GCE

Design and Technology

H004/01: Principles of Design Engineering

Advanced Subsidiary GCE

Mark Scheme for June 2019

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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.

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 (not used on level Qs)
BOD	Benefit of doubt
SEEN	Noted but no credit given
L1	Level 1 response
L2	Level 2 response
L3	Level 3 response
ECF	Error carried forward
RE	Rounding error
highlighter	A line is highlighted next to relevant part if only part is answering Q

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)	(i)	Possible design requirements may include: ● Size of buttons (1). ● Height of machine (1). ● The amount of clothes it can hold and wash (1). ● Cycle times (1). ● Cost of the machine (1). ● Materials the machine is made from (1). ● How the machine is recycled (1). ● How the machine is transported (1). ● How the machine is maintained (1). ● Any other valid suggestion.	2	One mark for identifying each of two design requirements that would have been taken into account when designing the washing machine.
1	(b)	(i)	Possible inputs may include: ● Push buttons (1). ● Switches (1). ● Dials (1). ● Touch screen panel (1). ● Any other valid suggestion.	2	One mark for identifying each of two inputs that would be included in a system diagram for the washing machine.
1		(ii)	Possible outputs may include: ● Heater (1). ● Motor (1) ● Screen interface (1). ● Water inlet/outlet (1). ● Sound signalling completion of cycle (1). ● Timer countdown (1).	2	One mark for identifying each of two outputs that would be included in a system diagram for the washing machine. Response can be

			● Any other valid suggestion.		component driven or holistic output i.e. clean clothes. Two **different** outputs must be given.
1	**(c)**	**(i)**	Possible reasons may include: ● Good ratios between motor and drum (1). This means the required torque and speed can be achieved (1) or the belt can be tensioned to increase/decrease friction (1). ● The belt is used in order to absorb the vibrations of the motor/drum (1) but still maintain connections between them (1). If the drum gets stuck it won't damage the motor (1). ● The belt systems is much easier to repair/maintain as it would (1); show signs of visible wear(1); or be suitable for a user to remove and replace (1). ● A belt system would be much quieter (1) than a chain driven system, geared system or mechanical system due to softer rubber materials used in the drive (1). ● Any other valid suggestion.	**3**	One mark for identifying a reason why washing machines use this belt driven system. Up to a further two marks for explaining why this belt driven system would be used. Specific reference to the context in the question is needed for marks to be awarded. Use mix and match approach with bullet points.
1		**(ii)**	45 x 60 = 2700 rev/min (1). 350/50 = 7 (1). 2700*/7* = output speed (1). 385.7 rev/min (1).	**4**	Award four marks as follows: One mark for converting rev/s to rpm for the motor speed. One mark for working out the VR (driven/driver).

					One mark for knowing that input speed/gear ratio will give output speed. One mark for calculating drum speed to 1 decimal place. 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.
1	**(d)**	**(i)**	Possible materials may include: ● Ferrous/non-ferrous metal or specific material (1). Stainless steel, chrome plated steel, aluminium, galvanised steel, or any other valid suggestion. Possible reasons may include: ● The material should have a good strength to weight ratio (1) so the drum can withstand spinning at high speed (1). ● The material should be light enough (1) so the drum can be turned by the motor (1). ● The material should be easy to fabricate (1) which can be achieved through stamping/welding processes (1). ● The material for the drum can withstand regular temperature changes (1) which	**5**	One mark for identifying a suitable metal that the drum could be made from. Then in each case: Up to a further two marks for explaining why the chosen metal is suitable. Specific reference to the context in the question is needed for marks to be awarded.

