# GCE

# Design and Technology

## H406/01: Principles of Product Design

A Level

# Mark Scheme for June 2024

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

# MARKING INSTRUCTIONS

## PREPARATION FOR MARKING
## RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Assessor Online Training*; *OCR Essential Guide to Marking*.

2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca

3. Log-in to RM Assessor and mark the **required number** of practice responses ("scripts") and the **number of required** standardisation responses.

   YOU MUST MARK 10 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

## MARKING

1. Mark strictly to the mark scheme.

2. Marks awarded must relate directly to the marking criteria.

3. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% (traditional 40% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.

4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone or the RM Assessor messaging system, or by email.

5. **Crossed Out Responses**
   Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

   **Rubric Error Responses – Optional Questions**
   Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM assessor, which will select the highest mark from those awarded. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

**Multiple Choice Question Responses**
When a multiple choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).
*When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.*

**Contradictory Responses**
When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

**Short Answer Questions** (requiring only a list by way of a response, usually worth only **one mark per response**)
Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

**Short Answer Questions** (requiring a more developed response, worth **two or more marks**)
If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

**Longer Answer Questions** (requiring a developed response)
Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there, then add a tick to confirm that the work has been seen.

7. Award No Response (NR) if:
    - there is nothing written in the answer space

Award Zero '0' if:

- anything is written in the answer space and is not worthy of credit (this includes text and symbols).

Team Leaders must confirm the correct use of the NR button with their markers before live marking commences and should check this when reviewing scripts.

8. The RM Assessor **comments box** is used by your team leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**
If you have any questions or comments for your team leader, use the phone, the RM Assessor messaging system, or e-mail.

9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10. For answers marked by levels of response:
    a. **To determine the level** – start at the highest level and work down until you reach the level that matches the answer
    b. **To determine the mark within the level**, consider the following

| Descriptor | Award mark |
|---|---|
| On the borderline of this level and the one below | At bottom of level |
| Just enough achievement on balance for this level | Above bottom and either below middle or at middle of level (depending on number of marks available) |
| Meets the criteria but with some slight inconsistency | Above middle and either below top of level or at middle of level (depending on number of marks available) |
| Consistently meets the criteria for this level | At top of level |

11. **Annotations**

| Annotation | Meaning |
|---|---|
|  | Blank Page – this annotation must be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response. |
|  | Tick |
|  | Cross |
|  | Confused (replaces the question mark) |
|  | Benefit of doubt |
|  | AO1 – Knowledge and understanding |
|  | AO2 – Apply knowledge and understanding |
|  | AO3 – Analyse |
|  | AO4 – Evaluation |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 1 | (a) | | Possible materials may include:<br><br>• Acrylic (1).<br>• Silicone (1).<br>• PVC (1).<br><br>Any other valid suggestion.<br><br>Justification for Silicone as an example:<br>• Flexible so it can fit into the ear comfortably (1).<br>• Transparent so that it can be discretely fitted (1).<br>• Malleable/ can be moulded to shape so it can be formed into the shape of ear (1).<br>• Any other valid suggestion.<br><br>Accept reference to flexibility if PP, LDPE, PVC or LSR (silicone rubber). | **2** | One mark for identifying a suitable material for the ear mould.<br><br>One mark for justifying why the material identified is suitable for its intended purpose. Specific reference to the context in the question is needed for marks to be awarded.<br><br>Reasons **must be justified for mark.**<br>No marks for one word answers e.g. flexible.<br><br>Accept<br>PC, PET, PVC, LSR (silicone rubber) PE, PP PS, PLA and ABS and nylon, resin or glass as all available in clear and can be moulded. Polymorph or Coolmorph are also acceptable. |
| | (b) | | Possible explanations may include:<br><br>• It gives a consistent accurate cross section for the tube (1) so it can be inserted into the ear mould/battery unit (1).<br>• It can be used for high volume production (1) and as there will be a lot of hearing aids manufactured (1).<br>• Extrusion allows for a continuous cross section/tube to be produced (1) and cut to length to fit the required length of tubing (1) | **2** | Up to two marks for explaining why extrusion would be used to manufacture the tube.<br><br>Specific reference to the context in the question is needed for marks to be awarded. |

