GCE

Design and Technology

H404/02: Problem solving in Design Engineering

A Level

Mark Scheme for June 2023

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

MARKING INSTRUCTIONS

PREPARATION FOR MARKING
RM

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 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 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 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 **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 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: Not applicable in F501
    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
KU	AO1 – Knowledge and understanding
APP	AO2 – Apply knowledge and understanding
AN	AO3 - Analyse
EVAL	AO4 - Evaluation
^	Omission
NAQ	Not answered question
SEEN	Noted but no credit given
TV	Too vague
OFR	Own figure rule
REP	Repetition

12. Subject Specific Marking Instructions

INTRODUCTION

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

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

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

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

Question			Answer	Mark	Guidance	
The indicative content in this mark scheme provides suitable exemplification of the key lines of enquiry that would be worthy of credit. In an examination series actual candidates responses will be reviewed to supplement this mark scheme with additional exemplification to ensure all key lines of enquiry are covered.						
					Content	**Level of response**
1*			**Indicative content:** Candidates will be expected to refer to the Resource Booklet in their answer **and** demonstrate their understanding and knowledge of the ways in which climate change, and the methods to control it, affects people and communities across the world. Their answers could include but not be limited to: **Effects of climate change:** • **Change in weather patterns** o Drought and water scarcity, leading to failed crops. Directly leads to famine but also causes prices of crops to rise, leading to rising food prices and secondary food poverty across a wider area. Can also lead to relocation of large numbers of people in search of water and food. o Drought also leads to increased risk of wildfires, causing widespread loss of land, property and life. Emissions from the fires (smoke) can also cause disruption to weather cycles. o Intense storms cause flash flooding, destroying land, property and livestock across huge areas. Intense winds cause destruction of property and loss of life. • **Melting polar ice**	**12**	All responses should be in relation to the information provided and supported by candidates own knowledge. Candidates may extract information from the Resource Booklet. Any such lifted information can be used in support of the critical examination but no marks should be awarded simply for duplicating text. There is no analysis or evaluation in Level 1. To access level 4, candidates must mention both climate change and methods to control it in detail, making reference to the people and communities affected. Level 3 must also have	**Level 4 (10-12 marks)** A **comprehensive** examination of climate change. Comprehensive understanding of the ways in which climate change, and the methods to control it, affects people and communities around the world. Information in RB is used effectively to fully exemplify the points being made which will be supplemented with own understanding. Well-constructed response in relation to question with a clear and developed narrative that covers both the impact of climate change and the steps taken to control it. Must contain 2 climate change and 2 methods of controlling it responses all outlined in detail, which link to the people and communities affected. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 3 (7-9 marks)** A **good** examination of climate change. Good level of understanding of the ways in which climate change, and the methods used to control it, affects people and communities around the world. Information in

			○ Caused by gradual global warming. ○ Melting ice leads to global rise in sea level, leading to flooding of low-lying communities. ○ Melting polar ice reduces biodiversity and threatens species. • **Flooding** ○ Can be caused by intense rainfall and by rising sea levels. ○ Can cause landslides, leading to destruction of property/infrastructure and loss of life. ○ Loss of livestock or land for grazing or for crops. Can lead to food shortages, famine and rising food prices. ○ Damage/loss to property and loss of life and livelihood. Raised insurance premiums. ○ Flooding also caused by rising sea level. ○ Small island communities have most to lose by rising sea levels. ○ Large scale relocation of people moving away from flooded areas. **Methods to control climate change:** • **Global approach** ○ The small, least-emitting countries have the most to lose. ○ The top ten emitting countries contribute 68% of emissions ○ The bottom 100 emitting countries contribute 3% ○ Richer countries need to help poorer countries prepare for the effects of climate change. • **Education** ○ Explaining climate change, it's impacts and the methods of controlling it.		Candidates who fail to say how these factors will affect people will be restricted to a level 2.	RB is used for the most part effectively with some of own understanding to exemplify points being made although one or two opportunities are missed. Well-constructed response in relation to question although one or two opportunities not taken to develop narrative in relation to both the impact of climate change and the steps taken to control it. Must contain 2 climate change and 2 methods of controlling or vice versa within the responses which links to the people and communities affected. *There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some evidence.* **Level 2 (4-6 marks)** A **sufficient** examination of climate change. Sufficient understanding of the ways in which climate change, and the methods used to control it, affects people and communities around the word.. Information in RB is used to exemplify some points being made with some of own understanding although much more could have been done to exploit the stimulus material available. Reasonable response in relation to the question although narrative at times lacks depth and cohesion in relation to both the impact of climate change and the steps taken to control it. Must contain 1 climate change and 1 methods of controlling or vice versa within the responses which links to the people and communities affected.

