GCSE
ENGINEERING
8852/W

Unit 1 Written Paper

Mark scheme

June 2024

Version: 1.0 Final

2 4 6 G 8 8 5 2 / W / M S

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

No student should be disadvantaged on the basis of their gender identity and/or how they refer to the gender identity of others in their exam responses.

A consistent use of 'they/them' as a singular and pronouns beyond 'she/her' or 'he/him' will be credited in exam responses in line with existing mark scheme criteria.

Further copies of this mark scheme are available from aqa.org.uk

Level of response marking instructions

Level of response mark schemes are broken down into levels, each of which has a descriptor. The descriptor for the level shows the average performance for the level. There are marks in each level.

Before you apply the mark scheme to a student's answer read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1 Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer. With practice and familiarity you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

When assigning a level you should look at the overall quality of the answer and not look to pick holes in small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level and then use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 3 with a small amount of level 4 material it would be placed in level 3 but be awarded a mark near the top of the level because of the level 4 content.

Step 2 Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this. The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do not have to cover all of the points mentioned in the Indicative content to reach the highest level of the mark scheme.

An answer which contains nothing of relevance to the question must be awarded no marks.

Glossary for maths

If a student uses a method which is not explicitly covered by the mark scheme the same principles of marking should be applied. Credit should be given to any valid methods. Examiners should seek advice from their senior examiner if in any doubt.

[a, b]	Accept values between a and b inclusive.
For π	Accept values in the range [3.14, 3.142]
Their	Accept an answer from the candidate if it has been inaccurately calculated but is subsequently used in a further stage of the question.

Questions which do not ask students to show working

As a general principle, a correct response is awarded full marks.

Qu	Part	Marking Guidance	Total marks	AO
01	1	**D** Normalising	1 mark	AO1a

Qu	Part	Marking Guidance	Total marks	AO
01	2	**D** Transistor	1 mark	AO1a

Qu	Part	Marking Guidance	Total marks	AO
01	3	**C** Lift	1 mark	AO1a

Qu	Part	Marking Guidance	Total marks	AO
01	4	**D** Young's modulus = stress/strain	1 mark	AO1a

Qu	Part	Marking Guidance	Total marks	AO
01	5	**B** Nylon **C** Polycarbonate Note: If a candidate shades more than two lozenges, deduct **one** mark for each additional shaded lozenge to a maximum of **two** marks.	2 marks	AO1a

Qu	Part	Marking Guidance	Total marks	AO
01	6	Award **one** mark for each correct response as shown in bold. Brass consists of two or more different metals which means it is **an alloy**. The two main metals are **copper** and **zinc**. Brass is non-ferrous because it does not contain **iron**.	4 marks	AO1a

Qu	Part	Marking Guidance	Total marks	AO
02	**1**	Award up to **two** marks for explaining the sintering process including the use of powdered metal. Award **one** mark for an incomplete explanation of the sintering process. **Indicative content sintering** • Use of pressure and heat. • Use of heat and a mould. • Use of powdered metal. Indicative content laser sintering • Preheat powder • Laser fusing a metal powder • Build layers of fused powder Award zero marks if the response is clearly for another process. Accept all other valid responses.	2 marks	AO1b

Qu	Part	Marking Guidance	Total marks	AO
02	**2**	Award up to **two** marks for identifying the differences between Medium Density Fibre board (MDF) and Oriented Strand Board (OSB). Award only **one** mark if only one material mentioned. **Indicative content** • MDF is made from bonded wood particles (saw dust) whilst OSB is made from bonded wood strands. • MDF has no grain whilst the strands in OSB are layered in varying directions. • MDF can absorb water whilst OSB is more water resistant. Accept all other valid responses.	2 marks	AO1b

Qu	Part	Marking Guidance	Total marks	AO
02	**3**	Award up to **two** marks for identifying the differences between hard and soft soldering. Award only **one** mark if only one process mentioned. **Indicative content** • Hard solder produces a stronger join than soft solder. • In hard soldering the filler metal (solder) melts at a higher temperature then the filler metal used in soft soldering. • In hard soldering the flux is added separately whilst in soft soldering the flux is usually contained within the soldering wire (filler metal). • Hard solder wire is made from an alloy based on silver whilst soft solder wire is made from an alloy based on tin. • Hard soldering is often used in jewellery making whilst soft soldering is frequently used in electrical connections. Accept brazing as hard soldering. Accept all other valid responses.	2 marks	AO1b