| Question | | | Answer | Mark | Guidance |
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| | | | • Any other valid suggestion. | | |
| | **(c)** | | Possible responses may include:<br><br>• Ear hook: prevents the device falling off when in use (1) as it wraps around the ear and enables the ear to carry some of the weight (1).<br>• Battery compartment: has a ridge on the surface for grip (1) to make it easier for the user to open it (1).<br>• Ear Mould: moulded to fit an individual's ear (1) meaning the user does not need to worry about it falling out when moving around (1).<br>• Any other valid suggestion. | **4** | In each case:<br><br>Up to two marks for explaining how a feature of the hearing aid improves ease of use.<br><br>Specific reference to the hearing aid or the user is needed for marks to be awarded.<br><br>**Note:**<br>Do not award any marks for just identifying a feature. |

| Question | | | Answer | Mark | Guidance |
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| | (d) | (i) | **Indicative content:**<br>**Influences of new and emerging technologies:**<br>Possible responses could include:<br>New and emerging technologies could develop the size, shape, materials and functionality of the design, to improve usability, manufacturing and ergonomics. Ways in which these technologies could influence the design could include:<br><br>• The ways that the device is programmed, they could consider the use of blue tooth to transmit settings and programs from a mobile phone to the device. This could include reference to the control of the volume level or settings for public places. The development of lithium batteries to enable the device to have a smaller battery *size* reducing to enable the device to be light enough and small enough to be worn daily increasing comfort.<br>• The development of rechargeable batteries and their life removing the need to replace the battery, removing waste and having longer intervals in between charging.<br>• The design could utilise contactless charging could be used to re-charge the earpieces while the user sleeps, this could be integrated into a bed enabling the user to be able to sleep in the hearing aids.<br>• The development of mouldable materials for the earpiece means that the user can customise the ear moulds to their ears for fit.<br>• Earpiece needing to fit the ear, ability to change this as the user grows makes it better as it can "grow" could be 3d printed. AI could be incorporated to allow intelligent volume control that responds to volume level of surrounding environment. Two-way audio allows users to make and take phone calls. | **6**<br><br>Accept reference to technological advancement and new materials.<br><br>Accept reference to the new technologies used by the designer or used in the product.<br><br>For level 3 candidates should be drawing on at least two specific examples of new and emerging technologies | **Level 3 [5-6 marks]**<br>The candidate has a clear understanding of the influences new and emerging technologies have on the design of the hearing aid They produce a thorough discussion in relation to the question.<br>The explanation of reasons is clear and well-developed and a number of examples are used to exemplify the points being made.<br><br>**Level 2 [3-4 marks]**<br>The candidate has a reasonable understanding of the influences new and emerging technologies have on the design of the hearing aid. They produce a reasonable discussion in relation to the question. The explanation of examples is sufficient although one or two opportunities are missed in referring to different examples.<br><br>**Level 1 [1-2 marks]**<br>The candidate has a basic knowledge of the influences new and emerging technologies have on the design of the hearing aid. Any reference to this issue is |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| | | | • IoT (Internet Of Things) use of phone to control hearing aid from a phone/device, set levels of volume etc.<br>• Use of smart and modern materials, graphene, shape memory polymer, conductive materials, graphene. Nano technologies allow use of superhydrophobic coatings and wax repelling surfaces to keep the device clean; or for reduction in size of transistors/ chips etc.<br>• Implants – cochlear implants, neuralink, BCI (brain computer interface) being developed by Elon musk trials in humans Jan 24 and FDA approval - fine threads to help transmit brain signals.<br>• Any other valid suggestion. | | descriptive in nature and has little appreciation of the issues. The response contains no analysis or evaluation.<br><br>**0 marks**<br>No answer or answer not worthy of credit. |
| | | **(ii)** | Possible impacts on the user may include:<br><br>• Positive effect on lifestyle and ease of use, through seamless updating/ easier charger leads/ reduction in size (1) means that can be worn more discretely and seen as less of a "disability" (1).<br>• Fashion influencing design so users feel that the device is not something to hide, (1) more throw away devices as they go out of fashion which could have a negative environmental effect/ larger cost for the consumer (1).<br>• Cost could increase with more complex features (1) which may make the product less affordable, making it less accessible to the people that need it (1).<br>• May be harder for elderly to "keep up" with new technologies (not got a compatible phone etc) (1) so this could alienate a key target market (1).<br>• Any other valid suggestion. | **6** | In each case:<br><br>Up to one mark for identifying an impact on the user of incorporating new and emerging technologies into the design of the hearing aid.<br><br>One mark for justifying impact given.<br><br>Specific reference to the context in the question is needed for marks to be awarded. |