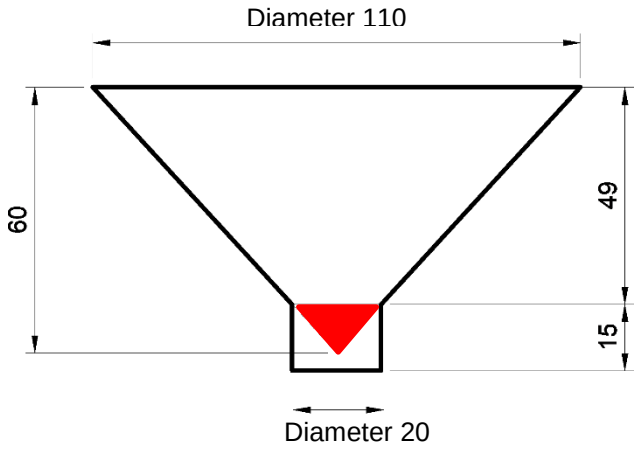
			○ People who understand the crisis are more likely to want to be part of controlling it. ○ Sacrifices needed to change lifestyles. ○ The idea of collective responsibility – we all play our part. ○ Explaining how apparently unrelated actions (e.g. eating less meat) can impact on the environment. • **Reduce the burning of fossil fuels** ○ Reducing demand for energy, raising energy awareness, low energy products ○ Switching to eco energy sources, greater use of renewables (wind/solar/hydroelectric/geothermal), argument for nuclear power, bio fuels. ○ Reducing transport, working from home, buying local produce, reducing air miles. ○ Switch to electric powered vehicles, charging infrastructure implications. • **Reduce the amount of land cleared** ○ Needs balancing against the need for crop growing and grazing land. ○ Initiatives to re-plant forests – plant a tree campaign. • **Reduce meat and dairy consumption** ○ Education needed, greater choice needed for consumers, awareness of costs ○ Implications for meat/dairy farmers. • **Compost waste food** ○ Need to reduce food placed in waste bins, sent to landfill ○ Need to separate out food waste ○ Local composting, food waste collection ○ Circular food economy • **Better control of agriculture** ○ Fuel use – switching to eco friendly fuels such as electric or bio-diesel			*The information has some relevance and is presented with limited structure. The information is supported by limited evidence.* **Level 1 (1-3 marks)** A **limited** examination of climate change. Limited knowledge and next to no understanding of the ways in which climate change, and the methods used to control it, affects people and communities around the world. Use of information from the RB is used in a simplistic way and adds limited value to the points being made. Limited response in relation to question. Narrative is basic and unstructured with limited reference made to the impact of climate change and the steps take to control it. Must contain 1 climate change and 1 methods of controlling or vice versa within the responses which links to the people and communities affected. *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* 0 marks = No response or no response worthy of credit.

			○ Manure management ○ Crop residue burning • **Electronic waste** ○ Greater incentives for manufacturers to take back and recycle used electronic products. ○ Recovery of valuable resources ○ Reduction of greenhouse gas emissions from burning/burying e-waste. Any other valid responses			

2*			**Indicative content:** Candidates will need to <u>discuss the factors</u> that a design engineer would need to consider <u>when manufacturing</u> the Pro Weather Station (PWS) sensor and remote display units, as shown on Page 4 in the Resource Booklet. There are five aspects of manufacturing that should be covered in the candidate's response. **Indicative content:** Candidates will be expected to refer to the Resource Booklet in their answer and demonstrate their understanding of the different factors that a design engineer would have to consider when manufacturing the PWS sensor **and** remote display units. Their answers could include but not be limited to: **1) Materials** • Main unit placed outdoors, so material must be stable in sunlight, water resistant, able to withstand wide temperature range over winter/summer. • Thermoplastic suitable for outdoor use, can be made stable in sunlight, can be a range of colours. Water resistant. Temperature stable. • LED or LCD display allows for full colour graphics • Consideration of weight of materials for transport around the country. • Consideration of sustainability, recycled/recyclable materials, degradable materials, EOL considerations.	**14**	All responses should be in relation to the information provided. Factors should be identified. Candidates may extract information from the Resource Booklet. Any such lifted information can be used in support of the critical examination but no marks should be awarded simply for duplicating text. There is no analysis or evaluation in Level 1. Any response that does not refer or can be linked to manufacturing should not be awarded.	**Level 4 [12-14 marks]** A **comprehensive** examination of the factors that a design engineer would need to consider when manufacturing the PWS sensor and remote display units. Comprehensive understanding of manufacturing considerations taking account of **the five elements** specified in question. Information in RB is used effectively to fully exemplify the points being made. Well-constructed response in relation to question with a clear and developed narrative. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 3 [9-11 marks]** A **good** examination of the factors that a design engineer would need to consider when manufacturing the PWS sensor and remote display units. Good level of understanding of manufacturing considerations taking account of at least **four of the five elements** specified in the question but one or two opportunities are missed to make connections. Information in RB is used for the most part effectively to exemplify points being made although one or two opportunities are missed. Well-constructed response in relation to question although one or two opportunities not taken to develop narrative. *There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some evidence.*

			2) Manufacturing methods • Batch of 100,000 requires an automated, repeatable and cost-effective manufacturing method e.g: o Casing of main unit and display: injection moulded thermoplastic o Electronics on a custom-designed PCB assembled by pick-and-place machines o Use of embedded microcontrollers • Injection-moulding allows for complex case features, e.g. vents **3) Power source** • Display unit can be plugged in to local mains power socket, so a small plug-top power supply can be used, e.g. a USB charger. Unit could be made portable by embedding a rechargeable battery. • Main unit will be placed away from mains power. Running a cable is undesirable – difficult to install, safety, cost. • Main unit could have an embedded rechargeable battery. Consideration of adding a solar panel to the unit to recharge the battery. Possible wind power using a turbine. • Consideration of embedding a 'lifetime battery' as used in some smoke alarms. • Low power modes to prolong battery life: o display to turn off unless being read o Main unit only 'wakes' to take a reading then goes into 'sleep' mode • Sustainability considerations. **4) Data transfer** • Running a cable between the main unit and the display is undesirable as it makes installation difficult, and the unit is aimed at householders to install themselves. Also issues of cost.			**Level 2 [5-8 marks]** A **sufficient** examination of the factors that a design engineer would need to consider when manufacturing the PWS sensor and remote display units. Sufficient understanding of manufacturing considerations taking account of at **least three of the five elements** specified in the question but there are significant opportunities missed to make connections. Information in RB is used to exemplify some points being made although much more could have been done to exploit the stimulus material available. Reasonable response in relation to the question although narrative at times lacks depth and cohesion. *The information has some relevance and is presented with limited structure. The information is supported by limited evidence.* **Level 1 [1-4 marks**] A **limited** examination of the factors that a design engineer would need to consider when manufacturing the PWS sensor and remote display units. Limited knowledge and next to no understanding of elements specified in question **(one/two at best).** Use of information from the RB is used in a simplistic way and adds limited value to the points being made. Limited response in relation to question. Narrative is basic and unstructured. *The information is basic and communicated in an unstructured way. The information is supported by*

