

A LEVEL

Examiners' report

**DESIGN AND
TECHNOLOGY:
DESIGN
ENGINEERING**

H404

For first teaching in 2017

H404/02 Summer 2023 series

Contents

Introduction	3
Paper 2 series overview	4
Question 1*	5
Question 2*	8
Question 3 (a) (i)	9
Question 3 (b) (ii)	10
Question 4.....	11
Question 5.....	12

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

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Paper 2 series overview

Candidates seemed to have responded well to this paper. There has been an improvement in the candidate's structuring of the questions. However, there are still also some areas that can be highlighted for further development.

This report aims to offer a pragmatic review of the performance by the candidates.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
<ul style="list-style-type: none"> • used the resource booklet to support their own learning and did not just copy elements from it • were able to communicate their ideas and thoughts clearly, either through graphical means or through structuring their written responses well • were able to relate their responses to industrial techniques and processes. 	<ul style="list-style-type: none"> • tended to list their points within the extended response question and not use any analysis or evaluation to support their learning • struggled to understand what the question was asking. They may have misinterpreted the question and went down the wrong path • seemed to get confused with workshop production techniques against industrial techniques.

Question 1*

- 1* Climate change is affecting all parts of the world. Failing to control it could have devastating impacts on our lives. People need to make big changes to their lifestyles to limit the impact of climate change.

Critically examine the ways in which climate change and the methods to control it, affects people and communities around the world.

Refer to information on **pages 2–3** of the Resource Booklet and also information from your own studies or experience. **[12]**

This question was answered successfully by the majority of candidates. Where candidates have gained the lower levels, they have either not included the effects of climate change or the methods of controlling it, with more emphasis on one or the other, or discussed the causes of climate change rather than focusing on the effects of climate change.

Candidates used the resource booklet effectively, taking the relevant information out of the passages and presenting it in their response. The most successful responses have used the resource booklet within their analysis to support their discussion, rather than using it as a starting point for their discussion.

Where a candidate has achieved a Level 4 response, they have given a balanced discussion on both the effects and the methods of controlling climate change. They have also related their discussion to the effect that these have on both people and communities. They will have used examples from both the resource booklet and their own learning to demonstrate their understanding.

This was an extended response question and candidates would have been expected to produce a well-constructed report showing a critical examination of the relevant issues. Bullet points were not acceptable for this response. Care should be taken by the candidates to make sure they are not simply listing points and are demonstrating that they can articulate the issues they are raising.

Misconception



There was a misconception where the effects of climate change were confused with the causes of climate change. This led to some candidates using time to write discussions that gained them no marks.

Exemplar 1

Climate change will most likely affect everyone, some people in different ways due to where they live and the geography of that area. One way to try to mitigate climate change is burning less fossil fuels this may mean incorporating more renewable energy sources into a national energy mix. China is currently a top investor into renewable sources of energy. However they are also a top emitter of CO₂ and fossil fuel consumption due to their rapid development into infrastructure and investment into Africa etc. Due to a ^{rapidly} growing population more food is needed to prevent food insecurity and famine. This means more land use is needed for cattle ranching / grazing space for animals and therefore their meat and animal products. Not only does cattle ranching cause a lot of greenhouse gas emissions through methane from cows etc but also the decaying food waste that contributes to 12% of the world's greenhouse gas emissions. Due to a land use change this often means forests need to be cut down for space and resources (deforestation) leading to less evapotranspiration and

therefore a loss of a carbon sink and more carbon in the atmosphere. Another method could be engineering heat resistant crop species through genetic engineering. This would allow farmers all around the world especially in hot areas e.g. Australia, Chad etc, to grow crops that are less reliant on water and can cope with the increased temperatures. This will lead to more food being available globally and allow farmers (subsistence and non subsistence) to produce a larger yield leading to more profit. High income countries will need to provide help and aid to lower income and island nations to ensure their survival. This may be providing new infrastructure or defences (sea walls, rip rap, revetments etc) or simply by educating the countries population about climate change, natural hazards, adaptation and mitigation, health and safety, evacuation etc. This may mean governments and nations ^{may} provides limits on electrical use and energy use in general. Schemes like this will work on a national scale so have more impact on mitigating climate change.

