AS LEVEL

Exemplar Candidate Work

DESIGN AND TECHNOLOGY

H004-H006
For first teaching in 2017

H004/01 Summer 2018 examination series
Version 1

www.ocr.org.uk/designandtechnology
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>Question 1(a)</td>
<td>4</td>
<td>26</td>
</tr>
<tr>
<td>Question 1(b)</td>
<td>6</td>
<td>28</td>
</tr>
<tr>
<td>Question 1(c)(i)</td>
<td>8</td>
<td>30</td>
</tr>
<tr>
<td>Question 1(c)(ii)</td>
<td>10</td>
<td>31</td>
</tr>
<tr>
<td>Question 1(c)(iii)</td>
<td>11</td>
<td>33</td>
</tr>
<tr>
<td>Question 1(c)(iv)</td>
<td>13</td>
<td>35</td>
</tr>
<tr>
<td>Question 1(d)(i)</td>
<td>15</td>
<td>36</td>
</tr>
<tr>
<td>Question 1(d)(ii)</td>
<td>17</td>
<td>37</td>
</tr>
<tr>
<td>Question 2(a)</td>
<td>19</td>
<td>39</td>
</tr>
<tr>
<td>Question 2(b)</td>
<td>20</td>
<td>41</td>
</tr>
<tr>
<td>Question 2(c)</td>
<td>22</td>
<td>43</td>
</tr>
<tr>
<td>Question 2(d)(i)</td>
<td>23</td>
<td>45</td>
</tr>
<tr>
<td>Question 2(d)(ii)</td>
<td>24</td>
<td></td>
</tr>
</tbody>
</table>
Introduction

These exemplar answers have been chosen from the summer 2018 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 2018 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 2019. 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  Fig. 1.1 shows a standard microwave oven used to heat or cook food/liquid.

(a) When a company is developing a new product like a microwave oven it needs to consider different stakeholder requirements.

Describe two methods which could be used to investigate stakeholder requirements for the design of a new microwave oven.

Exemplar 1  4 marks

1. Real Life (context) investigation - you could go to places which have a microwave and ask them to find out how they work and their advantages and disadvantages.

2. A Survey - you could carry out a survey about what they would want for a microwave.

Examiner commentary

The two responses given by this candidate are distinctly different approaches. As a high level response, the first method is an example of a live research task, where the researcher would visit a location where the product could be observed in use. The second method is an example where research is conducted using a digital response form remotely. In both instances the product is mentioned, and there is an attempt to state what the researcher might be trying to learn by conducting the research method.
Examiner commentary

The two responses given by this candidate are remarkably similar. As a low level response, the first method and second method are described in similar fashion, and despite the candidate suggesting what the researcher might learn from each research tool, both findings are the same. If the candidate had differentiated the approach, perhaps suggesting to observe one group, and interview the other to learn different things, a higher mark would have been awarded.
Question 1(b)

(b) The new microwave oven has an electronic system. A design engineer would make extensive use of computer-aided engineering (CAE) software when developing this electronic system.

Explain two reasons why CAE software would be used in the development of an electronic system, such as in a microwave oven.

Exemplar 1

4 marks

Examiner commentary

The two responses given by this candidate describe two advantages of using simulation software for developing an electronic system. The first describes the ability to simulate the system without buying and testing multiple physical components, which is a clear cost/time saving to the development process. The second advantage describes a different area of consideration, safety, and explains that simulating the testing of an electronic system would remove the risk to the engineer of conducting a real physical test, where an untested system could cause a serious fault. It is the reference to the ease of changing variables and testing without danger to the engineer that afford the second mark for each of these responses.

Exemplar 2

1 mark
Examiner commentary

The two responses given by this candidate are describing the act of testing/simulation. Due to the similar approach described for both answers, identifying how components would work for the real application, it is hard to credit the candidate for both responses. In this instance, one is awarded marks, as it describes a simulation of components using a possible circuit simulation software application, and though the second response would have equally been awarded the same marks, it is too similar to the first, and therefore identified by the examiner as repetition.
Question 1(c)(i)

(c) Fig. 1.2 shows the system diagram for the microwave oven with two labels missing.

Examiner commentary

For the label that is an input to the microcontroller, this candidate names a suitable microwave input device, a dial, which would likely be used to select the program function from a choice on the front of the device. For the label that is an output from the microcontroller, the candidate names a timer, which is consistent with the microwave and would feature on a screen to the user to communicate the time remaining for the programme to complete. The answers are recognisable for the product in question, and are not repeats of the input and outputs already provided in the diagram.
Examiner commentary

The candidate in this instance makes the mistake of naming a sensor already given in the diagram as an input to the microcontroller. A door sensor would be able to communicate to the controller if the door was open or closed, and therefore a separate sensor would not be required. The output label provided is correct, and is awarded a mark because it is appropriate to the product in question.
Question 1(c)(ii)

(ii) The system diagram in Fig. 1.2 is an example of an open loop control system.

Explain how an open loop control system works in a product such as a microwave oven.

