Oxford Cambridge and RSA

GCE

Design and Technology: Design Engineering

Unit **H004:** Principles of Design Engineering

Advanced Subsidiary GCE

Mark Scheme for June 2018

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.

Annotations

Annotation Name	*Description*
✓	Tick
X	Cross
✓+	Development of point
?	Unclear
BOD	Benefit of doubt
BP	Blank page
L1	Level 1
L2	Level 2
L3	Level 3
NAQ	Not answered question
NBOD	Benefit of doubt not given
OFR	Own figure rule
REP	Repeat
TV	Too vague

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:

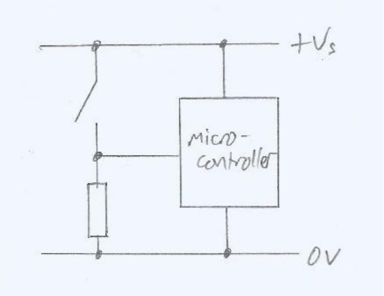
- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

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.

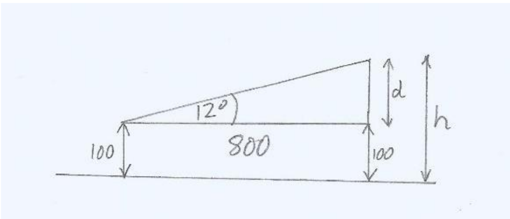
Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

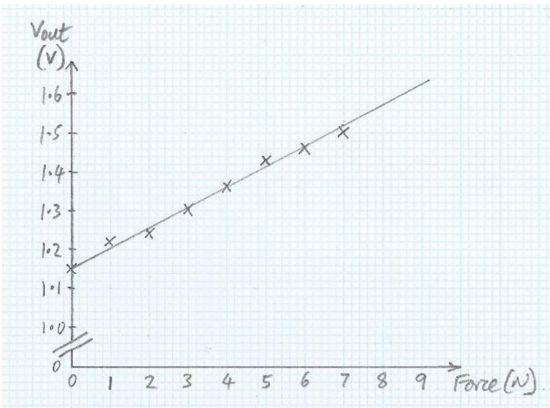
Question			Answer	Mark	Guidance
1	(a)		Possible methods include: • SWOT analysis (1) identifying the strengths and weaknesses, opportunities and threats associated with a microwave oven (1). • Focus groups (1) assemble a group of people to discuss the possible improvements to existing microwave ovens (1). • Qualitative observations (1) using non measurable data from observations of microwave use to propose improvements (1). • Market research (1) gathering information about consumer needs or preferences using a survey (1). • Analysis of existing products (1) using/testing existing microwaves to identify areas of improvement (1). • Mock-ups/control layouts (1) creating low quality mock up models to engage users in user centred discussion about microwave use (1). • Any other valid suggestion.	4	***In each case:*** ***One mark for identifying a method which could be used to investigate stakeholder requirements for the design of a new microwave oven.*** ***One mark for describing the method given.***
	(b)		Possible reasons include: • Simulation of the mechanical gear system (1) using modelled gears to examine performance (1). • Testing/validating the choice of materials in the gear system (1) exploring different materials and how they differ in use (1). • Modelling the electronic system (1) creating a testable circuit which can be tested at different points (1). • IDE for the microcontroller software (1) write and test software for the microwaves control system (1). • Design the PCB (1) generate a PCB design to fit inside the microwave outer casing (1). System simulation (1) recreating a real world	4	***In each case:*** ***One mark for identifying a reason why CAE software would be used in the development of an electronic system such as in a microwave oven.*** ***One mark for explaining the reason given.***

