the bracket requires no refinement as it will be able to withstand the intended working stresses. <p>This list is not exhaustive. Accept any other valid responses.</p>		
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09		<p>Discuss the advantages and disadvantages surrounding the use of software updates as part of the ongoing maintenance of electronic products.</p> <table border="1" data-bbox="331 465 1222 1167"> <thead> <tr> <th data-bbox="331 465 472 521">Marks</th> <th data-bbox="472 465 1222 521">Description</th> </tr> </thead> <tbody> <tr> <td data-bbox="331 521 472 775">7–9 marks</td> <td data-bbox="472 521 1222 775">The response includes detailed analysis and evaluation of the use of software updates in electronic products, with reference to the positive and negative impact to the consumer. The response refers to factors such as product performance and product lifespan. There may be some minor irrelevant points made but this will not detract from the overall quality of the response.</td> </tr> <tr> <td data-bbox="331 775 472 992">4–6 marks</td> <td data-bbox="472 775 1222 992">The response includes good analysis and evaluation of the use of software updates with some reference to factors such as product performance and product lifespan. There may be some irrelevant points made or a lack of clarity but this will not detract from the overall quality of the response.</td> </tr> <tr> <td data-bbox="331 992 472 1111">1–3 marks</td> <td data-bbox="472 992 1222 1111">The response includes basic analysis and tends to be descriptive rather than evaluative. At the lower end of the mark band statements will be largely generic.</td> </tr> <tr> <td data-bbox="331 1111 472 1167">0 marks</td> <td data-bbox="472 1111 1222 1167">No response worthy of credit.</td> </tr> </tbody> </table> <p>Indicative content</p> <p>Advantages</p> <ul data-bbox="331 1301 1222 1816" style="list-style-type: none"> • Software updates ensure that a device is continually protected from phishing software as it will have the most up to date security settings. • They can be released frequently to help manufacturers address issues with legacy software and remove any bugs or unwanted features or functions. • They can ensure that the software on the electronic product is in line with that of the software developers to ensure compatibility with new programmes or apps. • They can extend the lifespan of a product reducing the need to continually upgrade or replace a device. • Most software updates are free so the consumer has piece of mind that there will be no additional costs in the lifetime of the product. <p>Disadvantages</p> <ul data-bbox="331 1883 1222 2065" style="list-style-type: none"> • Software updates can often lead to a variation in versions being installed on different devices, preventing files from being opened or updated on machines with incompatible versions. • They can require access to Wi-Fi or mobile data which may impact updates being downloaded in areas with poor signals. 	Marks	Description	7–9 marks	The response includes detailed analysis and evaluation of the use of software updates in electronic products, with reference to the positive and negative impact to the consumer. The response refers to factors such as product performance and product lifespan. There may be some minor irrelevant points made but this will not detract from the overall quality of the response.	4–6 marks	The response includes good analysis and evaluation of the use of software updates with some reference to factors such as product performance and product lifespan. There may be some irrelevant points made or a lack of clarity but this will not detract from the overall quality of the response.	1–3 marks	The response includes basic analysis and tends to be descriptive rather than evaluative. At the lower end of the mark band statements will be largely generic.	0 marks	No response worthy of credit.	9 marks	AO3 2a AO3 2b
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	<ul style="list-style-type: none"> • On some devices they can only take place when the device such as a phone is connected to a power supply. • They can take a long time to download and may cause electronic devices to be unusable whilst the download and installation takes place. • They can make some legacy software redundant if they haven't been updated in line with an operating system or are no longer supported. • Often the option for software updates is automatically pushed out to a device, removing the responsibility and control from the user. • They can affect the function of the product without the user being aware such as slowing down the speed to conserve the battery. • In some cases, the hardware of the product can prevent any further software updates from taking place, rendering the product obsolete. <p>This list is not exhaustive. Accept any other valid responses.</p>		
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Qu	Part	Marking Guidance	Total marks	AO										
