



# Cambridge IGCSE™

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**DESIGN & TECHNOLOGY**

**0445/42**

Paper 4 Systems and Control

**October/November 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 October/November 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 **13** 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 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(a)	Shell structure.	1	
1(b)	Valid example of any shell structure, or valid example of structure given in <b>1(a)</b> , 1 mark Clear drawing / notes, 1 mark.	2	Sketch must relate to answer from 1(a)

Question	Answer	Marks	Guidance
2	Spring <b>A</b> will resist compression Spring <b>B</b> will resist tension Spring <b>C</b> will resist torsion, 1 mark for each correct answer.	3	Accept terminology with the same meaning as answer. No mark if more than one force given.

Question	Answer	Marks	Guidance
3	Property of concrete could be: <ul style="list-style-type: none"> <li>resists compression well</li> <li>long lasting / durable</li> <li>relatively low cost, 1 mark .</li> </ul> <b>Wood / timber</b> is a renewable resource, 1 mark. <b>Steel / iron</b> will corrode in damp conditions, 1 mark. Property of plastics could be: <ul style="list-style-type: none"> <li>Easy to form / mould</li> <li>Can be difficult to recycle / many types can be recycled</li> <li>Good insulator of heat / electricity</li> <li>Self-coloured no finish needed, 1 mark.</li> </ul>	4	Allow other valid responses in each case.  Must be a named resistant metal that will corrode for the mark.  Allow 'lightweight for plastics' Allow 'plastics don't corrode'

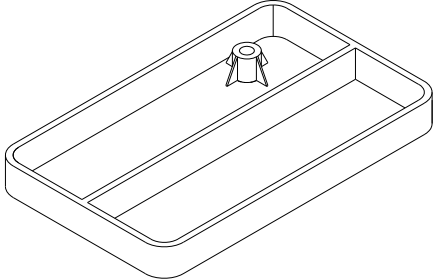
Question	Answer	Marks	Guidance
4	<b>Linear to rotary</b> , 2 × 1 marks.	2	Allow 1 BOD mark for <b>rotary to linear</b>

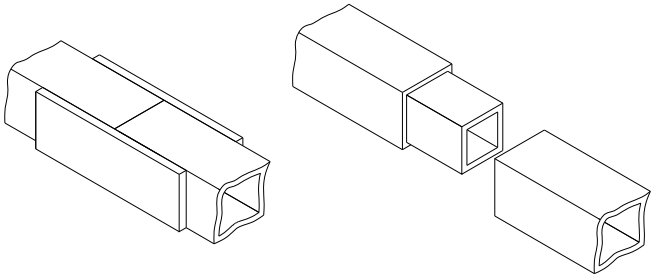
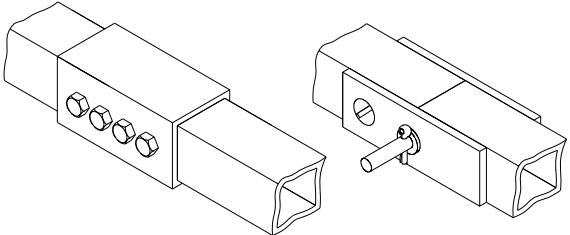
Question	Answer	Marks	Guidance
5(a)	Reasons for lubrication could include: <ul style="list-style-type: none"> <li>To reduce friction</li> <li>To prevent corrosion</li> <li>To prevent wear</li> <li>To cool</li> <li>Reduce noise</li> <li>Allow parts to move easier.</li> </ul> 2 × 1 marks	2	Allow other valid reasons.
5(b)	Oil, grease, graphite, silicone, 2 × 1 marks.	2	Accept trade names. Allow other valid responses.