Question			Answer	Mark	Guidance
			environment where physical and system factors can be tested virtually (1). • Any other valid suggestion.		
	(c)	(i)	LH Subsystem: Possible labels include: Control panel (1) / User controls (1) / Buttons (1) activated. Any other valid suggestion. RH Subsystem: Possible labels include: Display (1) / Clock (1) / Timer (1) / Screen (1). Any other valid suggestion.	2	***For two marks.*** LH Subsystem: Allow any answer which indicates that the candidate realises that there are user controls which act as inputs to the system. RH Subsystem: Allow any answer which indicates that the candidate realises that the visual display is an output subsystem.
		(ii)	Possible explanations include: • In an open loop system there is no feedback (1) the output is not measured/does not feedback to the input (1). • In an open loop system there are no sensors to detect the output (the food cooking) (1), so the input (the heat/time) does not detect if the food has been cooked (1). • In an open loop system the microcontroller has not ability to sense how the cooking process is proceeding (1). The cooking is controlled/set by the user before cooking starts (1). • In an open loop, the microcontroller does not provide any control/accuracy to the cooking process (1) that a closed loop system using sensors could achieve (1). • Any other valid suggestion.	2	***Up to two marks for explaining how an open loop control system works in a product such as a microwave oven.*** Reference to open loop control requires reference to feedback, either explicit or implied.

Question			Answer	Mark	Guidance
		(iii)		2	***Award two marks as follows:*** • One mark for a switch connected to +Vs and to input of microcontroller (1). • One mark for inclusion of pull-down resistor (1).
		(iv)	= Use of ohm's law formula V = IR (1). I = V/R Voltage across resistor = 12 – (3 x 2.5) = 4.5V (1). I = 4.5* / 200 I = 0.0225A I = 22.5 mA (1).	3	***Award three marks as follows:*** If correct answer is given without working out shown award full marks. If correct answer is not given, award marks as follows: • One mark for identifying ohm's law. • One mark for calculating the correct voltage across the resistor (4.5V). • One mark for calculating a Amp or Milliamp current by dividing voltage by resistance. *Allow error carried forward (ECF) where correct working out is shown. Working out must be shown in order to award appropriate marks.
	(d)	**(i)**	= Gear ratio for gears B:A = 48/12 = 4 Gear ratio for gears D:C = 60/10 = 6 (1). Overall gear ratio = 4* x 6* = 24 (1). Turntable rotational speed = 100 / 24* = 4.2 rpm (1). (accept answers not rounded to 1 decimal place, e.g.	3	***Award three marks as follows:*** If correct answer is given without working out shown award full marks. If correct answer is not given, award marks as follows: • One mark for working out gear ratios – B:A and D:C. • One mark for calculating the overall gear ratio. • One mark for dividing the overall speed (100 rpm) by the overall gear ratio which is the result of B:A

Question			Answer	Mark	Guidance
			4.17 rpm or 4.1666 rpm)		multiplied by D:C. *Allow error carried forward (ECF) where correct working out is shown. Working out must be shown in order to award appropriate marks.
		(ii)	Give credit for any mechanical method of joining the gear to the shaft: • Grub screw. • Split pin. • Friction fit. • Splined shaft. • Keyed shaft. • Flanged bushing. • Sweat fit (heated to expand, then cooled to shrink). **<u>Or</u>** Give credit for any joining process suitable for a gear and shaft: • Spot welding. • Brazing. • MIG/TIG welding.	3	***Award three marks as follows:*** • Two marks for suitable sketched feature on gear and shaft (x2). • Two marks for suitable joining process with supporting sketch including detail (e.g. chamfer to internal edge, filler, etc.) (x2). • One mark for correct use of technical vocabulary for either mechanical or joining method (1). Where either the gear or the shaft do not show a suitable feature, award one mark for either a correct feature on the shaft, or a correct feature on the gear. Do not allow ‘adhesive’ or ‘glue’.