10		<p>Explain why teak is an appropriate material for the manufacture of the sun lounger shown in Figure 7.</p> <table border="1" data-bbox="331 434 1222 1196"> <thead> <tr> <th data-bbox="331 434 472 490">Marks</th> <th data-bbox="472 434 1222 490">Description</th> </tr> </thead> <tbody> <tr> <td data-bbox="331 490 472 741">5–6 marks</td> <td data-bbox="472 490 1222 741">The response demonstrates a detailed and thorough understanding of why teak is an appropriate material for the sun lounger with reference to how performance characteristics and material properties make it appropriate for the sun lounger application. There may be some minor irrelevant points made but this will not detract from the overall quality of the response.</td> </tr> <tr> <td data-bbox="331 741 472 992">3–4 marks</td> <td data-bbox="472 741 1222 992">The response demonstrates a good understanding of why teak is an appropriate material for the sun lounger with some reference to how performance characteristics and material properties relate to the sun lounger application. There may be some irrelevant points made or a lack of clarity but this will not detract from the overall quality of the response.</td> </tr> <tr> <td data-bbox="331 992 472 1144">1–2 marks</td> <td data-bbox="472 992 1222 1144">The response offers a basic explanation of the material properties of teak with limited reference to the sun lounger application. At the lower end of the mark band statements will be largely generic.</td> </tr> <tr> <td data-bbox="331 1144 472 1196">0 marks</td> <td data-bbox="472 1144 1222 1196">No response worthy of credit.</td> </tr> </tbody> </table> <p data-bbox="331 1234 587 1267">Indicative content</p> <ul data-bbox="331 1301 1222 2033" style="list-style-type: none"> • Teak has a naturally occurring oil that makes it resist damage and degradation associated with the sun lounger being used and left outside. • Teak has a good level of hardness meaning it will resist the scratching and abrasion associated with it being used, moved and stored. • The natural oils in the timber provide a good level of chemical resistance preventing the accelerated degradation of the sun lounger that may be caused by bird droppings or cleaning products. • Teak is a naturally attractive aesthetic material that requires no additional surface finish for the sun lounger. • Teak has a close grain pattern making the sections and profile of timber used in the chair strong enough to be suitable for accommodating the weight of the user. • The natural oils in the teak remove the need for additional preservatives at point of manufacture to be added to the timber, reducing both production and ongoing maintenance costs. • Teak can be successfully steam bent to create the shallow radiused sections of the sun lounger. 	Marks	Description	5–6 marks	The response demonstrates a detailed and thorough understanding of why teak is an appropriate material for the sun lounger with reference to how performance characteristics and material properties make it appropriate for the sun lounger application. There may be some minor irrelevant points made but this will not detract from the overall quality of the response.	3–4 marks	The response demonstrates a good understanding of why teak is an appropriate material for the sun lounger with some reference to how performance characteristics and material properties relate to the sun lounger application. There may be some irrelevant points made or a lack of clarity but this will not detract from the overall quality of the response.	1–2 marks	The response offers a basic explanation of the material properties of teak with limited reference to the sun lounger application. At the lower end of the mark band statements will be largely generic.	0 marks	No response worthy of credit.	6 marks	AO4 1c
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		<ul style="list-style-type: none">• Teak is less prone to splinter or crack over time in the same way that alternative timbers might. <p>This list is not exhaustive. Accept any other valid responses.</p>		
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Qu	Part	Marking Guidance	Total marks	AO															
11		<p>Figure 8 shows the cross section of a piece of material that has been subjected to a hardness test.</p> <p>Table 1 shows the results of three other materials that have also been tested.</p> <p>The hardness test has been completed using a 4 mm diameter steel ball.</p> <p>The ball has been indented to its full diameter.</p> <p>Calculate the volume of the indentation and complete Table 1.</p> <p>Volume of a sphere $V = \frac{4}{3}\pi r^3$</p> <p>Volume of indentation $V = \frac{4}{3}\pi r^3 \div 2$ 1 mark (M1)</p> <p>$V = [33.49, 33.52] \div 2$</p> <p>$= [16.74, 16.76] \text{ mm}^3$</p> <p>Accurate completion of Table 1</p> <table border="1" data-bbox="320 1263 1217 1480"> <thead> <tr> <th>Test Sample</th> <th>Volume of indentation mm³</th> <th></th> </tr> </thead> <tbody> <tr> <td>Material A</td> <td>17.25</td> <td></td> </tr> <tr> <td>Material B</td> <td>15.90</td> <td></td> </tr> <tr> <td>Material C</td> <td>16.25</td> <td></td> </tr> <tr> <td>Material D</td> <td>[16.74, 16.76]</td> <td>1 mark (A1)</td> </tr> </tbody> </table> <p>Using the information in Table 1, complete the descending order of hardness in Table 2.</p> <p>Accurate completion of Table 2</p>	Test Sample	Volume of indentation mm ³		Material A	17.25		Material B	15.90		Material C	16.25		Material D	[16.74, 16.76]	1 mark (A1)	3 marks	AO4 1c