Exemplar 1

2 marks

Examiner commentary

The candidate response in this question clearly understands how an open loop control system works. Despite not giving a refined shorter response, what the candidate does correctly is to state that there is no feedback in the system, and for a microwave this means that the cooking program runs until a timer expires. There is no ability to sense the progress of the cooking program, which the candidate describes by stating it will stay on until it is manually turned off or the timer expires. It supported this candidate to try to explain the system in the context of operating the product in question, the microwave.

Exemplar 2

0 marks

Examiner commentary

The response given by the candidate in this example in part is correct, but does not answer the question. The candidate states that the program (in this example the turning of the plate), will stop when the time stops. This is correct, but without reference to an open loop control system being unable to sense, feedback or acknowledge in any way the progress of the program, the response is unable to gain any marks. There is no explicit or implied feedback in the answer.
Question 1(c)(iii)

(iii) The door closed sensor in the system diagram in Fig. 1.2 is constructed using a switch.

Draw a circuit diagram to show how a switch and a pull-down resistor are connected to the digital input of a microcontroller to produce a signal when the switch is closed.

Exemplar 1  2 marks

Examiner commentary

The candidate sets out a diagram in almost exemplar fashion in comparison to the examiners mark scheme. This is because the diagram includes the microcontroller, a switch (with correct symbol), and a pull down resistor (with correct symbol), all of which are listed in the "Draw" statement in the question. Not only are these drawn clearly and accurately, which would have seen both marks awarded, the candidate demonstrates the knowledge of how to draw a circuit which includes the voltage, the wire arrangement using horizontal and vertical lines, and a short description, which despite not adding additional marks to the response, confirm the candidates sound knowledge.
Examiner commentary

The candidate response here has wasted time to both draw and describe as a written statement. The written statement adds no value to the response due to the requirement of a drawn response. The diagram itself includes a clear resistor connected to a labelled microcontroller and voltage, which awards one mark. The second would be awarded to the switch in the diagram; however this has been labelled as the microcontroller. In order that the candidate is not penalised for falsely drawing the appropriate symbol for the microcontroller to achieve the mark that has been awarded, the second is not given despite the switch symbol being correct. If that candidate had additionally drawn the microcontroller separate to the switch, labelled or not, then both marks would have been awarded.
Question 1(c)(iv)

(iv) The oven light, located inside the microwave oven, consists of three white LEDs wired as shown in Fig. 1.3.

To connect the oven light to the microcontroller, it is necessary to know the current through the LEDs.

Each LED in Fig. 1.3 has a voltage drop of 2.5 V.

Calculate the current in mA through the LEDs. You must state the formula used in your calculation. Show your working.

Exemplar 1 3 marks

Examiner commentary

As a mathematical question, the achievement of the correct answer results in all marks being awarded, irrespective of the approach taken or inclusion of working out. However, in this instance, the candidates approach is included, which had the correct answer not been awarded, would have seen one mark given to the inclusion of the equation $V=IR$, and a mark given to the calculation of the correct voltage across the resistor, 4.5V. The key sentence in this question to calculate this voltage is that there is a voltage drop of 2.5V per LED, taking 12V down to 4.5V. Where a wrong final answer is given, the error carried forward marks credits candidates for including their working out, and ensures they are not punished for working out mistakes.
Examiner commentary

This candidate’s response exemplifies how the error carried forward acknowledged by the examiner results in two marks being awarded for taking the right approach. The equation has been identified and included, and subsequently used. The wrong voltage is included in the equation, and the resulting answer is not correct. The candidate achieves some marks where they would have achieved none had only the current been written into the answer space.
Question 1(d)(i)

(d) The microwave oven shown in Fig. 1.1 uses a rotating turntable inside for the food/liquid to sit on. This turntable is driven by a motor and a compound gear train as shown in Fig. 1.4.

(i) The motor speed is 100 rpm.

Calculate the rotational speed of the turntable shaft. Show your working.

Exemplar 1

Examiner commentary

Despite providing the correct answer of 4.2 rpm in this response, which as a mathematical question would result in all three marks being awarded, the candidate provides the working out, giving themselves the best chance to pick up marks should their final answer be incorrect. The method does not match the approach of the mark scheme, but the examiner acknowledges the approach as correct and simply different. The A:B ratio is identified, and this answer (4) is used to reduce the overall rpm of 100 to 25. There is then a second ration between C:D of 6, and the 25 rpm is divided by 6 to result in the correct answer. The mark scheme approach calculated the overall ratio by multiplying the ratios of A:B and C:D together, but importantly the same answer is achieved, and the candidate has used their working out as a backup.
Examiner commentary

This question asks candidates to demonstrate an understanding of gear ratios, and marks are awarded for recognising the ratio relationship between A and B, and C and D. This information can be derived from the diagram, and simplified numerically to 4 and 6 respectively. The calculation of the rpm requires the candidate to multiply these numbers to identify the overall ratio, then divide the rpm provided (100) by this number, resulting in 4.2rpm. There are error carried forward marks awarded for working out, but in this instance the candidate includes no working that demonstrates part of the credited process. The examiner would assume in this instance that the candidate did not have the appropriate knowledge to respond to the question.
Question 1(d)(ii)

(ii) Gear D and the turntable shaft are manufactured from a metal alloy.