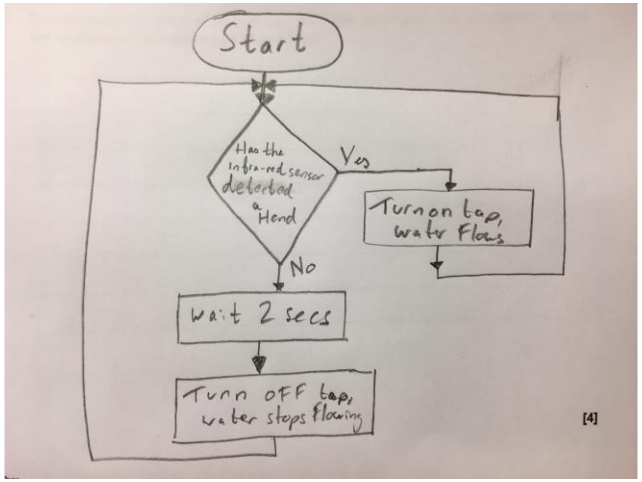
Question			Answer	Mark	Guidance
2	(a)		= 4.5 = 120% of lifetime of old battery (1). Lifetime of old type of battery = 4.5 / 1.2 = 3.75 hours (1).	2	***Award two marks as follows:*** If correct answer is given without working out shown award full marks. If correct answer is not given, award a mark as follows: • One mark for identifying that the new battery represents 120% of life compared to the old battery. **Or** • One mark for identifying the relationship between the lifetime of the new and old battery. Working out must be shown in order to award appropriate marks.
	(b)		=  Tan (12) = d / 800 d = 800 Tan (12) = 170 mm (1). Therefore, height of support B: h = 170* + 100 = 270 mm (1).	3	***Award three marks as follows:*** If correct answer is given without working out shown award full marks. If correct answer is not given, award marks as follows: • One mark for identifying a right angle triangle. • One mark for applying trigonometry to context. • One mark for calculating the height of the right angled triangle at 170mm (d in diagram). *Allow error carried forward (ECF) where correct working out is shown. Working out must be shown in order to award appropriate marks.

Question			Answer	Mark	Guidance
	(c)		= Probability of NOT finding a fault is (1 – probability of finding a fault) (1). P_1 = 0.9998 (1). P_2 = 0.9998* x 0.9998* = 0.9996 (1).	3	***Award three marks as follows:*** If correct answer is given without working out shown award full marks. If correct answer is not given, award marks as follows: • One mark for realising that each switch selection is mutually exclusive. • One mark for establishing the probability of not finding a faulty switch the first time = 1 - 1/5000. • One mark for establishing that the probability of both switches being faulty is the probability of one switch multiplied by itself. *Allow error carried forward (ECF) where correct working out is shown. Working out must be shown in order to award appropriate marks.
	(d)	(i)	=  	2	***Award two marks as follows:*** • One mark for plotting data onto graph. • One mark for drawing a best fit line.

Question			Answer	Mark	Guidance
		(ii)	Possible explanations include: • There is a positive correlation relationship between the two variables in which both variables move in tandem (1), where one variable increases while the other increases (1). • There is a consistent relationship between both sets of data (X & Y) (1) resulting in a straight line - an increase in one results in a consistent increase in the other (1). • The amount by which the output changes is by the same amount for each increase of 1N (1) resulting in a straight line (1). • The amount the Newton force changes is by the same amount for each increase of 0.053 volts (1), resulting in a straight line (1). • Voltage output rises evenly with an increase in applied force (1), resulting in a straight line (1). • The gradient of the graph is 0.053 volts per 1 newton (1), which creates a straight line (1). • Any other valid suggestion.	2	***One mark for identifying the straight line aspect of the graph.*** ***One mark for explaining why this indicates linearity.***
		(iii)	= Extrapolation/extension of graph line to at least 8.5N (1). When F = 8.5 N Output = 1.60 V (1).	2	***Award two marks as follows:*** One mark for extrapolation of graph line. One mark for predicting the output. Allow 1.57V to 1.60V.