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		<p>Test samples in descending order of hardness</p>	<p>Material B Material C Material D Material A</p> <p>Or</p> <p>Award 1 mark for the correct descending order of hardness using the candidate's earlier calculation.</p>	<p>1 mark</p>		
		<p>Test samples in descending order of hardness Where no working has been shown but final answer is accurate.</p>	<p>Material B or 15.90 Material C or 16.25 Material D or [16.74, 16.76] Material A or 17.25</p>	<p>1 mark</p>		

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12		<p>Describe how the critical assessment of existing products can influence the work of designers and manufacturers.</p> <table border="1"> <thead> <tr> <th>Marks</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>5–6 marks</td> <td>The response shows a detailed understanding of how the critical assessment of existing products can influence a designer and manufacturer. The response may refer to a variety of advantages and clearly describes their importance and how they may influence the designer and manufacturer. There may be some minor irrelevant points made but this will not detract from the overall quality of the response.</td> </tr> <tr> <td>3–4 marks</td> <td>The response shows a good understanding of how the critical assessment of existing products can influence a designer and manufacturer. The response may refer to some advantages with an understanding of how they may influence the designer and manufacturer. There may be some irrelevant points made or a lack of clarity but this will not detract from the overall quality of the response.</td> </tr> <tr> <td>1–2 marks</td> <td>The response offers a basic understanding of why existing products would be critically assessed by a designer and manufacturer. At the lower end of the mark band statements will be largely generic.</td> </tr> <tr> <td>0 marks</td> <td>No response worthy of credit.</td> </tr> </tbody> </table> <p>Indicative content</p> <ul style="list-style-type: none"> • Critical assessment of existing products is essential in identifying weaknesses in existing products. A manufacturer would need to be confident that their product is better or more desirable than the current products on the market. • The ergonomics of existing products can be tested and evaluated to identify desirable features that may be incorporated into a new product. • The use of materials can be analysed to identify improvements or alternative materials that may be considered in product manufacture. • Critical assessment can help identify why a competitor’s product is successful and ensure that a comparative level of performance is achieved or exceeded. • A manufacturer can analyse how a product is manufactured to identify improvements in the product manufacture or product assembly phase. • The way in which a user interacts with a product can be analysed in order to improve the user experience or make the next iteration more instinctive. 	Marks	Description	5–6 marks	The response shows a detailed understanding of how the critical assessment of existing products can influence a designer and manufacturer. The response may refer to a variety of advantages and clearly describes their importance and how they may influence the designer and manufacturer. There may be some minor irrelevant points made but this will not detract from the overall quality of the response.	3–4 marks	The response shows a good understanding of how the critical assessment of existing products can influence a designer and manufacturer. The response may refer to some advantages with an understanding of how they may influence the designer and manufacturer. There may be some irrelevant points made or a lack of clarity but this will not detract from the overall quality of the response.	1–2 marks	The response offers a basic understanding of why existing products would be critically assessed by a designer and manufacturer. At the lower end of the mark band statements will be largely generic.	0 marks	No response worthy of credit.	6 marks	AO4 1b
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13		<p>Explain why anodising is an appropriate finish for the aluminium torch shown in Figure 9.</p> <table border="1" data-bbox="331 434 1222 1198"> <thead> <tr> <th data-bbox="331 434 472 490">Marks</th> <th data-bbox="472 434 1222 490">Description</th> </tr> </thead> <tbody> <tr> <td data-bbox="331 490 472 741">5–6 marks</td> <td data-bbox="472 490 1222 741">The response demonstrates a detailed and thorough understanding of why anodising is an appropriate finish for the handheld torch with reference to how performance characteristics make it appropriate for the hand-held torch application. There may be some minor irrelevant points made but this will not detract from the overall quality of the response.</td> </tr> <tr> <td data-bbox="331 741 472 992">3–4 marks</td> <td data-bbox="472 741 1222 992">The response demonstrates a good understanding of why anodising is an appropriate finish for the hand-held torch with some reference to how performance characteristics of the finish relate to the hand-held torch application. There may be some irrelevant points made or a lack of clarity but this will not detract from the overall quality of the response.