GCE

Design and Technology

H404/01: Principles of Design Engineering

A Level

Mark Scheme for June 2025

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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 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 available in RM Assessor

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

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, email or via the RM Assessor messaging system.

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 the annotation 'SEEN' to confirm that the work has been seen and mark any responses using the annotations in section 11.

7. There is a NR (**No Response**) option. Award NR (No Response):

   - if there is nothing written at all in the answer space
   - OR if there is a comment which does not in any way relate to the question (e.g., 'can't do', 'don't know')
   - OR if there is a mark (e.g., a dash, a question mark) which is not an attempt at the question.

   Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).

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.**

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
BP	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
SEEN	Noted but no credit given
BOD	Benefit of doubt
L1	Level 1 response
L2	Level 2 response
L3	Level 3 response
ECF	Error carried forward
^	Omission
NAQ	Not answered question
CON	Confused (replaces the question mark)
TV	Too vague
OFR	Own figure rule
REP	Repetition

12. Subject Specific Marking Instructions

INTRODUCTION

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

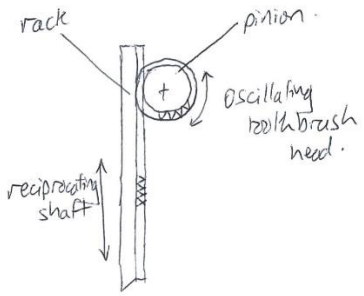
You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet Instructions for Examiners. If you are examining for the first time, please read carefully Appendix 5 Introduction to Script Marking: Notes for New Examiners.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

Question			Answer	Mark	Guidance
1	(a)	(i)	Possible functional reasons may include: • To allow different users to have their own toothbrush head (1). • To allow the head to be easily cleaned (1). • So the head can be replaced when worn (1). • To allow heads with soft/hard bristles to be used (1). • Removal makes the toothbrush more compact for transportation (1) as it takes up less space (1). • Any other valid suggestion.	3	In each case: One mark for identifying a functional reason why the electric toothbrush has a removeable head. Specific reference to the context in the question is needed for marks to be awarded.
		(ii)	Possible properties may include: • Thermo softening polymers (TPs) can be injection moulded (1) to create the complex shape of the electric toothbrush (1). • TPs can be coloured during the moulding process (1) which is needed to create a white case (1). • TPs are durable/water resistant which allows the electric toothbrush to be cleaned easily (1). • TPs can have a smooth surface (1) which allows the electric toothbrush to be kept hygienically clean (1). • TPs are recyclable (1), which would allow the casing to be recycled (1). • TPs can be manufactured in a range of colours (1), enabling the manufacturer to modify batch manufacture for a greater range of users (1). • Any other valid suggestion.	4	In each case: One mark for identifying a property of a thermo softening polymer that makes it suitable for the casing of the electric toothbrush. One mark for justifying response given. Specific reference to the context in the question is needed for marks to be awarded. Do not accept bad conductor as a property if not identified as being a bad electrical conductor.

Question			Answer	Mark	Guidance
		(iii)	Possible manufacturing challenges may include: • The soft grip section will be moulded on top of the main case (1). This is called over moulding which adds an additional stage/increases costs significantly (1). • Adding the soft grip section will require investment of extra moulding machinery (1) which requires operator training/wages (1). • Adding an extra stage slows down the manufacturing process (1). • Extra quality control checks will be needed to ensure that the soft grip material has bonded properly to the main case (1). • Thermosetting polymers are usually non-recyclable (1) which may impact on the EOL issues for the electric toothbrush (1). • The cost of the thermosetting polymer material needs to be taken into account (1). • Any other valid suggestion.	4	In each case: Up to two marks for describing a challenge to the manufacturer of including a soft-grip section on the casing of the electric toothbrush. Specific reference to the context in the question is needed for marks to be awarded. Do not re-award marks for repeated points (e.g. about cost or time).
	(b)	**(i)**	Recall of formula P=IV (1) (science) P = 0.1 x 3.7 = 0.37W (1)	2	Award two marks as follows: One mark for recall of P=IV (non maths) One mark for substitution of numbers into formula and calculation of the amount of power needed. If correct answer is given without working out shown award full marks.