Question			Answer	Mark	Guidance
3	(a)		***Indicative content:*** Possible reasons for the growing demand of automatic sensor sink taps in public toilets include: • Public toilet users wanting a more hygienic tap experience than mechanical taps which require touching them to operate. • Public toilet owners wanting to reduce water consumption from taps being left on by users. • Public toilet owners wanting to improve the perception of their public toilets. • Public toilet owners wanting to reduce water/energy consumption through general use. • Public toilet owners wanting to create more inclusive service for a wide range of public users including those with disability, old or young age, etc. • Public toilet owners wanting to control the temperature of water from the taps to ensure the safety of the public. • Public toilet owners wanting to improve the hygiene of the toilets by reducing cross contamination/bacteria areas. • Public toilet owners wanting to reduce the maintenance/cleaning of taps and sink areas due to reduced interaction. • Public toilet owners wanting to reduce wear and tear of their taps which could result in corrosion, damage or replacement. • Public toilet owners want to market the toilets as being smart/using sensors, or similar. • Any other valid suggestion.	6 As a guide for full marks there will be two or three different reasons given for the growing demand of automatic sensor sink taps. Generic reasons unrelated to product choice are unlikely to gain credit. If candidates do not provide an analytical/evaluative response then only Level 1 can be awarded.	**Level 3 (5–6 marks)** The candidate produces a thorough discussion of the reasons for the growing demand of automatic sensor sink taps. The candidate demonstrates a comprehensive understanding of the question by explaining a number of factors that have resulted in this product modification. When reasons are given they are clearly analysed in terms of why the demand for this type of product has increased. **Level 2 (3-4 marks)** The candidate produces a sound discussion of the reasons for the growing demand of automatic sensor sink taps. The candidate demonstrates a reasonable understanding of the question by explaining one or more factors that have resulted in this product modification. When reasons are given they are explained in terms of why the demand for this type of product has increased although one or two opportunities for development are missed. **Level 1 (1–2 marks)** The candidate demonstrates knowledge of automatic sensor sink taps with limited awareness of why there has been an increase in demand for this product. There is no analysis of the factors that have contributed to this increase in demand. **Level 0 (0 marks)** No response or no response worthy of credit. Do not award credit where answers refer to time or speed of response of the taps to dispense water unless the explanation is justified.

Question			Answer	Mark	Guidance
	(b)		Possible reasons include: • The material will not need an additional finish applied after the components have been made (1), because the material will not rust/corrode in use (1). • Non-ferrous metals are suitable for a range of casting, drilling and machining processes required to make the taps body (1), because of their working properties (1). • Non-ferrous metals can be polished to improve their appearance (1) which would then remove the need for applying a finish (1). • Non-ferrous metals do not rust/corrode (1) and will not be affected by water/air during testing and use (1). • Most non-ferrous metals have a suitable melting temperature (1) suited to withstand the temperature of hot water from a tap during use (1). • Most non-ferrous metals will not taint the water (1) passing through the tap during extensive/ongoing use because they are unreactive (1). • Non-ferrous metals can be cast into a tap body form (1), which allows them to be formed into the body shape (1). • If mistakes are made, non-ferrous metals can be melted and reprocessed (1) which will not reduce or degrade the materials properties (1). • Any other valid suggestion.	4	***In each case:*** ***One mark for identifying a reason why a non-ferrous metal is a suitable material for manufacturing an automatic sensor sink tap.*** ***One mark for explaining the reason given.***

Question			Answer	Mark	Guidance
	(c)	**(i)**	Possible descriptions include: • An infra-red sensor sends out an infra-red signal to hit objects placed in front of it (1). • If an object is close to the sensor, the signal will bounce off the object and return back to the sensor, where the signal will be received and cause the signal to be sent to the microcontroller to turn the water on (1). • At the end of the two second timer, the sensor will recommence sending out the infrared signal. • If the object is detectable still, it will do nothing for two seconds before sending out a further signal. • If the object is not detected, it will send a signal to turn the water off (1). • Any other valid suggestion.	3	***Up to three marks for describing how a reflective infra-red sensor works.*** Mix and match approach. The description can be taken from any of the listed points.
		(ii)		4	***Award four marks as follows:*** • One mark for input from IR sensor. • One mark for delay of two seconds. • One mark for output to water flow. • One mark for loop back to start. No marks to be deducted for incorrect use of flowchart shapes or missing arrow heads at the end of the connecting lines. The main focus is on the programming methodology and does it lead to a workable solution. However, if the water flow is turning off for two seconds while the hands are constantly present, this is not correct and marks should be deducted.

