# GCE

# Design and Technology

## H404/01: Principles of Design Engineering

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.

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## 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 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 |
| --- | --- |
| 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 |
| CON | Confused (replaces the question mark) |
| 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 |
| SEEN | Noted but no credit given |
| TV | Too vague |
| OFR | Own figure rule |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| **1** | **(a)** | **(i)** | Possible responses may include:<br><br>• "Hot" warning sign near coffee dispenser (1) to inform the users to keep their hands away (1).<br>• Lids supplied for the cups (1) so that users don't spill hot coffee as they walk away (1).<br>• Sleeves supplied for the cups (1), so that users don't burn their hands on a hot cup (1).<br>• Electrical safety (1) – the machine will need routine checks to ensure there is no electric shock risk (1).<br>• Refrigerator temperature warning (1) to prevent milk going sour and creating a food hazard (1).<br>• Clear interactive instructions on screen to help users place cup correctly (1) so hot coffee doesn't spill over (1).<br>• Sensors to stop hot coffee flow if hands are placed near the spout (1) to avoid injury (1).<br>• Any other valid suggestion. | **4** | In each case:<br><br>One mark for identifying a safety feature that could be included in the design of a coffee vending machine.<br><br>One mark for justifying how identified safety feature keeps users safe.<br><br>Specific reference to the context in the question is needed for marks to be awarded.<br><br>Answers may be taken from the image in **Fig. 1.1** or candidates may draw on their own knowledge/experience. |
| | | **(ii)** | Possible benefits may include:<br>• No need for physical buttons (1), so less wiring and less moving parts (1).<br>• Easy to add/remove buttons (1) and change the user interface (1).<br>• They add a prestige feel/look to a product (1).<br>• Intuitive (1) for users – easy to understand/use (1).<br>• Can be integrated into networked systems (1) and linked to e.g. stock control (1). | **4** | Up to two marks for explaining a benefit of using a touch screen interface in products such as coffee vending machines.<br><br>Up to two marks for explaining a drawback of using a touch screen interface in products such as coffee vending machines. |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| | | | • Can animate the user interface (1) – brand image, eye catching, advertising (1).<br>• Touchscreens provide a graphical user interface (1) so that users can see images of the products available to them (1)<br>• Any other valid suggestion.<br><br>Possible drawbacks may include:<br>• Touch screens can gave sensitivity issues with users that have wet hands (1) which can lead to user frustration or incorrect signals received by the microprocessor (1).<br>• High cost (1).<br>• Easy to break glass screen (1).<br>• High energy use when screen is on (1).<br>• May be over complicated for a simple product (1).<br>• Any other valid suggestion. | | Answers need not be restricted to vending machine products. |
| | **(b)** | **(i)** | Overall gear ratio = $\frac{72}{56}$ x $\frac{42}{16}$ = 3.375 <mark>[1]</mark><br><br>Output speed = input speed / gear ratio<br>                    = 3000 / 3.375*  <mark>[1]</mark><br>                    = 888.888889*<br>                    = 889* rpm <mark>[1]</mark> | **3** | Award three marks as follows:<br><br>One mark for calculating overall gear ratio.<br><br>One mark for inserting correct values into formula.<br><br>One mark for calculating the rotational speed of the output gear to nearest whole number. |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| | | | | | 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. |
| | | **(ii)** | Possible reasons may include:<br>• The larger teeth have a greater strength (1) (greater shear strength) as they have to cope with a larger torque (1) than the input gears.<br>• The larger teeth allow for a higher torque (1) therefore the grinder mechanism can deliver a higher force to crush the coffee beans (1).<br>• Any other valid suggestion. | **2** | Up to two marks for explaining a reason why the gear in the output stage has larger teeth compared to the gear in the input stage.<br><br>Specific reference to the context in the question is needed for marks to be awarded.<br><br>A maximum of one mark should be awarded where the reason is correct, but where the large toothed gear is directly crushing the beans. |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| | | **(iii)** | Possible responses may include:<br>• Glass reinforced plastic can be injection moulded (1) which is a process suitable for the intricate detail needed on the gears (1).<br>• Glass-reinforced polymers have a high stiffness (1) which prevents the gear teeth from flexing under high loads (1).<br>• High strength to weight ratio (1), which keeps the component weight low/reducing transport costs/without sacrificing strength (1).<br>• Relatively low cost to manufacture compared to steel gears (1) which helps keep the overall product cost down (1).<br>• Resistant to wear (1) which means they have a long service life/won't need frequently replacing (1).<br>• Any other valid suggestion. | **4** | In each case:<br><br>One mark for identifying a property of a glass-reinforced thermo softening polymer that makes it suitable for manufacturing gears.<br><br>One mark for justifying why suitable for intended purpose.<br><br>Specific reference to the context in the question is needed for marks to be awarded.<br><br>Cost/weight points must be fully justified. |
| | **(c)** | **(i)** | Possible ways may include:<br>• Corporate brand image (1) – developing a unique image (1) which might include the product shape or form (1) such as the glass Coca-Cola bottle (1).<br>• Brand logo (1) – instantly recognisable (1) by its shape and colour (1) such as the BMW logo (1).<br>• Advertising (1) including TV and social media (1) and promotional stands at shows (1).<br>• Social media presence (1) – providing a quick response to posts/queries (1).<br>• Choice of materials and finishes (1) that customers expect from the brand (1). | **4** | Up to four marks for describing ways in which product designers and manufacturers **promote brand awareness** in customers.<br><br>To get four marks candidates must identify at least two ways but could develop one answer up to three marks. |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| | | | <ul><li>Familiar aesthetics for the brand (1) – colours, patterns (1).</li><li>Familiar user experience (1) – user interface (1).</li><li>Word of mouth (1).</li><li>Forums, user-groups (1).</li><li>Any other valid suggestion.</li></ul> | | |
