Qualification Accredited

OCR
Oxford Cambridge and RSA

A LEVEL

Exemplar Candidate Work

DESIGN AND TECHNOLOGY

H404
For first teaching in 2017

H404/01 Summer 2019 examination series

Version 1

Contents

Would you prefer a Word version?

Did you know that you can save this pdf as a Word file using Acrobat Professional?

Simply click on **File** > **Export to** and select **Microsoft Word**

(If you have opened this PDF in your browser you will need to save it first. Simply right click anywhere on the page and select ***Save as . . .*** to save the PDF. Then open the PDF in Acrobat Professional.)

If you do not have access to Acrobat Professional there are a number of **free** applications available that will also convert PDF to Word (search for *pdf to word* converter).

We value your feedback

We'd like to know your view on the resources we produce. By clicking on the icon above you will help us to ensure that our resources work for you.

Introduction

These exemplar answers have been chosen from the summer 2019 examination series.

OCR is open to a wide variety of approaches and all answers are considered on their merits. These exemplars, therefore, should not be seen as the only way to answer questions but do illustrate how the mark scheme has been applied.

Please always refer to the specification https://www.ocr.org.uk/qualifications/as-and-a-level/design-and-technology-h004-h006-h404-h406-from-2017/ for full details of the assessment for this qualification. These exemplar answers should also be read in conjunction with the sample assessment materials and the June 2019 Examiners' report or Report to Centres available from Interchange https://interchange.ocr.org.uk/Home.mvc/Index

The question paper, mark scheme and any resource booklet(s) will be available on the OCR website from summer 2020. Until then, they are available on OCR Interchange (school exams officers will have a login for this and are able to set up teachers with specific logins – see the following link for further information http://www.ocr.org.uk/administration/support-and-tools/interchange/managing-user-accounts/).

It is important to note that approaches to question setting and marking will remain consistent. At the same time OCR reviews all its qualifications annually and may make small adjustments to improve the performance of its assessments. We will let you know of any substantive changes.

Question 1(a)

1 A home lift can be installed in a house where one or more occupants may have mobility problems and may not be able to use stairs easily.

Fig. 1.1 shows an electrically-powered home lift. The first image shows the lift on the ground floor. The second image shows the lift on the upper floor.

Fig. 1.1

(a) Identify **three** ways in which the manufacturer of the home lift can ensure the safe operation of the lift by its users. **[3]**

Exemplar 1 — 3 marks

1 Only allow for use when the doors are closed

2 install a weight sensor so that the limit isn't exceeded when in use

3 Place a secondary wall around the lift so people cannot stand on top of it when used or under

[3]

Examiner commentary

The candidate has been given all three marks in this response because three unique and relevant answers have been given, that would viably be carried out by the manufacturer. Although some might be considered design related responses, these are accounted for in the mark scheme due to the early position of the question in the paper.

Exemplar 2

2 marks

1 Aim A simple user interface to operate the lift

2 A smooth mechanism so there are is no distruption to the movement of the lift as it moves up/down.

3 Making sure all the movements and shapes are within the correct tolerances so that it fits through the hole in the roof floor as well as not creating a large step for the user to overcome when it stops. [3]

Examiner commentary

In this candidate response, only two marks are awarded. The first two answers are marked as correct as they relate to actions taken by the manufacturer, however the third response is unclear and difficult to award the benefit of doubt. The candidate appears to provide two answers, the first requirement is for manufacturing to a tolerance, and the second is to avoid including a large step. Although either could be given a mark, the first response is taken as the second has not been crossed out and is not given a mark as the response is vague when referring to 'movement and shapes'. A clearer response would have been required here for the third mark.

Question 1(b)(i)

(b) The home lift in **Fig. 1.1** uses a screw thread and nut mechanism in which the nut is attached to the lift and rotated through a double chain drive by an electric motor. The screw thread is held in position and does not move. **Fig. 1.2** shows the mechanism.

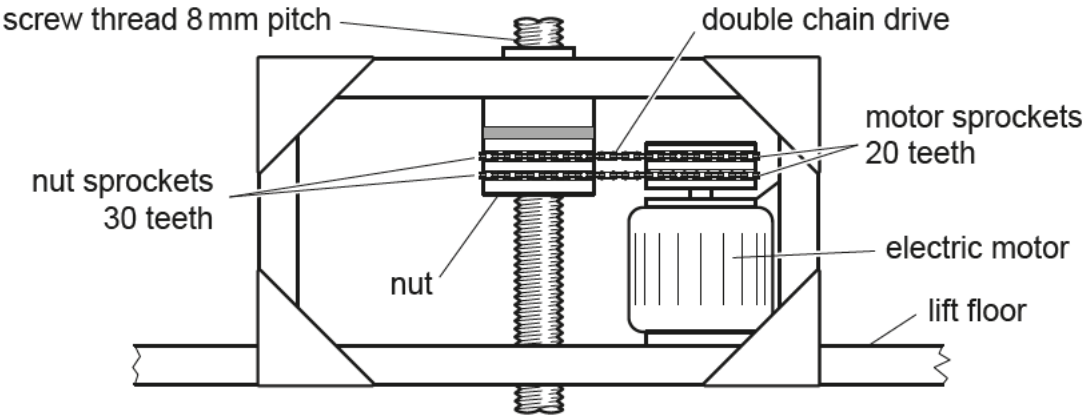


Fig. 1.2
(not to scale)

(i) The lift moves at a speed of $0.08\,m\,s^{-1}$.

Calculate the time taken in seconds (s) for the lift to rise between floors which are 2800 mm apart. Show your working. **[3]**

Exemplar 1 — 3 marks

$\frac{2.8}{0.08} = 35$

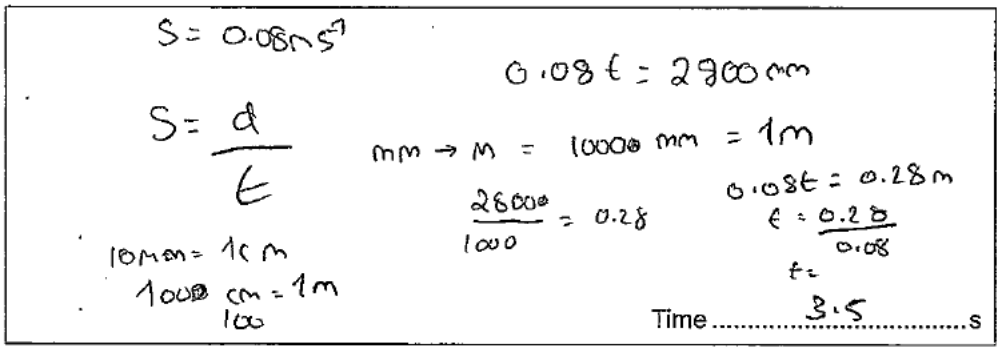
Time ..35.. s

Examiner commentary

The candidate response includes minimal working out, but in mathematical questions full marks are given irrespective of this due to the correct answer being given in the answer space.

Exemplar 2

1 mark



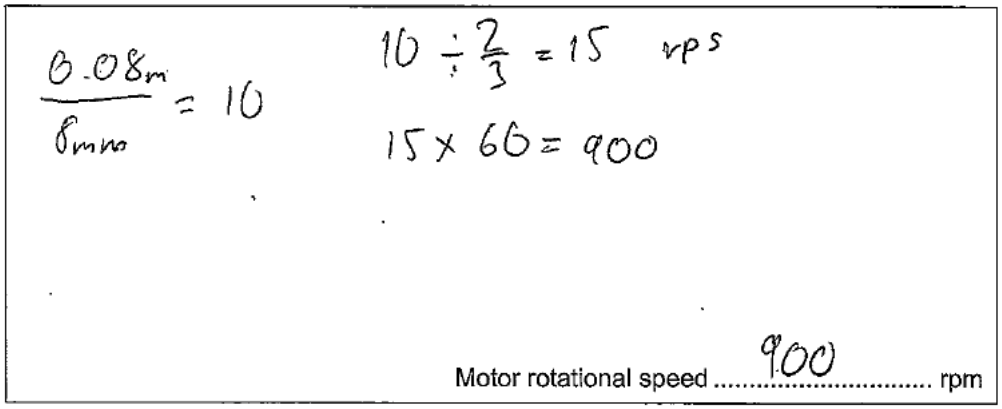
Examiner commentary

The candidates answer is incorrect in this example, therefore the working out is reviewed to identify if working out and method are worthy of credit. In this instance the candidate is not given a mark for the conversion of units, as they are incorrect. However, the rearrangement of the formula and input of relevant values is worthy of credit, scoring the candidate one mark.

Question 1(b)(ii)

(ii) Analysing the data in **Fig. 1.2**, calculate the motor rotational speed required in revolutions per minute (rpm) to cause the nut to climb up the thread at a speed of $0.08\,m\,s^{-1}$. Show your working. **[3]**

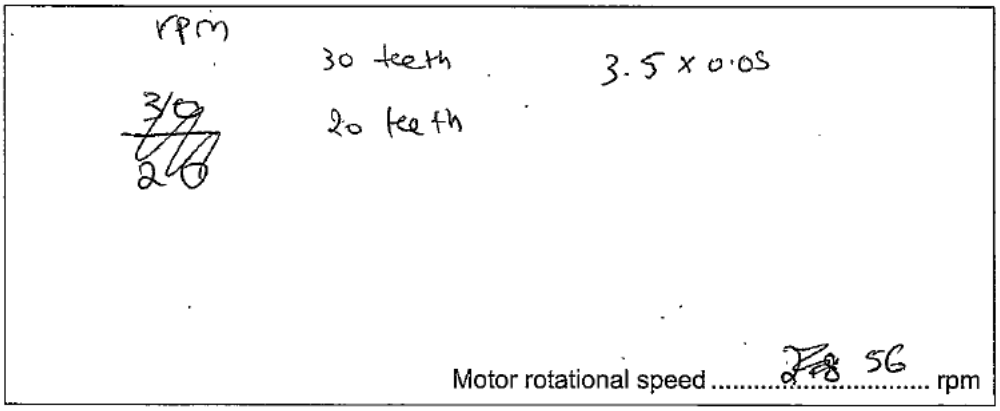
Exemplar 1 — 3 marks



Examiner commentary

This candidate shows working out but also has the correct answer in the space provided, therefore as with 1bi, the candidate automatically is given full marks irrespective of their working out.

Exemplar 2 — 0 marks



Examiner commentary

In this candidate response an incorrect answer has been given, therefore the working out is reviewed. The candidate does calculate the sprocket gear ratio, worthy of a mark, but has crossed this out. They have then conducted a calculation, which despite bringing forward an incorrect answer from the previous question, where benefit of doubt would be given through acceptance of 'Error Carried Forward', this does not score a mark as the calculation is incorrect.

Question 1(b)(iii)

(iii) Give **two** reasons why a double chain drive is used in this application. **[2]**

Exemplar 1 2 marks

1 The split the load across the two chains to reduce stress and wear

2 So that if one chain fails the lift may still be able to move so the user does not get happed. **[2]**

Examiner commentary

In this candidate response there are two clear correct responses, the first relating to sharing the load across two chains, and the second relating to safety and the potential failure of one chain. Both answers appear in the mark scheme and are not repeated.

Exemplar 2 0 marks

1 A double chain drive is used so that the speed in which the threaded screw will go at the right pace.

2 It is also used ~~as it~~ so that the elech's motor and the nut is connected, so that it will turn ~~and~~ : **[2]**

Examiner commentary

The candidate provides two clear answers, however they have been given no marks in this instance. This is because for the first response, as it suggests the two chains are controlling the pace of the thread. This is incorrect, as the thread will turn at the same pace with any number of chains. The second response about connecting the chain to the thread is also true of any number of chains, therefore for both responses, no credit is given.