Use annotated sketches and/or notes to show how gear D could be securely attached to the shaft. Include technical terms.

Exemplar 1

3 marks

Examiner commentary

The method of joining the gear and shaft in this question more often drew candidates to a mechanical joining method such as a grub screw through the gear into an indented shaft; however this candidate demonstrated sufficient subject knowledge about welding to achieve full marks. The candidates sketch is clear, including reference to technical details of the process of MIG/TIG welding. The sketch is clear and annotated appropriately. The description provided supports the sketch, referring to using a filler rod and heat from high current electricity, as well as referring to the inert gas that is often used in the process. Had the candidate only provided the sketch or the description, they would have achieved between 1 and 2 marks at most.
Examiner commentary

In order to achieve the marks for this question, the candidate must include either a clear sketch that communicates the appropriate joining technique, or a description of the appropriate technique, or a combination. For some candidates, it is often best to advise they do both, as often sketches alone do not convey sufficient information, and a description can fill in the gaps for an examiner. In this response, the sketches are weak, as the two drawings do not line up as a general arrangement drawing to aid the viewer, and the individual sketches alone do not convey enough information. A suitable exploded drawing in 2 point perspective would replace these drawings in this instance. The description given by this candidate however confirms that they have only considered how the two might join, not how they would remain joined. Describing a friction fit of the rod, the inclusion of a screw thread, or a form of welding would add a mark here, possibly two if the solution was appropriate. It is inferred in the candidates answer that mechanical joining is being described and supported by the top sketch of a gear and turntable cross section.
Question 2(a)

2 (a) A new type of battery is advertised as ‘lasting 20% longer’ than the old type.

In a test, the new type of battery has a lifetime of 4.5 hours.

Calculate the lifetime of the old type of battery. Show your working.

Exemplar 1

The candidate provides a correct answer of 3.75 hours. This ensures they will achieve all the marks as it is a mathematical question. The inclusion of the working out of the candidate ensures some marks will be awarded if this were not the case. The candidate correctly recognises that the new battery is 20% better than the old battery (total 120%), and not that the old battery is 20% worse than the new (80%). This was a common mistake of many candidates who multiplied 4.5 hours by 0.8 (80%), resulting in 3.6 hours. The approach shown is in line with the question description. The important part of the question is that the "new battery lasts 20% longer than the old".
Question 2(b)

(b) A design engineer wants to support a pipe at an angle of 12° to the horizontal to allow fluid to drain properly. The pipe is held between two vertical supports, 800 mm apart, as shown in Fig. 2.1.

![Diagram of a pipe supported at an angle]

Fig. 2.1 (not to scale)

The height of support A is 100 mm.

Calculate the height (h) of support B. Show your working.

Exemplar 1

Examiner commentary

The candidate provides a correct answer and therefore will be credited with all three marks. The candidate also includes useful working out as a backup in case they carry an error forward in their working out. The diagram in the top left of the answer box shows that they have identified the triangle as a right angled triangle. The calculations below this in the zoned off area of the answer box show that the candidate recognises that the question requires trigonometry, specifically using tan to calculate the missing length. The candidate finally remembers that the height (h) requires the addition of this calculated answer to the additional support (A) on the diagram, of 100 mm. Many candidates missed this last step, but scored marks for recognising the right angle and the use of trigonometry.
Examiner commentary

The candidate in this response scores one mark for recognising the need to use trigonometry, specifically tan, to calculate the answer. Had the candidate labelled the triangle sketch as a right angle, or written this somewhere, they would have achieved a second mark, despite not demonstrating the knowledge to calculate the correct answer.
Question 2(c)

(c) After manufacturing a batch of switches the probability of finding a faulty switch is \( \frac{1}{5000} \)

Two switches are selected at random.

Find the probability that both switches are not faulty. Show your working.

Exemplar 1

3 marks

Examiner commentary

The candidate has clearly read the question carefully, as without additional working out, is able to write immediately the probability of a switch being not faulty as 4999/5000. They also recognise from the question that because both switches are “selected at random”, the probability of each being faulty is the same as the other. Had the question stated that one switch would be picked first, then the second, the probability of the second would be out of 4999 not 5000. This was an important mistake made by candidates.

This candidate read carefully the question, and was able to confidently calculate the right answer, and would have achieved two of the marks had the final answer not been correct because in writing their working out, they have demonstrated that each selection is mutually exclusive, and that they can calculate the probability of an event not happening when given the probability of the event happening.
Question 2(d)(i)

(d) During the setting of a sensor to measure force, the data shown in Fig. 2.2 was collected.

<table>
<thead>
<tr>
<th>Force (Newtons)</th>
<th>$V_{out}$ (Volts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.15</td>
</tr>
<tr>
<td>1</td>
<td>1.22</td>
</tr>
<tr>
<td>2</td>
<td>1.24</td>
</tr>
<tr>
<td>3</td>
<td>1.30</td>
</tr>
<tr>
<td>4</td>
<td>1.36</td>
</tr>
<tr>
<td>5</td>
<td>1.43</td>
</tr>
<tr>
<td>6</td>
<td>1.46</td>
</tr>
<tr>
<td>7</td>
<td>1.50</td>
</tr>
</tbody>
</table>

Fig. 2.2

(i) Plot this data on the graph below and draw a best fit line.

