Cambridge Assessment International Education

# Cambridge IGCSE™

**DESIGN AND TECHNOLOGY** **0445/42**

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.

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## 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.

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| GENERIC MARKING PRINCIPLE 1:<br><br>Marks must be awarded in line with:<br><br>• the specific content of the mark scheme or the generic level descriptors for the question<br>• the specific skills defined in the mark scheme or in the generic level descriptors for the question<br>• the standard of response required by a candidate as exemplified by the standardisation scripts. |
| GENERIC MARKING PRINCIPLE 2:<br><br>Marks awarded are always **whole marks** (not half marks, or other fractions). |
| GENERIC MARKING PRINCIPLE 3:<br><br>Marks must be awarded **positively**:<br><br>• 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<br>• marks are awarded when candidates clearly demonstrate what they know and can do<br>• marks are not deducted for errors<br>• marks are not deducted for omissions<br>• 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:<br><br>Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors. |

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| GENERIC MARKING PRINCIPLE 5:<br><br>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:<br><br>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 | Coal [1]<br>Natural gas [1] | **2** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 2 | Any 2 reasons such as:<br>To maintain an ongoing need for the product [1]<br>To make use of new technology [1]<br>To cut costs [1]<br>Reduce ongoing need for spare parts [1] | **2** | Allow other valid alternatives. |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 3 | Reservoir overflow steps – **mass** structure [1]<br>5 section telescopic jib – **shell** structure [1]<br>Extension jib – **frame** structure [1] | **3** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 4 | Force **A** - torsion [1]<br>Force **B** - tension [1] | **2** | Allow ‘torque’ for torsion |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 5(a) | Reciprocating [1] | **1** | |
| 5(b) | Oscillating [1] | **1** | |
| 5(c) | Any 2 reasons for lubrication such as:<br>Reduce friction [1]<br>Reduction of wear in parts [1]<br>Smoother running [1]<br>Quieter operation [1]<br>Reduction in overheating [1] | **2** | Allow other valid alternatives. |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 6 | The gears will rotate at the **same speed** (VR is the same) [1]<br>The gears will rotate in **opposite directions** (driven gear anticlockwise) [1] | **2** | Allow ‘rotation at the same torque’ |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 7 | The symbols are:<br>Cell [1]<br>Signal diode [1]<br>Capacitor [1]<br>  | **3** | Allow:<br>Battery for the cell<br>Diode<br>Any named type of capacitor. |
| 8(a) | A toggle switch will:<br>Bring two conductors into contact with each other [1]<br>Remain in the new position until the switch is operated again [1] | **2** | Award marks for understanding shown. |
| 8(b)(i) | On a doorbell, the switch must release when finger is removed from the switch | **1** | Award marks for understanding shown. |
| 8(b)(ii) | Press to make switch (PTM) | **1** | |

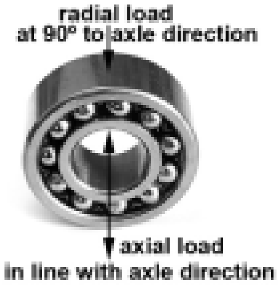
| Question | Answer | Marks | Guidance |
| --- | --- | --- | --- |
| 9 | <table><tr><td>smallest</td><td>pF</td><td>nF</td><td></td></tr></table> | 3 | 1 in correct position - 1 mark<br>2 in correct position - 2 marks<br>3 or 4 in correct position – 3 marks |