| Question | | | Answer | Mark | Guidance |
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| | **(e)** | | Possible explanations may include:<br><br>They could have been designed for disassembly with the labelling of materials on the casing parts for the ease of separating components (1) and joined with semi-permanent standardised fixings like screws(1) so they could be sorted and re-used, recycled etc. (1)<br><br>The parts of the hearing aid (tubing/ speaker/ microphone) could be use of standardised components that can be re-used on other products (1) The use of a neutral colour so other users could use the same casing (1) They could have optimised the materials so that there is less material wasted at the end of life (1)<br><br>Other possible references could include the use of biodegradable materials, Resin Identification Codes and snap fittings.<br><br>Any other valid suggestion. | **3** | Up to three marks for explaining how the hearing aid components could have been designed for disposal and end of product life.<br><br>Specific reference to the context in the question is needed for marks to be awarded. |

| Question | | | Answer | Mark | Guidance |
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| 2 | (a) | | Possible reasons may include:<br><br>• Increase of pets in the home due to covid, which may cause undesirable smells (1) might mean people need a way of 'freshening up' the smell of their house. (1).<br>• Social media promoting these products with influencers (1) would lead to an increase in demand as people want to emulate the celebrity (1).<br>• Increase awareness of environmental issues and carbon footprint (1) so users are moving away from products that need electricity e.g. plug in air fresheners (1).<br>• The increased awareness of the environmental issues (1) so that users are looking for more natural remedies that do not use chemicals/cruelty free for home air fresheners (1).<br>• Improve mood, well-being, metal health combatting the impact of stress (1) as they act as a relaxant/ sleep aid (1).<br>• Use of aromatherapy plant oils (1) to treat/ prevent disease (1).<br><br>Any other valid suggestion such as BOGOF offers, cost reductions, new ranges etc. | 4 | In each case:<br><br>Up to one mark for identifying a reason why sales of the reed diffuser may have increased in recent years.<br><br>Up to one mark for explaining reason given.<br><br>Specific reference to the context in the question is needed for marks to be awarded. |

