Cambridge Assessment International Education

Cambridge IGCSE™

DESIGN AND TECHNOLOGY **0445/43**

Paper 4 Systems and Control **May/June 2023**

MARK SCHEME

Maximum Mark: 50

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

[Turn over

PUBLISHED

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Question	Answer	Marks	Guidance
	Section A		
1(a)	Any recognisable natural frame structure [1] Any recognisable natural shell structure [1] Any recognisable natural mass structure [1]	**3**	Named structures must be natural. Accept 'Bird's nest' as a frame structure Accept 'Cave' and 'Tree trunk' as mass
1(b)	Any recognisable man-made mass structure [1]	**1**	If sketch is clearly recognisable without the name award mark

Question	Answer	Marks	Guidance
2(a)	**Bending** force [1]	**1**	
2(b)	**Reciprocating** motion [1] to **oscillating** motion [1].	**2**	

Question	Answer	Marks	Guidance
3(a)	Any two benefits such as: Accuracy [1] Repeatability / reduced waste material [1] Rapid change in item being produced / greater productivity [1] Fast transport of data to manufacturing facility / machine [1] Reduced workforce / 24/7 production [1]	**2**	Allow any valid benefit
3(b)	Any 2 drawbacks for one-off production such as: Expense of machinery [1] Setting up time increased [1] Skilled workforce needed for setting up machines [1] Skilled workforce needed for producing drawings [1]	**2**	Allow any valid drawback

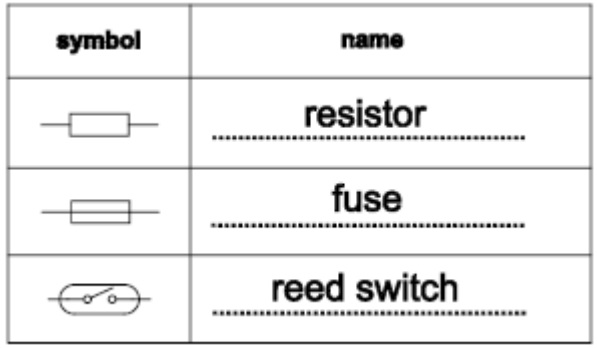
Question	Answer	Marks	Guidance
4	**A** – driven gear will rotate slower [1] and in the opposite direction [1] **B** – driven gear will rotate at the same speed [1] as driver and in the same direction [1]	**4**	Allow marks for understanding shown

Question	Answer	Marks	Guidance
5	Any 1 suitable reason: Lubrication will reduce wear in the gears [1] Reduce friction and heat build-up [1] Smoother running [1]	**1**	

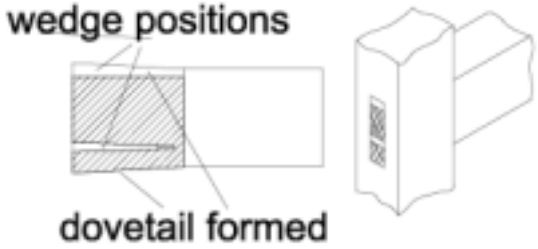
Question	Answer	Marks	Guidance
6	Any 1 suitable result: Teeth on gear will be damaged or could melt [1] Excessive noise from the gears [1] Mechanism sticks / breaks down [1]	**1**	Allow reference to increased wear on parts

Question	Answer	Marks	Guidance
7(a)	The microswitch is positioned so that the closing door will activate the switch [1] OR Being close to the hinges on door any slackness in door or catch will not cause enough movement to change the state of the switch [1]	**1**	Allow mark for understanding shown
7(b)	PTM = when the switch is pressed [1] the contacts will touch [1]	**2**	

Question	Answer	Marks	Guidance
8	Method 1 is **series** connection [1] Method 2 is **parallel** connection [1]	**2**	

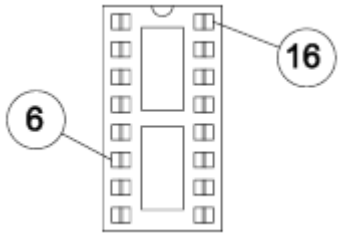
Question	Answer	Marks	Guidance
9	 [3 × 1]	**3**	