| | | **(ii)** | Possible ways may include:<ul><li>Product reliability (1) which gives users reassurance and builds trust (1).</li><li>Product resilience (1) including resistance to being dropped (1), resistance to water ingress (1) etc.</li><li>Familiarity of controls, user-interface, features (1) giving loyal users an intuitive feel for a new product (1) and a reassurance that they will feel 'at home' by staying with the brand (1).</li><li>A feeling of value for money (1).</li><li>Planned obsolescence with promise of new models (1) giving users the reassurance that they are not buying a product in a discontinued line (1).</li><li>Moving with latest fashions/trends (1).</li><li>Image of the brand (1) maintaining a loyal customer following (1).</li><li>Compatibility between old and new models (1) giving customer reassurance that they can easily upgrade (1) without losing their data/images etc (1).</li><li>Product support/aftersales service (1).</li><li>Any other valid suggestion.</li></ul> | **4** | Up to four marks for describing ways in which product designers and manufacturers **encourage brand loyalty** from customers.<br><br>To get four marks candidates must identify at least two ways but could develop one answer up to three marks. |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 2 | (a) | (i) | Candidate should realise that the unlabelled side of the triangle is 50 mm as it is isosceles.<br><br>$L^2 = 50^2 + 50^2 = 5000$ [1]<br><br>$L = \sqrt{5000}* = 70.7106781187*$ [1]<br><br>$L = 70.7*$mm [1] | 3 | Award three marks as follows:<br><br>One mark for inserting figures into Pythagoras Theorem formula.<br><br>One mark for correctly manipulating Pythagoras Theorem formula.<br><br>One mark for calculating the length $L$ to **1** decimal place.<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.<br><br>Alternative Method could involve using cosine or sine. Award as follows. The example given below is for cosine.<br><br>Recall of formula (1)<br>cosØ= adjacent/hypotenuse<br><br>Rearranging (1) |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| | | | | | hypotenuse = adjacent/cosØ |
| | | | | | Calculate correct answer (1)<br>L = 50/cos45 = 70.7mm |
| | | (ii) | Surface area of steel = (area of square sheet) – (area of square formed by two triangles)<br><br>**Area of square sheet = 100 x 100 = 10 000 mm$^2$ [GIVEN]**<br><br>Area of square formed by two triangles = 50 x 50 = 2500 mm$^2$ [1]<br><br>Area of steel = 10 000 – 2500\* = 7500\* mm$^2$ [1] | **2** | Award two marks as follows:<br><br>One mark for calculating the area of the square formed by the two triangles.<br><br>One mark for calculating the surface area in mm$^2$ of the face of the steel sheet once the two triangular holes have been cut out.<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.<br><br>Alternative Method (to get to area of square formed by two triangles):<br>Area of triangle = ½ x base x height<br>                 = ½ x 50 x 50 = 1250mm$^2$<br>Then multiply this by two. |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| | | **(iii)** | Total surface area of steel = <br><br> • Area of front and back faces = 2 x 7 500* <br>                           = 15 000* mm$^2$ [1] <br><br> • **Area of outside edges = 4 x 100 x 5** <br>                          **= 2 000 mm$^2$ [GIVEN]** <br><br> • Area of inside edges of triangles = <br>     (4 x 50 x 5) + (2 x 70.7* x 5) <br> = 1000* + 707* [1] <br> = 1707* mm$^2$ [1] <br><br> Total surface area = 15 000* + 2000 + 1707* <br>                   = 18 707* mm$^2$ [1] <br><br> Volume of paint needed = 18 707 x 2x10$^{-4}$ <br>                   = 3.74 cm$^3$ [1] | **5** | Award five marks as follows: <br><br> One mark for calculating the area of the front and back faces. <br><br> One mark for determining the two sets of values that are needed to determine the area of the inside edges of triangles. <br><br> One mark for adding these two sets of values together to calculate the total area of the inside edges of triangles. <br><br> One mark for calculating the total surface area. <br><br> One mark for calculating the volume of paint needed to **2** decimal places. <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. |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| **(b)** | **(i)** | | Recall of science formula $P = V^2/R$ [1] (Ohm's Law)<br><br>$P = 24^2 / 32$ [1]<br><br>$P = 18W$ [1] | 3 | Award three marks as follows:<br><br>One mark for recalling correct science formula.<br><br>One mark for inserting correct values into formula.<br><br>One mark for calculating the power in W that is dissipated in the heater.<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>Alternative Method:<br>$I = V/R = 24/32 = 0.75A$ (1)<br>$P = IV = 0.75 \times 24 = 18W$ (1)<br>Recall of both formulae (1) |
| | **(ii)** | | From the graph using the formula $I = Q/t$:<br>• On time = 2.5ms<br>• Length of time on in one complete pulsating cycle = 7.5ms<br><br>Ratio on-time : total-time = 2.5 / 7.5 = 1/3 [1]<br><br>Average current = 1/3* x 0.75 = 0.25*A [1] | 2 | Award two marks as follows:<br><br>One mark for determining that the current is on for 1/3 of the cycle.<br><br>One mark for calculating the average current in A that is flowing through the heater.<br><br>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.<br><br>*Allow error carried forward (ECF) where correct working out is shown. |
| | | (iii) | Recall of science formula $P = IV$ [1]<br><br>Average power $= 0.25^* \times 24$ [1]<br><br>        $= 6^*$W [1] | 3 | Award three marks as follows:<br><br>One mark for recalling correct science formula.<br><br>One mark for inserting correct values into formula.<br><br>One mark for calculating the average power in W that is dissipated in the heater when the current is pulsed as shown in **Fig 2.2**.<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. |