Question 1(b)(iv)

(iv) The maximum total mass of the lift and occupants is 350 kg.

Calculate the power required in watts (W) to raise the 350 kg lift at a velocity of 0.08 m s^{-1}. Show your working.

gravitational potential energy = mgh $\qquad$ *power* $= \frac{E}{t}$

gravitational field strength, g = 9.81 N kg^{-1}

[3]

Exemplar 1

3 marks

$P = \frac{W}{t}$

$= \frac{mgh}{t} = \frac{350 \times 9.81 \times 2.8}{35}$

$= 27.468$

Power ..... 275 ..... W

Examiner commentary

In this response, the candidate would normally only achieve two of the available three marks. This is because their answer has been rounded to the nearest whole number. They have included the appropriate working out enough to achieve two of the three marks, and the right answer is included before the rounding up. However, in this instance the candidate had previously (earlier in the paper) been deducted one mark for a rounding error. This deduction of one mark is only applied once throughout the whole paper, therefore because the correct answer is given, all three marks given.

Exemplar 2

2 marks

$350 \times 9.81 \times 2.8 = 961.8\ J$

$\frac{961.8}{35} = 274.7\ W$

Power ..... 275 ..... W

Examiner commentary

This candidate has only been given two marks of a possible three. Although they calculate an almost correct answer, they have made a rounding error in their calculation, and then rounded to the nearest whole number in their answer. This is not requested in this question; therefore, the two marks given to this response are for using a correct approach and working out the distance raised in one second.

Question 1(c)

(c) Discuss, using examples, the significance of good user interface design in engineered products. **[8]**

Exemplar 1 — 4 marks

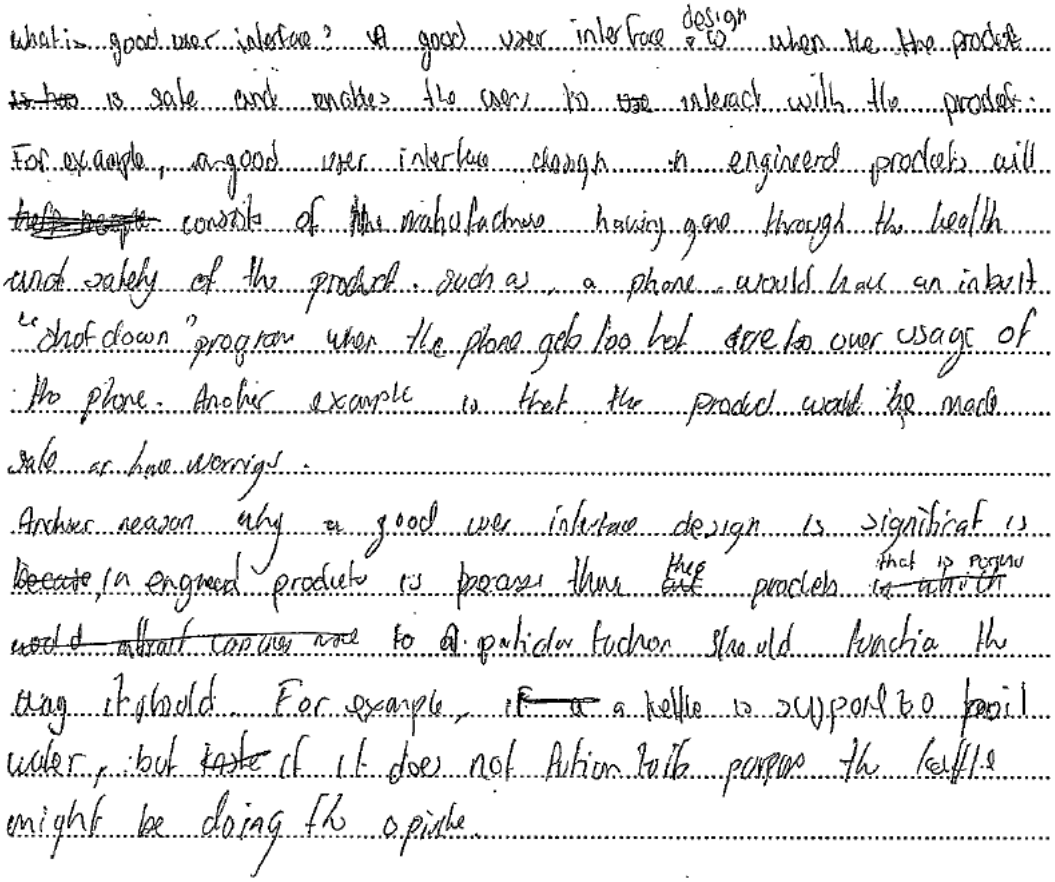
A good user interface allows for inclusivity and a good level of usability. An example of good user interface is a TV remote, TV remotes generally have raised bumps on important features like "on, off, play, pause" this allows users who might be visually impaired to use the same product without any special adaptation. Bathroom taps are another good example of an effective user interface. Taps are universally labled 'blue' for cold and 'red' for hot. This combined with an anticlock wise turn (which is a standardised mechanism for turning on taps) allows users to be able to use the product with little to no previous experience with the product.

Examiner commentary

The candidate has achieved a Level 2 response for their answer here. This candidate is judged to have reasonable understanding of user interface, by stating what a specific product does for a user group (visually impaired), or a type of user (no previous experience). The discussion flows well, however because the candidate does not mention that user interface can have significant benefit to users who need to carry out complex tasks in a simple way, the overall judgement is that the candidate has missed a couple of opportunities. For example, a TV remote might be discussed as making the recording of channels or the reprogramming of channels easier for the user, while the taps could make achieving a specific temperature of water easier for the user.

Exemplar 2

1 mark



Examiner commentary

In this candidate's response only one mark is given, for the statement that says, 'user interface enables the user to interact with the product', and the reference to a product suitable for this question, a phone. The rest of the candidate response discusses health and safety and functionality, and therefore does not respond to the question being asked. The candidate could have expanded on their definition, and given examples relating to a phone to begin to score more marks.

Question 2(a)

2 (a) A manufacturer wishes to ship items in the cardboard box shown in **Fig. 2.1**. The cardboard box is a cuboid shape.

Fig. 2.1

The box has internal dimensions of 305 × 215 × 100 mm.

Calculate the maximum straight part length which can be shipped in this cardboard box. Give your answer in mm to 1 decimal place and show your working. **[3]**

Exemplar 1 — 3 marks

$\sqrt{305^2 * 215^2} = 373.2\,mm$

$\sqrt{373.2^2 + 100^2} = 386.3\,mm$

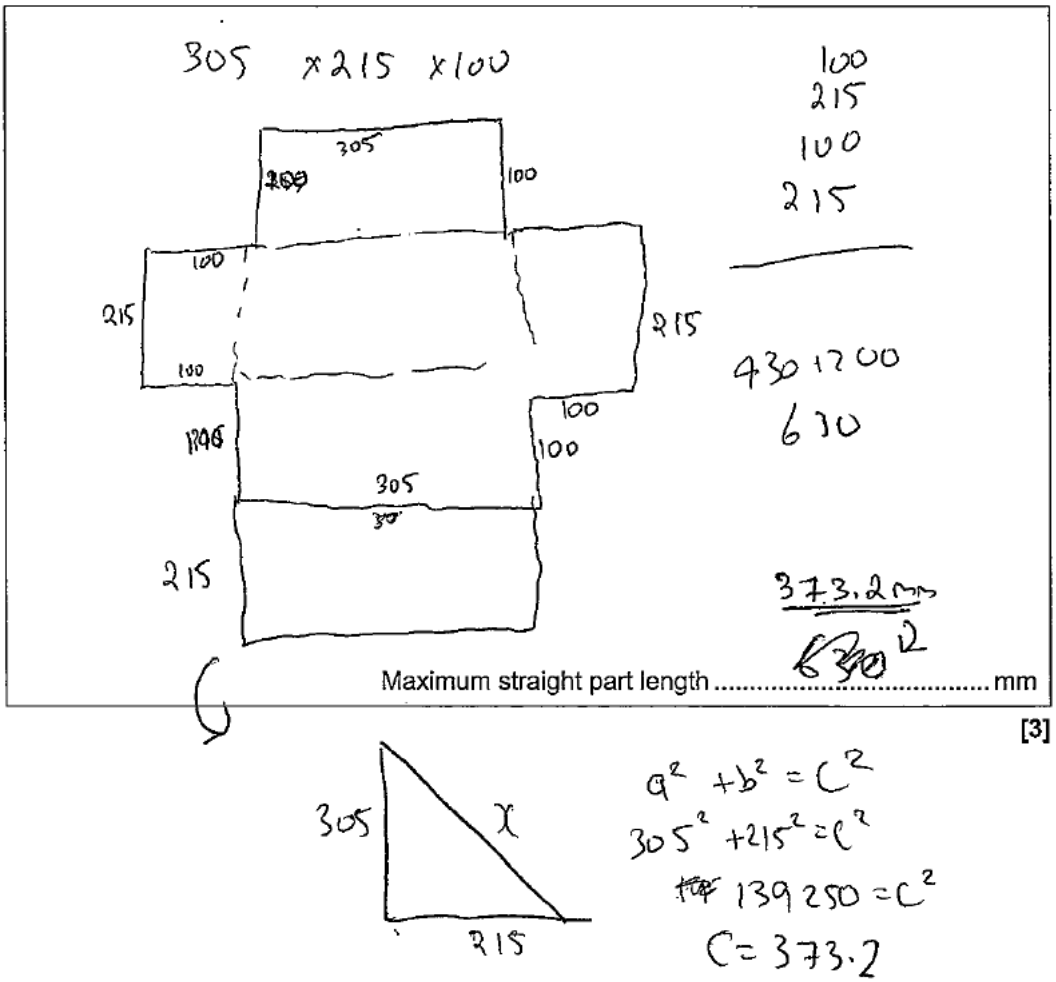
Maximum straight part length ..... 386.3 ..... mm

Examiner commentary

This candidate has been given full marks for the correct answer, which includes rounding to one decimal place. The working out is also enough to support the candidate towards two marks should they make a mistake with the final answer.

Exemplar 2

1 mark



$a^2 + b^2 = c^2$

$305^2 + 215^2 = c^2$

$139250 = c^2$

$c = 373.2$

Examiner commentary

This candidate includes useful working out in their response, offering access to marks as they have submitted a final answer which incorrect. The mark given for this candidate is for calculating the first base diagonal. They would still need to calculate the second base diagonal and then the final part length to one decimal place to achieve all three marks.

Question 2(b)(i)

(b) **Fig. 2.2** shows an orthographic (two-dimensional) diagram of a part manufactured from brass. Dimensions are given in mm.

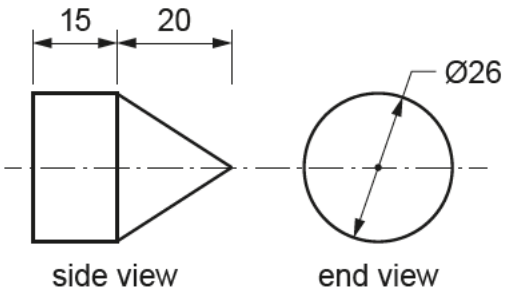


Fig. 2.2
(not to scale)

(i) Name an instrument which could be used to measure the diameter of the part shown in **Fig. 2.2** to a precision of 0.02 mm. **[1]**

Exemplar 1 — 1 mark

Digital Vernier Caliper ..... [1]

Examiner commentary

The candidate names the correct tool and includes reference to digital due to the high level of accuracy required in the example given.