			• However, a cable could also run power to the main unit, so should be considered.
			• Wireless data transfer is beneficial. Issues of range, interference, data security.
			• Possible use of technologies such as Wifi, Bluetooth, RFID.
			• Unit could be part of a local network, e.g. home WiFi.
			• Method of uploading data to the charity's website, e.g. mobile internet (SIM card needed, cost?) or use of home Wi-Fi.
			• Power considerations to prolong battery life, use of BLE (Bluetooth low energy)
			
			5) Aesthetic factors
			• Main unit will be outside, so consideration of suitable aesthetics:
			  ○ Outdoor colours green, brown, grey – all achievable with thermoplastic case.
			  ○ Unit may need to be white to minimise effect of thermal heating in bright sunshine.
			
			Any other valid response.
						limited evidence and the relationship to the evidence may not be clear.
						
						0 marks = No response or no response worthy of credit.

Question			Answer	Mark	Guidance
3	(a)	(i)	 Volume of cone section = Volume of entire cone – volume of small cone inside cylinder. Converting to cm^3 at end of calculation of volumes Diameter of entire cone area = 110 mm Radius (*r*) of entire cone area = 110/2 = 55mm [1] Height (*h*) of entire cone area = 60mm Volume of entire cone area = $1/3\ \pi r^2h$ = 1/3 π $(55)^2$ x 60 [1] = 1.0471975512* x 3025* x 60 = 1.0471975512* x 181500* = 190066.355543* mm^3 [1] Convert to cm^3 = /1000 = 190.07 cm^3 (to 2dp) [1] Therefore, volume of cone of funnel = 190.07* – 1.15* = 188.92 cm^3 [1]	6	Award six marks as follows: 1 mark for calculating the radius of the entire cone area. 1 mark for entering correct values into formula 1 mark for calculating volume of entire cone area. 1 mark for converting mm to cm. 1 mark for calculating the volume of top section of cone 1 mark for calculating total volume of funnel If correct answer is given without working out shown award full marks. Where an incorrect answer is given working out should be used to credit appropriate marks. *Allow error carried forward (ECF) where correct working out is shown. Award full marks for a range of responses between 193.52 – 193.62 to allow for Pi. If answer given to 1.d.p award up to 5 marks.

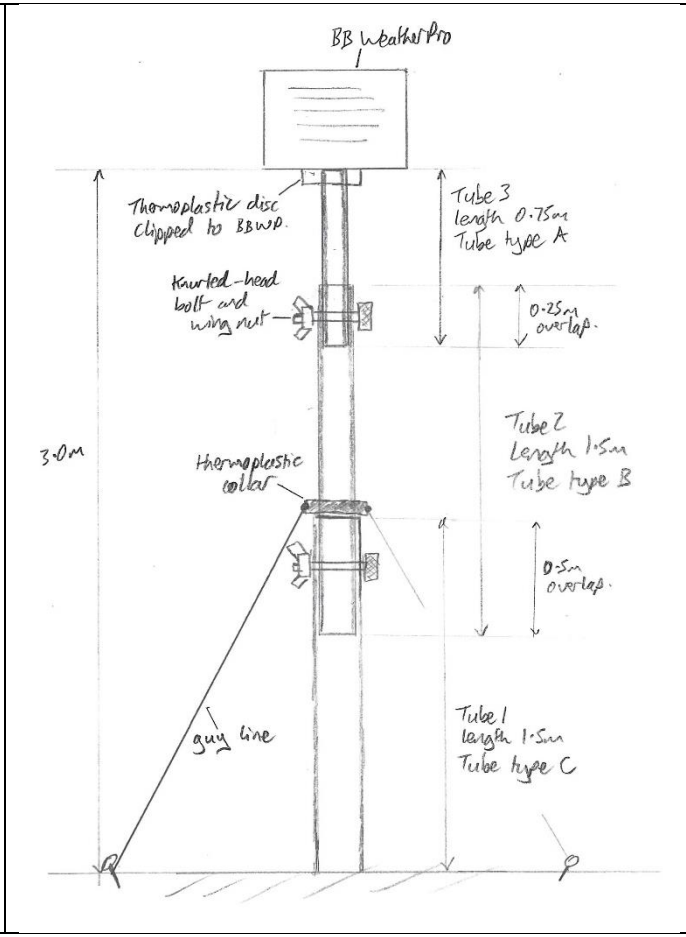
			Volume of cylinder given as 4.7 cm^3 Therefore, total volume 4.7 + 188.92 * = 193.6 cm^3 [1]		
3	**(a)**	**(ii)**	Volume of rain that falls into funnel in 1 hour = 0.2 x 95 = 19 cm^3 [1] Volume of cylindrical section = 4.7 cm^3 (data given in question) Time taken to fill cylindrical section (in hours) = 4.7/19* = 0.247 [1] Time taken (in minutes) = 0.247* x 60 = 14.8 minutes (1dp) [1]	**3**	Award three marks as follows: 1 mark for calculating the volume of rain that falls in 1 hour. 1 mark for calculating the time taken to fill the cylindrical section. 1 mark for converting hours to minutes. If correct answer is given without working out shown award full marks. Where an incorrect answer is given working out should be used to credit appropriate marks. Allow answer given in minutes and seconds 14.48 minutes *Allow error carried forward (ECF) where correct working out is shown.
3	**(b)**	**(i)**	V_{out} = 3.3V [1]	**1**	No other answer should be awarded marks
3	**(b)**	**(ii)**	Output sensitivity of pressure sensor = 40mV/kPa [1] Therefore, a change of 5mV represents a change in pressure of 5 / 40 = 0.125kPa [1]	**2**	Award two marks as follows: One mark for picking out relevant bit of data. One mark for calculating the smallest change in air pressure that can be detected by the system. #