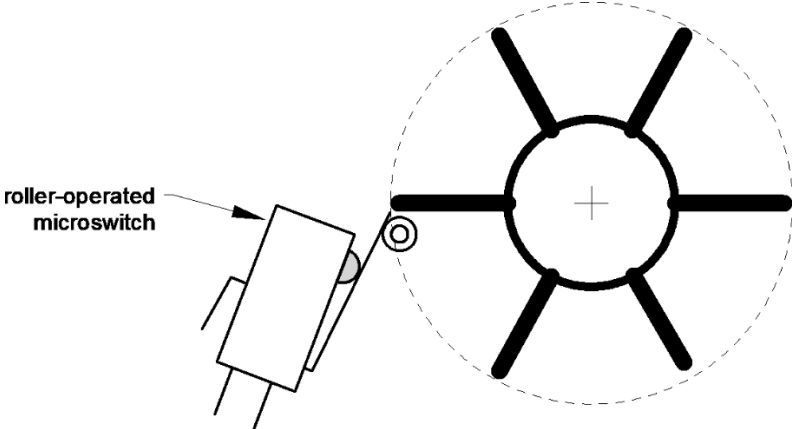| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| **3** | **(a)** | | Possible responses may include:<br>• In a planned obsolescence business strategy products are designed with a specific intended lifetime (1). For example, a laptop computer will be designed with the currently available processor and memory chips but these will become outdated as the manufacturers are always driven to make faster processors and bigger memory (1). This means that the laptop's power will start to look slow compared with newer models and the latest software may not run at all (1). The user will then need to buy a new laptop and, if they have had a good experience with a particular brand, they may wish to stay with that brand (1).<br>• Any other valid suggestion. | **4** | Up to four marks for explaining how a manufacturer can use a planned obsolescence business strategy to promote future product sales.<br><br>It is anticipated that a candidate will use an example to contextualise the points being made which can be awarded credit.<br><br>1 mark for showing a clear understanding of what planned obsolescence means: "The process of designing products to go out of fashion or no longer function after a specific period of time".<br><br>Candidate does not have to define PO – they can earn the first mark by implying an understanding of what PO means.<br><br>1 mark for using a specific product example to illustrate planned obsolescence.<br><br>1 mark for explaining how the example product inevitably becomes outdated or obsolete.<br><br>1 mark for explaining how this leads to predictable future product sales. |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| **(b)** | | | **Indicative content:** <br><br> • In a TQM business model, all areas of a business and its suppliers use agreed specifications and quality control methods, and quality is the responsibility of everyone. <br><br> • A company has a desire to gain customer satisfaction. <br><br> • Aim to guarantee the manufacture of a quality product, every time. <br><br> • Constantly seeking to improve both quality of product and efficiency in manufacture. <br><br> • Reviewing and monitoring every stage of the process. <br><br> • Quality assurance where the system is set up to produced guaranteed quality products every time. <br><br> • Quality checks <br><br> • Every employee is responsible for their quality standards. <br><br> • Employees encouraged to take pride in their work. <br><br> • Training of workers, setup quality management systems. Any other valid suggestion. | 8 | **Level 3 [6-8 marks]:** <br> The candidate has a clear understanding of a TQM strategy. They produce a thorough discussion in relation to the question by explaining how a TQM strategy can help a manufacturing company achieve sustained levels of quality. The explanation is clear and well-developed with at least two well supported examples used to exemplify the points being made and to show how a TQM strategy can drive quality. <br><br> **Level 2 [3-5 marks]:** <br> The candidate has a reasonable understanding of the role of a TQM strategy. They produce a reasonable discussion in relation to the question by explaining how a TQM strategy can help a manufacturing company achieve sustained levels of quality. The explanation is sufficient although one or two opportunities are missed in the use of examples to develop the stated points further to show how a TQM strategy can drive quality. <br><br> **Level 1 [1-2 marks]** <br> The candidate has a basic knowledge of the role of a TQM strategy. Any reference to this strategy is descriptive in nature and has little appreciation of how a TQM strategy can drive quality. The response contains no analysis or evaluation. <br><br> **0 marks** <br> No answer or answer not worthy of credit. <br><br> Award up to 5 marks if a response is exclusively about quality control and/or quality assurance of manufacturing and assembly processes, and/or product testing. |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| **4** | **(a)** | | Possible responses may include. <br> • In the preliminary design