



# Cambridge IGCSE™

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**DESIGN & TECHNOLOGY**

**0445/42**

Paper 4 Systems and Control

**May/June 2021**

MARK SCHEME

Maximum Mark: 50

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**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 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

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This document consists of **11** 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.

Question	Answer	Marks	Guidance
1	<b>Solar</b> , 1 mark. <b>Hydroelectric</b> , 1 mark.	<b>2</b>	

Question	Answer	Marks	Guidance
2(a)	Computer controlled machines will include: <ul style="list-style-type: none"> <li>• Lathe</li> <li>• Milling machine</li> <li>• Router</li> <li>• Vinyl cutter or 3D printer</li> <li>• Engraver</li> <li>• Laser cutter</li> </ul> <p style="text-align: right;">1 mark for valid CNC machine.</p>	<b>1</b>	Allow mark for any other valid alternative.
2(b)	Benefits will include: <ul style="list-style-type: none"> <li>• Accuracy</li> <li>• Storage of program for individual items</li> <li>• Repeatability</li> <li>• Can be operated directly from CAD design.</li> <li>• Reduced workforce</li> </ul> <p style="text-align: right;"><math>2 \times 1</math> marks.</p>	<b>2</b>	Allow other valid benefits

Question	Answer	Marks	Guidance
3	Example of an open loop system for system <b>A</b> , [1] Example of a closed loop system for system <b>B</b> , [1] Understanding of the part played by feedback in a closed loop system, [1].	<b>3</b>	

Question	Answer	Marks	Guidance
4(a)	<b>Oscillating</b> (door handle) to <b>reciprocating</b> (latch), 1 mark for each correctly identified motion.	<b>2</b>	

Question	Answer	Marks	Guidance
4(b)	Input motion identified 1 mark. Output motion identified, 1 mark.	2	No marks for name of mechanism Conversion must match mechanism.

Question	Answer	Marks	Guidance
5(a)	<ul style="list-style-type: none"> <li>• Output will rotate in the same direction as input, 1 mark</li> <li>• To connect two fixed shafts which are located apart from each other.</li> <li>• Idler gear could be a sacrificial gear to protect the input/output gears.</li> <li>• So that the drive does not slip</li> <li>• Speed of both shafts is the same.</li> </ul> <p style="text-align: right;">2 × 1 marks.</p>	2	Allow any other valid response.
5(b)	<p>Speed of rotation of the output gear will be reduced, 1 mark Direction of rotation changed, 1 mark Torque of output gear will increase, 1 mark.</p> <p style="text-align: right;">2 × 1 marks</p>	2	

Question	Answer	Marks	Guidance
6	Ear protection / ear defenders should be worn, 1 mark.	1	

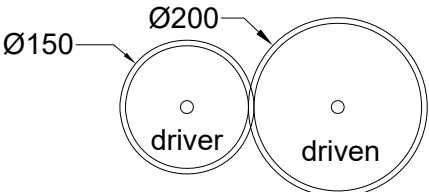
Question	Answer	Marks	Guidance
7	<p>Lubrication is used to:</p> <ul style="list-style-type: none"> <li>• Reduce friction</li> <li>• Reduce wear in moving parts</li> <li>• Provide a cooling effect on moving parts</li> <li>• Reduces sound</li> <li>• To carry away any small particles of material that could damage bearing surfaces in the mechanism.</li> </ul>	1	1 mark for any suitable reason.

Question	Answer	Marks	Guidance
8	Capacitance is measured in <b>Farads</b> Resistance is measured in <b>Ohms</b> Current is measured in <b>Amperes</b> or <b>Amps</b>  3 × 1 marks.	3	Accept any multiple sub-multiple units.

Question	Answer	Marks	Guidance							
9	<p style="text-align: center;">kV   mV   MV   <math>\mu</math>V   V</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>smallest</td> <td><math>\mu</math>V</td> <td>mV</td> <td>V</td> <td>kV</td> <td>MV</td> <td>largest</td> </tr> </table>	smallest	$\mu$ V	mV	V	kV	MV	largest	4	1 unit correct, 1 mark 2 units correct 2 marks 3 units correct 3 marks 4 or 5 units correct 4 marks No mark for any box containing more than one unit.
smallest	$\mu$ V	mV	V	kV	MV	largest				