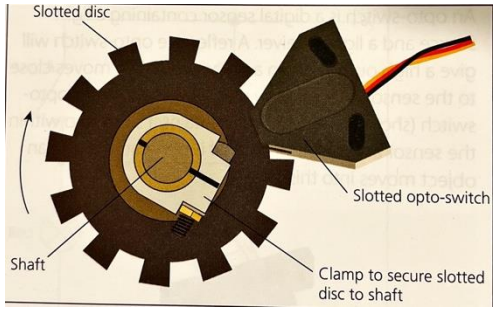
					If correct answer is given without working out shown award full marks. Where an incorrect answer is given working out should be used to credit appropriate marks.

Question			Answer	Mark	Content	Guidance
4			**Indicative content:** Candidates should use sketches and/or notes to outline a suitable monopole design for the mounting solution. Candidates will be expected to refer to the Resource Booklet in their answer and demonstrate their understanding of the design requirements that a design engineer would have to consider in the design of the monopole mounting solution. **The sensor unit must be mounted 3.0m above the ground** **Method 1 (monopole)** • The steel tubes are 1.5m long, so two tubes could be butted end-to-end. • A larger diameter (or smaller diameter) tube must be used as an outer (or inner) sleeve to support the butt join. • Data must have been extracted from Fig. 8 in Resource Booklet to prove that the sleeve will slide over (or inside) the main tube. • Method of fixing sleeve in place (bolts/clamps/collars etc.) • Method of mounting the WPS sensor unit to the monopole (bracket / plate / tube flange) **Method 2 (monopole)** • At least three 1.5m long tubes can be used in telescope-style to achieve the 3.0m length. • Data must have been extracted from Fig. 8 in Resource Booklet to prove that the tubes will slide inside each other. • Calculation/annotation to show the length of overlap to achieve a total length of 3.0m. • Method of fixing the extended 'telescope' in place (bolts/clamps/collars etc.)	**16** Candidates may present evidence worthy of marks using sketches and/or notes and calculations to outline a suitable monopole. The design outcome must clearly be a monopole stand capable of supporting the PWS sensor unit. Responses should be appropriate for manufacture of a batch of 100 000 PWS sensor unit mounting solutions.	Responses should provide details of processes to make and assemble a batch of 100 000 PWS sensor unit mounting solutions. Answers should include mild steel tube sizes, specialist parts and assembly methods, standard components, manufacturing processes and finishes for a design that considers the bullet pointed design requirements of the PWS sensor mounting solution in Fig. 8 of the Resource Booklet. Candidates can draw on practical experience to support responses. Candidates are expected to demonstrate understanding of the processes through annotated sketches and/or notes.	**Level 4 [13-16 marks]** A **comprehensive** approach taken to outline a suitable monopole design for the mounting solution. Comprehensive understanding of the design requirements and accompanying considerations as specified in question. Information in RB is used effectively to fully exemplify the points being made. Sketches will be clear and supported with relevant notes. The methods will be technically accurate and clear in the way they are explained. **Level 3 [9-12 marks]** A **good** approach taken to outline a suitable monopole design for the mounting solution. Good understanding of the design requirements and accompanying considerations as specified in question. Information in RB is used for the most part effectively to exemplify points being made although one or two opportunities are missed. Sketches will for the most part be clear and supported with relevant notes. The methods will be technically accurate and for the most part be clear in the way they are explained. **Level 2 [5-8 marks]** A **sufficient** approach taken to outline a suitable monopole design for the mounting solution. Sufficient understanding of the design requirements and accompanying considerations as specified in question. Information in RB is used to exemplify some points being made although much more could have been done to exploit the stimulus material available. Sketches will be adequate and supported with notes. The methods will not always be technically accurate with some knowledge gaps evident. **Level 1 [1-4 marks]**

			• Method of mounting the WPS sensor unit to the monopole (bracket / plate / tube flange) [4] **The dismantled stand will be flatpacked for transportation in a 1.5m long cardboard tube** • There must be an explicit statement or calculation which confirms that no single part of the dismantled stand exceeds 1.5m in length • There must be some reference (or calculation) relating to the shipping weight (or total weight of the stand), or an awareness that weight should be kept to a minimum for shipping (e.g. use the smaller diameter steel tubes). [3] **The stand must be assembled without the use of tools** • An explicit statement or annotation to indicate why no tools are needed for assembly. • Use of fixing methods that can be applied by hand (knurled features/wing nuts/spring clips. • Correct terminology used for parts. • No permanent fixing methods used during self-assembly (no welds/adhesive/rivets). [2] **The stand must be free-standing and stable in high winds** • Monopole-style must either have guy-lines, or wide (heavy) base, or be spiked into the ground (thus increasing the length of steel tube needed). • Explanation of how stability is achieved. • Some consideration given to tube thickness - an awareness of the potential for bending in high winds (tube stiffness). • Indication of how the BBWeather Pro is attached to the top of the stand. [3]	Candidates who have not made any use of the steel tubes in Fig. 8 cannot achieve more than 8 marks. Candidates who have not provided a monopole design cannot achieve more than 8 marks.	Marks should be broken down into the sections: Method (4) Flat-packed (3) Assembly (2) Freestanding (3) Manufacturing (3) Life expectancy **(1)**	A **limited** approach taken to outline a suitable monopole design to the mounting solution. Limited knowledge and next to no understanding of the design requirements and accompanying considerations as specified in the question. Use of information from the RB is used in a simplistic way and adds limited value to the points being made. Sketches if used will be unclear with only basic notes to accompany them. The methods may lack technical detail and be basic in nature. 0 marks = No response or no response worthy of credit.