Exemplar 2 — 0 marks

Ruler ..... [1]

Examiner commentary

Although the candidate does name a measuring tool, a ruler is too vague in this example for it to be worth credit, therefore no mark is given.

Question 2(b)(ii)

(ii) Calculate the mass in grams (g) of the part shown in **Fig. 2.2**. Give your answer to 1 decimal place and show your working.

Area of a circle $= \pi d^2/4$

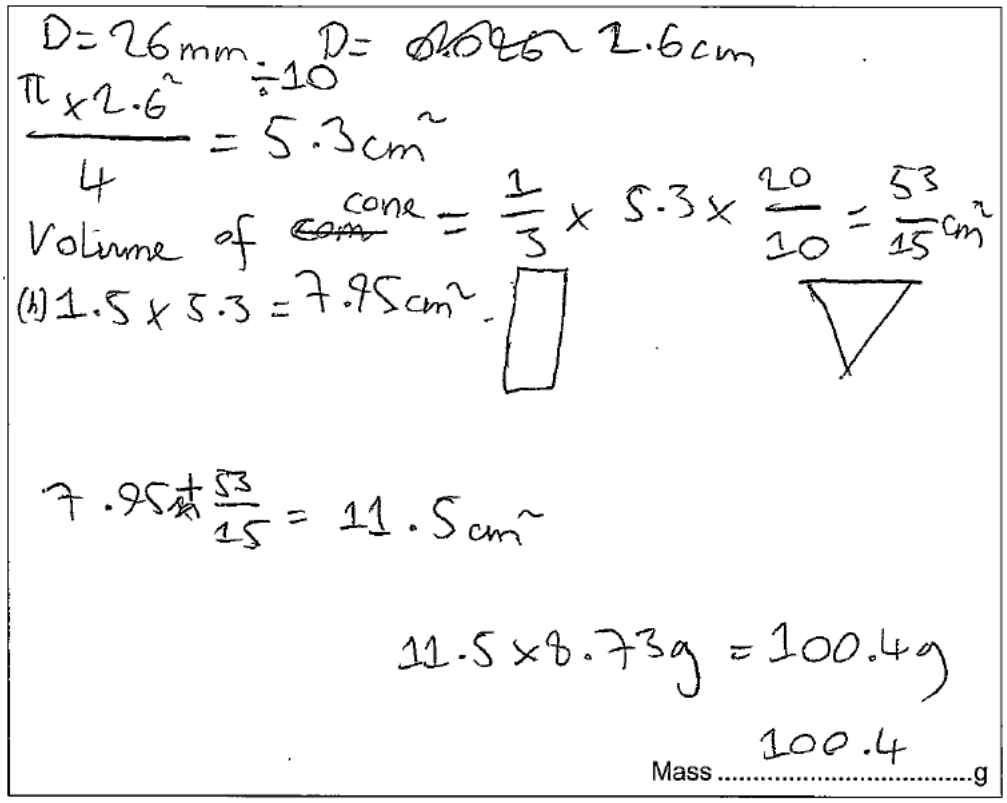
Volume of a cone $= \frac{1}{3} \times$ *base area* $\times$ *height*

Density of brass $= 8.73\,g\,cm^{-3}$

[5]

Exemplar 1

5 marks

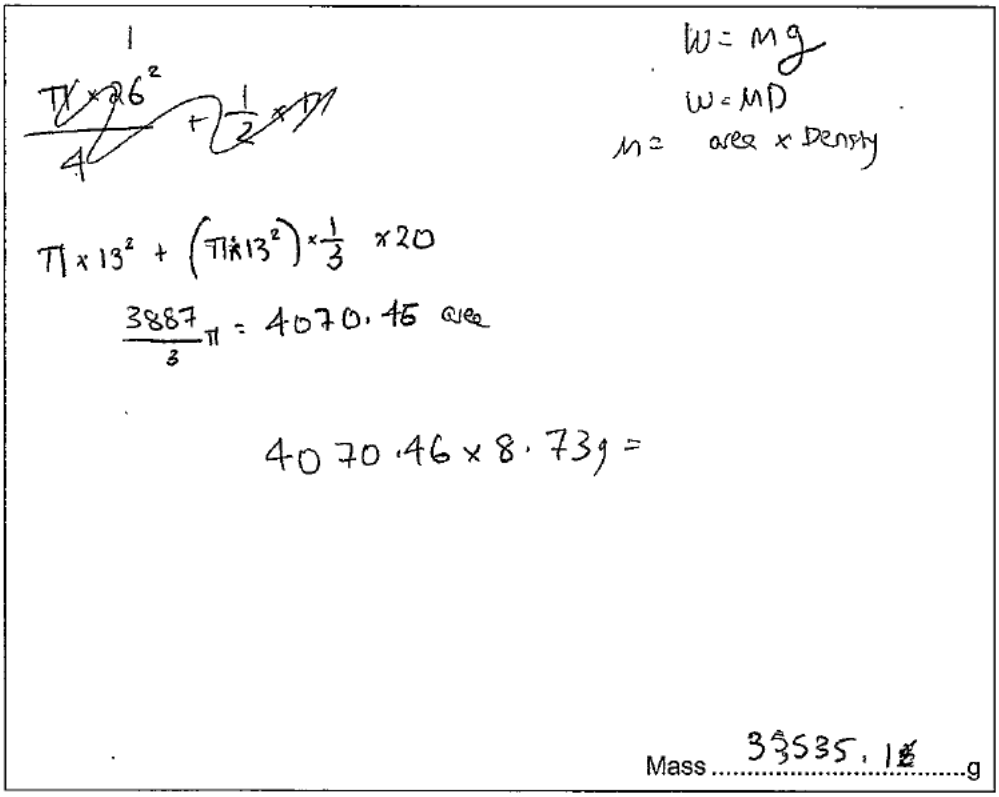


Examiner commentary

In this candidate's response the correct answer has been given in the answer space, automatically awarding full marks. The candidate also includes their working out in the space provided, which would support some marks if the correct final answer was not given.

Exemplar 2

0 marks



Examiner commentary

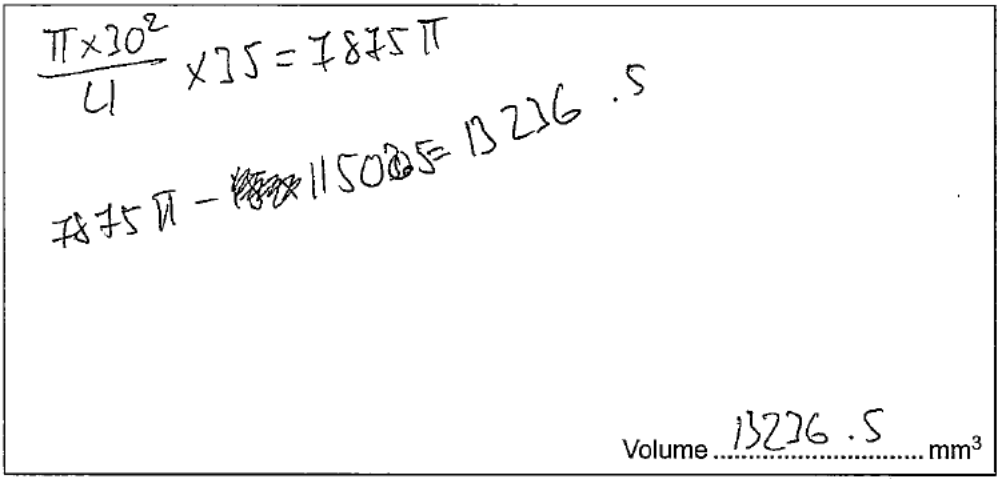
This candidate did not provide the correct answer. Therefore, a review of their working out has been conducted. Although it has been attempted, the candidate does not input the elements of the cone volume into the equation correctly in the first instance, and therefore does not come out with a viable answer that would provide some of the marks available, nor demonstrate a grasp of what they are trying to achieve, therefore no marks are given.

Question 2(b)(iii)

(iii) The part in **Fig. 2.2** is to be turned on a centre lathe from a cylindrical brass bar with diameter 30 mm and length 35 mm.

Calculate the volume in mm^3 of the waste brass generated. Give your answer to 1 decimal place and show your working. **[2]**

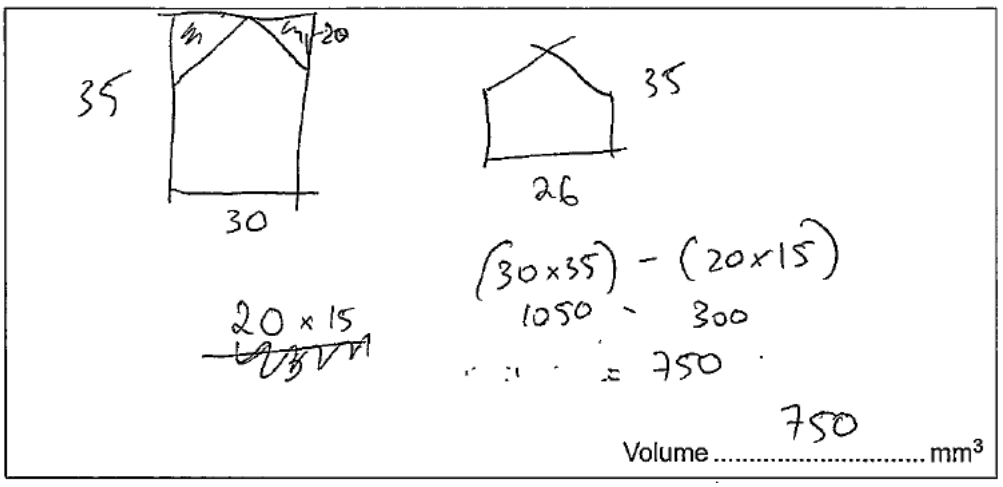
Exemplar 1 — 2 marks



Examiner commentary

In this candidate's response, it is clear they have brought forward the correct working out from the previous question, without rounding the answer to a decimal or whole number. This is then used as part of the working out, although again due to the correct answer being given, all marks are given irrespective of the working out presented.

Exemplar 2 — 0 marks



Examiner commentary

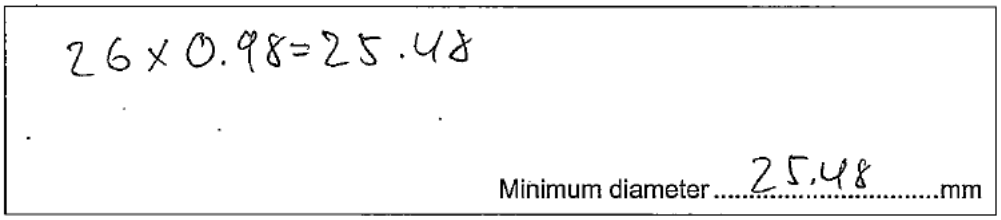
In this response, the candidate has included thumbnail sketches to support their thinking. They include also some working out. However, the final answer is wrong, and the candidate does not include a suitable calculation nor the individual volumes required to achieve the right answer or any marks in this instance.

Question 2(b)(iv)

(iv) The diameter of the part must be 26.00 mm with a tolerance of ±2%.