			is important given the number and types of wash that can be selected by the end user (1). ● Any other valid suggestion.		
1		**(ii)**	**Indicative content:** **The candidate is expected to demonstrate their understanding of the process involved through a series of annotated sketches and/or notes. There may be variations to the process as indicated but to get into L3 candidates must demonstrate a clear understanding of the end to end process.** Process: ● Laser/plasma cutter used to cut out drum design on a flat piece of stainless steel. NB Allow Die casting/investment casting as a process (historically appropriate but not current production process) ● Flat sheet is then formed round a circular mould or bent into shape using a roll bender (or similar named machine). ● Ends of drum are pressed into shape. ● Ends and circular drum either are seem folded or seem welded together. ● Plastic fins in the inside are injection moulded and then riveted/bolted or clipped into place. - these are not visible ● Any other valid suggestion. If alternative processes are given that demonstrate understanding then appropriate credit should be given.	**6** All processes demonstrated must relate to drum. The response from the candidate must be suitable for industrial manufacture.	**Level 3 [5-6 marks]** The candidate had demonstrated a thorough understanding of the process needed to manufacture the drum in large batches with accurate technical terms and detailed consideration of the bullet points listed. Sketches if used will be clear and supported with relevant notes. The process will be end to end and clear in the way it is explained. **Level 2 [3-4 marks]** The candidate has demonstrated a sound understanding of some aspects of the process needed to manufacture the drum in large batches with reasonable use of technical terms and some consideration of the bullet points listed. Sketches, if used, will for the most part be clear and supported with notes most of which are relevant. The end to

					end process may contain some gaps in understanding. **Level 1 [1-2 marks]** The candidate has demonstrated a limited knowledge of the process, applying this knowledge in a basic way to how the drums could be manufactured in large batches with a limited use of technical terms and a basic consideration of the listed bullet points. Sketches, if used, will be unclear with only basic notes to accompany them. The end to end process may not exist and if anything is basic in nature. **0 marks** No response or no response worthy of credit.

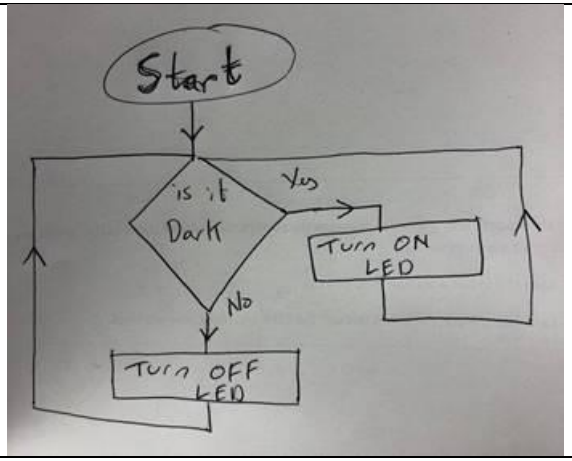
Question			Answer	Mark	Guidance
2	(a)	(i)	Force = mass x acceleration (1) or suitable equivalent. Force = 150 kg x 9.8 m/s^2 Force = 1470 N (1). Allow candidates to use 10m/s^2 which will result in an answer of 1500 N.	2	Award two marks as follows: One mark for recalling the formula to use. One mark for converting 150 kg to Newtons (N). 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.
		(ii)	Area = pi ($r_2^2 - r_1^2$) Area = pi ($0.025^2 - 0.023^2$) (1). Area = 3.016 x 10^{-4} m^2 (1).	2	Award two marks as follows: One mark for applying the area formula correctly. One mark for calculating the shaded area of the cylindrical tube to 3 significant figures. 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.
		(iii)	Stress = force / cross-sectional area (1). Stress = 1470* / 3.016 x 10^{-4} m^2 * (1). Stress = 4.87 MPa (1). If candidate pulls forward two inaccurate answers from (i) and (ii) they can still access the full three marks for this question. Careful check needed. This follows maths marking protocols.	3	Award three marks as follows: One mark for recalling the stress formula. One mark for applying the stress formula correctly. One mark for calculating the stress in the seat post when loaded to the maximum weight of 150 kg.