			Manufacturing processes • Mention of method for manufacturing the tubing or it being a standardised component. • Use of technical language when discussing processes and tools used to make the pole (pipe spreader/reducer). • Methods used to cut the pipe to size, CNC, cut-off saw) • Method used to create holes in the tube. [3] **The life expectancy must exceed 5 years** Awareness that mild steel tubes will corrode outdoors over 5 years. [1] • Description of suitable protective finish (galvanizing, applying paint).			

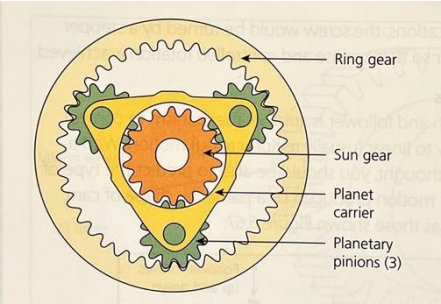

BB WeatherPro
Thermoplastic disc clipped to BB unit
Tube 3
length 0.75m
Tube type A
knurled-head bolt and wing nut
0.25m overlap
3.0m
Tube 2
Length 1.5m
Tube type B
Thermoplastic collar
0.5m overlap
guy line
Tube 1
length 1.5m
Tube type C

Question	Answer	Mark	Content	Guidance
5	**Indicative content** Candidates should use sketches and/or notes to further develop the wind speed sensor shown in Fig. 9 of the Resource Booklet. **Issue 1:** **Explain how the sensor works [2]** • Explanation (or annotation) of how the wind reacts with the design (e.g. turbine spins/flap gets lifted etc). • Clear principle of how increasing wind speed causes a bigger effect. **Identifying technical design elements within the system [4]** • Correctly identified sensing component(s) (e.g. slotted opto-sensor/potentiometer etc) Examples: • A slotted opto-switch can be used to detect the gaps in a slotted disc within the fixed base and connected to the rod via a concentric shaft, as shown below. • A reflective opto-switch can be used to detect the passing of a reflective patch which is attached to a rotating wheel within the fixed base and connected to the rod via a concentric shaft.  • A gear tooth sensor detects the individual teeth on steel spur gears as they rotate. • A quadrature rotation sensor (incremental encoder) could be connected to the rod via a concentric shaft. Dual digital outputs indicate the direction and angle of rotation of a shaft. • A potentiometer could be mechanically connected to the rod via a concentric shaft. **Identify any mechanisms used**	**16** The outcome for Issue 1 must clearly be a sensor capable of responding to wind speed (NOT wind direction). **8 marks** should be awarded for the response to issue 1	Responses to Issue 1 should be in relation to the information provided on pages 7, 8 and 9 of the Resource Booklet.	Each solution will reflect a Level 1 to 4. The combination of the two Levels needs to be taken into account when fixing the final mark to be awarded. Candidates may present evidence worthy of marks in various ways, including written notes, annotated sketching and calculations. **Level 4 (13-16 marks)** A **comprehensive** demonstration of technical solutions to overcome the two issues identified. Comprehensive understanding of technical design and technology principles to overcome the two issues

- Correctly identified mechanisms to show how the speed of rotation could be increased or decreased.
- Clear indication of how the mechanism will be housed within the fixed base of the wind speed sensor.

Examples:

- Simple gear train
- Compound gear train
- Helical gears to reduce noise
- Epicyclic gear train (see below)



Input	Output	Stationary	Gear ratio
Sun	Planet carrier	Ring	Speed reduction
Planet carrier	Ring	Sun	Speed increase
Sun	Ring	Planet carrier	Reverse and speed reduction

Describe the output signals produced [2]

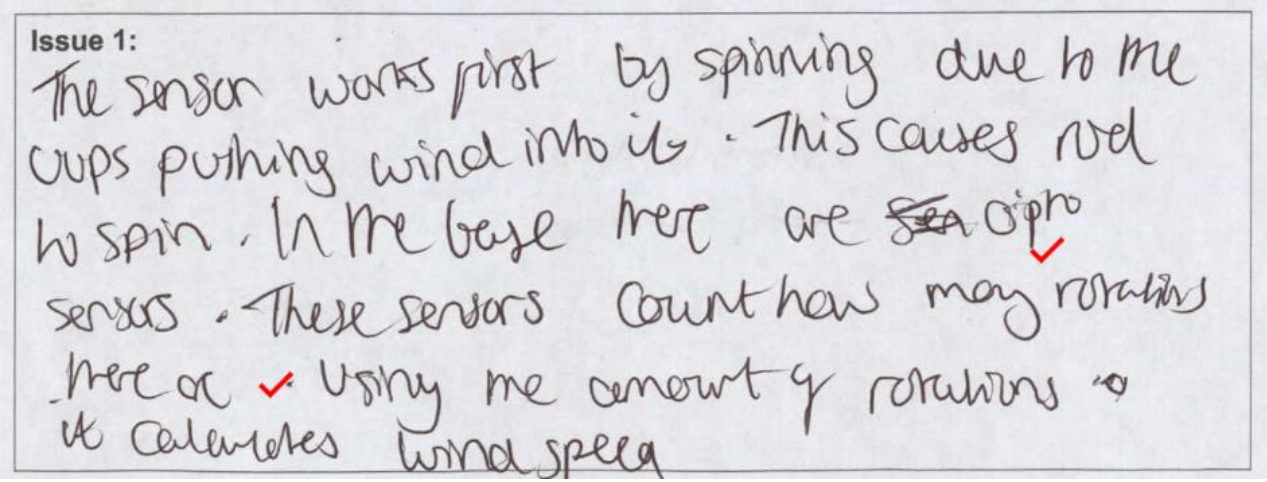
- Correctly described signal for the sensor used (e.g. digital pulses from opto-switch, analogue voltage from potentiometer)
- Clear principle of how the sensing component reacts to wind speed (e.g. more light pulses per second/bigger angle on potentiometer etc)