May not be viable for LIC due to the need for development and energy to survive. They also may have no access to other resources or infrastructure especially renewable energy sources.

Within this response the candidate has examined both the effects and the methods of controlling climate change. Their discussion covers more than one effect and method of controlling climate change and they have discussed the this in relation to how it both effect people and the communities.

This is a good example of a Level 4 response.

Question 2*

2* Weather Watch (WW) is using the funding it has received to manufacture its Pro Weather Station (PWS).

100000 of the sensor and remote display units will be required.

Critically examine the factors that a design engineer would need to consider when manufacturing the PWS sensor and remote display units.

In your answer you **must** consider:

- materials
- manufacturing methods
- power source
- data transfer
- aesthetic factors.

Refer to information on **page 4** of the Resource Booklet.

[14]

In general this question was answered well. Candidates were able to discuss most of the points requested with various levels of accuracy and detail.

The best responses were able to use the information in the resource booklet in constructing their response. They were able to use this information along with their own knowledge to examine each of the points, not just listing properties but analysing them in relation to the PWS sensor and remote display units environment in which it will be used.

A number of candidates referred to processes and materials which would be used in a school workshop rather than suitable processes and materials which would be used to manufacture 100,000 units in industrial production. There was also some confusion about a suitable production method, with some opting for mass production or continual flow.

A number of candidates got confused when discussing materials, some still stating that 'steel does not rust' and PLA is a suitable material for mass production.

This was an extended response question and candidates would have been expected to produce a well-constructed report showing a critical examination of the points to be considered. Bullet points were not acceptable for this response. Care should be taken by the candidates to make sure they are not simply listing points and are demonstrating that they can relate the points for consideration through clear analysis.

Assessment for learning



When teaching production processes and methods. It is worth highlighting to students which processes are best suited for which production method. For example (at present) 3D printing does not lend itself to mass production. There was some confusion with processes commonly used in a school workshop being transferred to industrial production methods and while this may be the case for some, the vast majority are not transferrable given the quantities being produced.

Question 3 (a) (i)

3 The funnel on the top of the PWS sensor unit catches rainwater for measurement. **Fig. 5** in the Resource Booklet shows 3D and 2D projections of the funnel.

(a) (i) Use the information in **Fig. 5** of the Resource Booklet to calculate the **total volume** of the funnel (**both sections**). Give your answer in cm^3 to **2** decimal places. Show your working.

Volume of a cone = $\frac{1}{3} \pi r^2 h$

[6]

Total volume cm^3

On the whole candidates did well in this question.

Where candidates made mistakes, it mainly revolved around bringing the wrong value for the height of the cone into the equation, choosing 49 instead of 60.

Some candidates had issues converting the final answer into cm^3 .

It is worth reminding candidates to present their workings within their response to allow access to all the marks if their answer is incorrect.

Final answers should be written in the space provided in the units stated and to the correct number of decimal places.

Question 3 (b) (ii)

- (ii) The output from the BP135 sensor is fed into the analogue input of a microcontroller. The smallest change of input voltage that the microcontroller can detect is 5 mV.

Use the information in **Fig. 6** of the Resource Booklet to calculate the smallest change in air pressure that can be detected by the microcontroller. Give your answer in kPa and show your working. **[2]**

Smallest change in air pressure kPa

In general this question was answered well. However it is worth noting that where candidates did not achieve the correct answer most made no attempt to show their workings. To achieve 1 mark, candidates need to have shown that they can get the correct information from the resource booklet.

Question 4

- 4 WW requires 100 000 PWS sensor unit mounting solutions that will be flatpacked for transportation.

Use sketches and/or notes to outline a suitable monopole design for the mounting solution.