</td> </tr> <tr> <td data-bbox="331 992 472 1144">1–2 marks</td> <td data-bbox="472 992 1222 1144">The response offers a basic explanation of the benefits of anodising with limited reference to the hand-held torch application. At the lower end of the mark band statements will be largely generic.</td> </tr> <tr> <td data-bbox="331 1144 472 1198">0 marks</td> <td data-bbox="472 1144 1222 1198">No response worthy of credit.</td> </tr> </tbody> </table> <p data-bbox="331 1234 587 1267">Indicative content</p> <ul data-bbox="331 1301 1222 1966" style="list-style-type: none"> • The anodising enhances the natural oxide layer of the aluminium, increasing its hardness and toughness, allowing for the torch to resist scratching and wear associated with storage and use. • The anodising process allows for a pigment or colour to be used which enhances the aesthetic of the torch. • An anodised finish can be laser etched to allow the text and logos to be added to the torch, using the natural colour of the aluminium to provide clear contrast. • Anodising protects the aluminium from further corrosion or oxidisation. • Anodising is an electroplating process which ensures that all surfaces of the components of the torch are evenly anodised. • The thickness of the anodised coating is minimal which therefore doesn't affect any threaded components, or interfere with the knurled surface of the torch handle. • The anodised finish is tough and hardwearing, requiring no maintenance during the lifespan of the torch. <p data-bbox="331 2000 1198 2033">This list is not exhaustive. Accept any other valid responses.</p>	Marks	Description	5–6 marks	The response demonstrates a detailed and thorough understanding of why anodising is an appropriate finish for the handheld torch with reference to how performance characteristics make it appropriate for the hand-held torch application. There may be some minor irrelevant points made but this will not detract from the overall quality of the response.	3–4 marks	The response demonstrates a good understanding of why anodising is an appropriate finish for the hand-held torch with some reference to how performance characteristics of the finish relate to the hand-held torch application. There may be some irrelevant points made or a lack of clarity but this will not detract from the overall quality of the response.	1–2 marks	The response offers a basic explanation of the benefits of anodising with limited reference to the hand-held torch application. At the lower end of the mark band statements will be largely generic.	0 marks	No response worthy of credit.	6 marks	AO4 1c
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14		<p>Explain why each of the following finishing techniques have been used.</p> <p>1 mark for a simple description.</p> <p>2 marks for a detailed description.</p> <p>Indicative content</p> <p>Embossing</p> <p>Example responses</p> <ul style="list-style-type: none"> • Produces a raised snowflake design that stands out from the white card. (1 mark) • Produces a raised snowflake design that adds depth to the card and allows for the design to be the same colour as the card without additional printing. (2 marks) <p>Foil Blocking</p> <p>Example responses</p> <ul style="list-style-type: none"> • Creates a metallic logo or text on the passport cover. (1 mark) • Provides aesthetic enhancement to the logo and text by providing contrast with the blue-black base colour of the passport due to its metallic properties. (2 marks) <p>Spot varnishing</p> <p>Example responses</p> <ul style="list-style-type: none"> • Produces areas of high gloss over the images and text. (1 mark) • Adds a high gloss coating to the images and text, improving the aesthetic and accentuating the individual details. (2 marks) <p>This list is not exhaustive. Accept any other valid responses.</p>	6 marks	AO4 1b

Qu	Part	Marking Guidance	Total marks	AO
15		<p>State two reasons why a low carbon steel component may be case hardened.</p> <p>1 mark for each appropriate reason to a maximum of 2 marks.</p> <p>Indicative content</p> <p>Case hardening:</p> <ul style="list-style-type: none"> • increases the hardness and carbon content of the outer surface of the metal which in turn improves the metal's resistance to wear and corrosion. • only increases the hardness of the outer surface of the metal, therefore helping to maintain the toughness of the component • increases the hardness of the outer surface of the metal which in turn improves the metal's resistance to indentation • is used due to low carbon content which prevents alternative hardening methods from being used. <p>This list is not exhaustive. Accept any other valid responses.</p>	2 marks	AO4 1a

Qu	Part	Marking Guidance	Total marks	AO
16	1	<p>Identify the specific material classification of gold.</p> <p>1 mark for the correct answer:</p> <p>non-ferrous metal.</p>	1 mark	AO4 1a

Qu	Part	Marking Guidance	Total marks	AO
16	2	<p>Describe two physical properties of gold.</p> <p>1 mark per appropriate physical property described to a maximum of 2 marks.</p> <p>Indicative content</p> <p>Gold:</p> <ul style="list-style-type: none"> • is an excellent conductor of electricity • is an excellent conductor of heat • is a particularly heavy metal with a high density • has excellent resistance to corrosion. 	2 marks	AO4 1a

		This list is not exhaustive. Accept any other valid responses.		
