



Cambridge IGCSE™

DESIGN & TECHNOLOGY

0445/42

Paper 4 Systems and Control

October/November 2022

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 October/November 2022 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

This document consists of **14** printed pages.

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.

PUBLISHED**Section A**

Question	Answer	Marks	Guidance
1(a)	Reasons for using glass will include: <ul style="list-style-type: none"> • Easy recycling • Hygienic, can be used multiple times • The raw materials used are not based on fossil fuels • Reusable • Less pollution caused. 	1	Allow any other valid reason.
1(b)	Functional reasons for plastics will include: <ul style="list-style-type: none"> • Lighter to transport / lightweight • Easily resealable • Plastic bottles do not break easily / more durable • Handles can easily be moulded into the shape • Suitable for bulk manufacture. 	1	Do not allow unjustified reasons related to cost. Allow any other valid reason.
1(c)	Both bottles are a shell structure , 1 mark.	1	

Question	Answer	Marks	Guidance
2	The skeleton leaf is a frame structure , 1 mark	1	

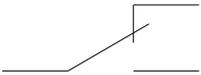
Question	Answer	Marks	Guidance
3	Reasons for steel being suitable for pylons include: <ul style="list-style-type: none"> • Relatively low cost • Plentiful supply • Can be recycled. • Strong in tension • Strong in compression • Resists torsion / bending • Steel is a durable material • Can be produced in several suitable sections, e.g. angle section. • Easily joined by mechanical means or heat processes. 3 × 1 marks	3	Allow other valid reasons. Do not allow reference to resisting corrosion.

Question	Answer	Marks	Guidance
4	<ul style="list-style-type: none"> • First order lever, 1 mark • Third order lever, 1 mark 	2	Drawing must be above the correct heading unless a separate heading has been used.

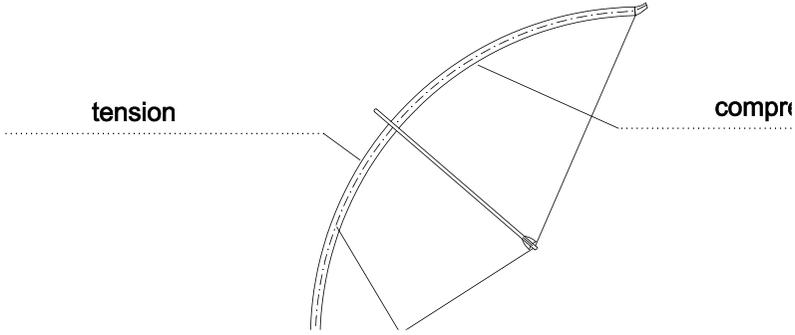
Question	Answer	Marks	Guidance
5	Reasons for using spur gears include: <ul style="list-style-type: none"> • To connect two shafts together / transmitting rotary motion • The gears will not slip • Gear ratio is easily changed • Transfer / increase torque effectively • Can be easily reversed by using an idler gear • Low cost materials can be used, e.g. nylon. 3 × 1 marks	3	Allow other valid reasons.

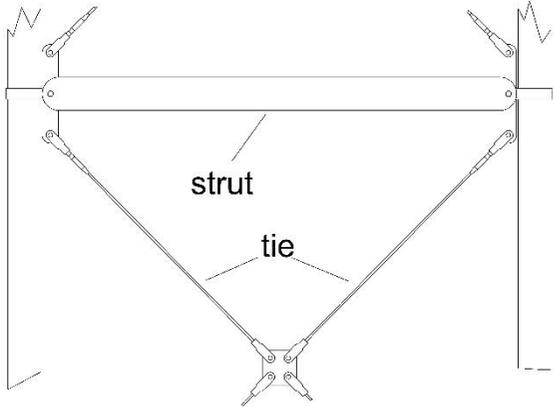
Question	Answer	Marks	Guidance
6(a)	Benefits include: <ul style="list-style-type: none"> • Visible reference to level of oil remaining • Gravity fed, does not rely on a pump • More efficient than hand lubrication • Low maintenance system • Regular feed of oil to the mechanism. • No spilled oil on surrounding parts 2 × 1 marks	2	To gain marks the response must refer to the method of lubrication.
6(b)	Explanation should include the following points: <ul style="list-style-type: none"> • Reduced friction / efficiency is increased • Lubrication will prevent wear / corrosion in the mechanism components • Mechanism is kept cool • Reduced noise from the mechanism • Dirt or debris is carried away from the moving parts • Build-up of heat due to friction is reduced. 	2	One mark for each point mentioned. Allow two marks for a single point fully explained. Allow reference to smooth running.