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>Volume of a cylinder = $\pi r^2 h$ [1]<br><br>32mm = 3.2 cm radius of circle and 44mm = 4.4 cm (height of cylinder reducing glass e.g. 52 – 5 – 3) [1]<br><br>Π x 3.2*$^2$ x 4.4* = Π x 10.24* x 4.4* = Π x 45.06* = 141.5475986* cm$^3$ [1]<br><br>=142 cm$^3$ [1]<br><br>Accept 141.566 as non-rounded for 3 marks as this is from Π as 3.142<br><br>The candidate may have used a different route using V=Cxrxh then followed through with integration (calculus) to achieve the answer; award credit if this process is used.</td><td>4</td><td>Award four marks as follows:<br><br>One mark for recalling formula $\pi r^2 h$ or Π x 3.2*$^2$ x 4.4*.<br><br>One mark for both calculating radius and height.<br><br>One mark for calculation.<br><br>One mark for rounding to the nearest cm$^3$.<br><br>If correct answer is given without working out shown award full marks.<br><br>Where an incorrect answer is given working out should be used to credit appropriate marks.<br><br>*Allow error carried forward (ECF) where correct working out is shown.</td></tr>
<tr><td></td><td></td><td>(ii)</td><td><table><tr><td>Quantity of oil</td><td>Cost</td></tr><tr><td>1 litre</td><td>£10.00</td></tr><tr><td>2 litres</td><td>£19.40</td></tr><tr><td>3 litres</td><td>£29.10</td></tr><tr><td>4 litres</td><td>£38.80</td></tr><tr><td>5 litres</td><td>£48.50</td></tr></table></td><td>2</td><td>Award two marks as follows:<br><br>One mark for first two boxes successfully competed. (£19.40 and £29.10)<br><br>One mark for third and fourth box successfully completed. (£38.80 and £48.50)</td></tr>
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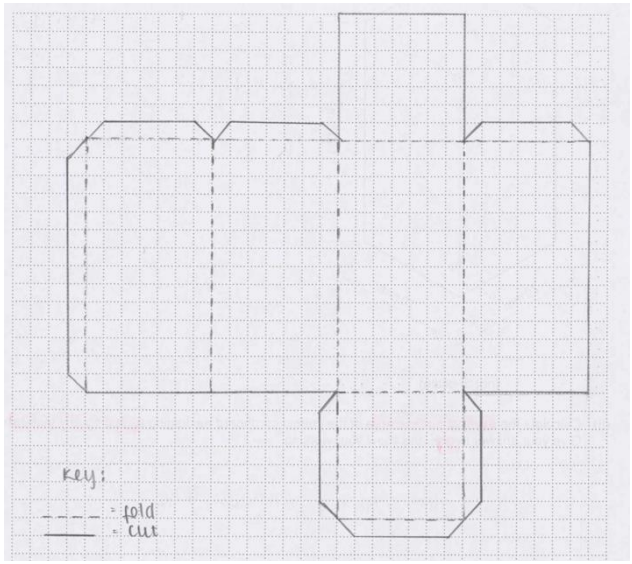
| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| | | **(iii)** | 142 $cm^3$ = 142ml<br><br>142*/ 25 = 5.68* [1] (portions of 25ml), has to be complete 25ml increments and therefore the answer would be 6 [1]<br><br>Answers need to be rounded up to work out oil increments | **2** | Award two marks as follows:<br><br>One mark for calculating portions of 25 ml.<br><br>One mark for calculating how many 25 ml increments are needed.<br><br>If correct answer is given without working out shown award full marks.<br><br>Where an incorrect answer is given working out should be used to credit appropriate marks.<br><br>*Allow error carried forward (ECF) where correct working out is shown. |
| | **(c)** | **(i)** | Example of drawn net<br>  <br> | **5** | Award five marks as follows:<br><br>One mark - all 6 panels drawn (any workable solution).<br><br>One mark - correct width of top/bottom and width of panels 70mm.<br><br>One mark - correct height of panels 140mm.<br><br>One mark – accurate glue tab(s) indicated on net to create a workable net.<br><br>One mark – accuracy of drawing.<br><br>**If panels are drawn separately max 3 marks** |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| | | **(ii)** | SA = 4 x sides + top and bottom)<br>= (4 x (14 x 7)) + (2 x (7 x 7)) [1]<br><br>SA = (4 x 98) + 98 = 5 x 98 = 490 $cm^2$ [1] | **2**<br>**M1** | Award two marks as follows:<br><br>One mark for determining the calculation that is needed to calculate the external surface area of the cardboard packaging.<br><br>One mark for calculating the external surface area of the cardboard packaging.<br><br>If correct answer is given without working out shown award full marks.<br><br>Where an incorrect answer is given working out should be used to credit appropriate marks. |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 3 | (a) | | Ethical Trade Initiative:<br>• An alliance of companies, trade unions and non-governmental organisations (1) that promotes respect for workers' rights around the globe (1).<br>or<br>• An internationally agreed code of practice among companies (1) for all areas of employment/ labour practice (1)<br>• Any other valid suggestion. | 2 | Up to two marks for a description. |
| | (b) | | Fair Trade:<br>• A concept about better process, decent working conditions (1) and fair terms of trade/ payment for farmers and their workers (1).<br>or<br>• Companies aim to be fair when sourcing/growing materials/ use of natural pesticides when producing materials and products (1) to the treatment of workers/provision of a safe working environment and fair pay and working conditions. (1)<br>• Any other valid suggestion. | 2 | Up to two marks for a description. |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| | (c)* | | **Indicative content:**<br><br>**Challenges/issues faced by manufacturers & designers:**<br>Possible responses could include:<br><br>• The selection of ethically **sourced materials** which could lead to an **increased cost** of ingredients or components, which drives the cost of the product up.<br>• **Limited choices of suppliers** as evidencing **transparency** in production can be difficult and **meeting high demand** for supply to keep up with changing trends might **lead to delays** in production which will **affect the brand**.<br>• Trust in suppliers and sources as links to child/ slave labour/ sweat shops can damage reputation. **Raising awareness** of working conditions amongst consumers to promote FT products. e.g. controversy with the BooHoo clothing brand<br>• Promotion of ethical choices which could lead to the **increased desirability** from consumers who are looking for ethical brands e.g. Greggs using fair trade cocoa in their products<br>• **Disclosure of sources** for components and transparency e.g. Apple disclosing identity of suppliers and joining the FLA (Fair Labor | **8** | **Level 3 [6-8 marks]**<br>The candidate has a clear understanding of the issues relating to industrial manufacture surrounding fairtrade and Ethical Trade initiative. They produce a thorough discussion in relation to the question.<br>The explanation of reasons is clear and well-developed and a number of examples of challenges/issues are used to exemplify the points being made. There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated with the use of examples.<br><br>**Level 2 [3-5 marks]**<br>The candidate has a reasonable understanding of the issues relating to industrial manufacture surrounding fairtrade and Ethical Trade initiative. They produce a reasonable discussion in relation to the question. The explanation of examples is sufficient although one or two opportunities are missed in referring to different examples of challenges/issues. There is a line of reasoning presented with some structure. The information presented is for the most part relevant and supported by some evidence.<br><br>**Level 1 [1-2 marks]**<br>The candidate has a basic knowledge of the issues relating to industrial manufacture surrounding |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| | | | Association) as a commitment to greater transparency and independent oversight, hoping participation will set a new standard for the electronics industry.