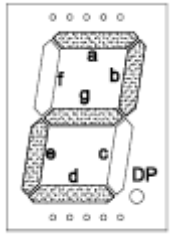
Question	Answer	Marks	Guidance
	Section B		
10(a)(i)	Reinforcing rods are used to increase the strength in tension	**1**	
10(a)(ii)	When the tension is released the rods contract [1] As the rods are held inside the concrete they will be pulling the concrete with them [1] When tension is applied to the concrete the compression caused by the rods contracting will cause the whole beam to resist rather than just the steel reinforcement [1]	**3**	Award marks for understanding shown Explanation with three points made [3] Allow 2 marks for a fully justified point
10(a)(iii)	Rearrangement of formula: original length = $\frac{\text{change in length}}{0.00025} = \frac{0.3}{0.00025}$ [1] Original length = 1200 mm (1.2 m) [1]	**2**	Award 2 marks for correct answer with no working
10(a)(iv)	The reasons for the marking should include: The marking is to show which way up the beam should be installed [1] The reinforcing rods are positioned below the centre [1] line, which is where the tension will occur when the beam is loaded [1]	**2**	Award marks for understanding shown
10(b)(i)	Any 1 benefit for each method: Method **A**: The steel plates will hold the two timbers in line [1] Steel is stronger [1] Bolts can be tightened if shrinkage occurs [1] Joint can be taken apart [1] Method **B**: Quick to join [1] Precise measurement not needed [1] Method **C**: More stable/Less space taken up [1] Timbers automatically held in line [1] Permanent joint [1] [3 x 1], 1 mark for each method	**3**	Allow any valid alternatives

Question	Answer	Marks	Guidance
10(b)(ii)	Any 1 drawback for each method: Method **A**: More expensive(cost of plates and bolts) [1] Increases the width of joint [1] Method **B**: Timber can split during nailing [1] Movement can occur during nailing [1] Method **C**: Mechanically weaker [1] Smaller surface area of joint [1] Permanent joint, i.e. cannot take apart Joints must be accurately cut [3 x 1], 1 mark for each method	**3**	Allow any valid alternatives
10(b)(iii)	Steel plates could be galvanised, dip coated or painted [1] Screws and nails, and bolts could be zinc plated or stainless steel [1]	**2**	Allow use of waterproof adhesive for method **C** Description to include two points or a single point described in depth
10(c)(i)	Sketch of gusset [1], rib [1] and brace [1] Notes to indicate position / fixing method / material [3 x 1]	**6**	
10(c)(ii)	**Shear** will act on the dowels	**1**	
10(c)(iii)	Functional method used [1] Clear sketch / notes [1] 	**2**	Allow PVA glue Allow the use of bolts

Question	Answer	Marks	Guidance
11(a)(i)		**3**	1 mark for each correct Max. 2 if one of spare circles used Max. 1 if both spare circles used
11(a)(ii)	Amplification of effort into a greater force applied to the load – increase in force measured as a number [1] A trade-off of input force against movement (larger movement and smaller force transferred into smaller movement but greater force [1] Load / effort [1]	**2**	2 × 1 marks for basic points given Award 2 marks for a single point fully explained
11(a)(iii)	MA can be increased by either: Extending the length of the lever [1] **OR** Moving the load closer to the fulcrum [1]	**1**	
11(a)(iv)	The lever is **second class**.	**1**	
11(b)(i)	Explanation could include: • On steep gradient the friction between train and rails will reduc • Conventional system can be used when possible to reduce fuel use • The rack and pinion is a positive form of drive that will ensure no slipping of wheels on rails	**3**	Allow other valid points Explanation with three points made [3] Award 2 marks for a single fully justified point
11(b)(ii)	Any valid use of rack and pinion [2 x 1] E.g. vehicle steering, pillar drill, bandsaw, microscope, tripod	**2**	
11(b)(iii)	Any 2 valid points such as: • The link rods do not require wheels to be close together • There will be no chance of belt slipping • The train is a very heavy load that would put undue stress onto a gear system • Reduced component count	**2**	Allow other valid points 2 × 1 marks for basic points given Award 2 marks for a single point fully explained