Question			Answer	Mark	Guidance
					Where an incorrect answer is given working out should be used to credit appropriate marks.
		(ii)	Power into battery = Power from mains x 0.74 Power from mains = Power into battery / 0.74 Power from mains = 0.37* / 0.74 (1) = 0.5W (1)	2	Award two marks as follows: One mark for correctly expressing the 74% efficiency of the system. One mark for calculating the power drawn from the mains power supply during the charging process. If correct answer is given without working out shown award full marks. Where an incorrect answer is given working out should be used to credit appropriate marks. *Allow error carried forward (ECF) where correct working out is shown. Note that candidates may express the % as: Power into battery = (Power from mains/100) x 74

Question			Answer	Mark	Guidance
	(c)		Mechanism could be a rack and pinion:  A crank mechanism would also work.	2	Award two marks as follows: One mark for communicating how reciprocating motion could be converted to oscillating motion in the brush head. One mark – sketch of suitable mechanism that will work. Responses with no sketch are limited to 1 mark.

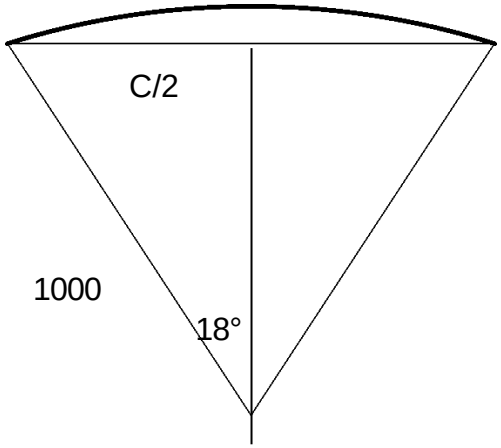
Question			Answer	Mark	Guidance
	(d)		**Indicative content:** • The head shape is small and round which gives better access to the sides of the teeth to improve brushing effectiveness. • Length and girth of electric case is designed to fit comfortably in the user's hand, which makes it easy to hold and to manipulate whilst brushing. • The soft grip surface improves grip especially when the electric toothbrush is wet. This makes it less likely to drop the electric toothbrush during use. • The control button lies neatly under the thumb which makes it easy to operate single-handedly. • There are some ridged grips under the thumb to improve grip, but more ridges might be helpful under the palm or where the fingers lie. • The indicator lights served a useful function, but their position means they cannot be seen during brushing. Placing them on the top of the cylindrical case would have improved their visibility. • Any other valid suggestion.	8	**Level 3 [6-8 marks]:** The candidate has a clear understanding of the ergonomic design features of the electric toothbrush They produce a thorough discussion in relation to the question. The explanation of features is clear and well-developed and four or more examples of these design features are used to exemplify the points being made. **Level 2 [3-5 marks]:** The candidate has a reasonable understanding of the ergonomic design features of the electric toothbrush. They produce a reasonable discussion in relation to the question. The explanation of two to three examples is sufficient although one or two opportunities are missed in referring to different examples of these design features. **Level 1 [1-2 marks]** The candidate has a basic knowledge of the ergonomic design features of the electric toothbrush. Any reference to this issue is descriptive in nature and has little appreciation of the issues. The response contains no analysis or evaluation. **0 marks** No response or no response worthy of credit.

Question			Answer	Mark	Guidance
2	(a)	(i)	Use Volume = $\frac{4}{3}\pi r^3$ to calculate the <u>inner radius</u> of the sphere: $\frac{4}{3}\pi r^3 = 45$ Rearrange: $r^3 = 45 \ / \ \frac{4}{3}\pi$ $r^3 = 10.7429586587$* r = 2.20652051* cm (1) = 22.0652051* mm (1) External radius of sphere: R = 22.0652051* + 3 = 25.0652051* mm (1) External diameter of sphere = 2 x external radius External diameter of sphere = 2 x 25.0652051* (1) = 50.1304102* mm = 50.1 mm (1)	5	Award five marks as follows: One mark for calculating inner radius. One mark for converting units (cm to mm). One mark for adding wall thickness. One mark for converting to diameter One mark for calculating external diameter of sphere to 3SF. If correct answer is given without working out shown award full marks. Where an incorrect answer is given working out should be used to credit appropriate marks. *Allow error carried forward (ECF) where correct working out is shown. Note: The candidate may use answers to 3SF throughout and should be awarded marks as above. The answer will be 50.2 mm and should be awarded full marks.