Exemplar 1 2 marks

Examiner commentary

The candidate has correctly plotted the values from the table to the graph. A line of best fit has also been drawn to have as many of the points on the line, and an equal amount of points sitting above and below the line. The candidates approach aids their chances of achieving a mark in part (iii) of this question.
Question 2(d)(ii)

(ii) Explain how the graph shows that this sensor produces a linear output in response to the applied force.

Exemplar 1

2 marks

Examiner commentary

In the candidate’s response, they have included a calculation of the voltage increase per increase in N force. This, along with the candidate’s reference to being able to draw a straight line and calculate the gradient of the line ensures that both marks are awarded. These statements infer the required knowledge for the mark scheme, that there is either a positive correlation relationship, a consistent relationship, or simply that as one increases, the other increases by a consistent/predictable amount.

Exemplar 2

1 mark

Examiner commentary

The candidate response here is a correct statement, that as one increases the other increases, however without reference to there being a consistent or predictable relationship, the examiner has in this instance given a generous mark for acknowledging that the increase is relatively consistent (between 0.02 and 0.07). Though the candidate fails to reference this as consistent, it is inferred that this is what the candidate is trying to convey in this response.
Question 2(d)(iii)

(iii) Extend the best fit line on the graph above, to predict the $V_{out}$ (V) when the force is 8.5 N.

Exemplar 1

2 marks

Examiner commentary

If candidates had translated the table data for part (i) of this question, the extension of a suitable best fit line would provide an answer between the range of volts provided in the mark scheme. The range accepted took into account the potential variation in the line of best fit, but would not take account of poor translation of the line to the Y axis. This candidate translated a voltage that was the most common answer provided by candidates, and which resided in the middle of the accepted range.
Question 3(a)

3 Fig. 3.1 shows an automatic sensor sink tap, which produces a flow of water when a person places their hands under the spout. Such taps are increasingly being installed in public toilets.

![Image of automatic sensor sink tap]

Fig. 3.1

(a) Discuss possible reasons for the growing demand of automatic sensor sink taps in public toilets.

Exemplar 1

... More people are becoming aware of the bacteria and pathogens that can be spread through dirty taps and soap dispensers. By installing sensors, the taps become safer to use and people therefore feel more secure using these kinds of taps instead of push ones. Sensor taps also mean that less bacteria can build up on the sink as people avoid pushing taps with already wet hands. This means that the taps are easier to clean but also last longer as water and limescale are less likely to get into the tap and affect the mechanism. This makes them more worthwhile in the long run. They can also be more accessible to some people as the older generation may not have the strength to force a push tap down, so the sensor enables many people to access the tap... [6]
Examiner commentary

In an ideal response, this candidate would have mentioned within the body of their response a reference to growing demand. However, in spite of not mentioning this in reference to their discussion of reasons, those that are listed cover a broad range of stakeholders, justified reasons, and analysis of their ideas in place of simply listing them. For example, the first idea about touch taps spreading bacteria, is supported by stating the alternative opportunity sensing taps present, making them feel safer and more secure to use. Later, the candidate proposes that sensing taps would need less cleaning, but then goes on to reference to the build-up of lime scale being less likely if the taps are not touched as much. The candidate makes use of referencing to user groups, in this instance the older generation, and could have gone on to talk about contexts or scenarios of the young, parents with children, etc. Additional paper is used to make a valid further point about reducing water consumption and the impact this has on the environment, and this final point helps to give the examiner the opinion that a thorough and broad discussion has taken place. The candidate could improve this response by talking about the council who might own the toilets, or be critical about the installation or initial cost, but by simply adding in reference to the growing demand, this response would include the elements expected for this style of question.

Exemplar 2

1 mark

Examiner commentary

This candidate’s response provides a clear example of failing to construct a discussion, by simply focusing on a single point which would have been comfortably covered in a single sentence. The response fails to conduct analysis in reference to the taps and the change in demand. By focusing on the broad issue of water wastage, the candidate has wasted time and failed to improve on a single mark. A simple technique to improve this response would be to consider other stakeholders, or to formulate three reasons why sensing taps are an improvement on mechanical taps, before drawing in on the discussion about demand.
AS Level Design and Technology

Exemplar Candidate Work

Question 3(b)

(b) The tap body is batch produced from a non-ferrous metal.

Explain two reasons why a non-ferrous metal is a suitable material for manufacturing an automatic sensor sink tap.

Exemplar 1

3 marks

1. A non-ferrous metal does not rust as it doesn’t contain iron, this is suitable as in sink taps there is constant water use, so the metal will need to be corrosion resistant.

2. Non-ferrous metals such as aluminium are quite easy to mould, which means they would be suitable for batch production.