Question	Answer	Marks	Guidance
6	Valid example of a second order lever, 1 mark label / notes on at least one feature, 1 mark.	2	

Question	Answer	Marks	Guidance
7	Ammeter A is connected in <b>series</b> in the circuit. Voltmeter V is connected in <b>parallel</b> . The reading on the voltmeter will be <b>+9 V</b> . When switch SW1 is pressed the <b>LED</b> will be turned <b>off</b> .	5	


Question	Answer	Marks	Guidance				
8	smallest <table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <td style="text-align: center;">pF</td> <td style="text-align: center;">nF</td> <td style="text-align: center;">μF</td> <td style="text-align: center;">F</td> </tr> </table> largest	pF	nF	μF	F	2	Any 2 in the correct order, 1, mark All correct, 2 marks.
pF	nF	μF	F				

Question	Answer	Marks	Guidance
9(a)(i)	Rib in correct position, 1 mark. Functional shape, 1 mark. 	<b>2</b>	
9(a)(ii)	Triangular gussets supporting pillar, 1 mark. Four gussets spaced around the pillar, 1 mark.	<b>2</b>	Accept 3 or more gussets.
9(a)(iii)	<ul style="list-style-type: none"> <li>• The rib and gussets are to provide support / reinforcement, 1 mark.</li> <li>• To add strength at a given point without significant increase in weight, 1 mark.</li> <li>• To prevent distortion</li> </ul>	<b>2</b>	Allow marks for understanding shown.
9(a)(iv)	Reasons for consideration of disassembly could be: <ul style="list-style-type: none"> <li>• Ease of access for repair</li> <li>• Recycling of usable part in the circuit</li> <li>• Removal of parts to allow for recycling / disposal of case.</li> </ul> 2 × 1 marks	<b>2</b>	Allow other valid reasons.

Question	Answer	Marks	Guidance
9(b)(i)	<p>Support either inside or outside of tubes, 1 mark.</p>  <p>Indication of methods – welding / brazing, pop rivets, 1 mark. Permanent, functional method, 1 mark.</p>	3	
9(b)(ii)	 <p>Support either inside or outside of tubes, 1mark. Indication of methods – bolts / screws / dowel pins, 1 mark. Temporary functional method, 1 mark.</p>	3	
9(c)(i)	<p>Definition of equilibrium – balanced, stable, all opposing forces are balanced, 1 mark.</p>	1	Award mark for understanding shown.
9(c)(ii)	<p><math>5500 \times 6 = (X \times 6200) + (3.6 \times 6200)</math>, 1 mark  <math>33\,000 = (6200 X) + 22\,320</math>, 1 mark  <math>6200 X = 33\,000 - 22\,320 = 10\,680</math>, 1 mark  <math>X = 10\,680 / 6200 = \mathbf{1.7226\ m}</math>, 1 mark</p>	4	Award 4 marks for correct answer with no working.

Question	Answer	Marks	Guidance
9(c)(iii)	Static load is: <ul style="list-style-type: none"> <li>• Load from any of the crane components</li> <li>• Counterweights</li> </ul> Moving load is: <ul style="list-style-type: none"> <li>• Wind, snow, any other weather related condition</li> <li>• Load from items being lifted</li> <li>• Torque caused by rotation of the tower</li> <li>• Movement / swinging of the load being lifted</li> </ul> 2 × 1 marks 1 mark for each	<b>2</b>	
9(c)(iv)	Reason for prefabrication will include: <ul style="list-style-type: none"> <li>• Can be constructed and then moved to site</li> <li>• Ease of storage</li> <li>• Ease of transport</li> <li>• Crane structure is temporary.</li> </ul> 1 mark.	<b>1</b>	Do not allow cost related reason. Allow other valid reasons.
9(c)(v)	Points in explanation could include: <ul style="list-style-type: none"> <li>• Unknown loads and conditions of use</li> <li>• Designer must consider all who will be working on the crane or in the area</li> <li>• Unknown stability of foundations where the base will rest.</li> <li>• Compliance with safety legislation.</li> </ul>	<b>3</b>	1 mark for each point mentioned. Allow 2 marks for a fully justified point.

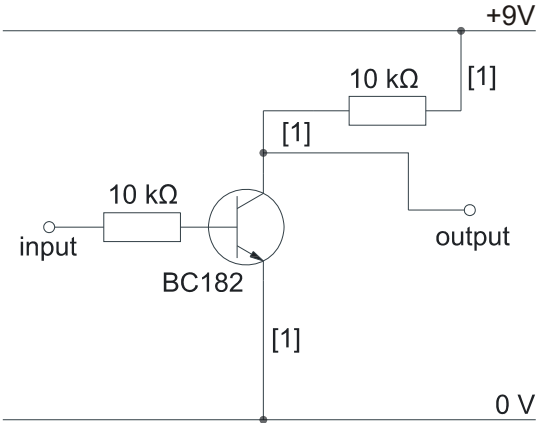
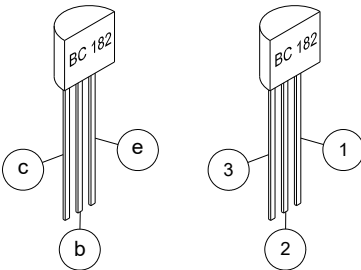