Qu	Part	Marking Guidance	Total marks	AO
02	**4**	Award up to **two** marks for stating two differences between thermosetting and thermoplastic polymers. Award only **one** mark if only one difference is identified. **Indicative content** • Thermoplastics can be reheated (remoulded) whilst thermosets cannot. • Thermoplastics can be recycled whilst thermosets cannot. • Thermosets tend to be harder and more wear resistant then thermoplastics. • Thermosets are more heat resistant then thermoplastics. • Thermosets tend to be more brittle than thermoplastics. • Thermosets have a high number of cross-links between molecules meaning that they cannot be remoulded whilst thermoplastics have a much lower number of cross-links. Accept all other valid responses.	2 marks	AO1b

<table>
<tr><th>Qu</th><th>Part</th><th>Marking Guidance</th><th>Total marks</th><th>AO</th></tr>
<tr><td>03</td><td>1</td><td>
<table>
<tr><th>Level</th><th>Marks</th><th>Description</th></tr>
<tr><td>2</td><td>3–4</td><td>Good understanding shown of one or more benefits of using a monocoque structure with justification.</td></tr>
<tr><td>1</td><td>1–2</td><td>Basic understanding shown of one or more benefits of using a monocoque structure with limited reasoning.</td></tr>
<tr><td>0</td><td>0</td><td>No response or nothing worthy of credit.</td></tr>
</table>
Indicative content

• Use of external shell for strength.
• No internal structure or frame.
• 3-dimensional formed shape.
• Creates a stiffer car body.
• Creates a more lightweight car body.
• Cheaper to manufacture.
• Strength created by 3D shape of monocoque shaped body.
• Quicker manufacture as car body panels can be produced in a single process.
• Reduces the need for a separate welded chassis.

Accept all other valid responses.
</td><td>2 marks

2 marks</td><td>AO1a

AO3a</td></tr>
</table>

Qu	Part	Marking Guidance	Total marks	AO
03	**2**	Award **one** mark **each** for one non-destructive and one destructive test (2 marks). **Indicative content** **Non-destructive** • Visual. • X-ray. • Dye penetrant. **Destructive** • Tensile. • Compressive strength. • Hardness (Rockwell). • Fire testing • Pressure Accept all other valid responses.	2 marks	AO1a

Qu	Part	Marking Guidance	Total marks	AO
03	**3**	Award **one** mark for stating a benefit of non-destructive testing. Award up to **two** further marks for a detailed analysis of the benefit. **Indicative content** • Non-destructive does not damage the item whereas destructive testing does and therefore the item may not be able to be used again. • Non-destructive testing can be used to sample all items for quality whereas destructive testing will test a sample only. • Non-destructive testing can be used as part of the maintenance procedure whereas destructive testing will require the replacement of the tested component. • Non-destructive testing requires less equipment whereas destructive testing often need specialised test equipment. • Non-destructive testing can confirm a product is still safe to use whereas destructive testing will destroy the product but will confirm whether other similar products are still fit for use. Accept all other valid responses.	1 mark 2 marks	AO1a AO3a

Qu	Part	Marking Guidance	Total marks	AO
03	**4**	Award up to **two** marks for correctly explaining the effect of changing the amount of carbon in steel. Award **one** mark per point or **two** marks for a detailed response to a single point. **Indicative content** • Adding carbon makes the steel harder. • Adding carbon makes the steel more brittle. • High carbon steel is not as tough as low carbon steel. • High carbon steel is harder to machine/form. Accept all other valid responses.	2 marks	AO1b

Qu	Part	Marking Guidance	Total marks	AO
03	**5**	Award **one** mark for naming a use for high carbon steel. **Indicative content** • Machine tools. • Drill bits. • Hand tools (chisels, saw blades). Accept all other valid responses.	1 mark	AO1a

Qu	Part	Marking Guidance	Total marks	AO
03	**6**	Award **one** mark for stating correct maintenance check. **Indicative content** • Check that the guard is in place. • Bed of drill is secure. • Drill guard works and is undamaged. • Emergency stop button functions correctly. • Condition of wiring/wiring connections. • Condition/wear of belt. • Smooth running of motor/drive system. Accept all other valid responses.	1 mark	AO1a