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>4</td><td>(a)</td><td>(i)</td><td>Either award for calculating that the flow rate of A is higher than required per minute.

As below:

Need to convert 0.18m^3 min^{-1} into m^3 $hour^{-1}$
1 hour = 60 mins (1).
0.18 x 60 = 10.8m^3 $hour^{-1}$ (1).

10.8m^3 $hour^{-1}$ is greater than the required 10m^3 $hour^{-1}$ so fan A is suitable (1).

<u>Or</u>

award for calculating that the required flow rate of 10m^3 is lower than the flow rate of fan A.

As below:

1 hour = 60 mins (1).
10/60 = 0.167m^3 $hour^{-1}$ (1).

0.167m^3 is less than the potential flow rate of 0.18m^3 produced by fan A.</td><td>3</td><td>Award three marks as follows:

• Recognising the requirement to convert 1 hour into 60 minutes (1).
• Calculating the air flow rate per hour of fan A (1).
• A written statement comparing the air flow rate calculated to the required air flow rate in (a) (1).</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Possible responses include:

• The voltage of the fan will affect the choice of power supply (1) which is important as it could provide the opportunity to power by battery or require mains electricity (1).
• The size of the fan will affect the size of the casing (1) as the material to enclose the casing will need to fit around the component to house it (1).
• The temperature range will affect the suitability of the fan for different climates (1) as the more extreme temperature ranges could cause the fan to</td><td>2</td><td>Up to two marks for justifying one other item of data from the table in Fig. 4.3 that a design engineer could consider when selecting a suitable fan for the automated air monitoring system.

The item of data on its own does not warrant a mark. Appropriate justification must be given for credit to be awarded.

Speed is unlikely to be a significant factor in this application, unless the candidate can clearly justify its consideration.</td></tr>
</table>

Question			Answer	Mark	Guidance
			stop working or malfunction (1). • The rotations per minute of the fan will affect the amount of air that can be drawn into the system (1) which will affect how large a sample of air is analysed in any given environment over a specific time frame (1). • Any other valid suggestion.		
		(iii)	= 1 x 0.3 x 03 = 0.09 m^3 (1). Mass = density x volume (1). Mass = 56 x 0.09* = 5.04 kg (1).	3	***Award three marks as follows:*** If correct answer is given without working out shown award full marks. If the correct answer is not given, award marks as follows • One mark for calculating volume of the panel. • One mark for listing the mass formula. • One mark for calculating the mass in kg. *Allow error carried forward (ECF) where correct working out is shown. Working out must be shown in order to award appropriate marks.

Question			Answer	Mark	Guidance
	(b)*		***Indicative content:*** Possible constraints for renewable energy sources as power supplies can include: • Renewable energy sources are relatively expensive to buy, so this must be factored in to the design strategy. In use, however, they provide free energy which is a strong selling point. • A battery is essential to act as an energy reservoir, adding to costs, and batteries have a limited life so will need to be replaced over time. • The average power consumption of the engineered system must be less than the average power generated throughout the day, or the battery will eventually run out. • Some sort of battery monitor circuit may be needed to sense brownout conditions and safely shut down the engineered system to prevent loss of data, or erratic operation. **<u>Solar Panels:</u>** • No energy is generated at night, so the system may need to go into standby at night to conserve energy. • Less energy is generated on a cloudy day, so the panel size may need to be much larger than the panel manufacturer suggests, because panel output is usually quoted in full sun. • They need to be kept clean for maximum efficiency, and a dusty urban environment may not help with this.	**8** As a guide for full marks there will be two or three different constraints given when using renewable energy sources to supply power for engineered products. Answer may or may not be within the context of the air monitoring system. If candidates do not provide an analytical/evaluative response then only Level 1 can be awarded.	**Level 3 (6–8 marks)** The candidate produces a thorough discussion of the constraints that come from renewable energy sources being used to supply power for engineered products. The candidate demonstrates a comprehensive understanding of the question by explaining a number of constraints that arise from the use of these sources to power engineering products. When constraints are given they are clearly analysed in terms of the implications they have had. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated with the use of examples.* **Level 2 (3–5 marks)** The candidate produces a sound discussion of the constraints that come from renewable energy sources being used to supply power for engineered products. The candidate demonstrates a reasonable understanding of the question by explaining one or more constraints that arise from the use of these sources to power engineered products. When constraints are given they are explained in terms of the implications they have had although one or two opportunities for development are missed. *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.*