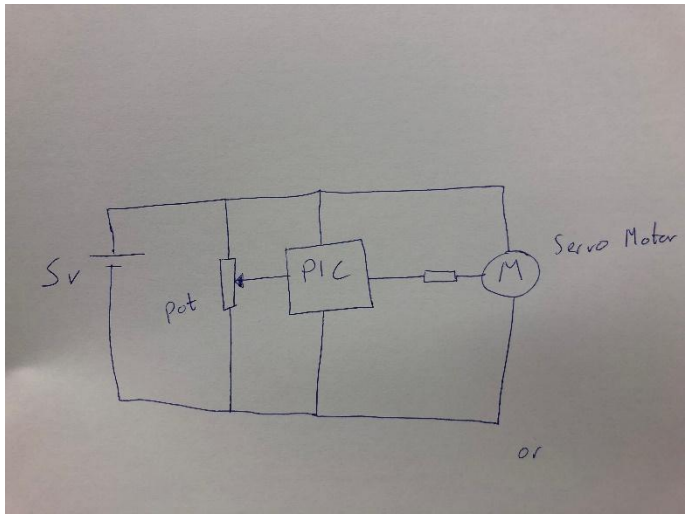
					If correct answer is given without working out shown award full marks. Where an incorrect answer is given working out should be used to credit appropriate marks. *Allow error carried forward (ECF) where correct working out is shown.
2	**(b)**		YM = stress/strain (1). Strain = extension / original length (1). Strain = 4 x10^{-5} / 0.6 Strain = 6.67 x 10^{-5} (1). YM = 4.87MPa* / 6.67 x 10^{-5} * (1). YM = 73GPa (1).	**5**	Award five marks as follows: One mark for identifying the correct formula for Young's Modulus. One mark for using correct formula for strain. One mark for calculating the strain. One mark for applying Young's Modulus formula correctly. One mark for calculating the Young's Modulus of this material. 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.

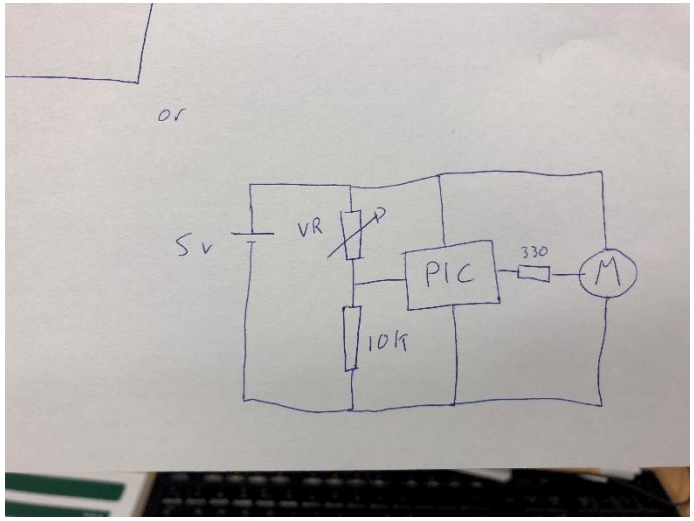
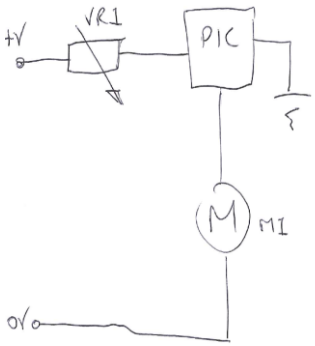
2	**(c)**		16 x 0.75 = 12 people (1). (12* x 2) + (4 x (2 + 2)) = £40 per day (1). 1400/40* = 35 days (1).	**3**	Award three marks as follows: One mark for working out that 12 people complete their journey within 30 minutes. One mark for working out daily cost. One mark for working out number of days. 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.

Question			Answer	Mark	Guidance
3	(a)		Cos30 = A/H (1). Cos30 = 2.7/x x = 2.7/cos30 (1). Length of beam = 3.12 m (1).	3	Award three marks as follows. One mark for understanding trigonometry formula that needs to be applied. One mark for inserting numbers into formula. One mark for calculating x to 2 decimal places. 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.