Qu	Part	Marking Guidance	Total marks	AO
03	**7**	Award up to **two** marks for correctly explaining the importance of carrying out routine maintenance checks. Award **one** mark per point or **two** marks for a detailed response to a single point. **Indicative content** • To ensure safety to minimise the likelihood of accidents. • To ensure proper functioning to minimise the likelihood of malfunction. • To reduce wear to improve the efficiency of operation/extend life. Accept all other valid responses.	2 marks	AO1b

<table>
<tr><th>Qu</th><th>Part</th><th>Marking Guidance</th><th>Total marks</th><th>AO</th></tr>
<tr><td>04</td><td>1</td><td>Award up to four marks for analysing the benefits of using a pulley system to lift heavy loads.

<table>
<tr><th>Level</th><th>Marks</th><th>Description</th></tr>
<tr><td>2</td><td>3–4</td><td>Good understanding shown of more than one benefit of the pulley system with some reasoning.</td></tr>
<tr><td>1</td><td>1–2</td><td>Basic understanding shown of only one benefit with limited/no reasoning.</td></tr>
<tr><td>0</td><td>0</td><td>No response or nothing worthy of credit.</td></tr>
</table>

Indicative content

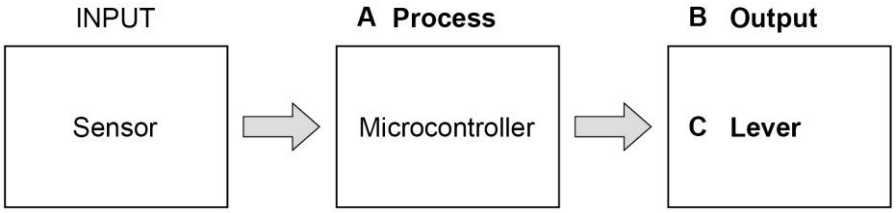
• Simple lifting system compared with other lifting systems.
• The components of pulleys are cheaper compared to other lifting systems.
• Reduces the amount of effort required.
• Creates a mechanical load.
• Person can stand away from under the load.
• Person can raise the load whilst standing on the floor.
• Can be operated by one person
• More straightforward to set up a pulley system than other lifting systems.

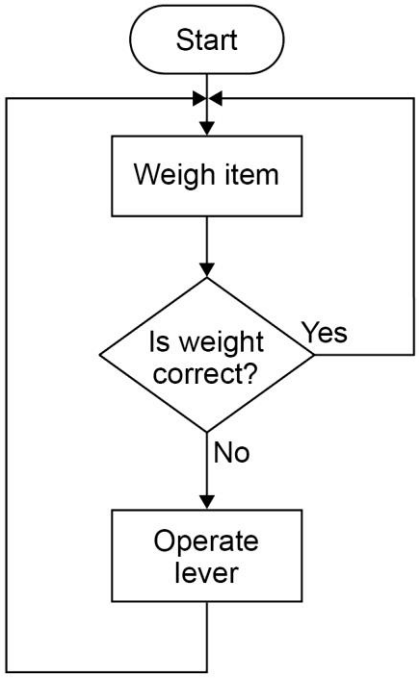
Accept all other valid responses.</td><td>4 marks</td><td>AO3a</td></tr>
</table>

Qu	Part	Marking Guidance	Total marks	AO
04	**2**	Award up to **three** marks. Allow error carried forward (ECF) if formula incorrectly rearranged or values incorrectly substituted. If correct answer (80 N) is given without workings, award full marks. **One** mark for re-arranging formula MA = load/effort Effort = load/MA (1 mark) **One** mark for correct substitution of MA and load MA = **their** 3 load = **their** 240 N Effort = load/MA = **their** 240/3 (1 mark)	3 marks	AO2

		Correct answer Effort = 80 N or **their** 80 N (1 mark)		

Qu	Part	Marking Guidance	Total marks	AO
04	**3**	Award up to **two** marks for correct stages of sand casting. **Indicative content** • Pattern is produced. • Build the sand up around the pattern. • Molten metal is poured in to form object. • Sand is removed and object cleaned up. • Remove pattern from mould. Accept all other valid responses.	2 marks	AO1b

Qu	Part	Marking Guidance	Total marks	AO
05	**1**	Award up to **three** marks. **One** mark for A) Process **One** mark for B) Output **One** mark for C) Lever 	3 marks	AO2

Qu	Part	Marking Guidance	Total marks	AO
05	**2**	Award up to **four** marks. **One** mark each for each of the below: • correct wording in both boxes • yes/no labelled correctly on flow lines • correct feedback from decision box • correct feedback from operate lever/remove item. **Illustrative Diagram**  Note: Feedback loop from operate lever may also go to the right and join feedback loop.	4 marks	AO2

<table>
<tr><th>Qu</th><th>Part</th><th>Marking Guidance</th><th>Total marks</th><th>AO</th></tr>
<tr><td>05</td><td>3</td><td>
Award up to six marks for evaluation of pneumatic and hydraulic systems.