Question	Answer	Marks	Guidance
10(a)(i)	<b>Frame</b> structure, 1 mark.	1	
10(a)(ii)	The cladding is used to: <ul style="list-style-type: none"> <li>• Fix to the frame to make the building watertight/weathertight</li> <li>• Provide insulation</li> <li>• Provide a weatherproof finish</li> <li>• Allows different colours to be used</li> </ul>	2	Allow other valid points 2 marks for two points mentioned 2 marks for one point described in depth.
10(a)(iii)	<b>Stationary loads:</b> 2 × 1 marks All materials used in construction Additional partitions inside the building Equipment / furniture of a permanent nature stored in the building <b>Moving loads:</b> 2 × 1 marks Wind/rain Snow Earthquake People inside the building Vehicles entering the storage building.	4	Allow any other valid responses

Question	Answer	Marks	Guidance
10(b)	Gusset plate drawn on any corner, 1 mark. Indication of fixing method, bolts, welding, rivets, 1 mark.	2	
10(c)(i)	Suitable joint shown, e.g. housing, comb, dovetail, 1 mark. Accurate drawing of details, 1 mark. Indication of how the joint will be fixed into position, 1 mark.	3	Allow KD fittings/nails/screws
10(c)(ii)	Natural defects will include: <ul style="list-style-type: none"> <li>• Knots / shakes / wind cracks</li> <li>• Woodworm / termites / beetles</li> <li>• Warping / twisting</li> <li>• Splitting</li> </ul> <p style="text-align: right;">2 × 1 marks.</p>	2	Allow any other recognised defect that occurs naturally. Do not allow rotting.
10(d)(i)	A state of rest or balance because the opposing forces are equal	1	
10(d)(ii)	A steel counterweight that is on the back of the crane base, preventing the jib from tipping forward, 1 mark. Extending legs on either side of crane, preventing the crane from rolling to the side, 1 mark. The safe working load of the crane, 1 mark. is checked against the load to be lifted, 1 mark.	3	First two points must be justified for marks. Any three points mentioned for 3 marks. 2 marks for a single point fully explained.
10(d)(iii)	<ul style="list-style-type: none"> <li>• Compression will be applied to the vertical parts of the crane structure, from the load being lifted and the weight of the crane itself.</li> <li>• Compression of the extended legs will occur</li> <li>• Tension will be applied to the cables carrying out the lift.</li> <li>• Torsion will occur in the tower when the crane is turning whilst carrying a load.</li> <li>• Torsion will occur as a result of wind blowing the jib.</li> </ul>	3	Any three points mentioned for 3 marks. 2 marks for a single point fully explained. Allow BOD for compression of wheels/tyres.
10(e)	Taking moments about R1 $(600 \times 1) + (2.5 \times 850) = R2 \times 4$ , [1] $R2 = (600 + 2125) / 4 = 2725 / 4$ [1] $R2 = 681.25 \text{ N}$ [1] $R1 = (600 + 850) - 681.25 = 768.75 \text{ N}$ [1]	4	Allow ecf for last part. Allow calculation of R1 first.

Question	Answer	Marks	Guidance
11(a)(i)	The output pulley will rotate slower than the input pulley, 1 mark. The output pulley will rotate in the opposite direction to the input pulley, 1 mark.	2	
11(a)(ii)	 <p>Correct choice of gears, 1 mark Positioning of gears, 1 mark Labelling of gears, 1 mark.</p>	3	
11(a)(iii)	<p>Benefits of spur gears could be:</p> <ul style="list-style-type: none"> <li>• No chance of slipping</li> <li>• Good transfer of torque</li> <li>• No belt to break</li> </ul> <p style="text-align: right;">2 × 1 marks</p> <p>Drawbacks could be:</p> <ul style="list-style-type: none"> <li>• Precise positioning of gears needed</li> <li>• More expensive than a belt and pulley system</li> <li>• Can jam, causing breakage of teeth</li> </ul> <p style="text-align: right;">2 × 1 marks.</p>	4	Allow any other valid benefits or drawbacks.
11(a)(iv)	<p>Ratio from A to B is <math>60 / 15 = 4 : 1</math>  Ratio from B to C is <math>75 / 18 = 4.2 : 1</math>  Ratio from C to D is <math>75 / 15 = 5 : 1</math>  Ratio from a to D is <math>4 \times 4.2 \times 5 = 84 : 1</math>  1 mark for each line correct, 4 × 1 marks.</p>	4	Award 4 marks for an answer of 84:1 with no intermediate values given.
11(a)(v)	Gear <b>A</b> will turn clockwise, 1 mark.	1	