3	**(b)**		Possible responses may include: When LDR is dark it becomes high resistance and allows current to travel to point A (**input**). VR is used to adjust the sensitivity (**input/process**). Potential divider. Transistors (darlington pair) (**process**) are triggered which then allows current to travel to the relay which then becomes energised (**process/output**). Diode is used to stop back EMF. When the relay energies it moves the contacts to allow 24V to travel to the 3 LEDs which are protected by R2 (**process/output**). The LEDs illuminate (**output**). The switch is activated by the solenoid triggering the 24V supply to the lights. Any other valid suggestion. If candidates describe the process without using the terms input, process or output, cap marks at 4/6 maximum.	**6**	Up to six marks for description of how the circuit shown in **Fig. 3.3** operates. If a candidate does not provide a description of the full operation of the circuit then MAX four marks can be awarded – i.e. if one of input/process/output missing. MAX two marks to be awarded for description that stops at input or process or output.
3	**(c)**	**(i)**	An example of a flowchart that candidates might use to respond to this question:	**4**	Award four marks as follows: One mark for correct shape of boxes – start and process (1). One mark for decision box, correct shape and labelled correctly (1). One mark for repeat, closed loop (1).

					One mark for does the system work (1).
		(ii)	$R_1 = ((V_{in} \times R_2) - R_2 V_{out}) / V_{out}$ (1). $R_1 = (45000 - 37500) / 3.75$ $R_1 = 2000$ **Ω** (1).	**2**	Award two marks as follows: One mark for rearranging formula. One mark for calculating the resistance of the LDR. 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.

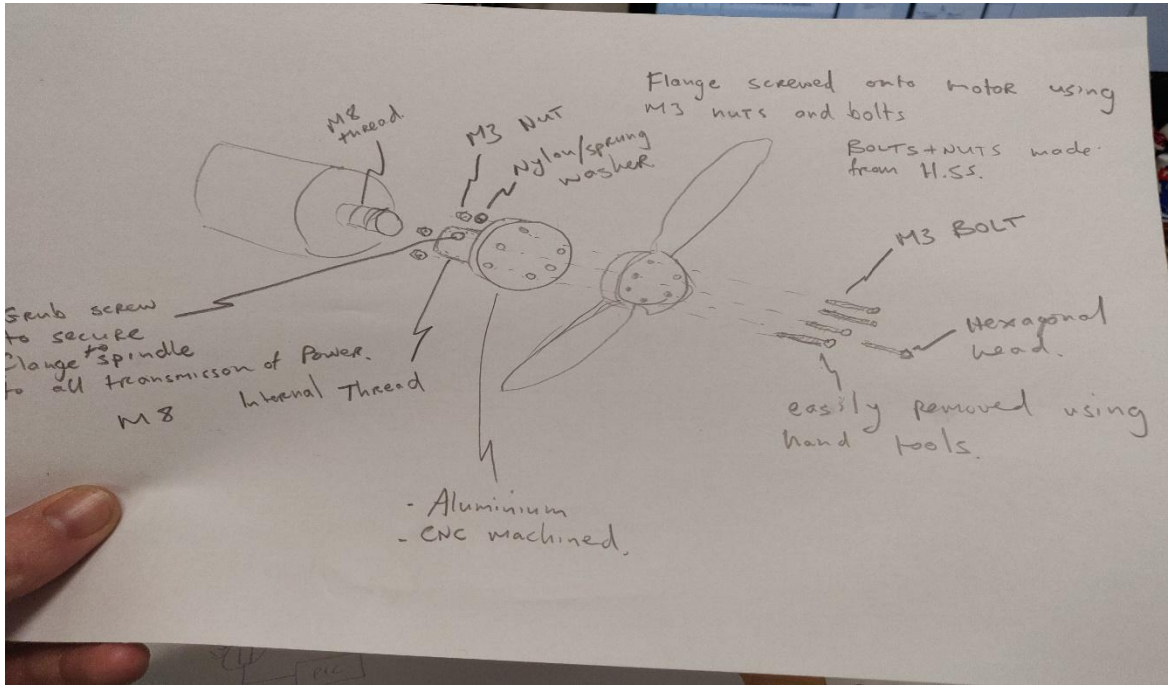
Question			Answer	Mark	Guidance
4	(a)	(i)	Possible responses may include: ● Better for precise movements (1) as with a servo motor different angles and directions can be implemented accurately (1). ● Better torque than a standard motor (1) due to the gearing inside a servo (1). ● Change of direction is somewhat easier with a servo (1) compared to having to do a motor reversal circuit with a DC motor (1). ● Any other valid suggestion.	**2**	One mark for identifying a suitable reason why a servo motor is better than a DC motor for controlling movement. One mark for explaining why a servo motor is the best option for controlling the aircraft flaps. Specific reference to the context in the question is needed for marks to be awarded.
		(ii)	Three examples of circuit diagrams that candidates might use to respond to this question 	**5**	Award five marks as follows: One mark for correctly connecting the potentiometer. One mark for correctly connecting the servo motor. One mark for correctly connecting the microcontroller. One mark for correct use of circuit symbols. One mark for suitable power supply.