Both advantages and disadvantages should be discussed.

Limit mark to three marks if only one system is discussed.

<table>
<tr><th>Level</th><th>Marks</th><th>Description</th></tr>
<tr><td>3</td><td>5–6</td><td>Good detailed understanding of the advantages and disadvantages of both pneumatic and hydraulic systems.</td></tr>
<tr><td>2</td><td>3–4</td><td>Some understanding shown of the advantages and disadvantages of both pneumatic and hydraulic systems or one system discussed in detail.</td></tr>
<tr><td>1</td><td>1–2</td><td>Limited knowledge shown or only one system discussed.</td></tr>
<tr><td>0</td><td>0</td><td>No response or nothing worthy of credit.</td></tr>
</table>

Indicative content

• Hydraulic systems based on using oil, whereas Pneumatic systems use air.
• Hydraulic systems are more powerful.
• Pneumatic systems are cleaner should a fault occur or they leak.
• Pneumatic systems operate quicker.
• Pneumatic systems are better suited for food production and other similar types of manufacturing where contamination could be a problem.
• Air compresses so higher pressures are needed.

Accept all other valid responses.
</td><td>6 marks</td><td>AO3b</td></tr>
</table>

<table>
<tr><th>Qu</th><th>Part</th><th>Marking Guidance</th><th>Total marks</th><th>AO</th></tr>
<tr><td>06</td><td>1</td><td>Award up to six marks for a correct answer.

<table>
<tr><th>Level</th><th>Marks</th><th>Description</th></tr>
<tr><td>3</td><td>5–6</td><td>Good clear notes and/or sketching showing how material is clamped and positioned correctly. Notes clarify the sketching adding additional information and safety issues.</td></tr>
<tr><td>2</td><td>3–4</td><td>Either sketching and/or notes used which largely show process but omits some information. Some details about safety and/or securing work given/shown but not fully explained.</td></tr>
<tr><td>1</td><td>1–2</td><td>Limited sketch or notes which do not fully address the question. Makes comment about safety or securing work but lacks detail on how this is achieved.</td></tr>
<tr><td>0</td><td>0</td><td>No response or nothing worthy of credit.</td></tr>
</table>

Indicative content

• The use of centre punch to aid accurate location of hole and prevent drill slippage.
• Reference to clamping aluminium sheet.
• Possible use of waste wood under metal to allow safer drilling.
• Pilot drill.
• Use of drill guard.
• Use of safety glasses.
• Reference to loose clothing or jewellery.
• Mention of swarf or waste material being sharp and/or hot.

Accept all other valid responses.</td><td>2 marks

4 marks</td><td>AO1a

AO1b</td></tr>
</table>

Qu	Part	Marking Guidance	Total marks	AO
06	**2**	Correct answer: Hacksaw/junior hacksaw.	1 mark	AO1a

Qu	Part	Marking Guidance	Total marks	AO
06	**3**	**Level** / **Marks** / **Description** 2 / 3 / Good understanding of how the tool should be used and how accuracy is achieved. 1 / 1–2 / Some understanding on how to use the tool but lack of detail on use or on ensuring accuracy. 0 / 0 / No response or nothing worthy of credit. **Indicative content** • Suitable to cut a marked straight line. • Ability to stop a cut at the corner. • Deep enough throat to accommodate 50 mm depth. • The blade is hard enough to be able to cut the material. • Thin blade allows for precision. Accept all other valid responses.	3 marks	AO3b

<table>
<tr><th>Qu</th><th>Part</th><th>Marking Guidance</th><th>Total marks</th><th>AO</th></tr>
<tr><td>06</td><td>4</td><td>
<table>
<tr><th>Level</th><th>Marks</th><th>Description</th></tr>
<tr><td>3</td><td>5</td><td>Detailed explanation clearly showing understanding of process and how to ensure accuracy.</td></tr>
<tr><td>2</td><td>3–4</td><td>Good explanation which lists tools and techniques used. Quality checks mentioned but not detailed.</td></tr>
<tr><td>1</td><td>1–2</td><td>Main steps and tools listed but process confused and difficult to follow. No or very little reference to quality checks.</td></tr>
<tr><td>0</td><td>0</td><td>No response or nothing worthy of credit.</td></tr>
</table>

Accept explanation in any form.