Question	Answer	Marks	Guidance										
7	<table border="1"> <thead> <tr> <th>Electrical measurement</th> <th>Alternative format</th> </tr> </thead> <tbody> <tr> <td>0.097 V</td> <td>97 mV</td> </tr> <tr> <td>1500 pF</td> <td>1.5 nF</td> </tr> <tr> <td>0.001 A</td> <td>1 mA</td> </tr> <tr> <td>36 000 000 Ω</td> <td>36 MΩ</td> </tr> </tbody> </table> 4 × 1 marks.	Electrical measurement	Alternative format	0.097 V	97 mV	1500 pF	1.5 nF	0.001 A	1 mA	36 000 000 Ω	36 MΩ	4	
Electrical measurement	Alternative format												
0.097 V	97 mV												
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Question	Answer	Marks	Guidance
8(a)		1	Accept any other recognisable version of a SPDT switch symbol.
8(b)	<ul style="list-style-type: none"> • The microswitch is operated by pressure on the lever actuating switch • The pressure needed is very light • The Common is connected to Normally Closed when not pressed • When pressed Common is connected to Normally Open. <p>Description to include any 2 of the above points.</p>	2	No mark for general statements e.g. allows electricity to flow.

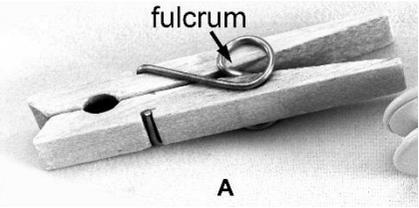
Question	Answer	Marks	Guidance
9	The contacts on a PTM switch will close when the switch is operated The contacts on a PTB switch will open when the switch is operated.	2	

Question	Answer	Marks	Guidance
10(a)(i)	 <p>1 mark for each correct label.</p>	3	
10(a)(ii)	<p>Benefits of composites will include:</p> <ul style="list-style-type: none"> • Material is more stable • Natural defects in the materials can be avoided • Greater range of designs are possible • Increased durability of the composite 	2	Allow any other valid benefits, e.g. reference to 'aesthetic qualities', 'increased strength'.
10(a)(iii)	<p>Adhesive properties will include:</p> <ul style="list-style-type: none"> • Flexibility will be needed • Moisture resistance / waterproof • Unaffected by change in temperature • Resistant to applied forces e.g. shear / tension • 'Gap filling' qualities. <p>1 mark</p>	1	Allow other valid properties.

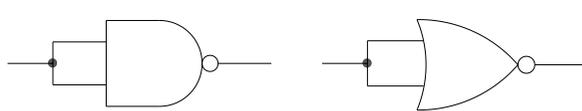
Question	Answer	Marks	Guidance
10(a)(iv)	<p>Examples of composites include:</p> <p>Resin based, GRP – polyester resin and glass fibres Carbon fibre – graphite fibres bonded with resin Concrete – Portland cement and aggregate Reinforced concrete – Concrete with the addition of reinforcing bars that are strong in tension</p> <p>1 mark for names 2 × 1 2 × 2 marks for constituent materials.</p>	6	<p>Allow other composites such as Kevlar and ceramic composites. Allow Fibreglass for GRP</p>
10(b)(i)	 <p>The diagram shows a truss structure with a horizontal top chord, a vertical right-hand chord, and a diagonal member connecting the top-left and bottom-right corners. A diagonal member also connects the top-right and bottom-left corners. The bottom-left and bottom-right corners are connected by a horizontal member. The top-left and top-right corners are connected by a horizontal member. The labels 'strut' and 'tie' are placed near the diagonal members.</p> <p>1 mark for each correct label, 2 × 1 marks</p>	2	
10(b)(ii)	<p>Change in length provided, 1 mark e.g. left and right hand threads on a connector. Adjustable method, capable of being tightened and loosened 1 mark Clear sketches / notes, 1 mark</p>	3	
10(c)(i)	<p>The following points could be included:</p> <ul style="list-style-type: none"> • Increased depth of the web will resist bending on beam A. • The top and bottom flanges are supporting the central web • In beam B there is less depth to resist the bending caused by a load on the beam. 	2	<p>One mark for each point mentioned. Allow two marks for a single point fully explained.</p>