			 or 5v VR PIC 330 M 10k  +V VR1 PIC M M1 0V		

4	(b)*		**Indicative content:** **Manufacturer (China)** **Ethical** ● Employment of local people. ● Setup to just manufacture so doesn't have to employ/designer or worry about if the product doesn't sell. ● Cheaper labour force. ● Giving china designs and access to new technology or designs. ● Can take orders from around the world. **Environmental** ● Uses up natural resources of China. ● China is more affected by pollution as a result of manufacture. **Company (UK)** **Ethical** ● Doesn't have to invest in manufacturing staff and equipment. ● Can change products easily, not worried about investment into machinery. ● Cheaper to manufacture in short term. ● Doesn't need to purchase a factory. **Environmental** ● Transport between China and UK, bigger carbon footprint. ● Natural resources of the UK are not being used.	**8** **For MB3 to be awarded a number of ethical/environmental issues in relation to the partnership will be covered.** **If candidates do not provide an analytical/evaluative response then only L1 can be awarded.**	**Level 3 [6-8 marks]** The candidate has a clear understanding of ethical and environmental issues. They produce a thorough discussion in relation to the question by explaining a number of ethical and environmental issues related to the partnership. The explanation of issues is clear and well-developed and a number of ways in which the partnership may develop are used to exemplify the points being made. *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 has a reasonable understanding of ethical and/or environmental issues. They produce a sound discussion in relation to the question by explaining a number of ethical and/or environmental issues related to the partnership. The explanation of issues is sufficient although one or two opportunities are missed in referring to the ways in which the partnership may develop. *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 has a basic knowledge of ethical and/or environmental issues. Any reference to this issue is descriptive in nature

					and has little appreciation of the ways in which the partnership may develop. The response contains no analysis or evaluation. *The information has some relevance and is presented with limited structure or detail. The information is supported by limited evidence.* **0 marks** No response or no response worthy of credit.
4	**(c)**	**(i)**	Possible responses may include: ● Through pulse width modulation (1) – turning the motor on and off quickly (1). By changing the time delay between on pulses this can then change the speed of the motor (1). ● Regulating the voltage and current powering the motor (1). This would mean the motor would decrease speed/torque (1). ● Any other valid suggestion.	**3**	Up to three marks for describing how a DC motor's speed can be controlled so the controller can easily change the speed of the aircraft when flying. Specific reference to the context in the question is needed for marks to be awarded. Use mix and match approach with bullet points.
4		**(ii)**	A possible response to this question is shown below: For each bullet point - candidate must describe how the propeller will not come off the motor thread, e.g. reverse thread for motor shaft to direction or rotation, gripping compound on the bolts/thread, locking nuts. (2) - candidate must show connectors/bolts and a threaded base to join both the motor and propeller (2)	**6**	**Level 3 [5-6 marks]** The candidate demonstrates a good level of detail of the process needed to connect the propeller to the DC motor. All bullet points are covered. Sketches, if used will be clear and supported with relevant notes. **Level 2 [3-4 marks]** The candidate demonstrates a sound level of detail of the process needed to connect the propeller to the DC motor. At least two of the

			- candidate must name a suitable material(s) for the part(s) and/or the bolts (2)		bullet points have been covered. Sketches, if used, will for the most part be clear and supported with notes most of which are relevant. **Level 1 [1-2 marks]** The candidate demonstrates a limited level of detail of the process needed to connect the propeller to the DC motor. At least one of the bullet points has been covered. Sketches, if used, will be unclear with only basic notes to accompany them. **0 marks** No response or no response worthy of credit.