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Qu	Part	Marking Guidance	Total marks	AO
17		<p>Give three reasons why a gel coat is used when laminating a glass reinforced plastic (GRP) product.</p> <p>1 mark for each appropriate reason to a maximum of 3 marks.</p> <p>Indicative content</p> <p>Gel coat:</p> <ul style="list-style-type: none"> • can be used to provide a pigment to the external surfaces of a GRP product • may be enhanced with additives such as UV stabilisers to increase the durability of the GRP product • provides a hard scratch resistant surface to a GRP product • produces an impermeable coating which protects the GRP product from water damage • provides a smooth flat surface that is capable of being polished to a high lustre. • Is the first stage of the moulding process that ensures a smooth outer surface finish and aids the release of the moulding once cured. <p>This list is not exhaustive. Accept any other valid responses.</p>	3 marks	AO4 1a

Qu	Part	Marking Guidance	Total marks	AO										
18		<p>Analyse and evaluate the impact that ‘open design’ has had on traditional product development.</p> <table border="1" data-bbox="331 434 1217 1081"> <thead> <tr> <th data-bbox="331 434 472 472">Marks</th> <th data-bbox="472 434 1217 472">Description</th> </tr> </thead> <tbody> <tr> <td data-bbox="331 472 472 707">7–9 marks</td> <td data-bbox="472 472 1217 707">The response includes detailed analysis and evaluation of the impact that ‘open design’ has had on traditional product development. The response outlines the key principles and how they have affected traditional product development. There may be some minor irrelevant points made but this will not detract from the overall quality of the response.</td> </tr> <tr> <td data-bbox="331 707 472 909">4–6 marks</td> <td data-bbox="472 707 1217 909">The response includes good analysis and evaluation of the impact that ‘open design’ has had on traditional product development with some reference to the key principles. There may be some irrelevant points made or a lack of clarity but this will not detract from the overall quality of the response.</td> </tr> <tr> <td data-bbox="331 909 472 1043">1–3 marks</td> <td data-bbox="472 909 1217 1043">The response includes basic analysis of ‘open design’ and tends to be descriptive rather than evaluative. At the lower end of the mark band statements will be largely generic.</td> </tr> <tr> <td data-bbox="331 1043 472 1081">0 marks</td> <td data-bbox="472 1043 1217 1081">No response worthy of credit.</td> </tr> </tbody> </table> <p>Indicative content</p> <ul data-bbox="331 1182 1217 1991" style="list-style-type: none"> • Allows any individual to design, develop, distribute and share their own work to anybody who wishes to make use of it in contrast to traditional designs whose ownership and rights to use are closely protected. • The ethos is to contribute for the greater good of society rather than traditional manufacture which is often financially driven. • Reduces opportunities for individuals and small businesses to profit from their own work. • Design work is often shared for no profit or fee so can prove popular with small designer/makers or hobbyists, removing the need to pay companies for their goods. • Supports collaborative development, so improvements and iterations are able to be constantly made and released in a much quicker timescale than commercial products. • Open design products can be developed with input from a huge volume of users with almost endless experience and skills, whereas traditional manufacture tends to have smaller teams with finite experience. • Open design can remove the demand and reliance on larger manufacturers as technologies such as 3D printing at home grow in popularity. 	Marks	Description	7–9 marks	The response includes detailed analysis and evaluation of the impact that ‘open design’ has had on traditional product development. The response outlines the key principles and how they have affected traditional product development. There may be some minor irrelevant points made but this will not detract from the overall quality of the response.	4–6 marks	The response includes good analysis and evaluation of the impact that ‘open design’ has had on traditional product development with some reference to the key principles. There may be some irrelevant points made or a lack of clarity but this will not detract from the overall quality of the response.	1–3 marks	The response includes basic analysis of ‘open design’ and tends to be descriptive rather than evaluative. At the lower end of the mark band statements will be largely generic.	0 marks	No response worthy of credit.	9 marks	AO3 2a AO3 2b
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0 marks	No response worthy of credit.													