Question	Answer	Marks	Guidance
11(b)(iv)	Any 2 valid points such as: With no cut-outs the wheels would not be in balance, weight of link rods would cause imbalance [1] Drive on rails would not be smooth [1] Vibration would be caused leading to loss of efficiency [1]	**2**	Allow other valid points
11(c)(i)	The key will turn in an **anti-clockwise** direction	**1**	
11(c)(ii)	Ratchet [1] and pawl [1]	**2**	Allow 'click' for pawl
11(c)(iii)	The mechanism allows the spring to be tensioned by winding it [1] It does not allow the spring to immediately unwind [1]	**2**	
11(d)	Gear ratio **A:B = 2:1** [1] Gear ratio **B:D = 2:1** [1] Gear **C** is an idler which does not affect the ratio Total reduction = 2 × 2 = **4:1** [1] If A rotates at 336 rpm gear D speed = 336 / 4 = **84 rpm** [1]	**4**	If correct answer is given with no working award 4 marks

Question	Answer	Marks	Guidance
12(a)(i)	Benefits of terminal block • Easy to connect and disconnect • No special tools needed (other two methods require crimp tools) Benefit of plug and socket • Once connected can be easily disconnected in one movement • No danger of fitting wire incorrectly • Take up little space Benefit of spade connector • Connection can be made in the most convenient position on PCB • Positive fitting, will not come loose • Can be used for high current applications. [3 x 1]	**3**	Allow other valid alternatives
12(a)(ii)	Precautions could be against fumes / poisonous chemicals / dust irritation / UV light. E.g. • Fumes from soldering, etching, tinning. • Chemicals used in photoetch process, developing solutions ferric chloride, tinning slats, • UV light used in photoresist process. 1 mark for each relevant precaution against an identified hazard.	**2**	No marks for generic PPE equipment
12(a)(iii)	 [2 x 1]	**2**	

Question	Answer	Marks	Guidance
12(a)(iv)	Any 2 points of explanation such as: • Cost of IC holder will increase cost of product. • With a prototype the IC may need to be removed, with production model it will not need removing. • Quicker production process without the extra part • More compact on circuit board, (less height)	**2**	Allow other valid points Explanation with two points made [2] Allow 2 marks for a single fully justified point
12(b)(i)		**1**	
12(b)(ii)	If signal is positive / logic 1 / high then the connection at the other side of the LED segment will need to be 0V, this will require a common cathode. [1] If the signal is negative the anode of each segment will need to be +9 V [2] Connecting the internal legs of all segments results in a common connection. [1]	**3**	
12(b)(iii)	Use of forward voltage 9 - 1.65 = **7.35 V** [1] Use of ohms law I = V/R, **0.03I = 7.35 /R** [1] R = **245Ω** [1]	**3**	Allow ECF from not using the forward voltage drop
12(c)(i)	Any 2 benefits of using a simulation such as: Actual components are not needed [1] Testing the circuit [1] Connection is simple [1] Components / values can be edited quickly [1] Tested design can be immediately transferred into a PCB layout [1]	**2**	Allow other valid benefits
12(c)(ii)	Component **A** is an NTC thermistor [1] Component **B** is a potentiometer [1]	**2**	Allow ‘thermistor’ Allow ‘variable resistor’

Question	Answer	Marks	Guidance
12(c)(iii)	Response to include: • The operational amplifier is set up as a voltage comparator. • Voltage at the inverting and non-inverting inputs is compared • If non-inverting > inverting the output is high. • If inverting > non-inverting the output is low. • The output will confirm which of the inputs is greater.	**3**	Allow other valid responses 3 marks for three valid points Allow 2 marks for full description of a single point
12(c)(iv)	When the operational amplifier output is low **LED 1 is on** [1] When the operational amplifier output is high **LED 2 and the buzzer are both on** [1]	**2**	