• Written description.
• Step by step plan.
• Table.
• Set of annotated sketches.

Indicative content

• Acceptable methods could include use of box former, clamp and block of wood. Use of vice and/or bending bars. Also accept any other suitable method.
• Tools and steps used will depend on method chosen.
• Reference to lining up (positioning) material accurately to ensure bend is in correct place.
• Reference to making closed corners (box forming/cut wooden block to size/use of vice).
• Reference to checking angle bent to.
• Reference to measuring after bending to ensure accuracy.

Accept all other valid responses.
</td><td>2 marks

3 marks</td><td>AO1a

AO2</td></tr>
</table>

Qu	Part	Marking Guidance	Total marks	AO
06	**5**	Calculate the **total** area of the material removed. Allow error carried forward (ECF) if values incorrectly substituted. If correct answer (10 000 mm^2) is given without workings, award full marks. Use of Area = length × width Substitution of information from **Figure 3** into formula Area of 1 corner = L × W = 50 × 50 = **their** 2500 mm^2 (1 mark) Understanding that there are 4 corners (1 mark) Therefore TOTAL area = 4 × corner area = 4 × 2500 = **their** 10 000 mm^2 Answer 10 000 mm^2 (1 mark)	3 marks	AO2

Qu	Part	Marking Guidance	Total marks	AO
06	**6**	Allow error carried forward (ECF) if values incorrectly substituted. If correct answer (6.67%) is given without workings, award full marks. Given % = **their** waste/original area × 100 Correct substitution into formula (1 mark) = their 2500/37500 × 100 = 1/15 × 100 = **their** 6.66666% (1 mark) If 6.666666 is given as their final answer, without workings, award just 2 marks. Award one mark for rounding their answer to two decimal places. (1 mark) Correct answer 6.67%	3 marks	AO2

Qu	Part	Marking Guidance	Total marks	AO
07	**1**	Correct answer: Fossil fuel – natural gas, coal, oil. Accept all other valid responses.	1 mark	AO1a

Qu	Part	Marking Guidance	Total marks	AO
07	**2**		4 marks 4 marks	AO3a AO3b

Level	Marks	Description
4	7–8	Demonstrates a comprehensive understanding of biomass and wind energy production methods. Evidence of comparison using the advantages and disadvantages of the methods used covering technologies used and impact on society.
3	5–6	Demonstrates a good understanding of biomass and wind energy production methods. Evidence of discussion of the advantages and disadvantages of the methods used covering technologies used and impact on society.
2	3–4	Demonstrates some knowledge of biomass and/or wind energy production methods. Evidence of knowledge of the advantages and/or disadvantages of the methods used covering technologies used and/or impact on society.
1	1–2	A limited level of detail given, demonstrating some knowledge of biomass and/or wind energy production methods and/or impact on society.
0	0	No response or nothing worthy of credit.