<br><br>Other specific examples could include:<br>• Body shop<br>• ASDA<br>• Primark<br>• Ben and Jerrys using fairtrade ingredients | | fairtrade and Ethical Trade initiative. Any reference to this issue is descriptive in nature and has little appreciation of the challenges/issues. The response contains no analysis or evaluation. The information has some relevance and is presented with limited structure or detail. The information is supported by limited evidence.<br><br>**0 marks**<br>No answer or answer not worthy of credit. |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 4 | (a) | (i) | Use annotated sketches and/or notes, to show how a single prototype of the **adjusting wheel and threaded bar** could be manufactured.<br><br>**Indicative content:**<br><br>**The candidate is expected to demonstrate their understanding of the process involved through a series of annotated sketches and/or notes.**<br><br>**There may be variations to the process as indicated but to get into L3 candidates must demonstrate a clear understanding of the end-to-end process.**<br><br>To manufacture the screw both hand, machine (centre lathe) and CNC methods are acceptable including the use of a 3D printer. With all references to CAD CAM there would be an expectation for all the relevant stages. This should include explaining how the files were created to program the machine, how the machine works and how the end product is removed and finished.<br><br>Metal rod could be mounted in a three-jaw chuck on the lathe. Select the speed, appropriate pitch and threading direction with clear markings on the rod for the start and finish of the thread. Set the threading tool into the tool post, ensuring it Is square and at the correct height. A thread is cut into the rod using the automatic feed. Use of the chamfering tool to remove any burrs or sharp edges. | **5**<br><br>For level 3 – answers should cover both the bar and adjusting wheel and cover materials, machinery and tools/equipment.<br><br>Candidates do not have to consider the assembly of parts to access the full 5 marks. | **Level 3 [4-5 marks]**<br>The candidate demonstrates a good level of detail of the process needed to manufacture a **single prototype** of the **adjusting wheel and threaded bar** using technical terms and considering any relevant equipment, machinery and materials. Sketches, if used will be clear and supported with relevant notes. The process includes all relevant stages.<br><br>**Level 2 [2-3 marks]**<br>The candidate will demonstrate a sound level of detail of the process needed to manufacture a **single prototype** of the **adjusting wheel and threaded bar** using some technical terms and there will be some consideration of any relevant equipment, machinery and materials. Sketches, if used, will for the most part be clear and supported with notes most of which are relevant. The process includes some relevant stages.<br><br>**Level 1 [1 mark]**<br>The candidate will demonstrate a limited level of detail of the process needed to manufacture a **single prototype** of the **adjusting wheel and threaded bar** with a limited use of technical terms and there will be a basic consideration of any relevant equipment, machinery and materials. |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| | | | The ends of the rod are then finished and faced off.<br><br>A tap and die could be used to cut the screw thread – involving use of a die cutter to cut an external thread and possibly a tap to cut internal thread in the adjusting wheel.<br><br>The adjusting wheel could be cast (resin or pewter) or cut with a CNC machine or plasma cutter or cut from a larger diameter rod with a hacksaw or faced and parted with a lathe (grip could be knurled). It could also be 3D printed, a CAD drawing would be produced then the part would be 3D printed from PLA or ABS layer by layer.<br><br>As this is a prototype candidates could also be rewarded for considering that the adjusting wheel and screw could be manufactured from an alternative material e.g. the adjusting wheel could be PLA.<br><br>Any other valid suggestion. | | Sketches, if used, will be unclear with only basic notes to accompany them. Few relevant stages are included.<br><br>**0 marks**<br>No response or no response worthy of credit |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| | | (ii) | Use annotated sketches and/or notes, to show how the **leg** could be manufactured. Identify any relevant specialist tooling and quality control checks.<br><br>**Indicative content:**<br><br>**The candidate is expected to demonstrate their understanding of the process involved through a series of annotated sketches and/or notes. There may be variations to the process as indicated but to get into L3 candidates must demonstrate a clear understanding of the end-to-end process.**<br><br>Candidates could cover cold chamber or hot chamber pressure die casting; this is the most appropriate cost effective and efficient process for a batch of 100,000 from metal.<br><br>Whichever die casting process is chosen, the following stages apply: A hardened steel mould / die capable of producing tens of thousands of castings in rapid succession is made in two parts to permit removal of castings. For Part A is it likely to be a multiple cavity die. 'Cores' (rods) would be included as part of the dies to produce the pivot holes. | **8**<br><br>Metal processes that are not the most efficient or most suitable for a batch of 100,000 of the compass leg (part A) can be credited but a suitable process that is cost effective and efficient is expected for level 3. | **Level 3 [6-8 marks]**<br>The candidate demonstrates a good level of detail of the process needed to manufacture **leg part A** using technical terms and considering any relevant specialist tooling and quality control checks. Sketches, if used will be clear and supported with relevant notes. The process includes all relevant stages.<br><br>**Level 2 [3-5 marks]**<br>The candidate will demonstrate a sound level of detail of the process needed to manufacture the **leg part A** using some technical terms and there will be some consideration of any relevant specialist tooling and quality control checks. Sketches, if used, will for the most part be clear and supported with notes most of which are relevant. The process includes some relevant stages.<br><br>**Level 1 [1-2 marks]**<br>The candidate will demonstrate a limited level of detail of the process needed to the **leg part A** with a limited use of technical terms and there will be a basic consideration of any relevant specialist tooling and quality control checks. Sketches, if used, will be unclear with only |