## Section B

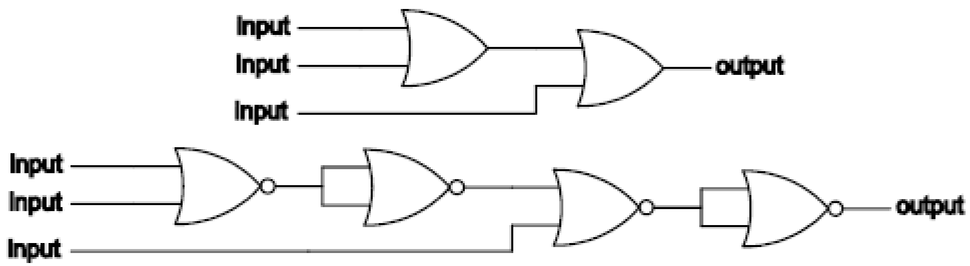
| Question | Answer | Marks | Guidance |
|---|---|---|---|
| **Section B** | | | |
| 10(a)(i) | Any 2 methods such as:<br>Locking pins [1]<br>Triangulation on legs [1]<br>Brackets to stop planks from sliding [1]<br>Width of feet to spread the load [1] | **2** | Allow reference to support provided by the trestle legs. |
| 10(a)(ii) | Any 1 suitable finishing method that will prevent water / moisture from coming into contact with the frame such as:<br>Paint, dip coating, electroplating, powder coating, galvanizing | **1** | Do not allow coating in oil or grease. |
| 10(a)(iii) | Any 2 benefits of removable legs such as:<br>Storage and transport [1]<br>Taking up far less room [1]<br>Each trestle folds / packs flat [1]<br>Easily repaired by changing damaged part [1] | **2** | Allow other valid alternatives. |
| 10(a)(iv) | Gusset plate position [1] suitable fixing method [1]<br>Strut position [1] suitable fixing method [1] | **4** | Fixing methods could include bolts, rivets, welding. |
| 10(a)(v) | Method of adjusting height of at least one foot [1]<br>Suitable size for adjustment piece [1]<br>Suitable position on the foot [1] | **3** | |
| 10(a)(vi) | Taking moments about $\mathbf{R_1}$<br>$(0.875 \times 400) + (2.625 \times 750) = R_2 \times 3$, [1]<br>$350 + 1968.75 = \mathbf{R_2} \times 3$, [1]<br>$2318.75 / 3 = \mathbf{R_2} =$ **772.92 N**, [1]<br>The reaction at $\mathbf{R_1}$ is 1150 – 772.92 = **377.08 N**. [1] | **4** | Award full marks for correct answers with no working shown. |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 10(b)(i) | Any 2 benefits of a hollow steel lintel such as:<br>Lighter than concrete [1]<br>More precise dimensions [1]<br>Easier to transport / move into position [1]<br>Quicker to manufacture [1]<br>Better strength : weight ratio [1] | **2** | Allow other valid benefits.<br><br>Do not allow reference to cost. |
| 10(b)(ii) | Line of force goes up at 45° from each end of the lintel through the courses of bricks [1]<br>Only those bricks within the triangle formed are directly loading the lintel [1] | **2** | 1 mark for each point mentioned.<br>Allow two marks for a full explanation of a single point. |
| 10(c)(i) | Any 2 methods of tensioning such as:<br>Use of threaded eyes through which the wire is fixed before using the thread to apply tension [1]<br>Wire pulled through holes in concrete and then bent back on itself before twisting to lock in place [1]<br>Threaded tensioning device with using left and right hand threads to pull in the steel wire [1] | **2** | Allow any other valid method.<br><br>1 mark for functional principle of method<br>1 mark for relevant sketches and notes to show application of method. |
| 10(c)(ii) | Calculation of cross-sectional area of wire using $\Pi r^2$ [1]<br>$3.14159 \times 2.5^2$ = **19.639** [1]<br>$3000 \div 19.639$ = **152.759** [1] | **3** | Allow any errors caused by rounding.<br>Award 3 marks for correct answer with no working shown. |

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>11(a)(i)</td><td>Lubrication should be applied at B and C [2 x 1]</td><td>2</td><td></td></tr>
<tr><td>11(a)(ii)</td><td>Oil should be applied</td><td>1</td><td>Accept any suitable named type /brand</td></tr>
<tr><td>11(a)(iii)</td><td>Tension is applied to the chain</td><td>1</td><td></td></tr>
<tr><td>11(a)(iv)</td><td>Any 2 advantages of a chain drive such as:<br>• Sprockets can be placed any distance apart no precision needed<br>• Less likelihood of damage to sprockets if drive system is blocked<br>• Different gear ratios can be applied easily<br>• Low maintenance system</td><td>2</td><td>Description to include any two valid points [2]<br>Full description of a single point [2]<br><br>Recognition that the driver and driven gears will turn in the same direction</td></tr>
<tr><td>11(b)((i)</td><td><table><tr><th>position on cam</th><th>type of movement</th></tr><tr><td>W</td><td>dwell</td></tr><tr><td>Z</td><td>rise</td></tr><tr><td>Y</td><td>dwell</td></tr><tr><td>X</td><td>fall</td></tr></table>[4 x 1]</td><td>4</td><td></td></tr>
<tr><td>11(b)(ii)</td><td>Award marks for any recognised type of follower, e.g. roller / knife edge</td><td>2</td><td></td></tr>
<tr><td>11(b)(iii)</td><td>The snail cam can only be rotated in one direction [1]</td><td>1</td><td>Allow drop cam</td></tr>
<tr><td>11(b)(iv)</td><td>Explanation may include:<br>• Bounce in follower at high speed<br>• Excessive wear in follower<br>• Excessive noise</td><td>2</td><td>Allow any other valid points<br><br>Explanation to include any two valid points [2]<br>Full description of a single point [2]</td></tr>
</table>