		<ul style="list-style-type: none"> • Increased use of open design has resulted in more regular copyright breaches on items such as CAD files that are shared for 3D printing. • Open design offers an endless possibility for customisation and maintenance of products, reducing the frequency of purchasing replacement parts for products. • Open design is not subject to any international standard for testing or quality control which can prevent the designer/manufacturer having proven confidence in a design of a component. • The use of open design has created a culture in which many internet users feel they can use any works they find online, ignoring copyright or patent laws in their own country. • Traditional procedures for protecting designs such as patents are no longer needed. <p>This list is not exhaustive. Accept any other valid responses.</p>		
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Qu	Part	Marking Guidance	Total marks	AO
19	1	<p>Figure 13 shows the cross section of a tree trunk that is going to be sawn into planks as illustrated.</p> <p>Calculate the maximum width of Plank A and Plank D to the nearest 1 mm.</p> <p>You must show your working out.</p> <p>Length of Plank A (to the nearest mm)</p> $70^2 - 15^2$ <p style="text-align: right;">1 mark (M1)</p> $= 4675$ $= \sqrt{4675}$ $= 68.37 \text{ (Half of Plank A)}$ 68.37×2 $= 136.75$ <p style="text-align: right;">1 mark (A1)</p> $= 137 \text{ mm}$ <p>Length of Plank D (to the nearest mm)</p> $70^2 - 60^2$ $= 1300$ $= \sqrt{1300}$ $= 36.05 \text{ (Half of Plank D)}$ 36.05×2 $= 72.11$ <p style="text-align: right;">1 mark (A1)</p> $= 72 \text{ mm}$ <p>Note to markers :</p> <ul style="list-style-type: none"> - First mark can be obtained for use of Pythagoras in relation to either plank. - Second mark can be obtained for correct answer for either plank, not necessarily rounded. - Final mark awarded for all correct calculations including rounding. 	3 marks	AO4 1c

		Award zero marks if no working is shown.		
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Qu	Part	Marking Guidance	Total marks	AO
19	2	<p>Calculate the percentage of timber that can be converted into planks from the tree trunk.</p> <p>Show your working out.</p> <p>Total area of trunk cross section = πr^2 1 mark (M1)</p> <p>= $\pi \times 70^2$</p> <p>= [15 386, 15 393.80]</p> <p>Or</p> <p>4900 π</p> <p>Total area of all planks Plank A + Plank B + Plank C + Plank D 1 mark (M1)</p> <p>= (their 137 × 15) + (their 125 × 15) + (their 105 × 15) + (their 72 × 15)</p> <p>= (their 2055) + (their 1875) + (their 1575) + (their 1080)</p> <p>= their 6585 × 2</p> <p>or</p> <p>= 13 170 mm</p> <p>Percentage of usable timber $\frac{\text{Area of planks}}{\text{Area of trunk}}$ 1 mark (M1)</p> <p>= $\frac{13\,170}{[15\,386, 15\,395.80]}$ 1 mark (A1)</p> <p>= [0.85, 0.86]</p> <p>= [85, 86] %</p> <p>Percentage of usable timber [85, 86] % 4 marks</p> <p>Where no working has been shown but</p>	4 marks	AO4 1c

		final answer is accurate.		
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Qu	Part	Marking Guidance	Total marks	AO										
20		<p>Explain why a manufacturer may choose to use a vertical in-house production system.</p> <table border="1" data-bbox="331 436 1225 1131"> <thead> <tr> <th data-bbox="331 436 472 488">Marks</th> <th data-bbox="472 436 1225 488">Description</th> </tr> </thead> <tbody> <tr> <td data-bbox="331 488 472 741">5–6 marks</td> <td data-bbox="472 488 1225 741">The response shows a detailed and thorough understanding of why a manufacturer may use in-house production. The response identifies and explains several advantages to the company and how they could impact the manufacture. There may be some minor irrelevant points made but this will not detract from the overall quality of the response.</td> </tr> <tr> <td data-bbox="331 741 472 958">3–4 marks</td> <td data-bbox="472 741 1225 958">The response demonstrates a good understanding of why a manufacturer may use in-house production. The response identifies some benefits to the company and how they could impact the manufacture. There may be some irrelevant points made or a lack of clarity but this will not detract from the overall quality of the response.</td> </tr> <tr> <td data-bbox="331 958 472 1077">1–2 marks</td> <td data-bbox="472 958 1225 1077">The response offers a basic understanding of the benefits in-house production. At the lower end of the mark band statements will be largely generic.</td> </tr> <tr> <td data-bbox="331 1077 472 1131">0 marks</td> <td data-bbox="472 1077 1225 1131">No response worthy of credit.</td> </tr> </tbody> </table> <p>Indicative content</p> <p>Vertical in-house production:</p> <ul style="list-style-type: none"> • removes the reliance of a company on third party manufacturers to supply components and parts • offers the manufacturer greater control over the pricing of its products as it removes the risk of unexpected price increases from its suppliers • can reassure the manufacturer that their product is less susceptible to a delay in manufacture due to the supply and transportation of components from third party manufacturers • mitigates against the supply of components ending should the supplier go bust • can allow manufacturers greater control over the quality assurance procedures and provide increased confidence in the quality of their product • can improve the security of the intellectual property rights of the company, by removing the amount of companies involved in the product’s manufacture • can mean that design developments or improvements can be quickly introduced without the need to communicate or involve third party component manufacturers • can allow manufacturers to train and deploy staff to other areas of the production process providing additional flexibility. 	