Calculate the **minimum** allowable diameter in mm of the part. Show your working. **[2]**

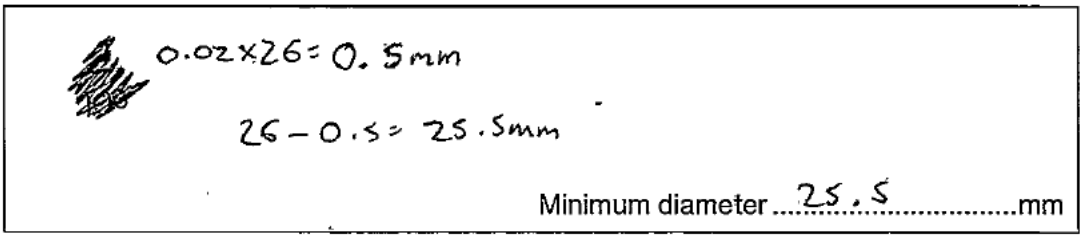
Exemplar 1 2 marks



Examiner commentary

The candidate has provided the correct answer in their response, automatically being given full marks.

Exemplar 2 0 marks



Examiner commentary

In this candidate response we firstly see that an incorrect final answer has been given. The candidate working out shows an appropriate method, but they have made a mistake rounding up their working out from 0.52 to 0.5. Although a suitable approach has been taken, the tolerance is 0.02 out because of this error, and no marks are given.

Question 2(c)

(c) A machine is being developed to help tennis players practise their serve. The machine projects a tennis ball vertically to a height, s, of 2.5 m.

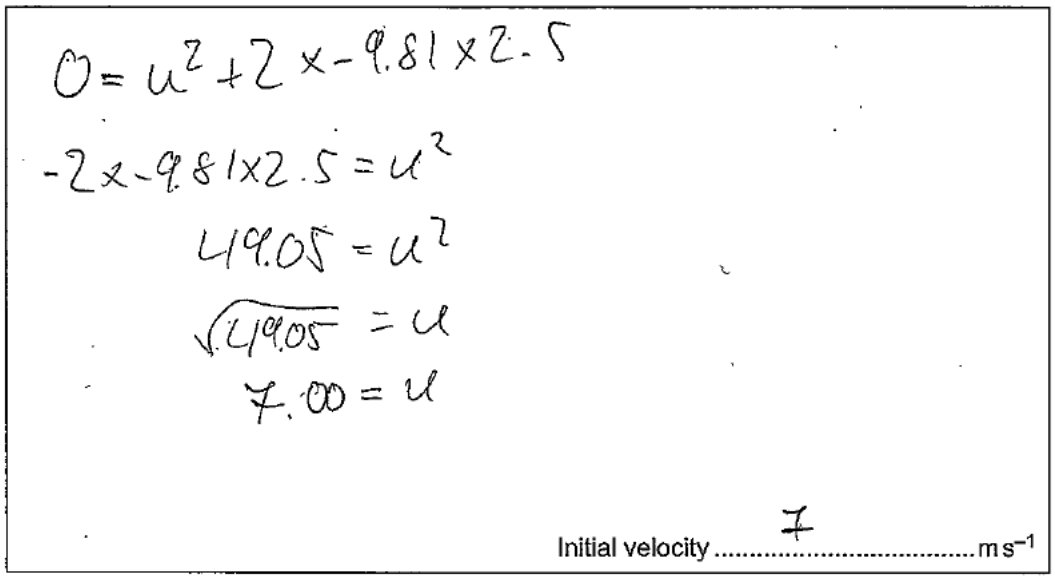
Use the formula, $v^2 = u^2 + 2as$, to calculate the initial velocity, u, at which the ball needs to leave the machine so that it just reaches the required height of 2.5 m. Give your answer in $m\,s^{-1}$ and show your working.

Acceleration, a, due to gravity in this situation is $-9.81\,m\,s^{-2}$

[2]

Exemplar 1

2 marks

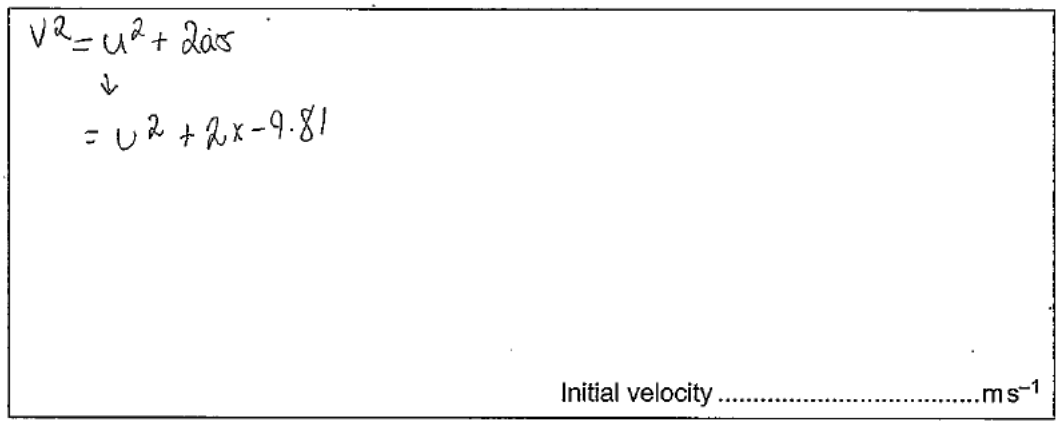


Examiner commentary

This candidate response is correct, and automatically results in full marks. However, they also include appropriate working out, showing how they have plugged values into the calculation, and recognised that at maximum height the vertical velocity is equal to zero.

Exemplar 2

0 marks



Examiner commentary

The response given by this candidate starts correctly, by writing in the equation that is provided, and inputting the values given. However, the candidate does not make enough progress to be suitable to receive a mark.

Question 3(a)

3 (a)* To certify that products conform to a standard set by the British Standards Institute (BSI), many products carry the BSI Kitemark® shown in **Fig. 3**.

Fig. 3

Discuss the implications to manufacturers of producing Kitemark® approved products. **[8]**

Exemplar 1 — 6 marks

Making BSI approved products means the companies must comply with all the standards relevant to the product.

This normally means having to manufacture the products in a certain way - which could mean they have to change their factories to meet the standards. This could cost time and money which the company ~~would~~ would otherwise be investing in new products.

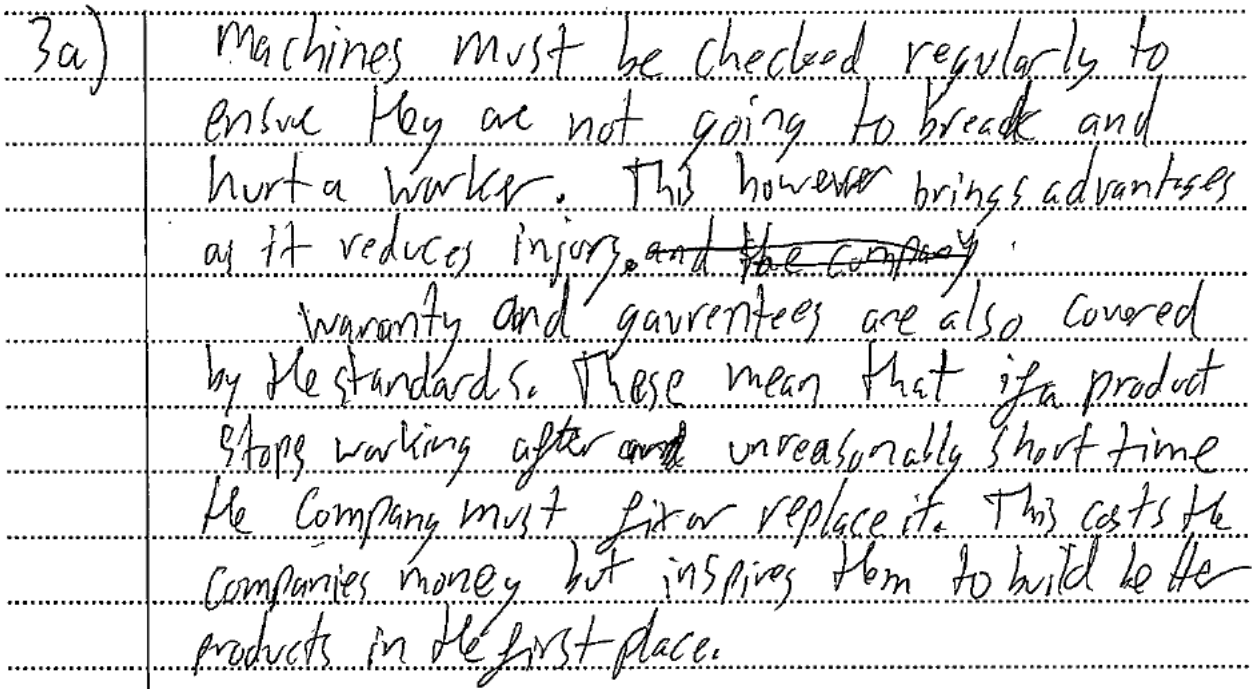
Following the standards also means that parts should be standardised - allowing for much easier repair of the products and could make it easier to upgrade or change a part of.

More time and money must also be spent testing and checking the products and devices to ensure they are fully functional and safe.

Manufacturing Safety Standards must also be met - ensuring the factory is safe for the workers. This again brings implications as

A+ Bucle

[8]



3a) Machines must be checked regularly to ensure they are not going to break and hurt a worker. This however brings advantages as it reduces injury, ~~and the company~~.

Warranty and gaurentees are also covered by the standards. These mean that if a product stops working after an unreasonally short time the Company must fix or replace it. This costs the companies money but inspires them to build better products in the first place.

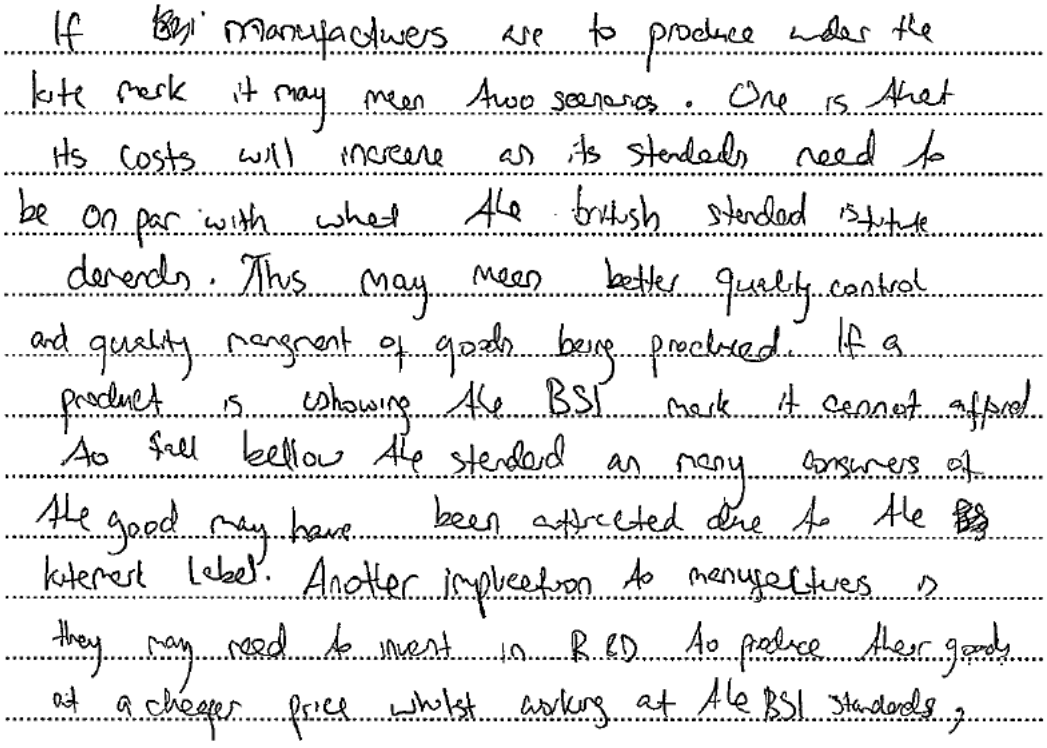
Examiner commentary

This candidate's response is judged to be place just within a Level 3 answer. Firstly, the candidate has made good use of the additional pages available, as they achieve some credit from what they write in this section.

