

Cambridge IGCSE™

DESIGN AND TECHNOLOGY**0445/42**

Paper 4 Systems and Control

May/June 2024

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.

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This document consists of **12** printed pages.

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 descriptions 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)	Frame structures	1	
1(b)	Any two reasons. Could include: <ul style="list-style-type: none"> • No support at ends of horizontals • Will only resist compressive force • Will not resist any force that is not vertical • Only two points of connection • No triangulation, struts or ties [2 × 1]	2	Accept any other valid points
1(c)	The force will be spread equally between the two triangles [1] The triangles will spread the force evenly across the three contact areas in lower horizontal [1]	2	Accept any other valid points e.g. bending in the top piece, compression on the sides of triangles.

Question	Answer	Marks	Guidance
2	Static load is the sum of all loads acting on the structure that do not move, change in magnitude or change over time [1]	1	Allow mark for understanding shown.

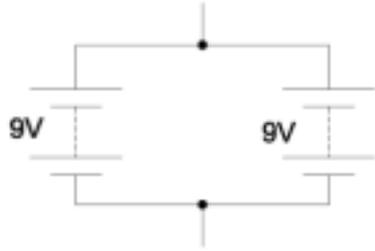
Question	Answer	Marks	Guidance
3		4	1 line correct [1] 2 lines correct [2] 3 lines correct [3] 4 or 5 lines correct [4]

Question	Answer	Marks	Guidance
4	1 mark for each correct example First order = L F E third order = F E L	2	Examples must be above correct label.

Question	Answer	Marks	Guidance
5	A – Same speed for driver and driven or opposite direction [1] B – Driven gear will be slower or rotating in opposite direction with increased torque [1] C – Same speed for both gears or they will rotate in same direction [1]	3	One part of statement must be correct for the mark for each arrangement.

Question	Answer	Marks	Guidance
6	Input motion is rotary [1] Output motion is linear [1]	2	

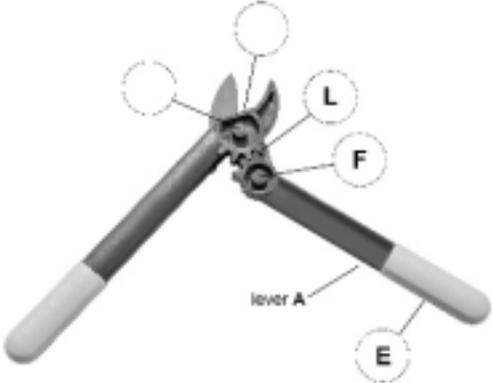
Question	Answer	Marks	Guidance
7	1 – fuse 2 – heater 3 – polarised capacitor, allow electrolytic capacitor [3 × 1]	3	Do not allow 'Capacitor'.

Question	Answer	Marks	Guidance
8(a)	 <p>Parallel connection [1]</p>	1	Connections to the paralleled batteries can be at any point but one must be to positive and one to negative.
8(b)	The output voltage is +9 V accept 9 V	1	

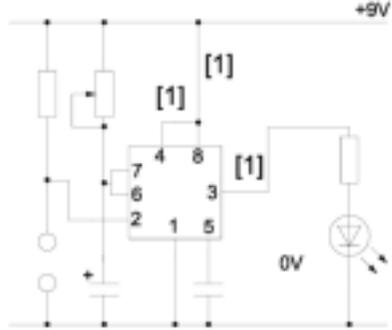
Question	Answer	Marks	Guidance								
9	<table border="1" data-bbox="353 1077 913 1311"> <thead> <tr> <th>Value in multiple units</th> <th>Value in ohms (Ω)</th> </tr> </thead> <tbody> <tr> <td>5 kΩ</td> <td>5000 Ω</td> </tr> <tr> <td>0.27 kΩ</td> <td>270 Ω</td> </tr> <tr> <td>3 MΩ</td> <td>3,000,000 Ω</td> </tr> </tbody> </table> <p>[3 × 1]</p>	Value in multiple units	Value in ohms (Ω)	5 k Ω	5000 Ω	0.27 k Ω	270 Ω	3 M Ω	3,000,000 Ω	3	
Value in multiple units	Value in ohms (Ω)										
5 k Ω	5000 Ω										
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Question	Answer	Marks	Guidance
Section B			
10(a)(i)	<ul style="list-style-type: none"> • Design is a suspension bridge [1] • Two or more softwood strips used to form bridge deck [1] • Strips used vertically to form towers at each end [1] • Suspension wires correctly placed [1] • Joining methods noted [1] • Only available materials used [1] <p>[5 × 1]</p>	5	
10(a)(ii)	The force is tension .	1	
10(a)(iii)	Moving loads on a bridge could be: <ul style="list-style-type: none"> • Traffic • People • Wind <p>[2 × 1]</p>	2	Accept any other valid responses
10(b)(i)	Explanation should include: <ul style="list-style-type: none"> • Moisture content of timber • Visible natural defects, splits, shakes, knots, warping • Insect / termite damage • Rot 	2	1 mark for each valid point included Allow 2 marks for a point that is fully explained.
10(b)(ii)	A sustainable resource is one that can renew itself, be harvested and regrown	1	Award mark for understanding shown