Examples:

- A reflective opto-switch will give a high output when a reflective object moves close to the sensor within a few millimetres.
- A slotted opto-switch contains a small gap within the sensor and an output signal is generated when an object moves into this gap.
- A quadrature rotation sensor can be rotated continuously, clicking as it does so. Every click produces a pulse, which can be read by the PICAXE 14M2.

identified. Both solutions are well-developed. Information in Resource Booklet is used effectively to fully exemplify the points being made. Sketches if used will be clear and supported with relevant notes.

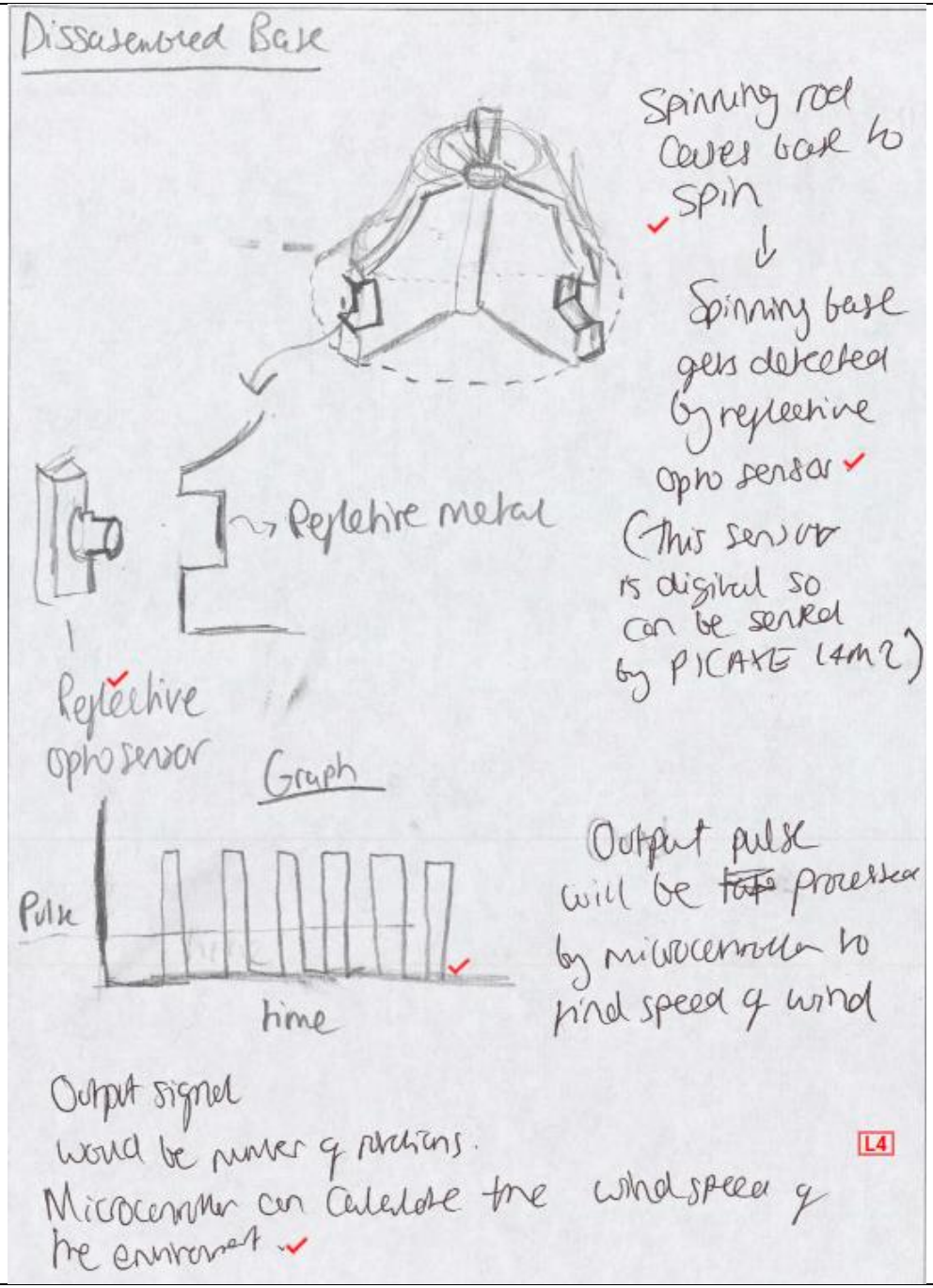
Level 3 (9-12 marks)
A **good** demonstration of technical solutions to overcome the two issues identified. Good understanding of technical design and technology principles to overcome the two issues identified. Both solutions will be covered but one of the solutions may be underdeveloped. Information in Resource Booklet is used



8 marks should be awarded for the response to issue 2, these should be broken down into **4 marks** for the circuit diagram and **4 mark**s for the flow chart.

for the most part effectively to exemplify points being made although one of two opportunities are missed. Sketches if used will for the most part be clear and supported with relevant notes although one or two opportunities for clarity may be missed.