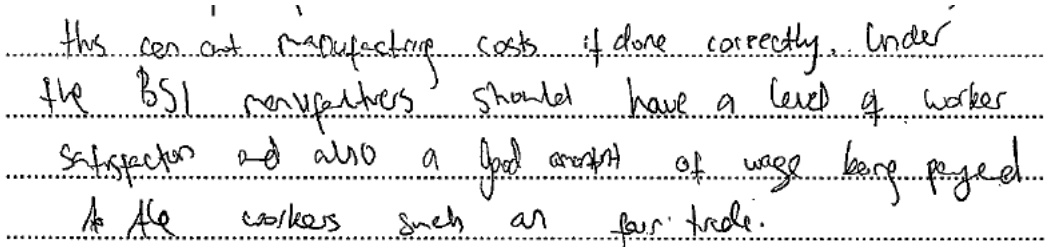
The whole response is academically judged to show a clear understanding of the implications on manufacturers of producing products to Kitemark approval standards. This is firstly because the candidate talks about the impact the standards have on the factory, time and costs. The candidate continues to suggest that an additional amount of money would be invested in testing and checking, including both product and factory inspection. They then go on to relate the standards to employees, and mention benefits to both worker and employer.

The structure of the response is adequate to convey a line of thought, and the response focuses on the manufacturer fully. The candidate could have based their response on a product and referred to specific types of changes that might relate to this product on behalf of the manufacturer.

Exemplar 2 3 marks



If BSI manufactuers are to produce under the kite mark it may mean two scenaros. One is that its costs will increase as its stendads need to be on par with what the british stendad institute dereads. This may mean better quality control and quality managment of goods being produced. If a product is showing the BSI mark it cannot afford to fall bellow the stendard as many consumers of the good may have been attracted due to the BS kitemark label. Another implication to manufactures is they may need to invest in R&D to produce their goods at a cheaper price whilst working at the BSI standards,



Examiner commentary

The candidate response is judged at the bottom of Level 2. This indicates that the candidate is credited with having shown a reasonable understanding of implications to the manufacturer of producing Kitemark approved products.

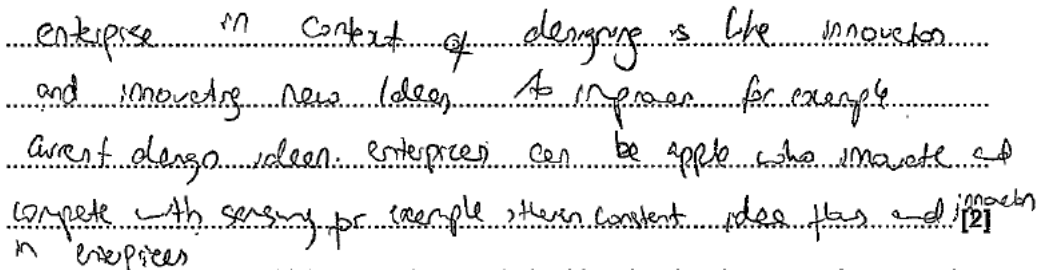
The candidate does have a line of reasoning and some structure, and although the response has examples that achieve marks; increase in cost; better quality control and management; and a need to invest in R&D, the candidate does also go on to make some assumptions that might not be true without a context to frame them.

This includes discussion about the product being cheaper, and worker satisfaction. The candidate would have achieved higher marks if they had included a broader set of examples of the impact of meeting standards, perhaps referring to short and long term changes to costs, investment in equipment and training, etc.

Question 3(b)(i)

(b) (i) Explain what is meant by '**enterprise**' in the context of designing. **[2]**

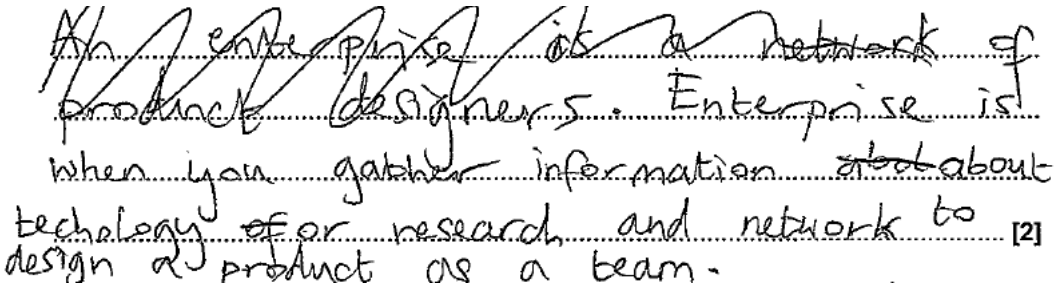
Exemplar 1 — 2 marks



Examiner commentary

This candidate response includes reference to innovation and innovating new ideas in the context of design. The two marks are given as a benefit of doubt but are not a solid definition of Enterprise. The candidate would do better to include investment, breaking ground or using initiative to make courageous and bold decisions to present a more secure answer.

Exemplar 2 — 0 marks



Examiner commentary

The response here references to viable activities such as research and team work, but fails to refer to the key terms in the definition of Enterprise which include bold venture, opportunity, new business, energetic undertaking and breaking new ground. Therefore, no marks have been given.

Question 3(b)(ii)

(ii) Describe **two** ways in which enterprise can help drive the development of new product ideas. **[4]**

Exemplar 1 2 marks

1 There is a larger pool of designers which may contribute new ideas to improve the product

2 The project can be split up and allocate to multiple groups based on specialty to allow for parallel development of parts or areas of the project.

[4]

Examiner commentary

In this candidate response, the benefit of doubt has been given to the first answer provided, and partly to the second answer which is essentially a repeat of the first. The candidate mentions bringing more parties on board (partnerships) and sharing ideas, which are both referenced to in the mark scheme. Although they are not perfectly formed responses, it can be interpreted that the candidate recognises through both answers the importance of sharing and working in collaboration with others who might help to innovate.

Exemplar 2 0 marks

1 An enterprise can help drive the development of the new product ideas because to show to the fact that people will have the opportunity to sell their product which means people will be able to create more ideas due to the market ever.

2 Another way in which enterprise can be of help is that the new ideas that keep coming will help alert designers to create or invent an improvement of an existing product or invent something entirely different.

[4]

Examiner commentary

The candidate has provided two clear answers, describing how they think Enterprise can help drive development. Although their response is product focused, they fail to mention any of the points listed in the mark scheme which include; entrepreneurship; setbacks; commercial partnerships; venture capitalism; crowd funding and sharing ideas.

Question 4(a)

4 **Fig. 4.1** shows a robotic lawnmower.

Fig. 4.1

(a) A 12V battery is used to power the robotic lawnmower. The robotic lawnmower returns to a charging station placed at the edge of the lawn to recharge its battery. The charging station requires a source of power.

Identify **two** issues associated with providing power to the charging station. **[2]**

Exemplar 1 — 2 marks

1 must be Completly water resistant as it is outside.

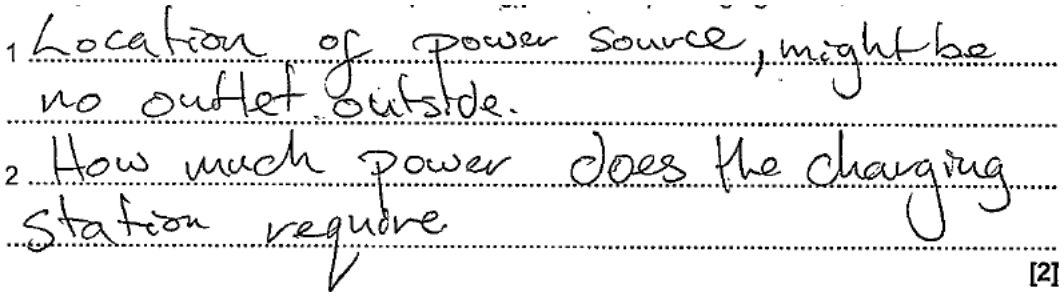
2 cable must be buried or out of the way to stop the lawnmower run over it and cut the cable, which is dangerous. **[2]**

Examiner commentary

This candidate response has been given both marks available. The first answer of being water resistant is in the mark scheme. The second answer of burying the cable to prevent it being cut, is a valid solution based on the issue of the cable being cut, which is also listed in the mark scheme.

Exemplar 2

0 marks


1 Location of power source, might be no outlet outside.
2 How much power does the charging station require
[2]

Examiner commentary

The candidate response does not receive any marks in this example because; the first answer of an outlet being outside does not give sufficient detail to convey what the issue might be; the second answer is a question rather than an issue, and is something the candidate would not have sufficient information to ask or know.

Question 4(b)(i)

(b) The case of the robotic lawnmower is made from a thermo softening polymer.

Fig. 4.2a and **Fig. 4.2b** show two views of a typical thermo softening polymer part from a similar garden product.

Fig. 4.2a

Fig. 4.2b

(i) Describe how the rigidity of the thermo softening polymer part in **Fig. 4.2a** and **Fig. 4.2b** is achieved through effective designing. **[2]**

Exemplar 1 2 marks

Webbing is used here - it allows for less material to be used while keeping the part rigid. They are placed at angles from each other so the part cannot twist in any direction [2]

Examiner commentary

The candidate response states a technical term for the injection moulded features seen in the image, 'webbing', and goes on to describe what their purpose is, resulting in full marks being given.

Exemplar 2

0 marks

Using thermoplastic polymer means that there is a mixture of types of plastic and materials to creat this case, having it thermo softening means that through using heat to make it flexible to mould meant that the bonds between were reshape so once cooled it became more rigid to hold shape. [2]

Examiner commentary

The candidate response is very knowledgeable about the process of forming plastics but does not answer the question. The candidate in this example is given no marks because they have not identified the physical features of the part in the photo; instead describing the moulding of plastics to achieve a rigid object, which does not provide enough information to justify any marks.

Question 4(b)(ii)

(ii) State the industrial method used to manufacture the thermo softening polymer part and identify **one** piece of evidence from either **Fig. 4.2a** or **Fig. 4.2b** that leads you to this conclusion. **[2]**

Exemplar 1 2 marks

Injection moulding may have been used to create the part as seen on fig. 4.2b there are marks which would have been left there by the mold. **[2]**

Examiner commentary

This candidate response is given one mark for naming the process of injection moulding, and a second mark is given for stating that marks have been left on the part from the mould. Although the marks are given with an element of benefit of doubt, a stronger response would have seen the candidate name features such as ejector pin imprints as visual features on the part.

Exemplar 2 0 marks

Both the part was prosy vacuum formed. The shape of the part is fairly detailed with the support beams on a very smooth interior from one sheet with the whole cut out. **[2]**

Examiner commentary

The candidate names an unsuitable process, 'vacuum forming', for the part in the question, and goes on to describe the features of the shape that would not be achievable with that process.

Question 4(b)(iii)

(iii) The >PP< marking that is visible on the surface of the product in **Fig. 4.2b** identifies the type of thermo softening polymer that has been used.

Explain **one** reason why a plastic manufacturer marks the type of plastic used on their product in this way. **[2]**

Exemplar 1 — 2 marks

The marked PP (Polypropylene) can be used to indicate to the consumer and recycling companies alike what form of plastic is being used to effectively recycle the product. [2]

Examiner commentary

The candidate correctly states that the marks on the plastic relate to the material type (polypropylene) and that this would be useful to a recycling set up to make sure plastics are recycled with the same plastic groups.