Question	Answer	Marks	Guidance
10(b)(iii)	<p>Joint A (Mortise and tenon) is fully supported and provides a good mechanical joint which does not rely on adhesive. Pegs or wedges can hold it in place, no additional clamps required, is more durable</p> <p>Joint B (nailed joint) no lateral strength, reliant on strength of nails and adhesive, or clamps to hold in place while being assembled. Nails are going into end grain so reduced holding power. Can cause splitting in the timber. Nails can corrode</p>	3	Accept any other valid response e.g. M&T has a larger cross sectional area, M&T is more durable 1 mark for each valid point included, allow two marks for a point that is fully explained.
10(b)(iv)	<p>Reasons for using braces to include:</p> <ul style="list-style-type: none"> • Provide additional support • Prevent distortion of a frame • Allow reduced sections of timber to be used on framing • Reduce the forces acting directly on a joint • Uses triangulation. <p>[2 × 1]</p>	2	Allow marks for understanding shown.
10(c)(i)	Example of strut shown [1] supporting existing structure [1]	2	
10(c)(ii)	Example of tie shown [1] supporting existing structure [1]	2	
10(c)(iii)	A strut resists compression [1] A tie resists tension [1]	2	
10(d)	Use of correct formula: force / cross sectional area [1] Calculation of cross sectional area $\pi \times 4.5^2 = 63.62 \text{ mm}^2$ [1] $1750 / 63.62 = \mathbf{27.51 \text{ N / mm}^2}$ [1]	3	

Question	Answer	Marks	Guidance
11(a)(i)	 <p>1 mark for load identified, 1 mark for fulcrum identified, 1 mark for effort identified</p>	3	
11(a)(ii)	<p>The use of gear mechanism will reduce effort / small to larger gear [1] The lever effect of the long handle is multiplied [1] by the gear ratio [1] to give overall reduced effort</p>	2	1 mark for each valid point. Award 2 marks for a single point fully explained.
11(a)(iii)	Lost efficiency will be due to friction in the mechanism.	1	
11(b)(i)	<p>Bevel gears are used where the input and output are in different orientations normally 90° to each other [1] VR needs altering [1] e.g. Drill chuck key [1]</p> <p>[2 × 1]</p>	2	Accept any other valid response
11(b)(ii)	<p>A worm gear will give a large reduction in speed [1] cannot rotate in reverse [1] so provides a self-locking facility [1] e.g. winch, elevator motor drive [1] small space used [1]</p> <p>[2 × 1, any two points made]</p>	2	Accept any other valid response, e.g. changing axes of rotation by 90°

Question	Answer	Marks	Guidance
11(b)(iii)	Rack and pinion gears are used to convert rotary motion into linear or reciprocating motion [1], e.g. car steering, drill table rise and fall [1]	2	Accept any other valid response, e.g. lifting mechanisms, positioning mechanisms.
11(c)(i)	A toothed belt will not slip, it is possible to keep pulleys in the same relative positions.	1	
11(c)(ii)	The vee belt will allow slipping [1] if the blades get jammed [1]	2	
11(c)(iii)	Tension of the vee belt may need adjusting: <ul style="list-style-type: none"> To allow a new belt to be fitted. To prevent slipping on the pulleys To compensate for wear in the belt as it stretches. To prevent wear in the belt. [2 × 1]	2	Accept any other valid reasons.
11(c)(iv)	Reduction from motor to intermediate pulley is 6:1 [1] Reduction from intermediate pulley to final drive is 2:1 [1] Total reduction is 12:1 [1] Final speed = 83.3 rpm [1]	4	Award 4 marks for correct answer with no working.
11(d)(i)	The pitch of a thread is: <ul style="list-style-type: none"> The distance that it moves in for each rotation or It is measured from the top of one thread to the top of the next 	1	Allow mark for understanding shown.
11(d)(ii)	The following methods can be used to specify a screw thread: length, diameter, material, finish, head shape [2 × 1]	2	Allow different thread profiles, e.g. acme, square, LH thread.
12(a)(i)	Monostable [1]	1	

Question	Answer	Marks	Guidance
12(a)(ii)	 <p>[3 × 1]</p>	3	Reset connection may go straight to +9V rail.
12(a)(iii)	$0.75 = 1.1 \times R \times 100 / 1\,000\,000$ [1] $R = 1\,000\,000 / 1.1 \times 100$ [1] $R = \mathbf{0.00681\ M\Omega}$ or $\mathbf{6.8\ k\Omega}$ [1]	3	Award 3 marks for correct answer with no working.
12(a)(iv)	Tolerance in the capacitor leading to a value above or below the stated value	1	Award mark for understanding shown.
12(a)(v)	Benefits of a programmable IC include: <ul style="list-style-type: none"> • Easily changed delay • Extremely accurate delay • Fewer components needed <p>[2 × 1]</p>	2	Accept any other valid benefits. Allow cost related benefits.
12(b)(i)	The NTC thermistor is a temperature sensor [1] Resistance decreases with an increase in temperature or vice versa [1]	2	
12(b)(ii)	If the voltage at the non-inverting input is greater than at the inverting input the output will be at or near to supply voltage [1] If the voltage at the inverting input is greater than at the non-inverting input the output is at or close to 0 V [1]	2	

Question	Answer	Marks	Guidance
12(b)(iii)	Use of formula $V_{out} = R_2 / R_1 + R_2 \times V_{in}$ [1] $V_{out} = (15\,000 / 15\,000 + 10\,000) \times 9\,V$ [1] $V_{out} = 5.4\,V$ [1]	3	
12(b)(iv)	The potentiometer is used to accurately set the threshold or switching point of the circuit. [1] With a fixed resistor there can be no variation in the voltage. [1]	2	Allow marks for understanding shown.
12(b)(v)	The output from the OP AMP cannot provide enough current to switch the relay / the transistor will amplify the current	1	Do not accept lack of voltage.
12(b)(vi)	+12 V to relay common. [1] Relay NO terminal to motor [1] Other motor terminal to 0 V [1]	3	
12(c)	Safety measures must relate to practical circuit construction and could include: Safety measures for soldering Safety measures for handling PCB chemicals Safety measures for drilling [2 × 1]	2	