stages, focus groups can help to develop a realistic design brief (1) <br> • They can help determine users needs and wants (1) and lead to a product specification (1). <br> • Focus groups can help determine quantitative parameters (1) such as the range of meal sizes for different cats (1), or how often the pet needs feeding (1). <br> • Focus groups can evaluate proposed ideas (1) and they can be asked for new ideas for design features or functionality (1). <br> • They can comment on styles and trends (1). <br> • In the later design development stages, user groups can be used to test prototype products (1), and evaluate their performance (1), and propose fixes or improvements (1). <br> • Evaluation of ergonomics (1). <br> • Evaluation of aesthetics (1). <br> • Testing with real cats (1). <br> • Evaluation and development of user interface (1). <br> • Fault finding (1) and identification of weaknesses in the prototype product (1). <br> • Any other valid suggestion. | **4** | Up to four marks for describing how focus groups can be used when developing a automatic cat feeder. <br><br> Specific reference to the context in the question is needed for marks to be awarded. |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| **(b)** | | **(i)** | Easiest to work in cm units.<br><br>Radius of paddle wheel = 1.0+1.3 = 2.3 cm [1]<br><br>Volume of cylinder with radius 2.3cm, length 5.0cm:<br>    $V1 = \pi r^2 h$<br>    $V1 = \pi \times 2.3^{*2} \times 5.0$<br>    $V1 = 83.1^* cm^3$ (1 d.p.) [1]<br><br>**Volume of inner core of paddle wheel, radius 1.0cm:**<br>    **$V2 = \pi r^2 L$**<br>    **$V2 = \pi \times 1.0^2 \times 5.0$**<br>    **$V2 = 15.7 cm^3$ (1 d.p.) (GIVEN)**<br><br>Volume of all compartments = V1 − V2<br>                    = 83.1* − 15.7*<br>                    $= 67.4^* cm^3$ [1]<br><br>Volume of one compartment = 67.4* / 6<br>                      $= 11.2^* cm^3$ [1] | **4** | Award four marks as follows:<br><br>One mark for calculating radius of paddle wheel. Award the mark if units are in cms or mms.<br><br>One mark for calculating volume of cylinder with radius 2.3 cm, length 5.0 cm.<br><br>One mark for calculating volume of all compartments.<br><br>One mark for calculating volume of one compartment.<br><br>No requirement for a decimal point correction so accept valid answer whether rounding has or hasn't taken place.<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. |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| | | | | | Alternative Method: <br> Candidates may use other methods, including: <br> Volume of all compartments = $\pi(R^2 - r^2)h$ <br> $= \pi \times (2.3^2 - 1^2) \times 5.0$ <br> $= 67.4\,cm^3$ |
| | | (ii) | Density of cat food = 400g per litre <br><br> 1 litre = 1000cm$^3$ [1] <br><br> Volume of one compartment in litres = 11.2* / 1000* <br> = 0.0112* [1] <br> Mass of cat food = density x volume [1] <br> = 400 x 0.0112* = 4.48*g [1] | **4** | Award three marks as follows: <br><br> One mark for recalling 1 litre = 1000cm$^3$ <br><br> One mark for calculating volume of one compartment in litres. <br><br> One mark for recalling correct formula. <br><br> One mark for inserting correct values into formula and calculating the mass of cat food in g carried in each compartment of the paddle wheel. <br><br> If correct answer is given without working out shown award full marks. <br><br> The answer is not required to any specific number of decimal points. Allow for rounding down to 4g or 4.5g for 1 d.p. If |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| | | | | | working to two decimal places, award the mark for 4.48g or 4.49g to allow for rounding / not rounding within calculation.<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)** | | Possible responses may include:<br>• In a closed loop system, feedback is used (1) to achieve precise control because information about the output is fed back to the control unit (1).<br>• Any other valid suggestion. | **2** | Up to two marks for describing how a closed loop control system achieves improved performance over an open-loop system.<br><br>"Feedback" can be implied to gain first mark. |