Exemplar 2 — 1 mark

This may be to allow users to understand what type of material is used, this may improve user understanding of what is accepted and what not then it goes to the merge of the plastic (weight, thickness, temperature observed) [2]

Examiner commentary

This candidate response has been given one mark only because the candidate does recognise that it is important to understand what type of material it is from a generic looking plastic but does not include in their answer a purpose for knowing this information, such as recycling.

Question 4(c)

(c) Compare the use of DC motors and stepper motors for driving the wheels of a robotic lawnmower. **[4]**

Exemplar 1 — 4 marks

DC motors are simpler and cheaper than stepper motors so they would allow for a cheaper product, however stepper motors allow for a greater control over the speed at which the robot moves. This greater control may be used to improve the robots performance when going around obstacles or when nearing the edges of the lawn. Also for DC motors the polarity of the circuit would have to change for the robot to be able to reverse, which may limit how effectively it can move in more obstructed areas. **[4]**

Examiner commentary

This candidate response has been given full marks for the subject knowledge they convey in their answer, and their explanation of their knowledge in relation to the context of the lawnmower. The candidate clearly understands the appropriate application of DC motors, and states where they would be applied to the robot. They then do so in relation to Stepper motors, and therefore are given all four marks available.

Exemplar 2 — 2 marks

DC motors provide 2 ranges of motion 'foward' and 'back' which is controlled by the direction of current, which is controlled by a PWM by a micro controller.
Stepper motors are more accurate as the micro controller tells the driver how many steps to take before feeding back information to the micro controller. **[4]**

Examiner commentary

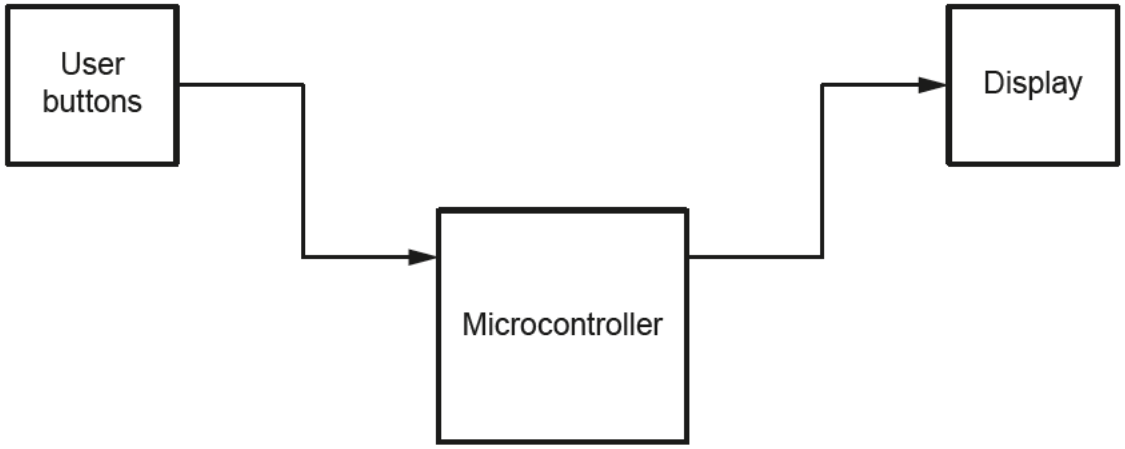
This candidate response is enough for half of the available marks. The candidate has been able to describe the simple functionality of DC motors and compared them to Stepper motors, stating that they are more accurate. If the candidate had gone further to relate this to the application of a lawnmower, it would have been more likely that more marks could have been given.

Question 4(d)

(d) The robotic lawnmower is controlled by an electronic system with a number of sensors, user-operated controls and outputs. The robotic lawnmower function is described below:

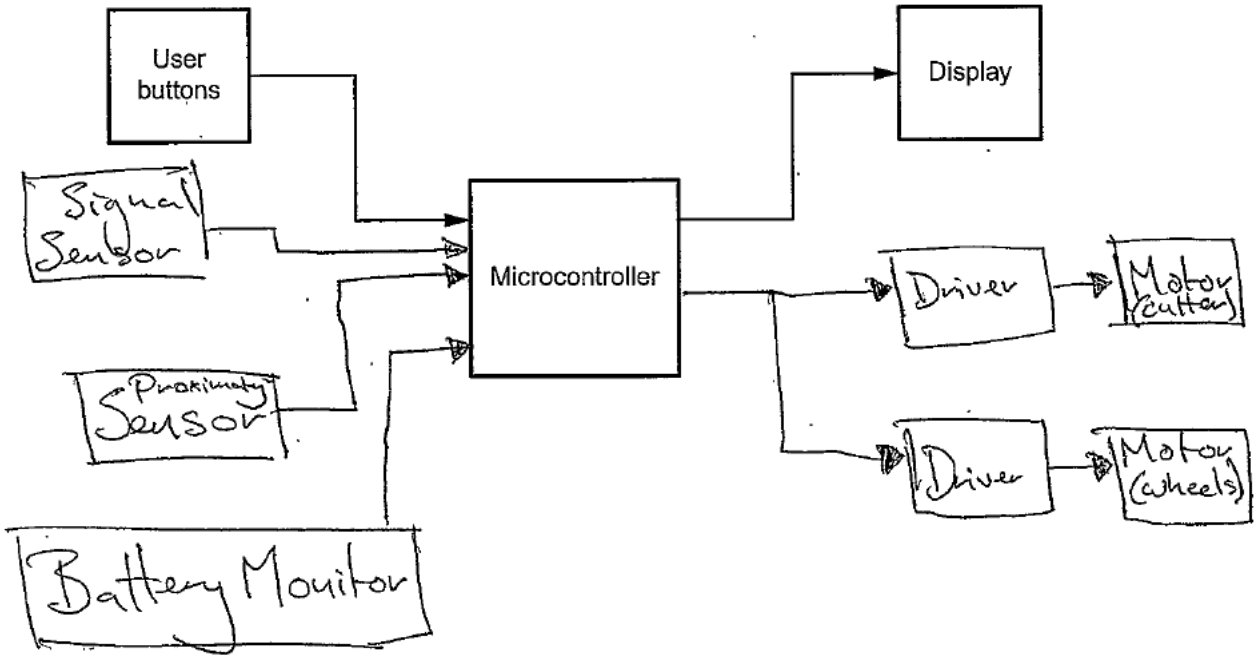
- The user sets the lawnmower to operate at a set time every day using buttons and a display.
- At the set time, the lawnmower automatically undocks from its charging station, starts its grass-cutting blade and begins to move across the lawn.
- A cable, buried around the edge of the lawn, carries an electronic signal which the lawnmower detects and uses to avoid running off the edge of the lawn.
- Proximity sensors on the lawnmower detect the presence of obstacles in the lawnmower's path so that they can be avoided.
- The lawnmower monitors its battery voltage and if the voltage falls below a set level the lawnmower returns to its charging station.

Use this function description to complete the system diagram below for the robotic lawnmower.



[4]

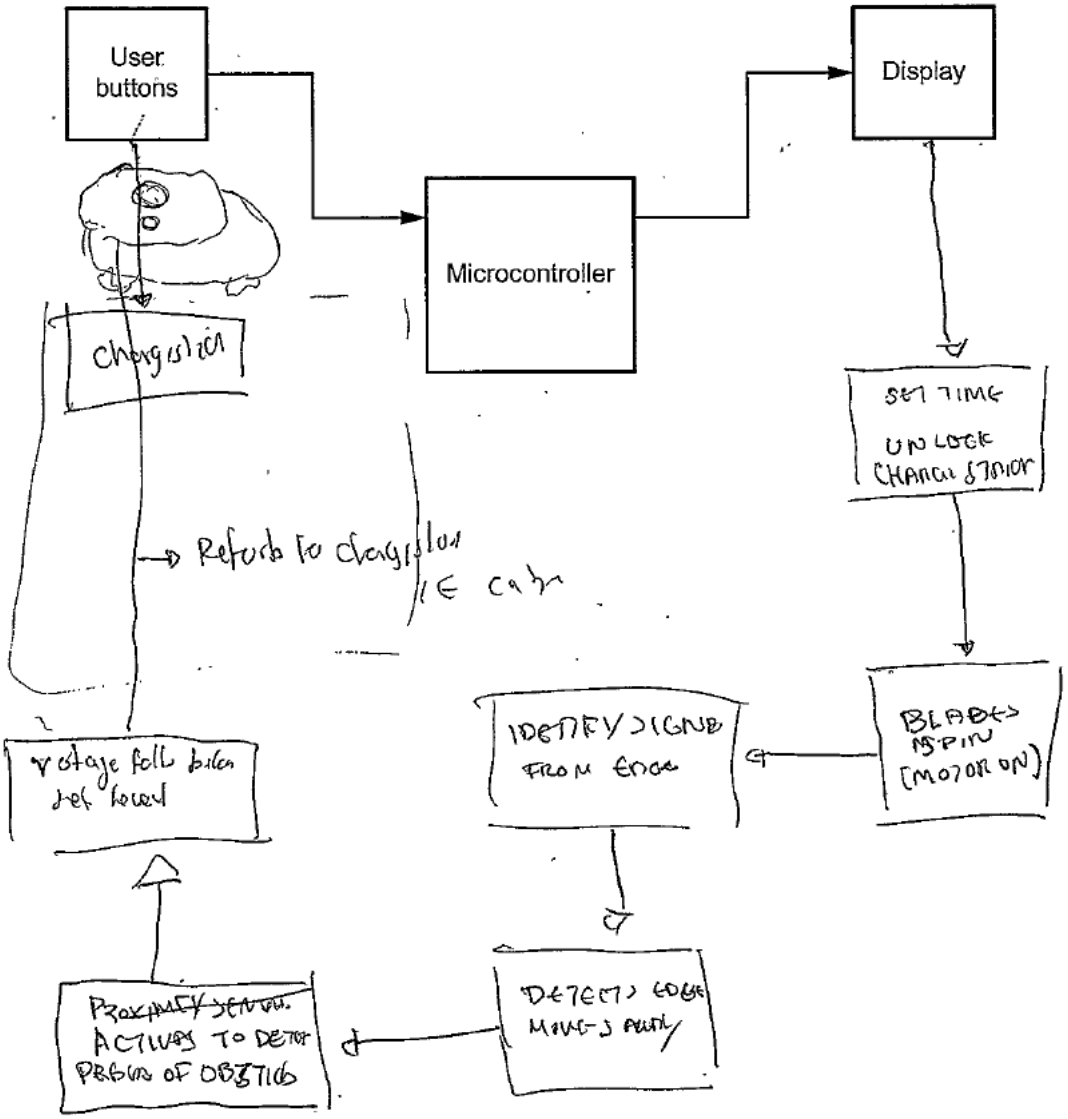
Exemplar 1 — 4 marks



Examiner commentary

The candidate has been given all four marks in this instance as they have been able to identify suitable inputs and outputs relating to the context of a microcontroller in the lawnmower. If the candidate had not differentiated the motor outputs as cutter and wheels, a mark would have been deducted. The answer of a signal sensor in this instance would also have been accepted.

Exemplar 2 1 mark



Examiner commentary

The candidate has made the mistake in this response to assume a flow diagram was required as an answer. Although this is incorrect, an appropriate output has been identified in the answer, and a single mark has been given for this.

Question 4(e)(i)

(e) **Fig. 4.3** shows a circuit diagram for the part of the robotic lawnmower which monitors the battery voltage.