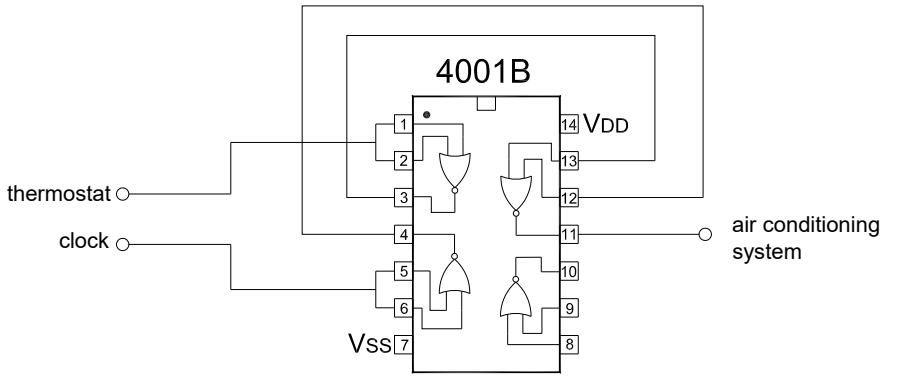
Question	Answer	Marks	Guidance
10(a)(i)	 <p>1 mark for fulcrum in correct position.</p>	<b>1</b>	
10(a)(ii)	<b>Second order</b> lever, 1 mark.	<b>1</b>	
10(a)(iii)	Mechanical advantage = length of effort arm / length of load arm = 68 / 12, 1 mark = <b>5.67</b> , 1 mark	<b>2</b>	Award full marks for correct answer with no working.  Allow <b>5.66</b>
10(a)(iv)	Advantages of a cam operated clamp will include: <ul style="list-style-type: none"> <li>• Speed of operation</li> <li>• Suitable for repeated operations</li> <li>• Consistent pressure applied each time it is used</li> <li>• Takes up a small amount of space.</li> </ul> 2 × 1 marks for suitable advantages.	<b>2</b>	Allow any other valid advantages. Allow 'easier to use'
10(b)(i)	Benefits of a ratchet and pawl drive will include: <ul style="list-style-type: none"> <li>• No need to remove the wrench from a nut to change position</li> <li>• Wrench does not have to turn through a large angle</li> <li>• Will only move in one direction / will not slip</li> <li>• Can be used in restricted space</li> <li>• Direction of drive can be reversed.</li> </ul> 2 × 1 marks for suitable benefits.	<b>2</b>	Allow any other valid benefits.

Question	Answer	Marks	Guidance
10(b)(ii)	The reversing lever will change direction of the drive allowing a nut to be undone as well as done up, [1] The lever moves the position of the pawls so that the one in contact with the ratchet can be disengaged and the opposite one is engaged, [1] Single handed operation is possible [1].	3	Explanation that includes two valid points, 2 marks. Allow 2 marks for a well justified explanation of a single point.
10(b)(iii)	Clear sketch, 1 mark. Valid use of ratchet and pawl, 1 mark.  Examples could be screwdriver, screw jack, winch or any device where slipping back is not desirable.	2	
10(c)(i)	Description could include: The velocity ratio refers to: <ul style="list-style-type: none"> <li>the speed with which the rope is pulled compared to the speed of the load being raised, [1]</li> <li>It relates directly to the mechanical advantage of the system, [1].</li> <li><math>\frac{\text{Distance moved by effort}}{\text{Distance moved by load}}</math> [1]</li> </ul> 2 × 1 marks	2	Allow marks for understanding shown.
10(c)(ii)	The system in Fig. 10.4 has a velocity ratio of 4:1 / MA of 4, 1 mark Length of pulled rope = 4 × 100 = 400 mm, 1 mark	2	
10(c)(iii)	The efficiency of a pulley system is decreased due to friction in the pulley bearings, 1 mark and the friction of the ropes against the pulley wheels, 1 mark.	2	Allow mark for results of friction – heat/sound
10(d)	Driver pulley will be 40t, 1 mark. Driven pulley 20t, 1 mark. Any of the remaining pulleys can be used as an idler to change the direction of driven to match that of driver, 1 mark.	3	
10(e)(i)	The bearing used is a <b>plain</b> bearing, 1 mark.	1	