Level 2 (5-8 marks)
A **sufficient** demonstration of technical solutions to overcome the two issues identified. Sufficient understanding of technical design and technology principles to overcome the two issues identified. Both solutions may be covered but both may be underdeveloped .



Response s to Issue 2 should be in relation to the informatio n provided on pages 8 and 9 of the Resource Booklet.

Information in Resource Booklet is used to exemplify some points being made although more could have been done to exploit the stimulus material available. Sketches if used will be adequate and supported with notes, some of which may be relevant.

Level 1 (1-4 marks)
A **limited** demonstration of technical solutions to overcome the two issues identified. Limited knowledge and next to no understanding of design and technology principles to overcome either issue identified. Any solution given will be basic.

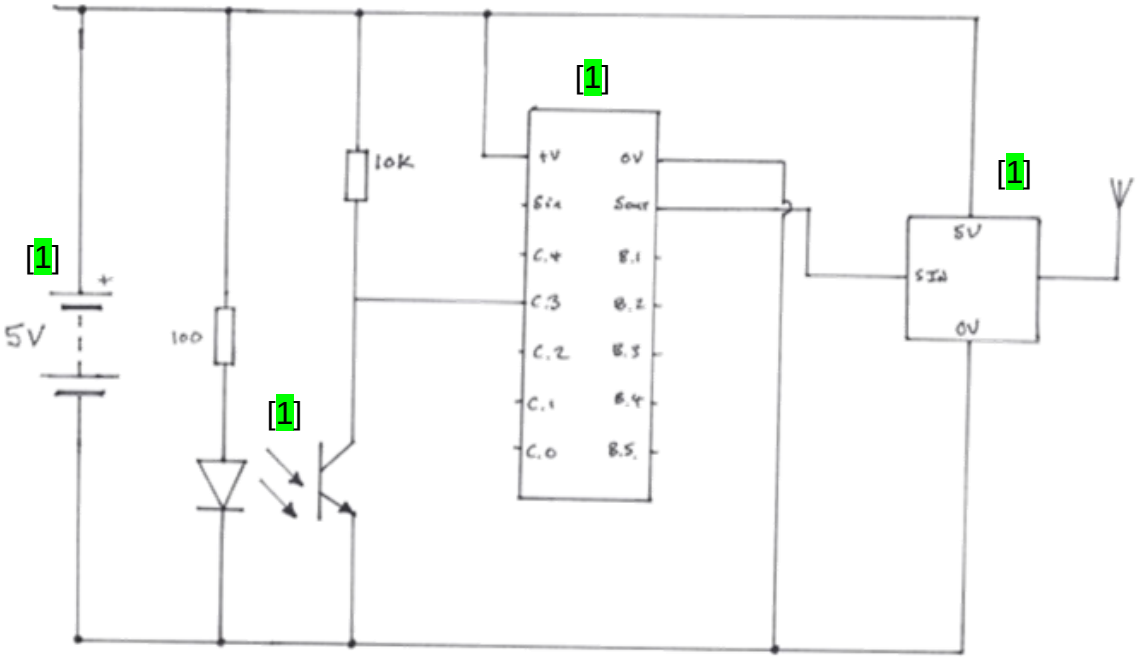
Issue 2:

Candidates should respond with solutions that include the electronic components detailed in pages 8 and 9 of the Resource Booklet (PICAXE 14M2 microcontroller and radio transmission circuit).

Circuit diagram to show how the wind sensor electronic components identified in the response to Issue 1 and the radio transmitter components should be connected to the PICAXE 14M2 microcontroller.

- Correctly drawn and connected power supply.
- Correctly drawn circuit symbols for the chosen wind sensor electronic components identified in Issue 1.
- Correct choice of Input/Output pins of the PICAXE 14M2 microcontroller.
- Correct connection of Serial Data Output pin B.0 of the PICAXE 14M2 to the Serial Data In connection of the radio transmission circuit.

Example: Opto-switch sensor

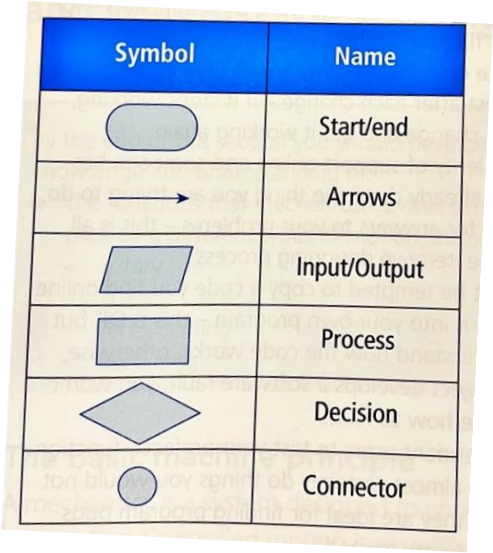


Use of information from Resource Booklet is used in a simplistic way and adds limited value to the points being made.
Sketches if used will be unclear with only basic notes to accompany them.

0 marks = No response or no response worthy of credit.

Program flowchart that indicates how rotation speed of the rod is monitored and data transmitted to the remote display unit.

- Correct identification of either analogue or digital signals as appropriate from the electronic components identified in the response to Issue 1 for the wind speed sensor.
- Evidence of analogue to digital conversion as appropriate.
- Correctly selected flow chart cells (see below).