Question			Answer	Mark	Guidance
		(ii)	Rearrange formula: $L = V / \pi r^2$ (1) $\prod r^2$ $= \prod ((1.75/2)^2 = \prod (0.875^*)^2 = \prod \times 0.765625^*$ $= 2.4052818754^*\ mm^2$ [1] [1] $(2.2 \times 10^4) / 2.4052818754^*$ $= 22000\ mm^3 / 2.4052818754^*\ mm^2$ $= 9146.53713771\ mm$ [1]	4	Award four marks as follows: One mark for rearrangement of cylinder volume formula. One mark for determining radius from given diameter. One mark for calculating cross sectional area. One mark for substituting values into formula and calculating length in millimetres (mm) of PLA filament wire that will be used. If correct answer is given without working out shown award full marks. Where an incorrect answer is given working out should be used to credit appropriate marks. *Allow error carried forward (ECF) where correct working out is shown. Accept reasonable rounding in answer. Accept different starting points for $\prod$.

Question			Answer	Mark	Guidance
	(b)	**(i)**	Number suffering Fault A = number in batch x Probability (A) Number suffering Fault A = 35000 x 0.02 (1) = 700 (1)	2	Award two marks as follows: One mark for determining the correct probability calculation. One mark for calculating the number of parts in the batch that are likely to suffer fault A. If correct answer is given without working out shown award full marks. Where an incorrect answer is given working out should be used to credit appropriate marks.
		(ii)	Probability of suffering both faults together = Probability (A) x Probability (B) Number suffering both faults = 35000 x 0.02 x 0.01 (1) = 7 (1)	2	Award two marks as follows: One mark for determining the correct probability calculation. One mark for calculating the number of parts in the batch that are likely to suffer from both faults. If correct answer is given without working out shown award full marks. Where an incorrect answer is given working out should be used to credit appropriate marks.

Question			Answer	Mark	Guidance
	(c)	**(i)**	Arc length L = 2πr x (subtended angle / 360) = 2π x 1000 x 36/360 (1) = 628.318530718mm = 628mm (rounded) (1)	2	Award two marks as follows: One mark for substituting values into formula. One mark for calculating the arc length ***L*** of the plywood beam to the nearest mm. If correct answer is given without working out shown award full marks. Where an incorrect answer is given working out should be used to credit appropriate marks.
		(ii)	A = $\sqrt{1000^2 + 1000^2 - (2 \times 1000 \times 1000 \times \cos 36)}$ (1) A = $\sqrt{2{,}000{,}000 - 2{,}000{,}000 \cos 36}$ A = $\sqrt{381996.011\ldots}$ A = 618mm (rounded) (1)	2	Award two marks as follows: One mark for substituting values into formula. One mark for calculating the chord length A to the nearest mm. If correct answer is given without working out shown award full marks. Where an incorrect answer is given working out should be used to credit appropriate marks.

Question			Answer	Mark	Guidance
					 Sin (18) = (C/2) / 1000 (1) C = 2 x 1000 x Sin(18) C = 618mm (1) Note: Where incorrect values have been substituted for a or b, allow error carried forward (ECF) where the answer has been calculated correctly. For example: A = $\sqrt{1000^2 + 628^2 - (2 \times 1000 \times 628 \times \cos 36)}$ A = 615mm (rounded) (ECF)

Question			Answer	Mark	Guidance
		(iii)	D = (arc length L) – (chord length C) (1) D = 628* – 618* D = 10mm (1)	2	Award two marks as follows: One mark for realising that distance D = arc length – chord length One mark for calculating the distance **D** moved by the right end of the flexible beam as it is flattened. If correct answer is given without working out shown award full marks. Where an incorrect answer is given working out should be used to credit appropriate marks. *Allow error carried forward (ECF) where correct working out is shown.