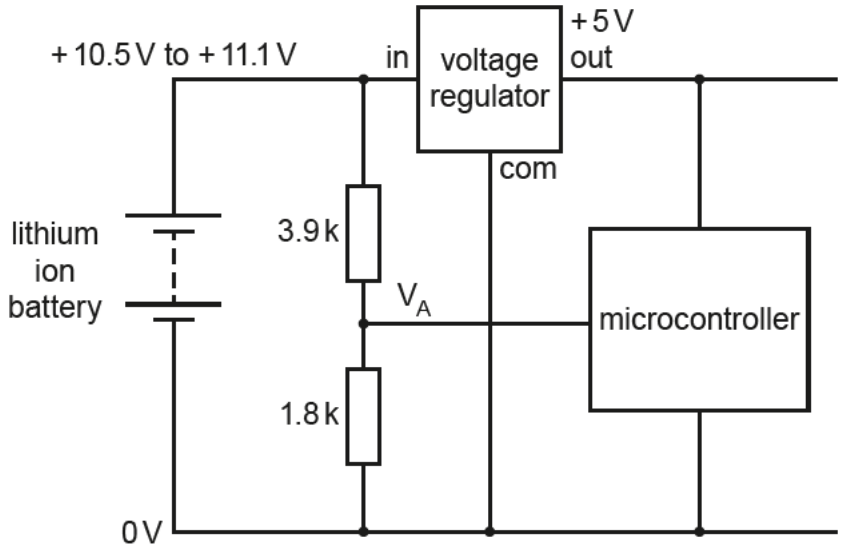
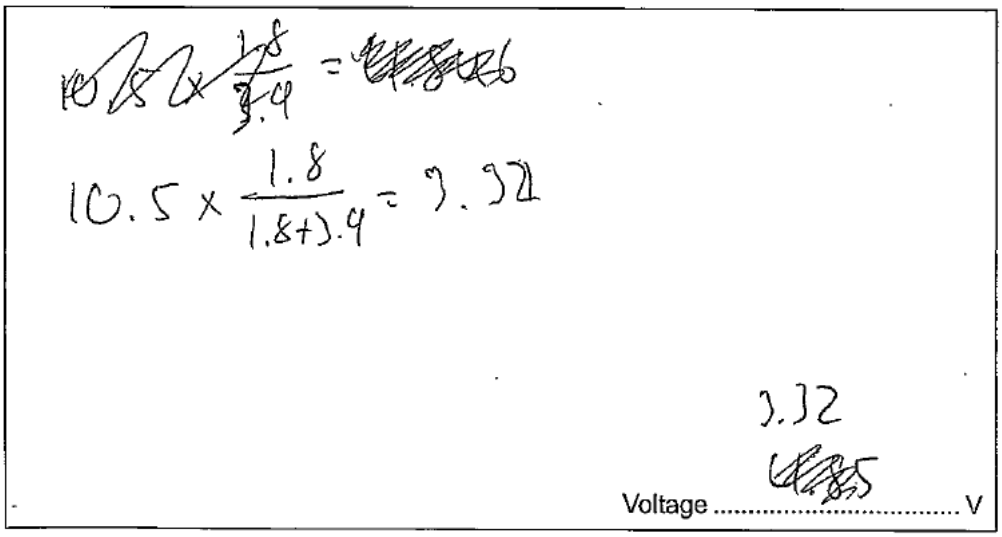


Fig. 4.3

The lithium ion battery produces a nominal voltage of 11.1 V. When the battery voltage drops to 10.5 V an alert is generated within the microcontroller code and the robotic lawnmower returns to its charging station.

(i) Calculate the voltage (V) at point V_A in **Fig. 4.3** when the battery voltage is 10.5 V. Give your answer to 2 decimal places and show your working. **[3]**

Exemplar 1 — 3 marks

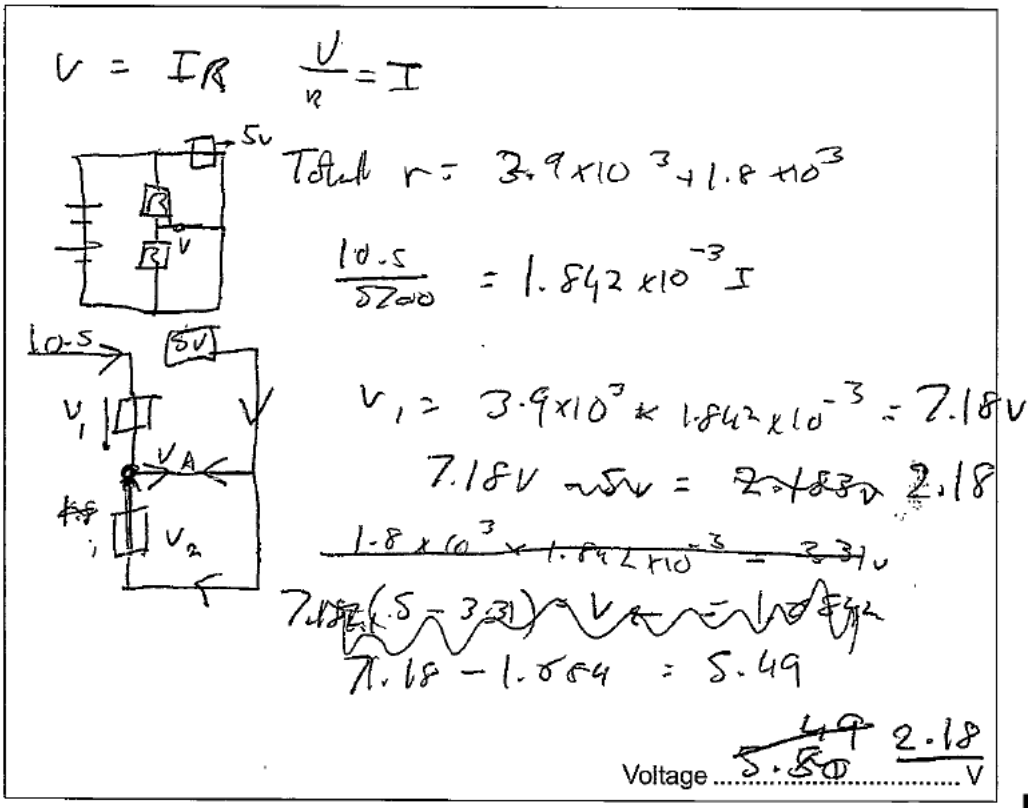


Examiner commentary

In this response the final answer is correct, automatically resulting in full marks. The candidate has also shown a sensible approach to showing their working out, and also crossing out mistaken working out so as not to confuse the examiner.

Exemplar 2

1 mark



Examiner commentary

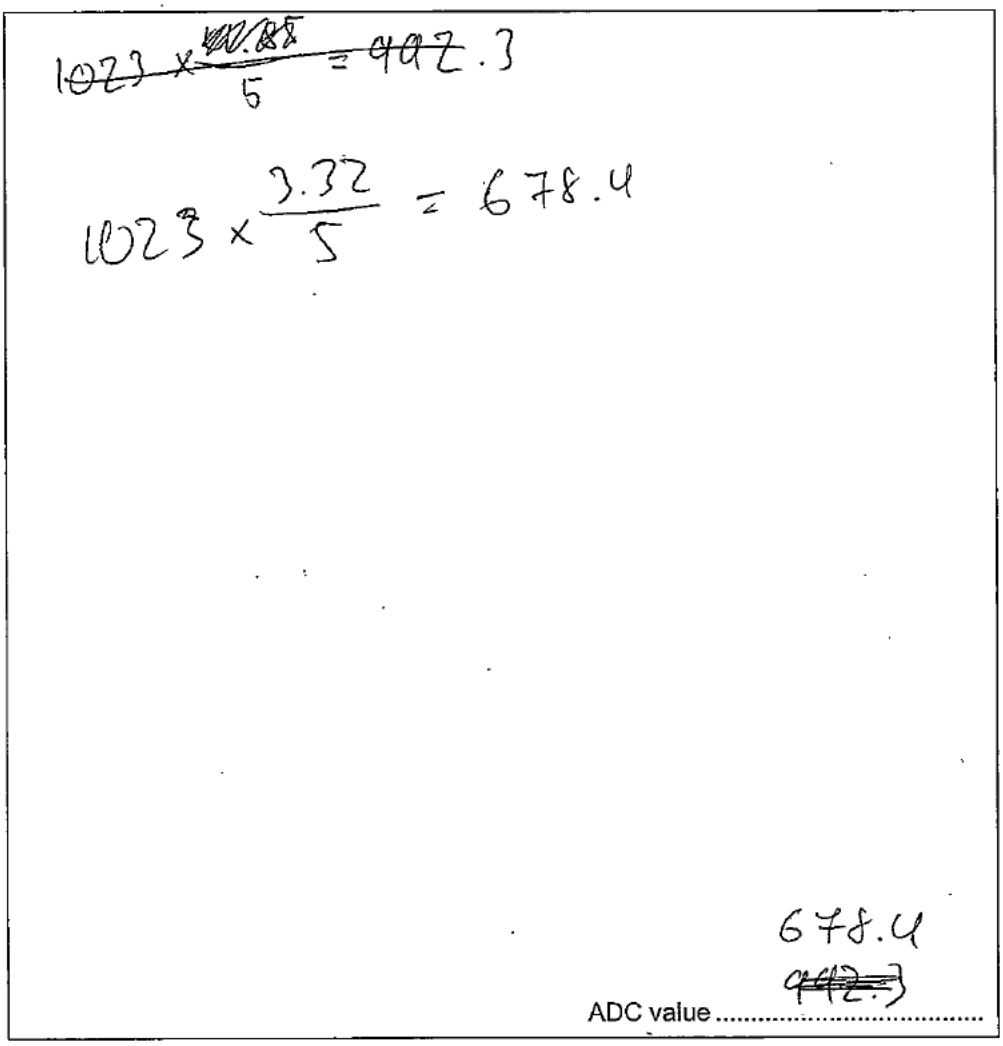
The candidate correctly rearranges the formulae given to calculate the current and is given one mark for this. They then go on to plug values into the equation, but do not do this correctly, and the final answer is wrong.

Question 4(e)(ii)

(ii) Voltage V_A in **Fig. 4.3** is fed into an analogue to digital converter (ADC) pin on the microcontroller. The ADC produces a full-scale value of 1023 when the analogue input is 5.0 V.