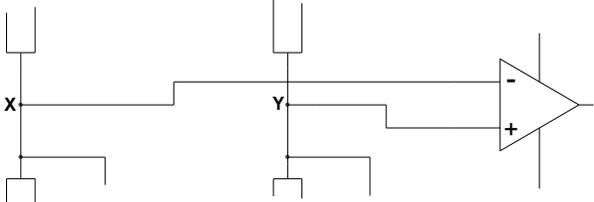
Question	Answer	Marks	Guidance
10(c)(ii)	Taking moments about R_1 $(1.8 \times 1200) + (3.8 \times 1200) = R_2 \times 5.2$, 1 mark $2160 + 4560 = R_2 \times 5.2$, 1 mark $6720 / 5.2 = R_2 = \mathbf{1292.3\ N}$, 1 mark The reaction at R_1 is $2400 - 1292.3 = \mathbf{1107.7\ N}$, 1 mark	4	Award full marks for correct answer with no working.
10(c)(iii)	<ul style="list-style-type: none"> The factor of safety of a structural design will be calculated from the failure loading divided by a number, the factor of safety. This means that even under exceptional conditions the structure should not fail. A higher factor of safety number will result in the design load that the structure can take being lower. Accurate calculation and use of the factor of safety means that there is reduced chance of the structure collapsing. 	2	One mark for each point mentioned. Allow two marks for a single point fully explained.

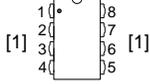
Question	Answer	Marks	Guidance
11(a)(i)	Rotary to Linear , 1 mark.	1	
11(a)(ii)	Benefits will include: <ul style="list-style-type: none"> Reduced stock Interchangeability of components Helps global manufacturing Easier to get spare / replacement parts. 2 × 1 marks	2	Allow other valid benefits.
11(a)(iii)	The thread diameter 12.00 mm (M12), 1 mark The thread pitch 1.75mm, 1 mark.	2	

Question	Answer	Marks	Guidance
11(b)(i)	 <p>Correctly marked fulcrum position, 1 mark.</p>	1	
11(b)(ii)	In peg A the spring is under torsion when the peg is opened, 1 mark In peg B the spring is compressed when the peg is opened, 1 mark.	2	For peg A allow tension.
11(b)(iii)	Points will include: <ul style="list-style-type: none"> The wooden parts of the peg have come from a sustainable resource The two types of plastic bonded together in peg B prevents recycling The plastic comes from a non-renewable resource. 	2	Allow other valid points. 1 mark for each valid point mentioned in explanation. Allow 2 marks for single point fully explained.
11(c)(i)	The purpose of the mechanism is: <ul style="list-style-type: none"> To move the chain from one sprocket to another To keep the chain in tension. <p>2 × 1 marks</p>	2	Allow 1 mark for the benefits of using a lower gear.
11(c)(ii)	<ul style="list-style-type: none"> Individual bearings make maintenance more difficult A sealed bearing will not allow water or grit to enter To prevent individual bearings falling out during maintenance The jockey wheel will last longer. <p>2 × 1 marks</p>	2	
11(c)(iii)	Velocity ratio = driver gear / driven gear, 1 mark $49 / 28 = 1.75$, 1 mark	2	Allow 7:4
11(c)(iv)	Rear wheel speed = chainwheel speed × VR, 1 mark $78 \times 1.75 = 136.5$ rpm, 1 mark	2	Award both marks for correct answer with no working. Allow ecf.