| Question | | | Answer | Mark | Guidance |
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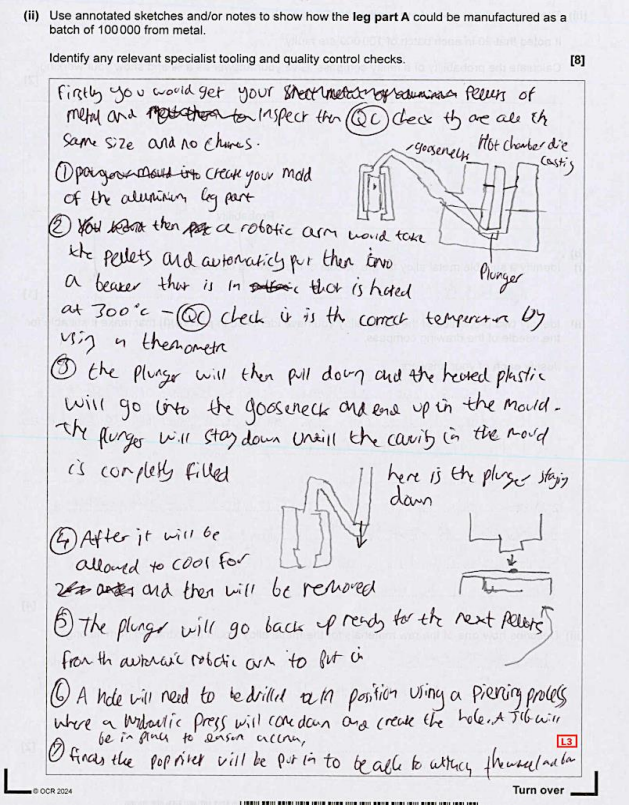
| | | | The two sections of the mould / die are mounted securely in a machine and are arranged so that one is stationary (fixed) while the other is moveable.<br><br>To begin the casting cycle, the two die halves are clamped tightly together by the die casting machine. Hydraulics are used to achieve the high pressures involved. Molten metal of a sufficient quantity for Part A (plus sprue) is injected into the die cavity where it solidifies quickly.<br><br>Dies are cooled by water circulating through channels / holes in the dies. The components will solidify quicker, and the casting can be removed while solid but still hot, enabling the process to be repeated giving a much faster cycle time / turnaround of components.<br><br>The die halves are drawn apart and the casting is ejected. The sprue and flashing are trimmed off and fed back into the system<br><br>**Quality Control**<br>The die is prepared, heated to a suitable temperature and lubricant added/ sprayed. This is a QA stage as it helps to maintain the temperature, prevents premature solidification and aids removal of cast.<br>• the moulding is checked for porosity, cracks and problems with the evenness of the flow. QC | | basic notes to accompany them. Few relevant stages are included.<br><br>**0 marks**<br>No response or no response worthy of credit.<br><br>Example of a level 3 response<br><br>  <br>(ii) Use annotated sketches and/or notes to show how the **leg part A** could be manufactured as a batch of 100 000 from metal.<br>Identify any relevant specialist tooling and quality control checks. [8]<br>Firstly you would get your ~~sheet metal~~ pellets of metal and ~~put them~~ to inspect then (QC) check they are also the same size and no chunks.<br>(1) ~~pour~~ ~~mould into~~ check your mold of the aluminium leg part<br>(2) ~~You~~ ~~then~~ ~~put~~ a robotic arm would take the pellets and automatically put them into a beaker that is in ~~the~~ that is heated at 300°c – (QC) check it is the correct temperature by using a thermometer<br>(3) the plunger will then pull down and the heated plastic will go into the gooseneck and end up in the mould. The plunger will stay down until the cavity in the mold is completly filled<br>here is the plunger staying down<br>(4) After it will be allowed to cool for ~~2 mins~~ and then will be removed<br>(5) The plunger will go back up ready for the next pellets from the automatic robotic arm to put in<br>(6) A hole will need to be drilled to in position using a piercing process where a hydraulic press will come down and create the hole. A jig will be in place to ensure accuracy, L3<br>(7) finally the pop rivet will be put in to be able to attach the metal and leg<br>Gooseneck Hot chamber die casting Plunger<br>© OCR 2024 Turn over |