Question			Answer	Mark	Guidance
3	(a)		Possible responses may include: • Producing a service schedule for the product (1) such as routine lubrication or replacement of parts which wear out (1). • Releasing free service manuals or instructions (1) which allow non-experts to carry our servicing or repair (1). • Making spare parts available (1). • Designing the product to be easily opened using simple tools (1) so that repairs can be carried out (1). • Designing key parts to be easily replaceable (1) e.g. phone screens which are easily smashed (1), using simple plug connectors rather than soldering (1). • Using standard parts such as screws/fasteners (1) rather than bespoke parts which are hard to obtain or expensive (1). • Designing for repair and maintenance extends lifespan (1), which reduces waste (1). • Any other valid suggestion.	4	Up to four marks for describing the principle of designing a product for repair and maintenance. Use a mix and match approach with bullet points. Positively mark and award credit as candidate makes each valid point. One principle could be developed and still achieve four marks.

Question			Answer	Mark	Guidance
	(b)*		**Indicative content:** **Social issues** • Sourcing materials creates a social footprint, which describes the impact on people and communities. • Sourcing materials which have been reclaimed or recycled can support recycling business, which promotes employment for workers. • Some manufacturers actively promote their products as being socially responsible, and they look to improve the quality of life for the workers who produce the materials. • A high demand for materials can lead to unscrupulous suppliers trying to undercut established rivals, which can lead to social/political instability in a country. **Ethical issues** • Manufacturers should look for the ethical trade initiative (ETI) which is an independent organisation that promotes respect for workers' rights. • Some manufacturers commit to tracing the source of the materials they use, e.g. cotton. • In some countries, workers who reclaim precious metals from waste electronic products are exposed to fumes and toxins from their work. Workers may not be given PPE and not be trained about the dangers. • In some countries, workers are paid very low wages and expected to work in unsafe conditions. There	8	**Level 3 [6-8 marks]:** The candidate has a clear understanding of the responsibilities of manufacturers to ensure that the materials they use are sourced responsibly. They produce a thorough discussion in relation to the question, **addressing all three areas**. The explanation of responsibilities is clear and well-developed, for at least two areas, and a number of examples 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.* **Level 2 [3-5 marks]:** The candidate has a reasonable understanding of the responsibilities of manufacturers to ensure that the materials they use are sourced responsibly. They produce a reasonable discussion in relation to the question, **addressing only two areas**. The explanation of responsibilities is sufficient although one or two opportunities are missed in referring to different examples of these responsibilities. *There is a line of reasoning presented with some structure. The information presented is for the most part relevant and supported by some evidence.* **Level 1 [1-2 marks]** The candidate has a basic knowledge of the responsibilities of manufacturers to ensure that the materials they use are sourced responsibly. Any reference to this issue is descriptive in nature and has little appreciation of the areas highlighted. The response contains no analysis or evaluation.

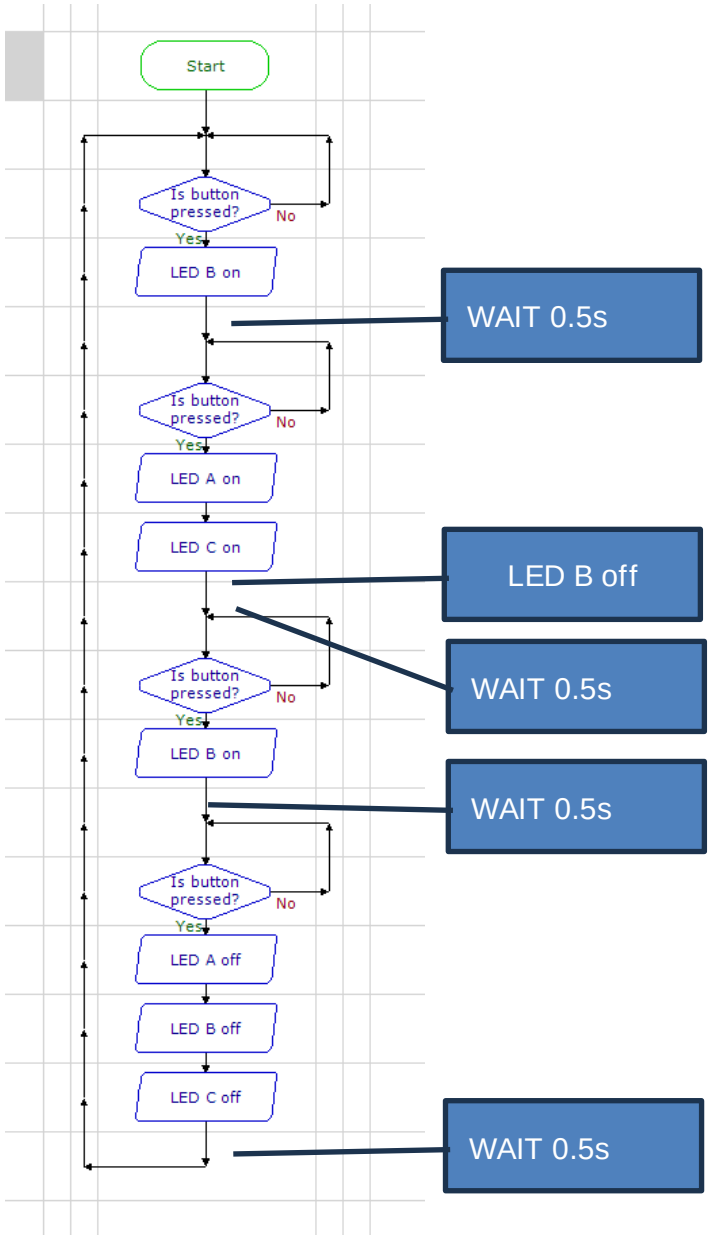
Question			Answer	Mark	Guidance
			may be little alternative employment available for them. • Competition between suppliers will force them to keep their costs low, which leads to low wages, no PPE, long hours, unsafe conditions. **Environmental issues** • Ecological footprint, which is the area of planet needed to sustain the resource. • The demand for grown resources can lead to deforestation which reduces biodiversity and can affect atmospheric quality and climate. • Sustainably managed forests (FSC) can contribute towards a carbon zero economy. • Transportation can cause carbon emission resulting in damage to the environment. • Mining materials can release toxic heavy metals and air pollutants into the environment. It is energy intensive and creates a large amount of waste. Can also pollute water courses and rivers. Any other valid suggestion.		*The information has some relevance and is presented with limited structure or detail. The information is supported by limited evidence.* **0 marks** No response or no response worthy of credit.

