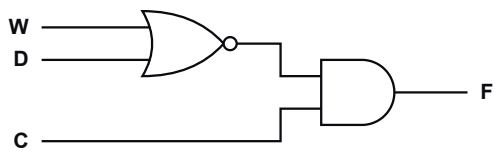
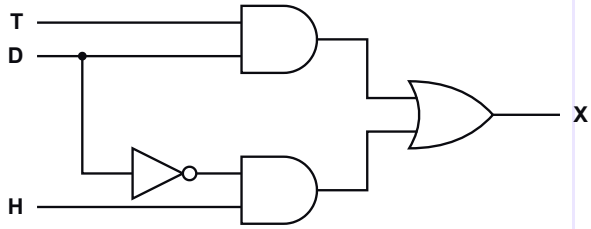
MODULE Q BOOLEAN LOGIC · Q7

From problem statement to logic circuit: mark scheme

20 marks · Cambridge 0478 syllabus 10.1 (standard logic gate symbols), 10.2 (functions of NOT, AND, OR, NAND, NOR, XOR), 10.3(a)(i) (create a logic circuit from a problem statement), 10.3(b)(i) (complete a truth table from a problem statement), 10.3(c)(i) (write a logic expression from a problem statement)

How to use. One mark per bullet point up to the maximum shown. **//** separates alternative answers. Words in (brackets) are not needed for the mark. Circuits: one mark for each correct gate with the correct inputs; each gate must have a maximum of two inputs; gates must be drawn with the 0478 section 4 symbols (a box with the gate name inside is not credited). Expressions: brackets must make the order clear; accept lower case.

QUESTION	ANSWER	MARKS	GUIDANCE
1 0478 10.2	A or B, but not both: **XOR** // EOR // exclusive OR neither A nor B: **NOR** // NOT OR not both A and B: **NAND** // NOT AND	**3**	One mark for each correct gate. Do not accept OR for row 1, or NOT for rows 2 and 3.
2(a) 0478 10.3(c)(i)	One mark per bullet point. Max 2. (W NOR D) // NOT (W OR D) // (NOT W AND NOT D) … AND C Example answer: `F = (W NOR D) AND C`	**2**	Second mark depends on a correct attempt at the first. Accept `C AND (W NOR D)`. Do not accept `(W OR D) AND C` or `(W NAND D) AND C`. Do not accept `NOT W OR D` (NOT applies only to W).
2(b) 0478 10.3(a)(i)	One mark for each correct gate with the correct inputs. Max 2. NOR gate with inputs W and D // OR gate with inputs W and D followed by a NOT gate // NOT W and NOT D into an AND gate AND gate with inputs C and the output of the first part, giving F Example answer:  	**2**	A three-input AND gate is not credited. The NOR gate must have its circle; an OR gate with no circle and no NOT gate scores 0 for the first mark.

<table>
<tr><th>QUESTION</th><th>ANSWER</th><th>MARKS</th><th>GUIDANCE</th></tr>
<tr><td>3(a)
0478 10.3(c)(i)</td><td>One mark per bullet point. Max 3.
(D AND T)
(H AND NOT D)
the two bracketed parts joined by OR
Example answer: <code>X = (D AND T) OR (H AND NOT D)</code></td><td>3</td><td>Accept the inputs in any order inside each bracket, e.g. <code>(T AND D) OR (NOT D AND H)</code>. Do not award the third mark if the brackets are missing so that the order is unclear. Do not accept <code>D NOT</code> for NOT D.</td></tr>
<tr><td>3(b)
0478 10.3(a)(i)</td><td>One mark for each correct gate with the correct inputs. Max 4.
AND gate with inputs D and T
NOT gate with input D
AND gate with inputs H and the output of the NOT gate
OR gate with the outputs of the two AND gates as inputs, giving X
Example answer:

</td><td>4</td><td>The circuit must be drawn for the statement as given, without simplification. A gate with more than two inputs is not credited. The NOT gate must have its circle. Ignore whether input D is drawn once with a branch or written twice.</td></tr>
<tr><td>3(c)
0478 10.3(b)(i)</td><td><table><tr><th>D</th><th>T</th><th>H</th><th>X</th></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>0</td><td>1</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td></tr></table></td><td>4</td><td>4 marks for 8 correct outputs; 3 marks for 6 or 7; 2 marks for 4 or 5; 1 mark for 2 or 3. The working space is not marked. Mark the table against the problem statement, not against the candidate's circuit.</td></tr>
<tr><td>4(a)
0478 10.2, 10.3(a)(i)</td><td>U = 1, L = 1, G = 1</td><td>1</td><td>All three values needed. (Both buttons pressed with the gate closed: the circuit gives 1 but the lift should not move.)</td></tr>
<tr><td>4(b)
0478 10.2</td><td>XOR // EOR // exclusive OR</td><td>1</td><td>Do not accept NOR, NAND or AND.</td></tr>
</table>

Total: 20 marks