M8 thread
M3 Nut
Nylon/spacing washer
Flange screwed onto motor using M3 nuts and bolts
BOLTS+NUTS made from H.SS.
M3 BOLT
Hexagonal head.
Grub screw to secure flange to spindle to all transmisson of Power.
M8 Internal Thread
easily removed using hand tools.
- Aluminium
- CNC machined.

Question			Answer	Mark	Guidance
5	(a)*		**Indicative content:** **Advantages of renewable energy sources** ● Renewable energy sources are better for the environment. ● On an isolated island community it is much easier to set up a source of renewable energy than a non-renewable source. ● Although time consuming to set up renewable energy sources will be much more cost effective in the long term. ● There are a number of different types of renewable sources of energy (solar, hydro, wind, kinetic). ● Renewable sources of energy allow islands to be power themselves autonomously and use non-renewable sources as a back-up if necessary. ● Any other valid suggestion. **Advantages of non-renewable sources of energy** ● They provide energy faster than renewable sources which can take time to generate energy. ● Although more supplies may be consumed they can generate larger amounts of energy in a short time.	**8** **For MB3 to be awarded a number of advantages in relation to renewable/non-renewable energy sources will be covered.** **If candidates do not provide an analytical/evaluative response then only L1 can be awarded.**	**Level 3 [6-8 marks]** The candidate has a clear understanding of the advantages of using renewable and non-renewable energy sources. They produce a thorough discussion in relation to the question by explaining how renewable and non-renewable energy sources can meet the energy requirements of communities on isolated islands in the UK. The explanation of advantages is clear and well-developed and a clear attempt has been made to balance up the relative merits of both types of energy source. *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 has a reasonable understanding of the advantages of using renewable and/or non-renewable energy sources. They produce a reasonable discussion in relation to the question by explaining how renewable and/or non-renewable energy sources can meet the energy requirements of communities on isolated islands in the UK. The explanation of advantages is sufficient although one or two opportunities are missed in balancing up the relative merits of both types of energy source. *There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some*

			● While it would be expensive to set up, pipelines for gas and oil could be set up to provide a constant supply of energy to an island community which would prove more reliable than renewable sources, for example, solar energy. ● Non-renewable sources of energy like coal and oil can always be used as a backup if renewable energy sources fail. ● Any other valid suggestion.		*evidence.* **Level 1 [1-2 marks]** The candidate has a basic knowledge of renewable and/or non-renewable energy sources. Any reference to this issue is descriptive in nature and has little appreciation of how these energy sources can meet the energy requirements of communities on isolated islands in the UK. The response contains no analysis or evaluation. *The information has some relevance and is presented with limited structure or detail. The information is supported by limited evidence.* **0 marks** No answer or answer not worthy of credit.
5	**(b)**		Possible measures may include: ● Add more tax onto plastic products (1) so people would be more aware of recycling/ reusing these products (1). ● Companies pay a levy (1) therefore they would be more inclined to encourage clients to recycle or reuse their products (1). ● Make it easier to recycle (1) therefore instead of just throwing plastic away people would choose to recycle them (1). ● Incentivize recycling (1), make new recycling laws (1). ● Invest in research into using substitutes rather than plastic (1) so as to cut out using plastics	**4**	In each case: One mark for identifying a measure that the Government of a small island could put in place to tackle this problem. One mark for justifying why this measure would tackle the stated problem. Single words do not constitute an explanation.

			altogether (1). ● Any other valid suggestion.		

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