Question			Answer	Mark	Guidance
4	(a)	(i)	Possible reasons may include: • Physical testing is used to gather data (1) to confirm the manufacturing methodology or to highlight to the changes needed at the final production stage (1). • Physical testing can be carried out with a focus group (1) with a view to identifying weaknesses in design or in usability (1). • Physical testing can be carried out to check accuracy and quality of the product (1) to feed back to stakeholders for evaluation (1). • Physical dimension checks (1) to confirm dimensions are suitable for the range of users (1). • Any other valid suggestion.	2	One mark for identifying a reason why physical testing would be carried out on a pre-production protype of the head torch. One mark for justifying answer given. Specific reference to the context in the question is needed for marks to be awarded.
		(ii)	Possible tests may include: • Drop test of the product on various surfaces (1) to discover the product's strength and likely weak spots (1). • Accelerated stretch test on the elasticated strap (1) to discover the likely lifetime before it snaps (1). • Waterproof pressure test (1) to test the product IP rating (1). • Accelerated press test on the button (1) to test the likely lifetime before failure (1). • Any other valid suggestion.	2	One mark for identifying a destructive test that could be carried out on a manufactured head torch. One mark for description of this test. Or, One mark for explanation of the reason for this test. Specific reference to the context in the question is needed for marks to be awarded.

Question			Answer	Mark	Guidance
	(b)	**(i)**	38 + 42 + 18 + 6 + 2 = 106 (1)	1	One mark for calculating the number of respondents.
		(ii)	Mean head circumference of sample = ((Mean value of each class) x (frequency)) / (number of people in sample) (55x38) + (57x42) + (59x18) + (61x6) + (63x2) (1) =2090+2394+1062+366+126 =6038* (1) / 106* = 56.962264 cm (1)	3	Award three marks as follows: One mark for determining how to calculate the mean value of each class – identifying a mid-point. One mark for adding the mean value of all classes together. One mark for inserting values into formula to estimate by calculation the mean head circumference of the sample. If correct answer is given without working out shown award full marks. Where an incorrect answer is given working out should be used to credit appropriate marks. *Allow error carried forward (ECF) where correct working out is shown. Accept reasonable rounding in answer.