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| | | **(ii)** | **Indicative content:**<br><br>• Microswitch with lever (1) arranged so that the paddles press the switch as they rotate past it (1). Each paddle produces one pulse from the switch (1).<br>• Any other valid suggestion.<br><br>roller-operated microswitch | **3** | One mark for correctly named sensor.<br><br>Give benefit of doubt for name where 'infra-red' sensor is being named and IR LED emitter / photo diode pair are being shown in sketch.<br><br>One mark for shown interaction between paddle wheel and sensor.<br><br>One mark - system is feasible and will work.<br><br>Candidates only need to sketch the paddle wheel sensor system, not the entire control system.<br><br>Responses with no sketch are limited to 1 mark. |

| (d)* | | **Indicative content:**<br>the factors that need to be considered when distributing products to markets.<br><br>**Environmental considerations:**<br>• Reducing packaging, recyclable/reusable packaging. Government directives relating to packaging.<br>• Transport by sea or rail generally better for the environment than road or air transport.<br>• Shipping large quantities to distribution centres has less environmental impact than shipping individual items to home addresses.<br>• Fuel efficient vehicles.<br>• Electric/biofuel vehicles rather than fossil fuels.<br>• Using local suppliers to reduce transport distances.<br>• Demand for perishable goods, e.g. fruit – fast transport by air – huge environmental impact.<br>• Carbon footprint.<br>• Efficient product design with distribution in mind, e.g. reducing weight, flat pack to reduce transport volume.<br>• Downloadable items, e.g. instruction manuals, books.<br>• Life cycle assessment to assess/reduce impact.<br>• Any other valid suggestion. | **8** | **Level 3 [6-8 marks]:**<br>The candidate has a clear understanding of the factors that need to be considered when distributing products to market. They produce a thorough discussion in relation to the question by discussing both bullet points and how they can impact the distribution process. The explanation is clear and well-developed and a number of examples are used to exemplify the points being made.<br><br>*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 factors that need to be considered when distributing products to market. They produce a reasonable discussion in relation to the question by discussing both bullet points and how they an impact the distribution process, or there is a thorough discussion in relation to only one of the bullet points. The explanation is sufficient although one or two opportunities are missed in the use of examples to develop the stated points further.<br><br>A thorough discussion in relation to only one of the bullet points can achieve a maximum of 5 marks.<br><br>*There is a line of reasoning presented with some structure. The information presented is* |

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| | | | **Supply and demand**<br>• High initial demand for popular new product – storage issues.<br>• Logistics and planning.<br>• High volume manufacture is slow to respond to changes in demand. Batch production is better.<br>• Global manufacturing – long lead times due to transport.<br>• Global manufacturing using smaller factories in several countries helps improve supply and distribution issues.<br>• High trend or fashionable products likely to require faster response to demand changes.<br>• Any other valid suggestion. | | *in 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 factors that need to be considered when distributing products to market. Only one bullet point covered. The response is descriptive in nature and has little appreciation of how factor(s) impact the distribution process. The response contains no analysis or evaluation.<br><br>*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. |

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