Calculate the ADC value produced when the input voltage V_A is at the value you calculated in **part (e)(i)**. Give your answer as a rounded-down integer and show your working. **[3]**

Exemplar 1 — 3 marks

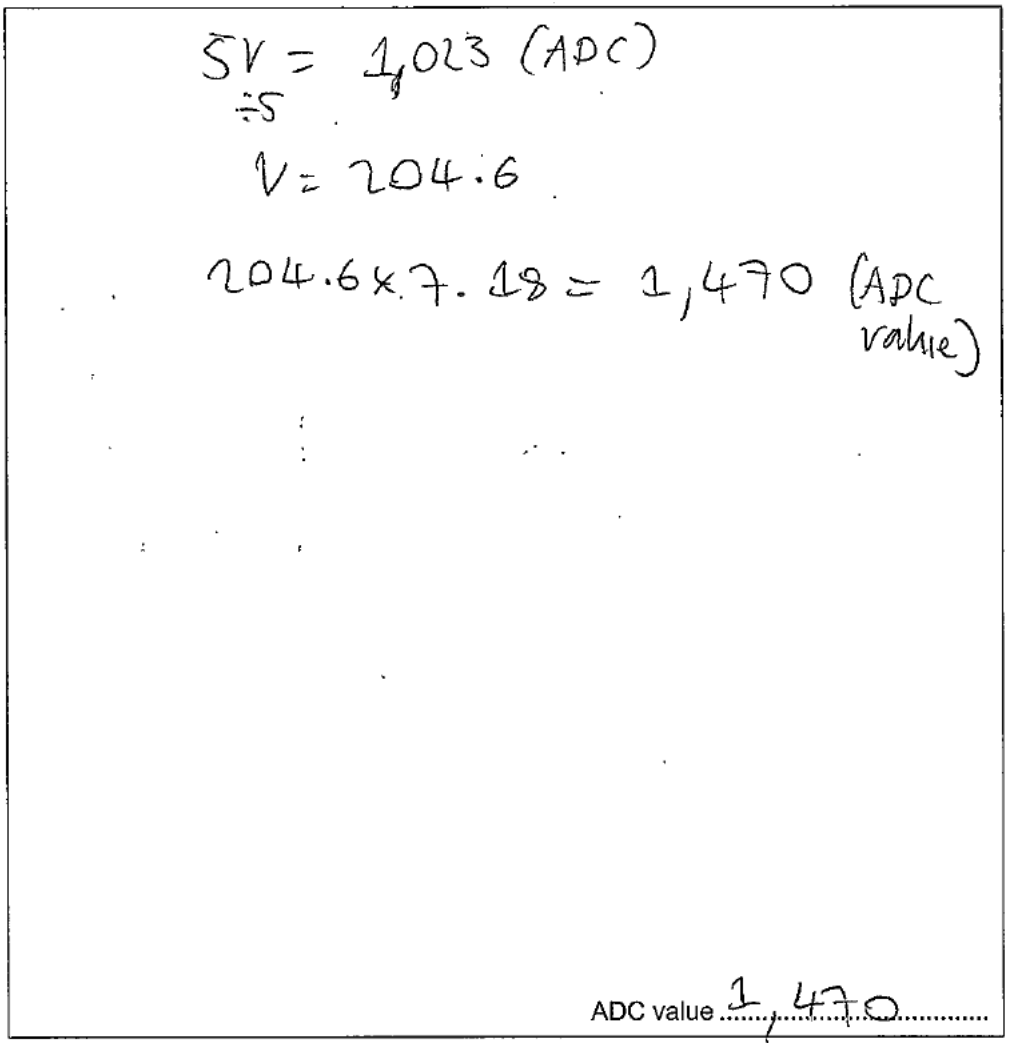


Examiner commentary

The candidate response has been given full marks for the correct answer. Had the candidate carried an incorrect current value from the previous question forward, they would still have been able to achieve full marks due to the use of 'Error Carried Forward'. They can only achieve this thanks to the working out shown alongside the final answer. The candidate's answer contains a rounding error and because this was not the first instance in their paper, the question does not have any marks deducted because of this, as this had already been applied, and is not repeated.

Exemplar 2

0 marks



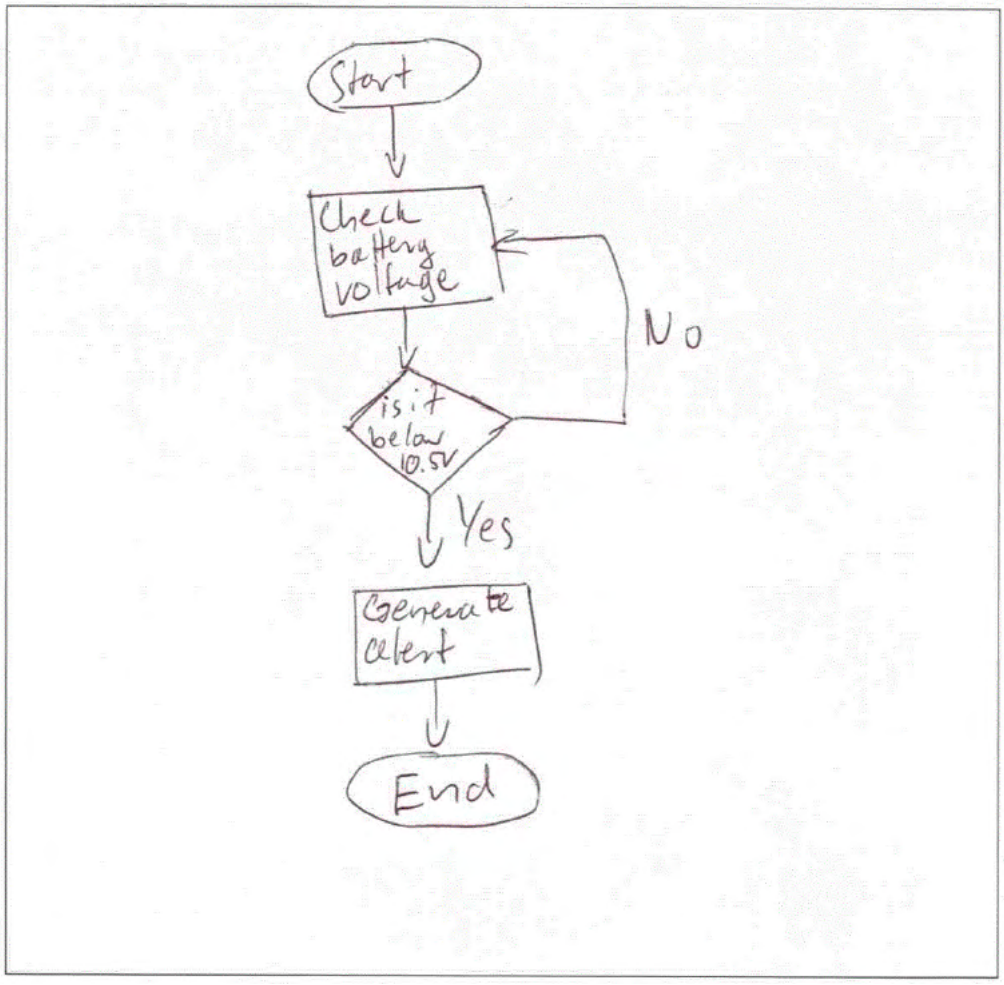
Examiner commentary

This candidate response could potentially achieve a mark, if the approach is correct, but an error has been carried forward from the previous question. In this instance the approach is incorrect, and therefore despite including the working out, both the approach and final answer are wrong. The candidate should have identified the ratio of Va first, then calculated the value of ADC, with the final mark given for rounding to the nearest whole number.

Question 4(e)(iii)

(iii) Draw a flowchart of the robotic lawnmower subroutine to check the battery voltage and generate an alert if the battery voltage falls below 10.5 V. **[3]**

Exemplar 1 — 3 marks

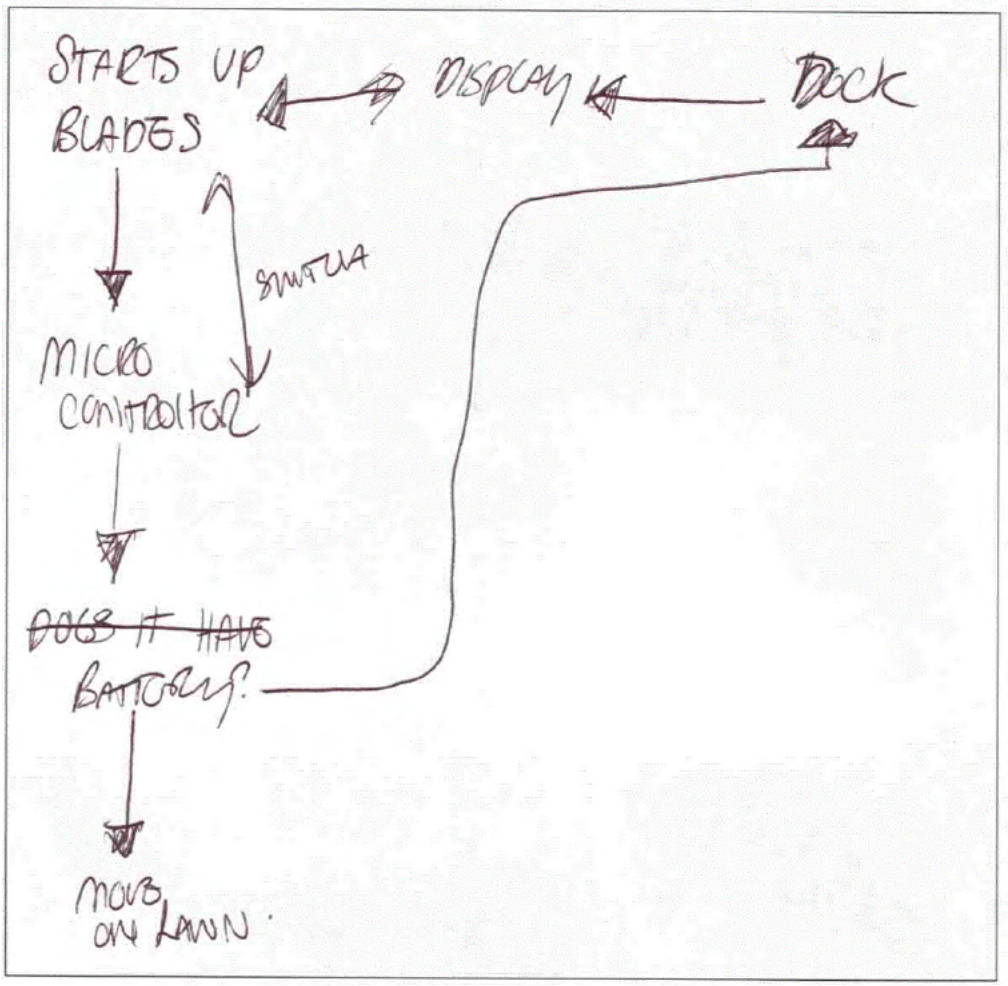


Examiner commentary

The candidate response here is given full marks for identifying the three key elements of the flowchart. The first is the decision box relating to the voltage or ADC value. The second is to generate some form of alert to the system and take action. The third is to convey that the system is constantly monitoring itself through some form of check. Although the actual solution would be much more refined, this answer included all three basic elements for the marks.

Exemplar 2

0 marks



Examiner commentary

The candidate did not recognise in this question the need to draw a flow chart as an appropriate response. This would require the use of appropriate symbols and a suitable translation of the functional requirement of the robot during its self-monitoring recharge, for any marks to be given.

Did you know?

OCR Resources: *the small print*

OCR's resources are provided to support the delivery of OCR qualifications, but in no way constitute an endorsed teaching method that is required by OCR. Whilst every effort is made to ensure the accuracy of the content, OCR cannot be held responsible for any errors or omissions within these resources. We update our resources on a regular basis, so please check the OCR website to ensure you have the most up to date version.

Our documents are updated over time. Whilst every effort is made to check all documents, there may be contradictions between published support and the specification, therefore please use the information on the latest specification at all times. Where changes are made to specifications these will be indicated within the document, there will be a new version number indicated, and a summary of the changes. If you do notice a discrepancy between the specification and a resource please contact us at: resources.feedback@ocr.org.uk.

OCR acknowledges the use of the following content: N/A

Whether you already offer OCR qualifications, are new to OCR, or are considering switching from your current provider/awarding organisation, you can request more information by completing the Expression of Interest form which can be found here: www.ocr.org.uk/expression-of-interest

Please get in touch if you want to discuss the accessibility of resources we offer to support delivery of our qualifications: resources.feedback@ocr.org.uk

Looking for a resource?

There is now a quick and easy search tool to help find **free** resources for your qualification:

www.ocr.org.uk/i-want-to/find-resources/

Need to get in touch?

If you ever have any questions about OCR qualifications or services (including administration, logistics and teaching) please feel free to get in touch with our **Customer Support Centre**.

General qualifications

Telephone 01223 553998
Facsimile 01223 552627
Email general.qualifications@ocr.org.uk

www.ocr.org.uk