Question			Answer	Mark	Guidance
			• They need to track the sun for highest efficiency, but this will be unlikely in most applications, so a compromise is achieved when positioning the panel. **Wind Turbine:** • Wind does not always blow so a backup energy source may be needed such as a solar panel. • Wind turbines need to always face the wind so they need mounting on a free-turning bearing. • They can be noisy in high winds, so consideration of noise nuisance may need to be considered. • Rotating blades can be dangerous so the turbine would need to be mounted out of reach. • Any other valid suggestion.		**Level 1 (1–2 marks)** The candidate demonstrates knowledge of renewable energy sources with limited awareness of possible constraints that might arise when using them to supply power for engineered products. There is no analysis of any implications. *The information has some relevance and is presented with limited structure or detail The information is supported by limited evidence.* **Level 0 (0 marks)** No response or no response worthy of credit

Question			Answer	Mark	Guidance
	(c)	(i)	Possible design features include: **Water Inflow** • Water can be fed into the system which allows it to be filtered in the main chamber (1), which can be drawn from a water supply that needs to be tested (1). **Water Outflow** • Water can leave the chamber having been filtered (1) and be fed back into the water supply (1). **Filter** • The filter can remove micro-particles from the water that is fed through the system (1), creating clean water and providing data of the amount of micro-organisms contained at any time (1). • The filter can be removed and replaced over time (1) allowing for consistent data to be recorded (1). **Casing** • The casing can be removed and cleaned after prolonged us/ allows for the filter to be changed/provides a transparent casing to view the filter (1), allows the user to view the particle build up during use/allows the filter to be removed for testing (1). **Wall mounting** • The system can be mounted close to a water supply that is to be monitored (1) or requires few tools to mount the system securely (1), prevents the system from moving which could cause water leakage (1). • Any other valid suggestion.	4	***In each case:*** ***One mark for identifying a design feature of the water filter that would make it suitable for use in the water monitoring system.*** ***One mark for justifying the design feature given.*** For a mark to be awarded **Fig. 4.4** must be analysed.

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td></td><td>(c)</td><td>(ii)</td><td>Possible reasons include:

Analysis of products is conducted to inform opportunities and constraints that may influence design decisions. Information sourced from product analysis could include:

• Exploring a product in context, as this allows the designer to experience the product in use for its purpose (1), and therefore establish future design decisions to be made (1).
• Explore materials and components, as this allows the designer to understand material performance requirements (1), potentially changing material choices in relation to the components used in the product (1).
• Explore construction/manufacturing methods, as this allows the designer to identify how the product has been made (1), and make informed changes to how future products could be made (1).
• Testing functionality/ease of use/fitness for purpose, as this allows the designer to appreciate what the product does well (1), and propose changes to these where it could do better (1).
• Exploring ergonomics/anthropometric data use, as this gives a hands on appreciation of the product in use (1), and make tactile design decisions (1).
• Exploring use with a range of users, allows the designer to assess how inclusive a product is (1) and therefore identify improvement that could be made relating to a sub group of people (1).

Evaluation of products is conducted to identify successes against the specification for the product/system. This includes:</td><td>4</td><td>In each case:

One mark for identifying a reason why it is important to undertake product analysis/evaluation.

One mark for explaining the reason given.</td></tr>
</table>

Question			Answer	Mark	Guidance
			• **Testing the product in use** (1), so that the user can test the product and assess its merits (1). • **Comparing the product against the list of requirements** (1) will allow the product to be compared to the intended list generated from research to see where the product meets requirements (1). • **Analysis with users**, giving potential customers the opportunity to critique the finished product prior to project completion. • Any other valid suggestion.		