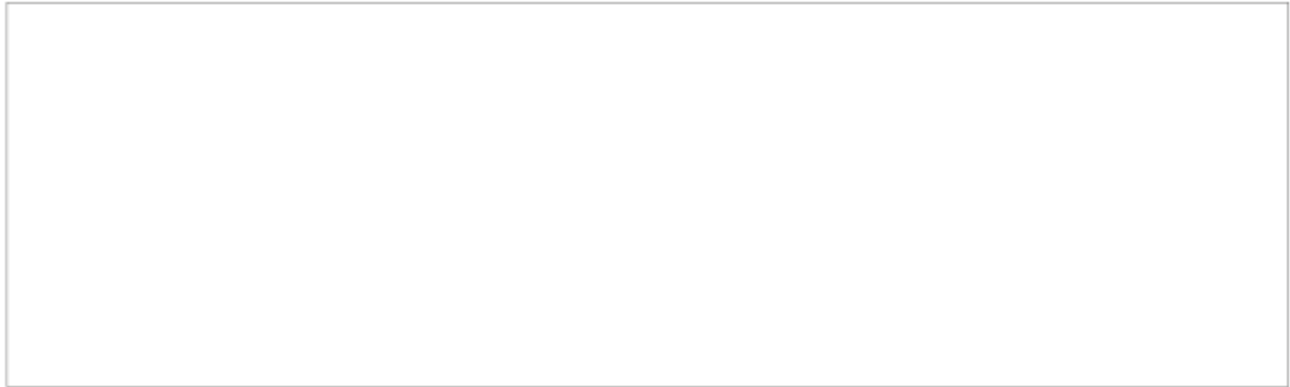
For the monopole you must only select mild steel tubes from **Fig. 8** of the Resource Booklet but you may cut or modify the tubes if you wish.

In your answer you **must** consider the **design requirements** as listed on **page 6** of the Resource Booklet and include details of:

- mild steel tube sizes chosen for the monopole
- specialist parts and assembly methods to enable flatpacking
- standard components to be used
- manufacturing processes
- finishes.

Refer to **all** of the information on **page 6** of the Resource Booklet.

[16]



This question brought a full range of responses from the candidates, with most finding it harder to access the higher levels.

Where candidates have achieved a higher level, they have given clear details of their design, through quality sketches and descriptions. The candidates need to understand the requirements of the design and use the available materials in the resource booklet well, realising that at 1.5 meter lengths they will require at least 3 to complete the monopole successfully. They should also show a suitable method of assembly without using tools and make reference to it being flat packed. More successful candidates also used calculations to show their design meeting the defined height requirements.

Where candidates have missed out on marks, they have generally only given a cursory explanation of the required points. Some opting to design a tripod rather than a monopole and others opting to use tools for assembly. Care should also be taken in this question that the candidates are using the correct materials as stated in the resource booklet.

Candidates should be encouraged to use good quality sketches and annotation to clarify and explain their design.

Question 5

- 5 WW wants to explore the feasibility of adding a wind speed sensor to the PWS.

The design engineers have to solve the following **two** issues to help with the development of the wind speed sensor.

Issue 1:

The sensor must produce output electrical signals which could be processed by a PICAXE 14M2 microcontroller.

Use sketches and/or notes to further develop the wind speed sensor shown in **Fig. 9** of the Resource Booklet.

In your answer you **must**:

- explain how the sensor works
- identify specific electronic components
- identify any mechanisms used
- describe the output signals produced.

Issue 2:

The signal from the wind speed sensor will be processed by a PICAXE 14M2 microcontroller and transmitted to the remote display unit by radio frequency.

Details of the PICAXE 14M2 microcontroller and the radio frequency transmitter are shown in **Fig. 10** and **Fig. 11** of the Resource Booklet.

To enable the wind speed sensor to function as described:

- Draw a circuit diagram to show how the wind sensor electronic components identified in your response to Issue 1 and the radio transmitter components should be connected to the PICAXE 14M2 microcontroller.
- Draw a program flowchart that indicates how rotation speed of the rod is monitored and data transmitted to the remote display unit.

In your answer use the simplified block circuit symbol to draw the radio transmission circuit.

Refer to **pages 7–9** of the Resource Booklet.

[16]

Issue 1:

Issue 2:

This style of question allowed candidates to demonstrate their understanding of different systems and their applications. While this question has been a staple part of the examination, some candidates are still finding it challenging and are not meeting the requirements of the question.

Issue 1:

Out of the two issues, Issue 1 was answered the best, with most candidates able to state a suitable sensor to detect the change in speed of the wind. Most opting to use a slotted opto sensor and others using a motor to generate a voltage.