Examiner commentary

The key word in this question is “manufacturing”, which means that the explanation about why non-ferrous metals are suitable for this application does not accept responses relating to subsequent use. The two answers given by this candidate show contrasting quality. The first references to the metal not rusting, which alone would result in one mark, but because the candidate infers that there is then no requirement for the material to be finished (corrosion resistant), the examiner can generously award the second mark. For the second answer, the candidate states that the material will mould easier, which is assumed that the candidate means the material requires less energy to melt and therefore form, however this is not stated in contrast to an alternative material, so only one mark is awarded in this instance. Though this question appeared easy to respond to for candidates, they need to be aware of what is being asked as this example shows.

Exemplar 2

1 mark

1. As they’re non-ferrous they won’t get any rust or wear on them overtime.

2. They also give a nice and smooth finish too them with no sharp edges.

Examiner commentary

The key word in this question is “manufacturing”, which means that the explanation about why non-ferrous metals are suitable for this application does not accept responses relating to subsequent use. The two answers given by this candidate show contrasting quality. The first references to the metal not rusting, which alone would result in one mark, but because the candidate infers that there is then no requirement for the material to be finished (corrosion resistant), the examiner can generously award the second mark. For the second answer, the candidate states that the material will mould easier, which is assumed that the candidate means the material requires less energy to melt and therefore form, however this is not stated in contrast to an alternative material, so only one mark is awarded in this instance. Though this question appeared easy to respond to for candidates, they need to be aware of what is being asked as this example shows.
Examiner commentary

The candidate provides two sound attributes to the material in question, that it will not rust and can have a smooth finish applied to the surface. However the reference to not rusting is not given in the context of manufacturing, and results only in one mark, whilst the second response though valid, is not supported by the candidates further writing to demonstrate they understand how the material can be finished in manufacturing, and they have simply stated a possible aesthetic feature of the material which is only relevant in a specific context. Had the candidate described this appropriately, in relation to manufacturing, then two marks would have been awarded for the second response.
Question 3(c)(i)

(c) The automatic sensor sink tap is controlled by an electronic system, based around a microcontroller. A reflective infra-red sensor is used to detect the presence of a user’s hands. The water continues to flow for two seconds after the hands are removed.

(i) Describe how a reflective infra-red sensor works.

Exemplar 1

3 marks

Examiner commentary

This question requires the candidate to identify how the sensor would perform three key stages of the taps operation; how it operates when no hands are present; what happens when hands trigger the sensor; and what happens when the hands were there and then subsequently are removed. This candidate does this well, describing first how the signal bounces off the hands (or reads the heat change) and is read by the sensor. The candidate then explains that this registers a change, inferring that no change is read unless the hand(s) are present. Finally the candidate recognises the final step, that when the hand(s) are removed, the sensor signal does not return, and the water turns off. Some candidates mentioned that a timer might be used to provide a specific window for washing hands before a signal is sent out to check for the presence of the hands.

Exemplar 2

1 mark

Examiner commentary

This candidate describes in detail the operation of the sensing taps, however the opening sentence is a repetition of the second sentence (minus the word ‘on’ after turn), and therefore the second sentence is awarded a mark. No further mark is awarded as the candidate does not explain the other stages of the programs operation; i.e. how the program turns off or how the program works without the hands present.
Question 3(c)(ii)

(ii) Draw a flow chart to show how the microcontroller could be programmed to achieve the correct function for the automatic sensor sink tap.

Exemplar 1

4 marks

Examiner commentary

This candidate provides a poorly laid out flow chart in response to this question, but includes all four elements required for the marks. No marks are awarded for specific symbols or layout being employed. Therefore the candidate is awarded a mark for each of the following stages of the taps operation; the detection of the user through a sensor; the turning on of the taps; a time or wait command to ensure the program pauses sufficiently; and, a loop back to the start of the program where the users hands are sensed by the sensor. In this response, it would have been better to have included the timer/wait command after the turning on of the water, which would be designed to provide the user time to wash before the tap attempts to sense the user is no longer there and turns itself off. However because the mark scheme acknowledges the inclusion of an appropriate timer to aid the program, all marks are awarded in this instance.
Examiner commentary

This candidate produces a clear flow chart, using appropriate symbols for each stage starting with the sensor detecting the user (1 mark), turning on the water (1 mark), and a timer running for a period of time allowing the user to wash their hands (1 mark). The candidate misses the final loop back in the flowchart, which represents the program resetting back to the sensor triggering at the start. A simple line and arrow back from the last diamond to the first rectangle would have seen this candidate achieve the final mark.
**Question 4(a)(i)**

4 A weather station has an automated air monitoring system which monitors the air quality in an urban environment. Fig. 4.1 shows an automated air monitoring system.

![Image of weather station's air monitoring system. Air intake slot, air intake pipe and box containing fans, filters and control system are labelled.](image)

**Fig. 4.1**

(a) The automated air monitoring system uses fans to draw air from the environment and pass it through filters which trap particles, such as dust, for later analysis.

**Fig. 4.2** shows an example of the type of fan that could be used in the automated air monitoring system. Three fans were identified for this purpose. The table in **Fig. 4.3** below shows the data collected. The filter manufacturer recommends that an air flow rate of at least $10 \text{ m}^3 \text{ hour}^{-1}$ is required.