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| | | | dimensions and weight of casting (every 100 are checked (Go/no-go gauge). Visual inspection etc<br><br>Any other valid suggestion.<br><br>MIM (metal injection moulding) is acceptable, but this process uses powder and heat (sintering) and differs from the polymer process. | | |
| | | **(iii)** | P = 20/100000 = 0.0002 [1]<br><br>= 0.02% [1] | **2** | Award two marks as follows:<br><br>One mark for calculating probability.<br><br>One mark for giving answer as a percentage.<br><br>If correct answer is given without working out shown award full marks.<br><br>Where an incorrect answer is given working out should be used to credit appropriate marks. |

| Question | | | Answer | Mark | Guidance |
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| 4 | (b) | (i) | Possible metal alloys could include:<br><br>• High Carbon Steel (1).<br>• Stainless Steel (1).<br>• Aluminium alloy (1).<br>• Any other valid suggestion. | 1 | One mark for identifying a suitable material.<br><br>Specific reference to the context in the question is needed for marks to be awarded.<br><br>Accept Tungsten, Steel and Aluminium as they are commonly materials in alloy form. Brass and Bronze are also acceptable |
| | | (ii) | Justification could include:<br><br>High Carbon Steel:<br>• The carbon in the steel could be heat treated which would enable the tip to be **hardened** (1) so that it would not wear over time or break with the force exerted on it in use (1).<br>• High carbon steel has good **hardness** (1) and the tip will not damage easily over time (1).<br>• The **toughness** of the material would mean that it would withstand being knocked around in the school bag or pencil case (1) without snapping and increase the product life (1).<br><br>Stainless Steel:<br>• **Resists corrosion**, through the addition of alloyed elements (1) so would last longer and would not mark the paper being drawn on (1). | 4 | In each case:<br><br>One mark for identifying a physical or working property of the metal alloy with reference to context. Do not accept one-word answers such as durable, lightweight, tough without qualification.<br><br>One mark for justifying given **property**. Specific reference to the context in the question is needed for marks to be awarded.<br><br><u>Properties guidance:</u><br>**Stainless steel** – corrosion resistant, good compressive strength, durable and tough<br>**Mild steel** – can be hardened by case hardening, tough<br>**High Carbon Steel** – high resistance to wear/ durable, hardness/withstands scratches<br>**Tungsten** – corrosion resistant, good compressive strength, durable and tough |