Candidates who achieved a Level 4 response (as shown in Exemplar 2) were able to clearly explain how their sensor choice would work with the system shown in the resource booklet and were able to identify components correctly. Some candidates used bearings to reduce friction and improve efficiency, while others used a gear system to increase the rotational speed to get a better output from the sensor. High level responses have also discussed the output signal that would be produced and how this can be used in the micro controller.

Issue 2:

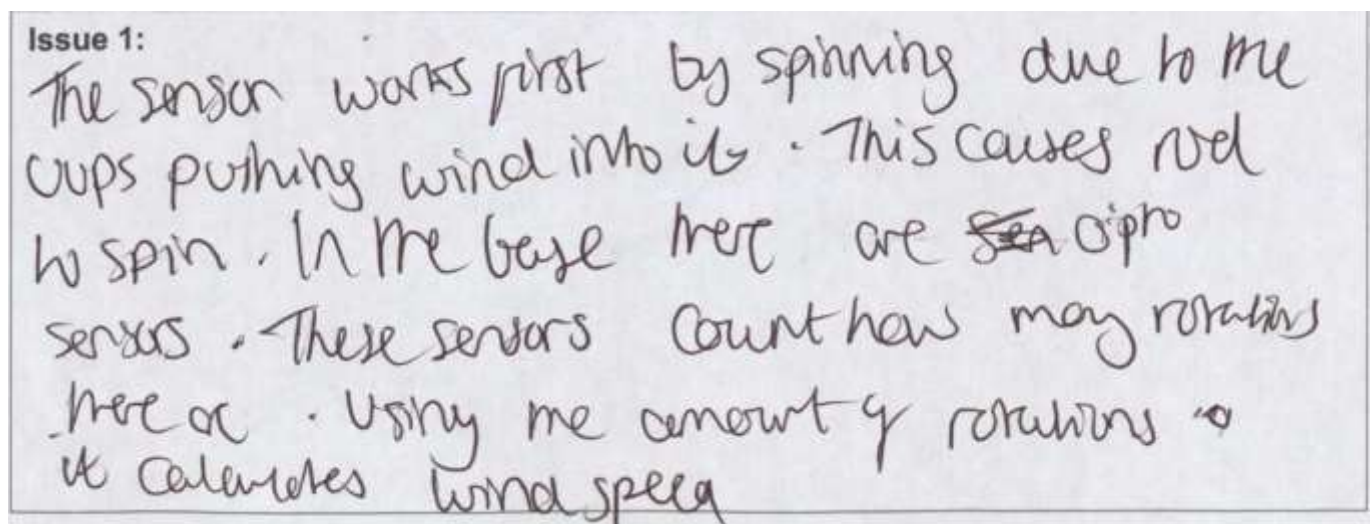
Issue 2 was not answered as well. Issue 2 was split into two parts, with candidates having to produce a circuit diagram and a flow chart for the system.

While most candidates recognised the need for a power source in the circuit fewer were able to use the resource booklet to retrieve the information needed to produce the circuit diagram for the Picaxe and the transmitter. Fewer candidates were then able to draw their sensor in a suitable circuit arrangement that would work as an input. Most neglected a pull down/up resistor and some did not use the correct circuit symbol for the sensor they mentioned in Issue 1.

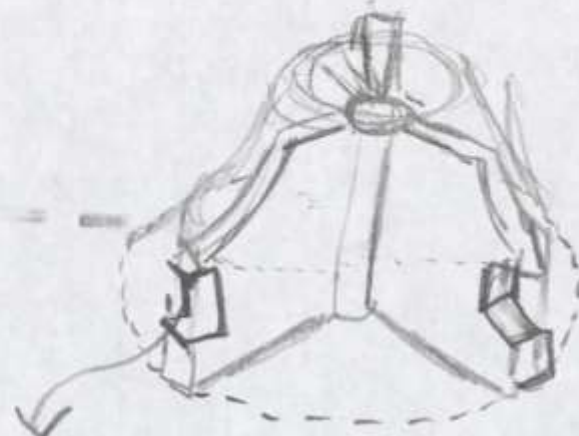
For the second part of Issue 2 most candidates were able to use the correct symbols when using a flow chart.

The high level responses for this question were able to identify the need for the system to store the data from the input transducer, and then have some comparison to get a relevant output, before finally outputting that information to the transmitter.