![Image of a fan](image)

**Fig. 4.2**

<table>
<thead>
<tr>
<th>Fan</th>
<th>Voltage</th>
<th>Dimensions</th>
<th>Air flow rate</th>
<th>Speed</th>
<th>Temperature range</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5 V dc</td>
<td>$40 \times 40 \times 20 \text{ mm}$</td>
<td>$0.18 \text{ m}^3 \text{ min}^{-1}$</td>
<td>6200 rpm</td>
<td>$-10$ to $+70 ^\circ \text{C}$</td>
</tr>
<tr>
<td>B</td>
<td>12 V dc</td>
<td>$40 \times 40 \times 10 \text{ mm}$</td>
<td>$0.20 \text{ m}^3 \text{ min}^{-1}$</td>
<td>6000 rpm</td>
<td>$-10$ to $+70 ^\circ \text{C}$</td>
</tr>
<tr>
<td>C</td>
<td>24 V dc</td>
<td>$80 \times 80 \times 25 \text{ mm}$</td>
<td>$1.16 \text{ m}^3 \text{ min}^{-1}$</td>
<td>3000 rpm</td>
<td>$-10$ to $+70 ^\circ \text{C}$</td>
</tr>
</tbody>
</table>

**Fig. 4.3**
(i) Carry out a calculation to show that the air flow rate of fan A is suitable for the automated air monitoring system.

**Exemplar 1**

3 marks

Examinar commentary

For this mathematical question, the challenge is to show through calculation that a fan has suitable air flow rate sufficient for a given application. It is important in this type of question that candidates are able to work methodically, and show their thinking clearly. This candidate does so very clearly, writing each stage of their calculation on a different line to be followed by the examiner. They firstly identify that the flow rate is shown in minutes, and convert it to hours (multiply by 60). Once this has been achieved, the simple task remains to provide a statement that shows that the flow rate of fan A is greater than the flow rate required for this application. The candidate uses a ‘greater than’ symbol in this instance, but supports their answer by writing a clear “therefore” statement.
Question 4(a)(ii)

(ii) Other than the air flow rate, justify one other item of data from the table in Fig. 4.3 that a design engineer should consider when selecting a suitable fan for the automated air monitoring system.

Exemplar 1

Dimensions... as in an urban environment you may not have access to a lot of space so the fan must be kept small... to be able to fit into... practical spaces... [2]

Examiner commentary

This question asks candidates to justify one further piece of data from the table provided. They can achieve both marks by firstly stating why the information might be important to the design or operation of the monitoring system, and then for the second mark explain how it might have to be considered in context. This candidate imagines the system in an urban environment, and predicts that these spaces might be small, therefore dimensional data would be important.

Exemplar 2

The dimension of the fan is important as the greater the size of the fan the more powerful it is. [2]

Examiner commentary

This candidate in this response states an obvious fact, that the larger the fan, the greater potential draw of voltage. However this response does not explain the context of why the design engineer would want to consider this. If the candidate was able to explain this response in the context of power supply, battery size, or similar, then they would demonstrate that the fan size would be important for the performance of the finished system. The candidate could equally have justified the size of the fan through an explanation of the need for designing the casing that encloses it, and how the size would decide the specific size of a possible sheet metal net or similar construction approach.
Question 4(a)(iii)

(iii) The automated air monitoring system box, as shown in Fig. 4.1, is manufactured from aluminium alloy and has a density of 56 kg m\(^{-3}\).

Calculate the mass (in kg) of the aluminium alloy box measuring 1.0 m x 0.3 m x 0.3 m.

Exemplar 1

\[
\text{Mass} = 5.04 \text{ kg}
\]

3 marks

Examiner commentary

As a mathematical question, this candidate achieves all three marks by providing the correct answer. In this instance the candidate also provides the working out, which will ensure marks are awarded if the final answer is incorrect. The candidate correctly calculates the mass of the box for the system by multiplying all three measurements provided. This value multiplied by the density of the material provides the mass of the box. The candidate takes a clear approach which is commended in questions such as these.
Question 4(b)

(b)* Discuss the possible constraints when using renewable energy sources to supply power for engineered products such as the automated air monitoring system.

Exemplar 1

8 marks

Examiner commentary

For this extended response question the candidate has received all 8 marks. Though the response does not present a planned structure, for example critically evaluating different renewable energy sources in turn and crediting or discrediting each for the context, the candidate addresses numerous constraints to two renewable energy sources, and justifies each of these throughout the answer. As an example, for the first constraint about not providing a constant energy supply, the candidate gives the context of changing weather and urban environments. The candidate then links this thought process to the need for an additional battery which would impact on the cost of the system. The context of the weather is then re-imagined as an issue relating to potential cleaning or maintenance, and incurs a cost to the user on an ongoing basis. The candidate could continue in this vein and consider...
different issues relating to function, size, safety, performance over time, construction considerations, quality of the final system, amongst other channels of consideration. Though not viable as an energy source, the candidate instead discusses and discounts the opportunity of geothermal energy as an impractical solution, which is a valid approach showing both a breadth of knowledge and an ability to critically consider its viability for the system or product. The candidate then returns to the consideration of solar energy and critiques the aesthetics and how people might consider the installation an eyesore. Though the candidate could consider wind power or other scalable renewable energy sources, the response shows clear ability to discuss the topic, demonstrate a breadth of knowledge, empathy with stakeholders and essentially common sense to present the implications of different possible solutions.