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>5</td><td>(a)</td><td></td><td>Possible reasons include:

• Ensuring the life expectancy of a product in the customer's eyes is achieved (1), as this will ensure customer satisfaction from the product in use (1).
• Ensuring the life expectancy of the product will require the customer to replace/repair/return the product after a specific amount of time (1) which will benefit the retailer/manufacturer with future business (1).
• Ensuring that the product can be updated/upgraded (e.g. firmware or part replacement) to extend the life expectancy of a product (1) will provide an ongoing improvement of the product over time (1).
• Design for repair/modular design (1) allows the product to be updated as required/with new technologies (1).
• Allowing the manufacturer to periodically affect the performance of a product in use, reducing its performance until a customer is required to replace the product at an appropriate time (1) helps the customer identify when to stop using the product (possibly linked to safety) (1).
• Installing components with predictable life expectancy through appropriate use (1) creates the opportunity for service provision to be offered by the manufacturer post sales (1).
• Any other valid suggestion.</td><td>4</td><td>In each case:

One mark for identifying a reason why a design engineer would consider planned obsolescence when designing a new engineered product.

One mark for explaining the reason given.</td></tr>
</table>

Question			Answer	Mark	Guidance
	(b)*		***Indicative content:*** How environmental incentives or directives have impacted on the way in which engineered products and systems are produced include: Engineered products are manufactured to account for environmental incentives and/or directives in the following ways: • Considering the need to accept returned products at the end of their lifecycle, for recycling, repair, reuse or landfill (e.g. the WEEE directive). • Considering which products or systems are currently receiving end of life incentives for customers to update their product or system (end of life diesel vehicle directive). • Considering products that benefit from existing systems that avoid the product ending up in landfill at the end of its lifecycle (existing recycling directives/incentives). • Considering the impact of different choices in power supply, by choosing carefully whether to allow batteries to be replaced or not, use USB or standard power connectors, using a sustainable power supply. • Considering the need to package products through their lifecycle and ensuring materials used can be reclaimed or recycled using existing packaging systems. • Considering the inclusion of hazardous materials or substances, their function in the product/system, and how these can be removed to meet directives relating to their	8 As a guide for full marks there will be two or three ways in which environmental incentives or directives have impacted on the way in which engineered products and systems are produced. If candidates do not provide an analytical/evaluative response then only Level 1 can be awarded.	**Level 3 (6–8 marks)** The candidate produces a thorough discussion of how environmental incentives or directives have impacted on the way in which engineering products and systems are produced. The candidate demonstrates a comprehensive understanding of the question by explaining a number of impacts that may arise from these incentives/directives. When impacts are given they are clearly analysed in terms of how they affect the way engineered products and systems are produced. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated with the use of examples.* **Level 2 (3–5 marks)** The candidate produces a sound discussion of how environmental incentives or directives have impacted on the way in which engineering products and systems are produced. The candidate demonstrates a reasonable understanding of the question by explaining one or more impacts that may arise from these incentives/directives. When impacts are given they are explained in terms of how they affect the way engineered products and systems are produced. *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 1 (1–2 marks)** The candidate demonstrates knowledge of environmental incentives/directives and how they might affect the way engineered products and

Question			Answer	Mark	Guidance
			disposal (RoHS). • Helping a manufacturer in meeting recycling directive/incentive targets through the products/systems they manufacture. • Ensuring communication of products/systems meeting or responding to directives or incentives is well communicated through packaging/marketing/product specification/symbols on the product/packaging. • Being proactive in meeting new or existing incentive or directive programmes so that the manufacturer is well perceived in the market. • Any other valid suggestion.		systems are produced. There is no analysis of any impacts. *The information has some relevance and is presented with limited structure or detail The information is supported by limited evidence.* **Level 0 (0 marks)** No response or no response worthy of credit

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