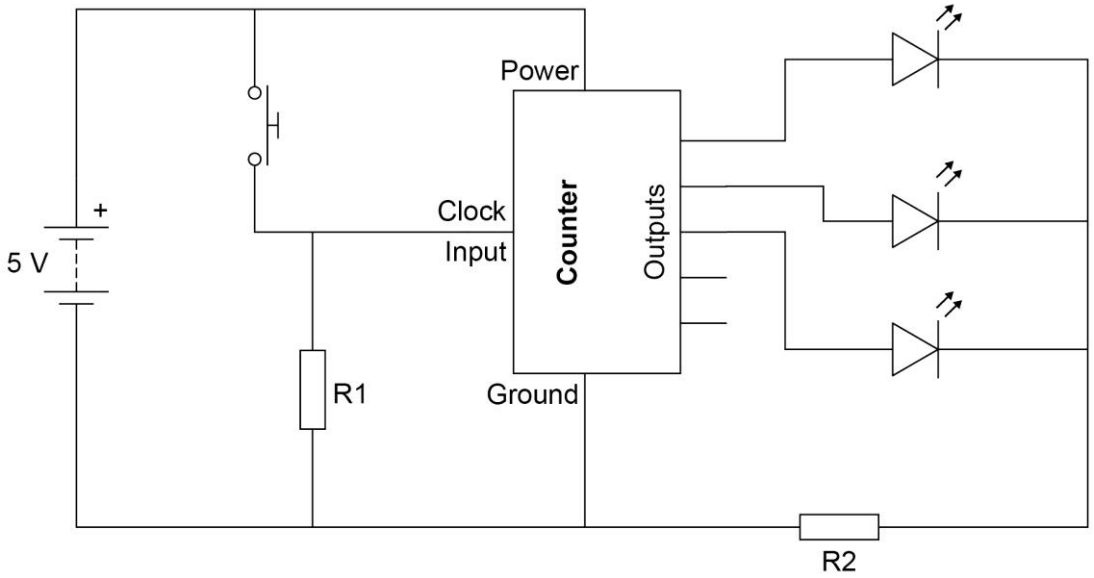
Indicative content

Biomass energy

- More consistent than wind power as burn rate can be easily controlled.
- It can be located where it is not an eyesore and near good transport connections.
- Uses a sustainable fuel (such as fast grown wood).
- Does produce greenhouse gases, contributing to global warming.
- Land required to produce the fuel crop which could otherwise be used for food production.
- Can result in mass removal of woods and forests.

		• Large areas of ground could be used to produce biomass fuel making it unavailable for other farming, development or leisure use and changing the local area impacting on the society. • Could change the local environment by planting different crops and farming techniques. • Could provide manual employment in growing and harvesting the 'crop'. **Wind energy** • Electricity is produced at very low cost. • Cost effective compared to fossil fuels. • Clean, constant energy source. • Can be sited offshore so less visual impact. • Small carbon footprint. • Not always constant as there could be no wind. • Too much wind and turbines switch off. • Only produce energy when there is wind, wind is variable. • Methods needed to store the energy which adds costs and reduces efficiency. • Expensive setup costs of building the turbines. • Spoil the look of the landscape. • Can be noisy. • Costly to maintain. • May impact the landscape by being erected in prominent locations. • Can provide well paid employment to maintain the turbines. • Produces noise so are not usually cited near areas of population. • Pollution is decreased so improving the health of the local population. Accept all other valid responses.		

Qu	Part	Marking Guidance	Total marks	AO
08	**1**	Award up to **three** marks if the reason is fully justified. Award up to **two** marks if the reason is justified. Award **one** mark if the reason is given without justification. (Maximum **one** mark if no justification given, even if multiple valid reasons are given.) **Indicative content** Simplifies electronic design because: • a standard 'off the shelf' solution could be used which means it may be cheaper • program can be changed repeatedly which means it can be adjusted to another system (such as many car parks of different size) • standard well-tested circuit design can be used which minimises design/manufacture/testing. • A microcontroller is able to perform lots of functions. Accept all other valid responses.	3 marks	AO3a

Qu	Part	Marking Guidance	Total marks	AO
08	**2**	Award up to **six** marks for a correct schematic.	6 marks	AO2
				
		Marks awarded (**one** mark each) for: • correctly connecting battery to power • correctly connecting battery to ground • correctly connecting switch to clock/input • correctly connecting switch to power • correctly connecting all LEDs to outputs (must be connected correct way round) • correctly using resistor R2 with LEDs to limit current flow.		

Qu	Part	Marking Guidance	Total marks	AO
08	**3**	Award **one** mark for correctly stating the function of the resistor. **Indicative content** • Limits current flow to LED. • Protects LED from excessive current. • Current limiting resistor. Accept all other valid responses.	1 mark	AO1a

Qu	Part	Marking Guidance	Total marks	AO
08	**4**	Award up to **three** marks. Allow error carried forward (ECF) if formula incorrectly rearranged or values incorrectly substituted. If correct answer (450 ohms) is given without workings, award full marks. **One** mark for correctly re-arranging formula V = IR R = V/I (1 mark) correct substitution of V and I (1 mark) V = **their** 9 V I = **their** 0.02 amp R = 9/0.02 R = **their** 450 ohms Answer R = 450 ohms (1 mark)	3 marks	AO2