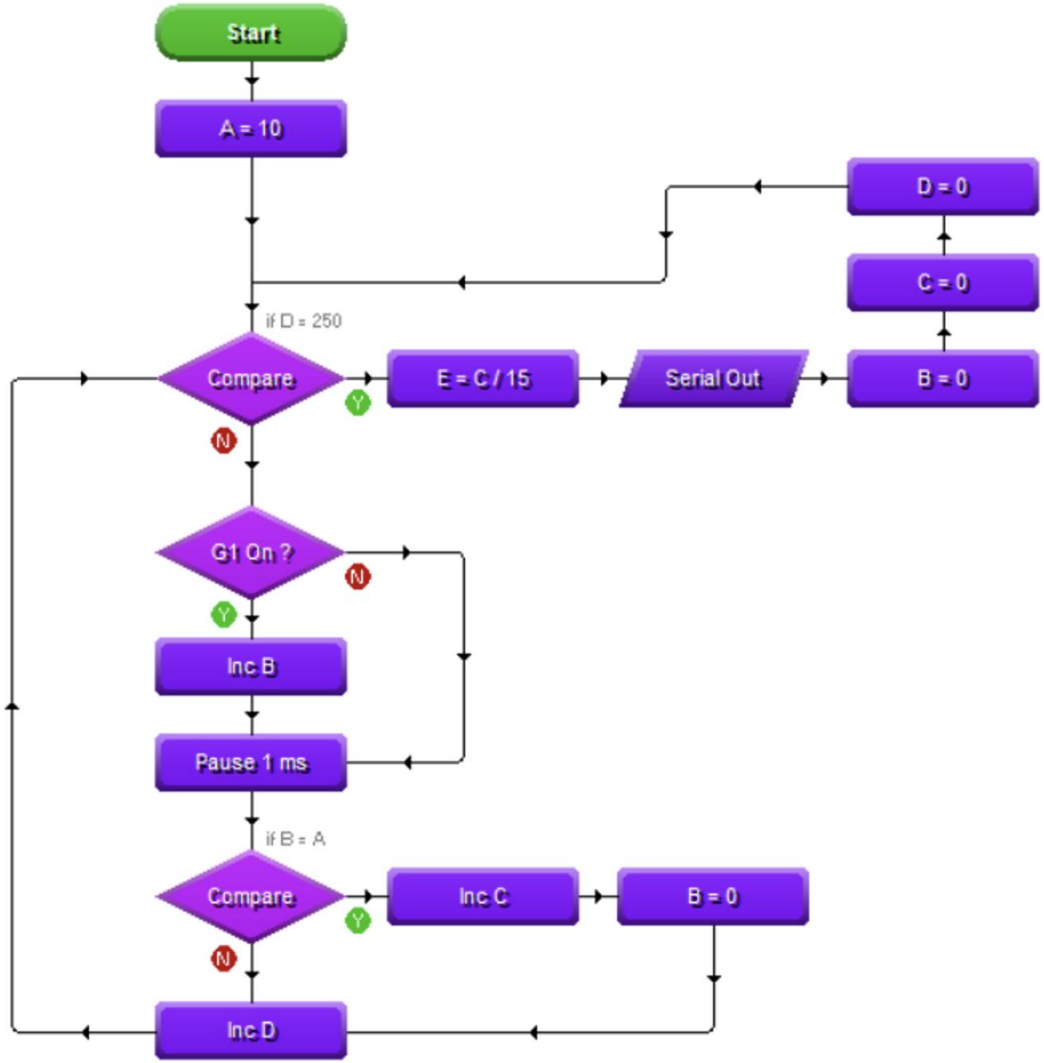


Award 1 mark for each of the points below:

- Clear identification of how the signal from the sensor is being received into the micro-controller.
- Clear identification of how the rotations are being compared against a base value.
- Clear identification of Serial Data output to the radio transmission circuit.
- Correct use of circuit symbols

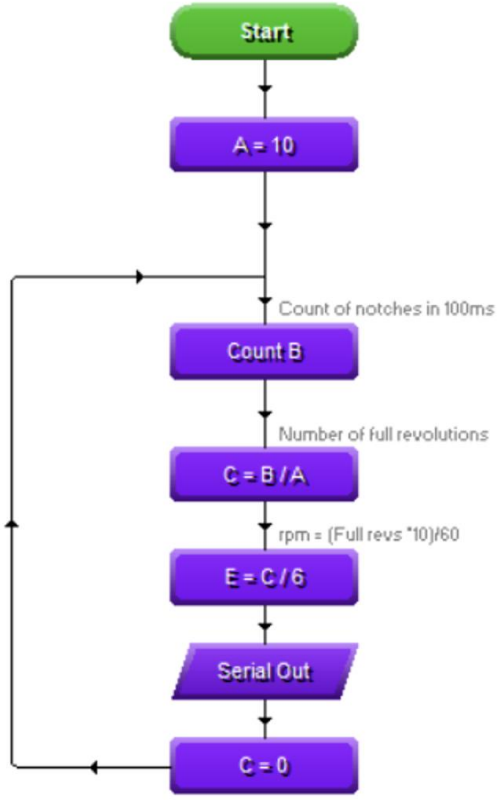
Example 1: Opto-switch sensor – using counting rotations

A=number of slots/notches in wheel
B=count of notches units (variable can't be higher than 255)
C=number of full rotations in 1/4 of a second
D=milliseconds passed
E= rpm ((rotations in 1/4 of a second * 4)/60



Example 2: Opto-switch sensor – using variable count

A=number of slots/notches in wheel
B=count of notches units (variable can't be higher than 255)
C=number of full rotations in 1/4 of a second
D=milliseconds passed
E= rpm ((rotations in 1/4 of a second * 4)/60



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