Exemplar 2



Dissasembled Base



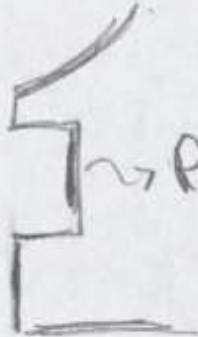
Spinning rod
causes base to
spin



Spinning base
gets detected
by reflective
opto sensor.

Opto sensor.

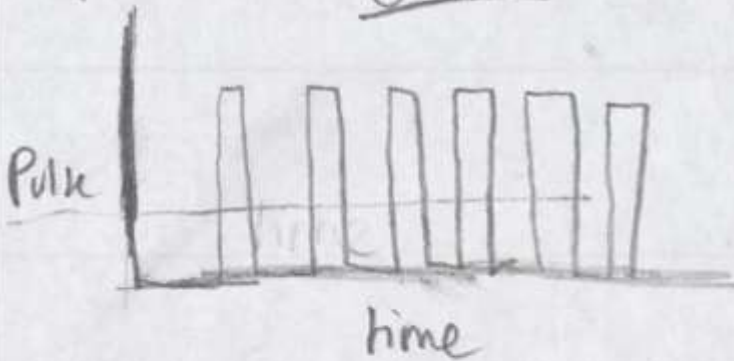
(This sensor
is digital so
can be sensed
by PICAXE 14M2)