Qu	Part	Marking Guidance	Total marks	AO
09	**1**	Award up to **three** marks. Allow error carried forward (ECF) if formula incorrectly rearranged or values incorrectly substituted. If correct answer (20.83 mm^2) is given without workings, award full marks. **One** mark for re-arranging formula Stress = force/csa Csa = force/stress (1 mark) **One** mark for correct substitution of force and stress Force = **their** 2500 N Stress = **their** 120 N/mm^2 Csa = force/stress = **their** 2500/120 (1 mark) Correct answer Csa = **their** 20.83 mm^2 (1 mark) **Also accept any answer in the range 20.8 – 21 mm^2**	3 marks	AO2

Qu	Part	Marking Guidance	Total marks	AO
09	**2**	Award up to **two** marks for correctly explaining what is meant by buckling. **Indicative content** Examples for **one** mark: • force causes the leg to curve • leg distorts • tube folds. Example for **two** marks: • force causes the leg to deform due to compression. Accept all other valid responses.	2 marks	AO1b

Qu	Part	Marking Guidance	Total marks	AO
09	**3**	Allow error carried forward (ECF) if values incorrectly substituted. If correct answer (2 238 384 mm^3) is given without workings, award full marks. **One** mark for conversion Diameter into radius Diameter = 100 mm Radius = 50 mm (1 mark) Length = 1.5m = 1500 mm (1 mark) **One** mark for correct substitution into formula Tube volume = $\pi \times R^2 \times$ Length = $\pi \times 50^2 \times 1500$ = **their** 11 780 972 mm^3 (1 mark) Award **one** mark for calculating the radius of the hole in the tube Tube radius = 50 mm Wall thickness = 5 mm Hole radius = Tube radius – Wall thickness = 50 – 5 = **their** 45 mm (1 mark) Award **one** mark for calculating volume of hole Hole volume = $\pi \times R^2 \times$ Length = $\pi \times 45^2 \times 1500$ = **their** 9 542 587 (.685) mm^3 (1 mark) Award **one** mark for correct calculation of volume of steel Volume of low carbon steel = tube volume – hole volume = 11 780 972 – 9 542 587 = 2 238 384 (.766) mm^3 Correct answer Volume = 2 238 384 – 2 238 385 mm^3 or **their** 2 238 384 – 2 238 385 mm^3 (1 mark) Also accept answer in terms of π (712 500 π mm^3) Accept alternative methods including conversion at a different stage.	6 marks	AO2

Qu	Part	Marking Guidance	Total marks	AO
09	**4**	Allow error carried forward (ECF) if values incorrectly substituted. If correct answer (852.50 kg or 852 500 g) is given without workings, award full marks. **One** mark for re-arranging formula Density = mass / volume Mass = density × volume (1 mark) **One** mark for correct substitution of density and volume **AND** calculating answer Density = 7750 kg/m^3 Volume = 0.11 m^3 Mass = 7750 × 0.11 Mass = **their** 852.50 Correct answer Mass = **their** 852.50 kg (1 mark) Correct unit = kg (1 mark) Also accept g (grams) if calculation is done in this format. Mass = **their** 852 500 g Correct answer Mass = 852.50 kg (852 500 g) or their 852.50 kg (852 500 g) Award only **two** marks if unit is not given.	3 marks	AO2

Qu	Part	Marking Guidance	Total marks	AO
09	5	**Indicative content** • To prevent rusting. • To prevent corrosion. • To prevent oxidation. • To put on a protective layer. Accept all other valid responses.	1 mark	AO1a

Qu	Part	Marking Guidance	Total marks	AO
09	6	Award up to **three** marks for any of the following. **Indicative content** • Steel is cleaned/pickled. • Hot zinc bath. • Application of zinc/put in molten zinc. • Allowed to cool. Accept all other valid responses.	3 marks	AO1b

Qu	Part	Marking Guidance	Total marks	AO
09	7	Award up to **two** marks for at least one difference stated with analysis. Award **one** mark for an example of a static load. Award **one** mark for an example of a dynamic load. **Indicative content** Example of difference: • dynamic load varies over time whereas static load doesn't change/constant. Example of static load: • weight bearing down (bridge, house, roof). Example of dynamic load: • moving objects (cars on bridge, people in houses, parts rotating in an engine). Accept all other valid responses.	2 marks 2 marks	AO3a AO1a