Question	Answer	Marks	Guidance
11(c)(v)	The efficiency of the drive system will be reduced by: <ul style="list-style-type: none"> • Friction in all the moving parts • Sound created by the drive system, • Heat generated by the moving parts • Lack of lubrication of moving part 	3	One mark for each point mentioned. Allow two marks for a single point fully explained.
11(d)(i)	Reasons for using grease include: <ul style="list-style-type: none"> • Oil could drain away from the lubrication point • Rain / snow could quickly wash oil away • Excessive heat in the summer would dry the oil up • Reduced chance of grit gaining access to the pivots. <p>2 × 1 marks.</p>	2	Reasons given must compare the use of grease to the use of oil.
11(d)(ii)	If rod A is moved to the left: <ul style="list-style-type: none"> • The LH bell crank will rotate anti-clockwise about the fixed pivot. • The central link is then pushed to the right. • The RH bell crank rotates clockwise about the fixed pivot. • Rod B moves to the right, in the opposite direction to rod A 	2	One mark each for any two points mentioned.

Question	Answer	Marks	Guidance
12(a)(i)	AND, NAND, OR, NOR , 1 mark for each	4	
12(a)(ii)	A NOT gate or inverter will change a logic signal level to the opposite level, logic 1 becomes logic 0 and logic 0 becomes logic 1	1	Award mark for understanding shown.
12(a)(iii)	 <p>Correct gate used, 1 mark Inputs connected, 1 mark</p>	2	Accept either NAND or NOR gate as a NOT gate.

Question	Answer	Marks	Guidance
12(a)(iv)	<p>R1 is a current limiting resistor to protect the transistor. R2 is a pull up resistor to provide a logic 1 signal when 0 is input from the logic circuit. X is a NOT gate which inverts the input signal allowing the output signal to be at the same logic level as the input. Y is an NPN transistor to amplify the current from the input signal.</p>	4	Award marks for understanding shown.
12(b)(i)	 <p>1 mark for each correct connection.</p>	2	
12(b)(ii)	<p>The resistance of LDR1 will change, 1 mark The resistance increases 1 mark as light level decreases, 1 mark The voltage at X will decrease, 1 mark. 3 x 1 marks</p>	3	
12(b)(iii)	<p>$6.5 = 9 \times VR2 / (10 \text{ k}\Omega + VR2)$ $6.5 / 9 = VR2 / (10 \text{ k}\Omega + VR2)$, 1 mark $0.722 \times (10 \text{ k}\Omega + VR2) = VR2$, 1 mark $7.22 + (0.722 \times VR2) = VR2$, 1 mark $7.22 = 0.278 VR2$ $VR2 = 7.22 / 0.278 = \mathbf{25.97 \text{ k}\Omega}$, 1 mark</p> <p>or</p> <p>$6.5 = 9 \times VR2 / 10 + VR2$ 1 mark $6.5 \times (10 + VR2) = 9 \times VR2$ 1 mark $65 + 6.5 VR2 = 9 VR2$ 1 mark $65 = 9 VR2 - 6.5 VR2 = 2.5 VR2$ $VR2 = 65 / 2.5 = \mathbf{26 \text{ k}\Omega}$ 1 mark</p>	4	<p>Award 4 marks for correct answer with no working.</p> <p>Allow use of alternative formula or ohms law $V_{\text{total}} = 9 \text{ V}$, $V1 = 2.5 \text{ V}$, $V2 = 6.5 \text{ V}$</p> $\frac{V1}{V2} = x \quad \frac{R1}{x} = R2$ <p>$2.5 / 6.5 = 0.3846$ $10 \text{ k}\Omega / 0.3846 = R2 = 26 \text{ k}\Omega$</p>

Question	Answer	Marks	Guidance
12(c)(i)	 <p>Pins 1–4 correct, 1 mark. Pins 5–8 correct, 1 mark.</p>	2	
12(c)(ii)	The pins are bent over to secure the IC / IC holder while it is being soldered.	1	
12(c)(iii)	<p>Health and Safety procedures while soldering will include:</p> <ul style="list-style-type: none"> • Safety glasses • Fume extraction • Checking the soldering iron cable for damage • Fixing circuit board so that it does not move about • Washing hands after handling lead based solder. <p>2 × 1 marks.</p>	2	Allow any other valid procedures that should be carried out.