Question	Answer	Marks	Guidance
11(b)	<p>A <b>crank</b> and <b>slider</b> mechanism connects the piston rod to wheel <b>A</b>. The <b>reciprocating</b> motion of the piston rod is converted to <b>rotary</b> motion at wheel <b>A</b>. Part <b>C</b> is a <b>linkage</b> that connects wheel <b>A</b> to wheel <b>B</b>.</p> <p>1 mark for each word in the correct position, 5 × 1 marks.</p>	5	Accept <b>slider</b> and <b>crank</b> .
11(c)(i)	<p>Reasons for using bearings could include:</p> <ul style="list-style-type: none"> <li>• To reduce friction in the moving parts</li> <li>• To allow for a film of oil / grease to separate the surfaces of mating parts</li> <li>• To prevent wear in the shaft</li> <li>• To prevent wear in body of machine</li> <li>• Bearings allow for replacement when worn.</li> </ul>	2	<p>Allow other valid points</p> <p>2 marks for two points mentioned</p> <p>2 marks for one point described in depth.</p>
11(c)(ii)	<p>Features of a plain bearing could include:</p> <ul style="list-style-type: none"> <li>• No moving parts</li> <li>• Normally a softer material than the shaft or body of machine</li> <li>• Can be porous to allow oil to be absorbed.</li> <li>• Can be split to allow for fitting</li> </ul> <p>2 × 1 marks.</p>	2	Allow other valid features.
11(c)(iii)	<p>Other types of bearing include:</p> <ul style="list-style-type: none"> <li>• Ball</li> <li>• Roller</li> <li>• Tapered roller</li> <li>• Needle</li> </ul> <p>2 × 1 marks.</p>	2	

Question	Answer	Marks	Guidance
12(a)(i)	Stage 1 ... <b>design circuit</b> Stage 2 ... <b>design PCB</b> Stage 3 ... <b>make PCB</b> Stage 4 ... <b>drill holes in PCB</b> Stage 5 ... <b>fit components to PCB</b> Stage 6 ... Solder components	4	1 mark for each correct stage. 4 marks for 4 or 5 stages correct. 1 mark for a pair of stages in sequence but in wrong position.
12(a)(ii)	Fault A: Re-heating of solder to melt it, 1 mark. Use of desoldering tool, braid or other valid method of removing excess solder, 1 mark.  Fault B: Clean track and reheat with soldering iron in contact with component and pad, 1 mark Feed in solder to the joint, 1 mark.	4	Allow other valid methods for correcting the faults.
12(b)(i)	Component C is a <b>variable resistor</b> Component D is a <b>thermistor</b>  2 × 1 marks.	2	Accept potentiometer
12(b)(ii)	Substitution into formula $V_{out} = (3000 / (3000 + 95\ 000)) \times 9$ , 1 mark $(3000 / 98\ 000) \times 9$ , 1 mark $V_{out} = 0.2755\ V$ , 1 mark.	3	Award 3 marks for correct answer with no working.
12(b)(iii)	The resistance will <b>increase</b> , 1 mark The voltage at X will <b>increase</b> , 1 mark.	2	
12(b)(iv)	The resistors are <b>protective / current limiting</b> resistors, 1 mark.	1	
12(b)(v)	NPN bipolar junction transistor / NPN / NPN transistor, 1 mark.	1	
12(c)(i)	Circuit 1 is <b>AND</b> logic  Circuit 2 is <b>OR</b> logic.	2	

Question	Answer	Marks	Guidance																									
12(c)(ii)	Reasons for using a logic IC could include: <ul style="list-style-type: none"> <li>• Fewer parts if multiple gates are being used</li> <li>• Less space used on circuit board</li> <li>• Faster action</li> <li>• More than one gate available on an IC</li> <li>• Can interface with other ICs directly</li> <li>• Lower cost of components.</li> </ul> <p style="text-align: right;">2 × 1 marks.</p>	<b>2</b>	Accept other valid reasons.																									
12(c)(iii)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>A</th> <th>B</th> <th>Q<sub>1</sub></th> <th>Q<sub>2</sub></th> <th>Q<sub>3</sub></th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>1</td> <td>1</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> <td>0</td> <td>0</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>1</td> <td>0</td> <td>0</td> <td>1</td> </tr> </tbody> </table> <p>1 mark for each column correct.</p>	A	B	Q <sub>1</sub>	Q <sub>2</sub>	Q <sub>3</sub>	0	0	1	1	0	0	1	1	0	0	1	0	0	1	0	1	1	0	0	1	<b>3</b>	
A	B	Q <sub>1</sub>	Q <sub>2</sub>	Q <sub>3</sub>																								
0	0	1	1	0																								
0	1	1	0	0																								
1	0	0	1	0																								
1	1	0	0	1																								
12(c)(iv)	<b>AND</b> is the overall logic from the system.	<b>1</b>	Allow ecf from <b>(c)(iii)</b>																									