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 11(c)(i) | <br>[2 x 1] | **2** | Do not allow cost related benefits |
| 11(c)(ii) | Example benefits for:<br>**A** – bearings cannot fall out / easy to re-pack with grease [1]<br>**B** – bearings can be removed for cleaning during maintenance / easy to examine individual components for wear/damage / more compact [1]<br>**C** – dirt/debris cannot enter bearing area / maintenance free [1] | **3** | Allow other valid responses |
| 11(d)(i) | Distance moved by effort = $\Pi \times 2 \times 60$ or $\Pi \times 120$ = **376.99** [1]<br>Distance moved by load = **2.0 mm** [1]<br>376.99 / 2 = **188.496** [1] | **3** | Allow rounding differences in final answer<br>Correct answer with no working [3] |
| 11(d)(ii) | **Rotary** [1] motion is converted to **linear** [1] motion. | **2** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 12(a)(i) | Any 2 benefits of LEDs for the cycle rear light such as:<br>Long life [1]<br>Low current draw compared to filament lamp [1]<br>Small size [1]<br>Low cost [1]<br>Very bright light emitted within a set angle rather than 360º [1] | **2** | Allow other valid benefits |
| 12(a)(ii) | An **astable** circuit will cause flashing at regular intervals. | **1** | |
| 12(a)(iii) | The LEDs will be on 4 times per second. | **1** | Accept 4Hz flashing rate |
| 12(a)(iv) | **NE555** IC or any others from that family [1]<br>**PIC** IC [1] | **2** | Accept NAND / NOR / Schmitt inverter astable circuits. Allow programmable IC / microcontroller |
| 12(a)(v) | The LEDs are connected **in parallel** | **1** | |
| 12(a)(vi) | Use of forward voltage drop 5 V – 2 V = 3 V [1]<br>Rearrangement of formula I = V/R to R = V/I [1]<br>3 /.060 = **50 Ω** [1] | **3** | |
| 12(b)(i) | Any 2 hazards such as:<br>Burns – from iron or from solder splatter [1]<br>Inhalation of flux fumes [1]<br>Inhalation of lead fumes / lead on hands [1]<br>Electric shock from damaged cables [1]<br><br>Any 2 precautions for above hazards:<br>Keeping hands / fingers away from the soldering iron [1]<br>Wear goggles / visor [1]<br>Use of extraction equipment [1]<br>Use of extraction equipment / washing hands after handling leaded solder [1]<br>Check cable and body of iron for damage [1] | **4** | Allow other valid hazards<br><br><br><br><br><br>Allow other valid precautions |

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>12(b)(ii)</td><td>
<table>
<tr><th>stage</th><th>description of stage</th></tr>
<tr><td>1</td><td>fit resistor into PCB</td></tr>
<tr><td>2</td><td>bend resistor legs to secure in PCB</td></tr>
<tr><td>3</td><td>apply soldering iron tip to resistor leg and PCB pad</td></tr>
<tr><td>4</td><td>apply solder and allow to flow into joint</td></tr>
<tr><td>5</td><td>cut off spare wire from resistor leg</td></tr>
<tr><td>6</td><td>allow joint to cool</td></tr>
</table>
</td><td>4</td><td>Any one stage in correct position in the table [1]<br><br>Any two stages in correct order (not including the given stage) [2]<br><br>Any three stages in correct order [3]<br><br>Four or five stage in correct order [4]<br><br>Allow marks for stages 5 & 6 reversed</td></tr>
<tr><td>12(c)</td><td>Examples of possible logic gate arrangements:<br>
</td><td>3</td><td>3 inputs used [1]<br>Suitable logic used [1]<br>Functional solution [1]</td></tr>
</table>

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 12(d)(i) | Any 2 differences from:<br>Transistor switch:<br>• Is capable of high speed switching<br>• Inverts<br>• No human intervention needed for switching to occur<br>• Can be very small<br>• Low cost<br>• Can only handle limited current depending on the transistor used<br><br>Mechanical switch:<br>• Slow switching rate<br>• Can cause contact bounce<br>• Limited number of guaranteed switching operations 1<br>• Needs to be operated manually / is not automatic | **2** | 1 mark for each difference clearly described |
| 12(d)(ii) | Explanation could include:<br>• When the holes for transistor pins are labelled, it is far quicker to fit the transistor into the correct hole<br>• Separate circuit diagram is not needed for correct assembly<br>• The information is always there for reference<br>• With a batch of circuits each needs to be identical so repetitive work will be completed faster. | **2** | Allow other valid points in explanation.<br>1 mark for each point made<br><br>Full and clear explanation of a single point [2] |