Exemplar 2

2 marks

When using renewable energy, there are some constraints. For example, it is initially expensive to start up, which means the cost for the product will be high. In addition, renewable energy can vary; for example, if it was solar powered, it may not absorb as much sunlight, one day, but it may absorb more another day. This could therefore lead to not enough power for the product to function.

Another constraint could be that the product requires to be larger. Products will require more renewable energy as oppose to non-renewable energy. Furthermore, the product may be more expensive as it cost more than using fossil fuels.

Examiner commentary

The candidate response in terms of the amount written is similar to the full mark response; however there is a clear difference in how this candidate fails to achieve a higher mark. The response includes two valid responses for two marks, the first is an inferred statement that there would be a potential increase in cost, however the candidate does not explain or justify specifically why the cost would be higher or because of what specific parts or components. The second states that the energy provided to the system would vary, a point listed in the mark scheme. This statement is correct however the candidate does not explain the impact this would have on a system of this sort. They state that the light would be different day to day, and therefore there would not be enough power for the system to function, however this needs a simply final explanation. For example the system is monitoring air quality, and collecting data. If the system were to switch off for periods of the week, the data would not be recorded consistently, and make the data useless to the user. Later the candidate suggest two points, that the system would require more renewable energy than non-renewable, and would cost more than using fossil fuels. For these to be credited, they need justification, as it is hard for the examiner to predict what the candidate is inferring with these two points. They may subsequently through justification be valid, but without context, it is impossible for the examiner to understand what is or is not being proposed.
Exemplar Candidate Work

Question 4(c)(i)

(c) Included in the weather station is a water monitoring system that uses a filter to collect data on water quality. A water filter will trap microorganisms that may be living in the water.

Fig. 4.4 shows a water filter that could be used in the water monitoring system.

(i) Analysing Fig. 4.4, give two design features of the water filter that would make it suitable for use in the water monitoring system. Justify your response.

Exemplar 1

4 marks

1. It has a water filter and a keypad which means it won’t be filled up quickly; it can be left for long periods of time to collect data.

2. It is aligned with a grey tank which is arranged on a wall. This means it can be mounted securely. So it will not fall or come off. The casing can easily be removed to read the data and then be replaced to continue collecting.

Examiner commentary

Candidates who successfully responded to this question were those who commented on features clearly visible from either the annotation of the image, or that were visible in the image. Those who scored lower marks often gave examples that were guesses based on the context, but were not backed up by the image and annotation provided. The candidate in this example provides an answer from each. The first relates to the annotated inflow and outflow, and it justified through the context of moving the water.
through the system to gather data. The second relates to the clearly visible screw thread on the casing, and the screws/bracket holding the system to the wall, both of which are identifiable and therefore provide an accepted response. The candidate could have provided either the casing example or the screws and bracket for the wall as two separate responses. The combined response they provide is justified again in relation to collecting data and securing the system in situ.

**Exemplar 2**

1 mark

<table>
<thead>
<tr>
<th>Question Item: 4cii</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. That the filter can trap microscopic bacteria which means that the filter can trap the bacteria.</td>
</tr>
<tr>
<td>2. The filter could include some kind of boiler to simply heat up the water at very high temperature, this means that the filter needs sufficient voltage so that the site's transformer has sufficient power.</td>
</tr>
</tbody>
</table>

**Examiner commentary**

This candidate’s response gives a good first design feature which is the filter to trap bacteria for examination, however the approach to justifying this feature is simply a repeat of the feature itself, and therefore is only awarded one mark. The second design feature has been fabricated by the candidate and is not visible or annotated on the image. The system does not show a heater nor is this an annotated feature. It would have been better in this response for the candidate to choose an annotated feature and consider why this feature is important to the system and how it operates or is used.
Question 4(c)(ii)

(ii) Analysis and evaluation of products are important parts of the design and manufacturing process. Explain two reasons why it is important to undertake product analysis/evaluation.

Exemplar 1

1. Product analysis allows you to compare your design to other solutions that are already known to work and improve your design to make it viable before manufacture.

2. Evaluation allows the final product to be assessed by users to state whether it meets user specifications and what would happen if a second generation was made of that product. Helps identify flaws to change in future products.

Examiner commentary

In this candidate’s response, they explain both the use of product analysis and evaluation. Candidates do not need to explain both, and could have justified one of these with two separate statements. What this candidate has done to achieve the marks, is to ensure they explain how each is useful within the design and manufacturing process. If the candidate had simply explained at different stages in a design process, they would not have received the marks. For product analysis, the candidate explains that the activity would help to improve the design through direct comparison. For evaluation, the candidate explains that a solution would be considered against the specification to help develop the next generation or iteration of the product. The candidate is close to not achieving the marks for the evaluation explanation as had they stated the product was made and evaluated at the end without reference to designing a second generation solution, this would not have answered the question which is focused on the design and manufacturing stages.