Marks	Description	5–6 marks	The response shows a detailed and thorough understanding of why a manufacturer may use in-house production. The response identifies and explains several advantages to the company and how they could impact the manufacture. There may be some minor irrelevant points made but this will not detract from the overall quality of the response.	3–4 marks	The response demonstrates a good understanding of why a manufacturer may use in-house production. The response identifies some benefits to the company and how they could impact the manufacture. There may be some irrelevant points made or a lack of clarity but this will not detract from the overall quality of the response.	1–2 marks	The response offers a basic understanding of the benefits in-house production. At the lower end of the mark band statements will be largely generic.	0 marks	No response worthy of credit.	6 marks	AO4 1b
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Qu	Part	Marking Guidance	Total marks	AO										
21		<p>Explain how a manufacturer of children’s toys would ensure that their product is safe for the consumer.</p> <table border="1" data-bbox="331 434 1224 1265"> <thead> <tr> <th data-bbox="331 434 472 490">Marks</th> <th data-bbox="472 434 1224 490">Description</th> </tr> </thead> <tbody> <tr> <td data-bbox="331 490 472 777">5–6 marks</td> <td data-bbox="472 490 1224 777">The response provides a detailed and thorough understanding of the measures that a toy manufacturer may undertake to ensure the safety of their products. The response identifies a range of manufacturer considerations and specific tests that may take place to ensure the safety of the toy. There may be some minor irrelevant points made but this will not detract from the overall quality of the response.</td> </tr> <tr> <td data-bbox="331 777 472 1064">3–4 marks</td> <td data-bbox="472 777 1224 1064">The response demonstrates a good understanding of the measures that a toy manufacturer may undertake to ensure the safety of their products. The response may identify considerations and some specific tests that may take place to ensure the safety of the toy. There may be some irrelevant points made or a lack of clarity but this will not detract from the overall quality of the response.</td> </tr> <tr> <td data-bbox="331 1064 472 1211">1–2 marks</td> <td data-bbox="472 1064 1224 1211">The response offers a basic understanding of measures that a toy manufacturer may undertake to ensure the safety of their products. At the lower end of the mark band statements will be largely generic.</td> </tr> <tr> <td data-bbox="331 1211 472 1265">0 marks</td> <td data-bbox="472 1211 1224 1265">No response worthy of credit.</td> </tr> </tbody> </table> <p>Indicative content</p> <ul data-bbox="331 1368 1206 1993" style="list-style-type: none"> • The manufacturer should ensure the shape and form of the product is safe with no sharp corners or features that may cause entrapment. • The toy should have been initially designed to meet international standards such as British Standard BS EN 71 or ‘The European toy safety directive’. • Appropriate choice of materials, fixings and fittings and finishes selected based on the desired mechanical and physical properties. • A range of testing would take place on all aspects of the toy including the form, the materials, its function and finish. • ‘Sharp point detection’ and ‘cutting edge’ test could take place to ensure that no harm comes to the user when interacting with the toy. • Detachment tests could take place and ‘small parts cylinders’ could be used to ensure that any small parts such as wheels or figure heads would not pose a choking hazard. 	Marks	Description	5–6 marks	The response provides a detailed and thorough understanding of the measures that a toy manufacturer may undertake to ensure the safety of their products. The response identifies a range of manufacturer considerations and specific tests that may take place to ensure the safety of the toy. There may be some minor irrelevant points made but this will not detract from the overall quality of the response.	3–4 marks	The response demonstrates a good understanding of the measures that a toy manufacturer may undertake to ensure the safety of their products. The response may identify considerations and some specific tests that may take place to ensure the safety of the toy. There may be some irrelevant points made or a lack of clarity but this will not detract from the overall quality of the response.	1–2 marks	The response offers a basic understanding of measures that a toy manufacturer may undertake to ensure the safety of their products. At the lower end of the mark band statements will be largely generic.	0 marks	No response worthy of credit.	6 marks	AO4 1b