Question	Answer	Marks	Guidance
10(e)(ii)	<p>Reasons for using nylon will include:</p> <ul style="list-style-type: none"> <li>• It does not need regular lubrication</li> <li>• Nylon is a relatively soft material which can carry any debris / waste material without damaging the dovetail slot</li> <li>• Nylon can be compressed slightly so adjustment of the bearing is not so critical</li> <li>• Nylon is a low cost material.</li> <li>• Can resist a high load without deforming</li> </ul> <p>2 × 1 marks for suitable reasons.</p>	2	

Question	Answer	Marks	Guidance
11(a)(i)	<p>Switch <b>A</b> – Make contact, spring return            Switch <b>B</b> – Break contact            Switch <b>C</b> – Single pole double throw switch.            1 mark for each correct.</p>	3	<p>Accept ptm or push to make for switch <b>A</b>            Accept ptb or push to break for switch <b>B</b>            Accept SPST for either switch <b>A</b> or switch <b>B</b> but not for both</p>
11(a)(ii)	<p>Reasons for using a relay could include:</p> <ul style="list-style-type: none"> <li>• Different input and output voltage</li> <li>• High output current</li> <li>• To isolate input from output</li> <li>• To provide reversing on a motor</li> <li>• To provide latched switching.</li> </ul> <p>1 mark for a valid reason.</p>	1	
11(a)(iii)	<p>The coil of the relay requires a 12 V supply, 1 mark.            There are two double throw switches in the output, 1 mark.</p>	2	Allow marks for understanding shown.
11(a)(iv)	<p>The maximum current and voltage for the output contacts, 1 mark.</p>	1	

Question	Answer	Marks	Guidance
11(b)(i)		<b>3</b>	<p>Emitter to 0 V, 1 mark.</p> <p>Pull up resistor to 9 V, 1 mark.</p> <p>Collector to output and pull up resistor, 1 mark.</p>
11(b)(ii)	<p>Advantages of a transistor switch could include:</p> <ul style="list-style-type: none"> <li>• No mechanical parts to wear out</li> <li>• Fast switching</li> <li>• Low current requirement</li> <li>• Takes up less space</li> <li>• Can be operated directly / automatically by another part of the circuit</li> <li>• Low cost.</li> </ul> <p>2 × 1 marks for valid reasons.</p>	<b>2</b>	<p>Accept 'cheap'.</p>
11(b)(iii)	 <p>1 mark for one leg identified. 1 mark for two / three legs identified.</p>	<b>2</b>	<p>Allow lines from the leg names in Fig. 11.4 to the correct leg.</p> <p>Allow use of either leg functions or numbers for identification.</p>
11(c)(i)	<b>AND gate</b> , 1 mark	<b>1</b>	

Question	Answer	Marks	Guidance
11(c)(ii)		<b>3</b>	<p>Pins 1&amp;2 and 5&amp;6 connected to invert signal, 1 mark.</p> <p>Inverted thermostat signal to pin 13, 1 mark. Allow pin 12</p> <p>Inverted clock signal to pin 12, 1 mark. Allow pin 13</p>
11(c)(iii)	Unused inputs are <b>8</b> and <b>9</b> , 1 mark for each.	<b>2</b>	
11(d)(i)	<b>Astable</b>	<b>1</b>	
11(d)(ii)	Conversion of resistance and capacitor values to suitable units, 1 mark Substitution to formula $T = 0.7 \times (10\,000 + 20\,000) \times 0.000047$ , 1 mark $T = 0.7 \times 30\,000 \times 0.000047$ $T = \mathbf{0.987s}$ , 1 mark.	<b>3</b>	Award 3 marks for correct answer with no working.
11(d)(iii)	Polarised means that the capacitor must be connected the right way around in the circuit, it has a negative connection and a positive connection.	<b>1</b>	Award mark for understanding shown.