| Question | | | Answer | Mark | Guidance |
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| | | | Any other valid justified suggestion. | | **Brass** – durable, hardness/withstands scratches, resistant to corrosion, good compressive strength<br>**Bronze** – tough, corrosion resistant<br>**Aluminium/ aluminium alloy**- good strength to weight ratio, corrosion resistant, good compressive strength. |
| | | **(iii)** | Possible responses may include:<br><br>Iron ore is **mined** from earth (1) It is refined/ with smelting in a blast furnace to remove impurities/ separate impurities (1).<br>**or**<br>Bauxite ore/ Ore is **mined** from earth. (1) It is refined using **Electrolysis/ smelting/ heat to separate impurities** to extract the aluminium (1).<br><br>Any other valid justified suggestion depending on response to part i. | **2** | One mark for reference to **how** the material is extracted from the ground.<br><br>One mark for reference to the **refining** of the material. |

| Question | | | Answer | Mark | Guidance |
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| | | **(iv)** | Possible ways may include:<br><br>• Elimination of waste from the flashing or sprues (1) by feeding it back into the process and using it again/ elsewhere (1).<br>• Reduction of components within the design to have less stages in the production. (1) which saves time and costs (1).<br>• More efficient work areas that are organisation with consecutive tasks next to one another (1) to avoid time lost moving between stations (1).<br>• Any other valid suggestion. | **4** | In each case:<br><br>Up to two marks for describing a way in which lean manufacturing could have impacted on production.<br><br>Specific reference to the context in the question is needed for marks to be awarded. |

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