Question			Answer	Mark	Guidance
	(c)	**(i)**	Possible responses may include: • These are high speed automated robotic machines (1) that use vacuum cups to take SMT (SMD) components from a ribbon and place them directly onto the PCB (1). • The machine picks up a component (1) and places it into the pre-soldered contacts on the PCB (1). • Any other valid suggestion.	2	Up to two marks for describing the meaning of the term pick-and-place machine.
		(ii)	**Possible responses may include:** • The assembled PCB is passed through an oven on a conveyor belt (1) and this causes the solder paste on all the solder joints to melt and complete the joints (1). • The reflow soldering oven heats up the PCB just enough to allow any solder on it to melt (1) which will then be able to flow around the components that have been placed. When the PCB cools, the solder will solidify making solid joints (1). • Any other valid suggestion.	2	Up to two marks for describing the meaning of the term reflow soldering oven.
	(d)		The flowchart has two issues: 1) On the second press of the button, all three LEDs will be on, rather than just A and C, so it is not possible to select the 'Normal' mode (1). The solution is to add an output box "LED B off" as shown below (1). 2) The program will execute at very high speed, so pressing the button will cause the program to skip	4	One mark for identifying an issue, one mark for indicating the solution. There are TWO issues, so 4 marks in total. An alternative to each Wait command is to use an "Is button RELEASED?" decision command, with the NO

Question			Answer	Mark	Guidance
			through several modes, rather than advancing only one mode for each press (1). The solution is to add FOUR wait commands (e.g. Wait 0.5s) as shown below (1).		branch looping back to the top of the decision command.


Start
Is button pressed?
No
Yes
LED B on
WAIT 0.5s
Is button pressed?
No
Yes
LED A on
LED C on
LED B off
Is button pressed?
No
Yes
LED B on
WAIT 0.5s
WAIT 0.5s
Is button pressed?
No
Yes
LED A off
LED B off
LED C off
WAIT 0.5s

Question			Answer	Mark	Guidance
	(e)		Possible points: **Hardware** • The Basic and Intermediate versions of the torch use exactly the same hardware, so the same PCB can be used for both versions. • The decision to use SMT means that an automated pick and place assembly method is used. • The only difference for the advanced version is the addition of a red LED, and it would be a straightforward change for the pick and place machine to produce a batch of Advanced PCBs with one of the LEDs being red instead of white. • It may be more cost effective to produce identical PCBs for all models (red LED included on all models) but simply disable the red LED on the Basic and Intermediate models. • The single push button on the torch can be programmed to achieve all the different functions on the different versions, so no extra buttons are needed. **Software** • The decision to use a microcontroller means that software can be used to develop the product's functionality with no (or very few) hardware differences between the versions. • The only functional difference between the Basic and Intermediate models is the LED brightness, and this can be achieved through different software in the two models.	8	**Level 3 [6-8 marks]:** The candidate has a clear understanding of how the use of surface mount technology and the inclusion of an embedded microcontroller makes it straightforward for the manufacturer to release the three different models with minimal changes to its manufacturing system. They produce a thorough discussion in relation to the question. The explanation of benefits is clear and well-developed **and a number of examples** related to hardware and software are used to exemplify the points being made. **Level 2 [3-5 marks]:** The candidate has a reasonable understanding of how the use of surface mount technology and the inclusion of an embedded microcontroller makes it straightforward for the manufacturer to release the three different models with minimal changes to its manufacturing system. They produce a reasonable discussion in relation to the question. The explanation of benefits is sufficient although one or two opportunities are missed in referring to different examples of hardware and software considerations that would be taken into account. **Level 1 [1-2 marks]** The candidate has a basic knowledge of how the use of surface mount technology and the inclusion of an embedded microcontroller makes it straightforward for the manufacturer to release the three different models with minimal changes to its manufacturing system. Any reference to this issue is descriptive in nature and has little appreciation of hardware/software considerations. The response contains no analysis or evaluation.

Question			Answer	Mark	Guidance
			• The microcontroller can be programmed with different software versions either before being soldered to the PCB, or it may be programmed once embedded in the product. • If programming is done after embedding, then all models can be made with identical PCBs which simplifies the manufacturing process as only one type of PCB is required for all three versions. • Once the hardware is fixed, the product's functionality can be developed to a high level through its software, and this can make an Advanced version of the product very attractive to customers. • Pick and place machines can be programmed to pick and place additional components for the advanced level head torch PCB. Any other valid suggestion.		**0 marks** No response or no response worthy of credit.

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