Reflective metal

Reflective
opto sensor

Graph

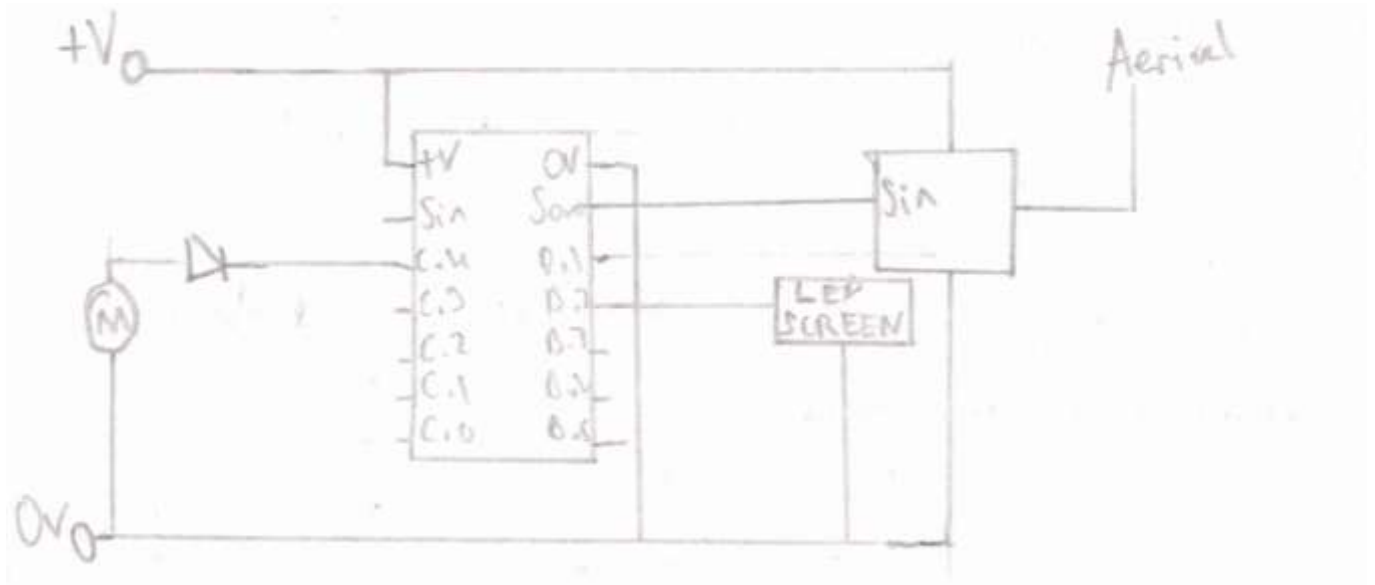


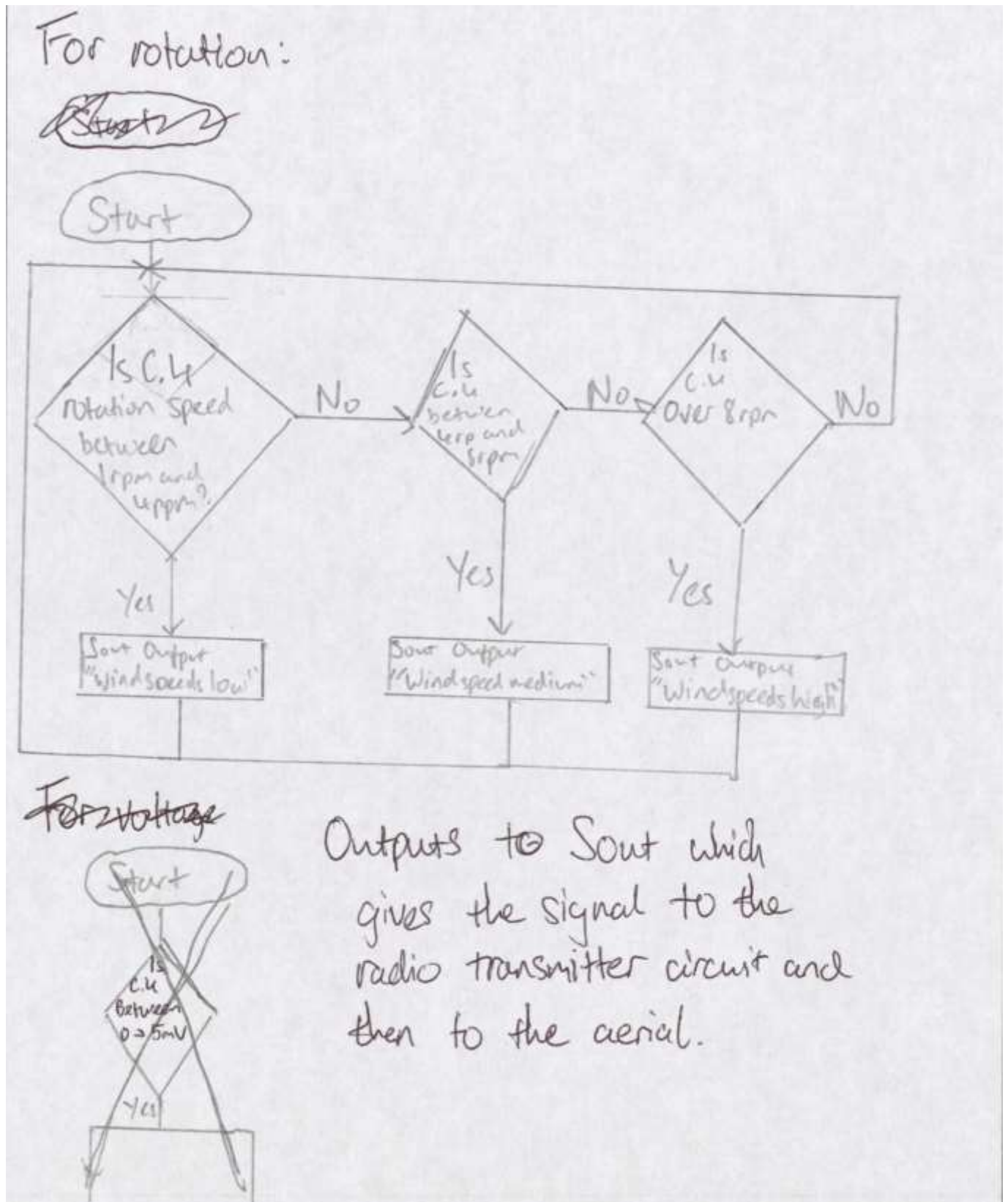
Output pulse
will be ~~fast~~ processed
by microcontroller to
find speed of wind

Output signal
would be number of rotations.

Microcontroller can calculate the wind speed of
the environment.

Exemplar 3





This response clearly shows the method they would use to detect the speed of the wind and the sensor that would be used to do this. They have a clear explanation of how the system would work and have made reference to the output signal that would be produced by the sensor.

It shows a well-drawn circuit which used the information from the resource booklet to accurately draw a functioning circuit.

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