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	<ul style="list-style-type: none"> • ‘Flammability testing’ would take place on the toy to ensure that the child has time to move away from the toy should it catch fire. • ‘Toxicity’ tests would take place on the material and surface finish to ensure that no harm would come to the child if a part of the toy was ingested. • Frequent sample testing would take place throughout manufactured batches to ensure consistent quality of manufacture. • The toy and the packaging would clearly display safety information, graphical symbols and user guidance such as suggested age ranges. • They would ensure that their product is sold with instructions for use and relevant safety information. <p>This list is not exhaustive. Accept any other valid responses.</p>		
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Qu	Part	Marking Guidance	Total marks	AO
22		<p>Name a specific application for each of the following composites:</p> <p>1 mark per correct application for each of the following to a maximum of 1 mark each.</p> <p>Indicative content</p> <p>Reinforced concrete:</p> <ul style="list-style-type: none"> • buildings • bridges • grid floors <p>Fibre cement:</p> <ul style="list-style-type: none"> • suspended flooring applications • exterior wall cladding and roofing • drainage components such as gutters and downpipes. <p>Carbon fibre reinforced plastic (CFRP):</p> <ul style="list-style-type: none"> • lightweight named piece of sports equipment • fishing rods • prosthetics <p>This list is not exhaustive. Accept any other valid responses.</p>	3 marks	AO4 1a

Qu	Part	Marking Guidance	Total marks	AO										
23		<p>Describe the stages required to produce a vacuum formed polymer product.</p> <table border="1" data-bbox="331 434 1222 929"> <thead> <tr> <th data-bbox="331 434 472 490">Marks</th> <th data-bbox="472 434 1222 490">Description</th> </tr> </thead> <tbody> <tr> <td data-bbox="331 490 472 607">5–6 marks</td> <td data-bbox="472 490 1222 607">The response covers in detail the required stages in a logical sequence to produce a successful vacuum formed polymer product.</td> </tr> <tr> <td data-bbox="331 607 472 792">3–4 marks</td> <td data-bbox="472 607 1222 792">The response recalls with some description, most of the main stages of the process, which, if followed, would achieve a successful vacuum formed polymer product. There may be some inaccuracies in the response, but they do not detract from the overall quality.</td> </tr> <tr> <td data-bbox="331 792 472 875">1–2 marks</td> <td data-bbox="472 792 1222 875">The response recalls the basic stages of vacuum forming.</td> </tr> <tr> <td data-bbox="331 875 472 929">0 marks</td> <td data-bbox="472 875 1222 929">No response worthy of credit.</td> </tr> </tbody> </table> <p>Indicative content</p> <p>Mould production</p> <ul data-bbox="331 1070 1222 1285" style="list-style-type: none"> • An accurate mould resembling the desired product is manufactured. • The mould may feature elements such as tapered sides, radiused edges, vacuum holes etc to aid a successful polymer moulding. • The completed mould is placed on the bed of the machine known as the 'platen'. <p>Mounting the polymer sheet in the machine</p> <ul data-bbox="331 1361 1222 1429" style="list-style-type: none"> • The thermoplastic polymer sheet is clamped into the machine above the mould creating an airtight seal. <p>Heating the polymer sheet</p> <ul data-bbox="331 1505 1222 1538" style="list-style-type: none"> • The polymer is then heated via a radiant heater. <p>Moulding the product</p> <ul data-bbox="331 1615 1222 1830" style="list-style-type: none"> • When the polymer is heated and has softened, the heat is removed. • The polymer sheet may be blown a little before raising the platen and mould into the softened sheet. • The vacuum pump is switched on and the air removed forcing the sheet to take the shape of the mould. <p>Removal of the mould</p> <ul data-bbox="331 1906 1222 2074" style="list-style-type: none"> • Once cooled, the mould is removed by lowering the platen. • Air can be blown in between the mould and moulding to aid its release. • The moulding is unclamped and removed from the vacuum forming machine. 	Marks	Description	5–6 marks	The response covers in detail the required stages in a logical sequence to produce a successful vacuum formed polymer product.	3–4 marks	The response recalls with some description, most of the main stages of the process, which, if followed, would achieve a successful vacuum formed polymer product. There may be some inaccuracies in the response, but they do not detract from the overall quality.	1–2 marks	The response recalls the basic stages of vacuum forming.	0 marks	No response worthy of credit.	6 marks	AO4 1a
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0 marks	No response worthy of credit.													

		<p>Trimming and finishing of the polymer product</p> <ul style="list-style-type: none">• Waste material is trimmed from the mould and can then be recycled.• Any apertures can be cut out and any decals or printed details can be added to the moulded product. <p>This list is not exhaustive. Accept any other valid responses.</p>		
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