Exemplar 2

1. Firstly, to make sure the product is safe before it goes on sale so that nobody gets hurt by the product.

2. Also to check if the product does its specified purpose and does what the client would want it to do.
Examiner commentary

In this candidates response, they fail to mention which of the two tools, product analysis or evaluation, they are discussing. Because of this the examiner awards a single mark for each valid explanation, but is unable to award a second mark without the candidate stating which they are explaining. The first answer about safety would be viable for an evaluation of a product in manufacture, whilst the second answer would be viable for using product analysis during the design phase.
Question 5(a)

5 (a) Explain two reasons why a design engineer would consider planned obsolescence when designing a new engineered product.

Exemplar 1

Examiner commentary

This question is challenging because it is often assumed that planned obsolescence is a negative feature of products, and therefore a design engineer would only consider it for reasons not beneficial to the user. In this candidate response, the answer shows empathy with the need in some situations for products to become obsolete. The first answer is correct, that some products become dangerous over time, and should become obsolete solely to prevent them from reaching a point where continued use would place greater risk with the user. Examples such as car brake pads ensure that the product (the car) is inspected more for potential hazards than if the brake pads lasted for many years. The second answer provided by this candidate was much more typical of responses to this question, and suggests there is financial incentive for a company to design in obsolescence. However this candidate could have justified its inclusion for financial gain by considering that if a company were to make products that never become obsolete, the company would fail to sustain itself into the future.

Exemplar 2

Examiner commentary

Both of this candidate’s answers are essentially on the right path, however at this point in the exam paper you would be expecting candidate responses to be detailed and justified, potentially with examples. The first answer relates to making a product obsolete to
then have a market to bring out a newer version. However this is not explained by the candidate and requires too much inference from the examiner as to what they mean by their response. The second answer relates to obsolescence through changes in trends and fashion, which despite being a design engineering exam paper is an accepted response relating to the aesthetics and changes in what is fashionable. However as with the first, this answer is no explained with an example, and would require the examiner to infer what is meant. If the candidate were able to discuss an engineered product in their response, they would have been more likely to be credited with marks.
Examiner commentary

For the final extended answer question, the candidate has taken care to present a series of points to formulate a discussion about environmental incentives and directives. Though only one specific example relating to Dyson is given, it is not a requirement that candidates list answers from a specified list, as this is not featured in the specification. The candidate will achieve a Level 3 response if they are able to discuss how incentives and directives in general impact on how products and systems are produced. This candidate gives a discussion which considers reducing waste, using recycled materials, designing products to have replaceable parts, altering products if industry requirements change, and including renewable energy sources in production. The candidate could have discussed the approaches taken by companies such as the Smart car manufacturers, who run much of the manufacturing facility using renewable energy and natural light sources, to give just one example, however being able to discuss these is the main requirement here. For the candidate to achieve a higher mark here, they would need to discuss contextually how older approaches have been replaced with new approaches, in relation to incentives and directives, and what has changed. Common incentive schemes across many industries are take back schemes which financially incentivise the customer returning the product to the manufacturer. Many companies as mentioned, also look at their energy consumption and look to make improvements in both the source and use of their energy to run their manufacturing plants. Within the lifecycle of a product, there are also numerous stages to consider, such as transportation, which could provide candidates with memorable examples of engineered products to discuss.
Examiner commentary

In this example, the candidate gives a useful engineered example, the motor car, and constructs a discussion about how cars have changed the fuel they use to run, due to new regulations. Had the candidate constructed this valid discussion focused on the way the vehicles are produced, for example making the vehicles form lighter materials to reduce the need for high energy fossil fuel powered cars, producing smaller vehicles to ensure a viable vehicle can be produced with sufficient power and battery life, or by focusing on the diesel emissions issue and how older vehicle owners have been encouraged through incentives to take their cars off the road in favour of better produced and running newer vehicles, the candidate could have achieved a much more solid discussion which would allow them to demonstrate their knowledge and critical analysis skills. Without specific examples or further evidence, the marks are difficult for the examiner to award what is essentially a sound line of discussion for this question.
We’d like to know your view on the resources we produce. By clicking on the ‘Like’ or ‘Dislike’ button you can help us to ensure that our resources work for you. When the email template pops up please add additional comments if you wish and then just click ‘Send’. Thank you.

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

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.

This resource may be freely copied and distributed, as long as the OCR logo and this small print remain intact and OCR is acknowledged as the originator of this work.

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:
Square down and Square up: alexwhite/Shutterstock.com

Q1, Fig.1.1: © Ksander, Shutterstock Photo Library, www.shutterstock.com.

Q3a, Fig. 3.1: © Aubord Dulac/shutterstock.com.

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/

www.ocr.org.uk
OCR Customer Contact Centre

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

OCR is part of Cambridge Assessment, a department of the University of Cambridge. For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored.

© OCR 2018 Oxford Cambridge and RSA Examinations is a Company Limited by Guarantee. Registered in England. Registered office The Triangle Building, Shaftesbury Road, Cambridge, CB2 8EA. Registered company number 3484466. OCR is an exempt charity.