MODULE Q BOOLEAN LOGIC · Q3

Truth tables for single gates: mark scheme

22 marks · Cambridge 0478 syllabus 10.1 (standard symbols for logic gates), 10.2 (functions of NOT, AND, OR, NAND, NOR, XOR: the binary output produced from all possible binary inputs), 10.3(a)(i) and 10.3(b)(i) (circuit and truth table from a problem statement), 10.3(c)(i) (logic expression from a problem statement)

How to use. One mark per creditworthy point up to the maximum shown. **/** separates alternative words; **//** separates alternative answers. Words in (brackets) are not needed for the mark. **...** means the mark depends on the point before it. Gate names must be the Cambridge names (NOT, AND, OR, NAND, NOR, XOR or EOR). Credit any other valid answer that shows the same understanding.

<table>
<tr><th>QUESTION</th><th>ANSWER</th><th>MARKS</th><th>GUIDANCE</th></tr>
<tr><td>1(a)
0478 10.2</td><td>• The (binary) output produced for all possible (combinations of binary) inputs</td><td>1</td><td>Do not accept “the inputs and outputs” without the idea of all possible inputs.</td></tr>
<tr><td>1(b)
0478 10.2</td><td>One mark for each:
• (i) 2
• (ii) 4</td><td>2</td><td>Ignore working. Do not accept 3 for (i) or 2 / 8 for (ii).</td></tr>
<tr><td>2(a)
0478 10.1, 10.2</td><td>For each gate: 2 marks for 4 correct outputs; 1 mark for 2 or 3 correct outputs
Gate 1 (NAND)<table><tr><th>A</th><th>B</th><th>X</th></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table>Gate 2 (NOR)<table><tr><th>A</th><th>B</th><th>X</th></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table>Gate 3 (XOR)<table><tr><th>A</th><th>B</th><th>X</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table></td><td>6</td><td>Max 2 per gate.
Mark each table on its own; the outputs must match the symbol shown.</td></tr>
<tr><td>3(a)
0478 10.2</td><td>One mark for each:
• E: NOR
• F: AND
• G: XOR // EOR
• H: OR</td><td>4</td><td>Accept a correct gate symbol in place of the name.
Do not accept “NOT OR” for E or “exclusive” on its own for G.</td></tr>
<tr><td>4(a)
0478 10.2</td><td><table><tr><th>A</th><th>X</th></tr><tr><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td></tr></table></td><td>1</td><td>Both rows needed.</td></tr>
</table>

<table>
<tr><th>QUESTION</th><th>ANSWER</th><th>MARKS</th><th>GUIDANCE</th></tr>
<tr><td>4(b)
0478 10.2</td><td>Any two from:
• The NAND output is the opposite / inverse of the AND output // NAND is AND followed by NOT // NAND = NOT (A AND B)
• … for every combination of inputs // in every row of the truth table
• e.g. when both inputs are 1, AND outputs 1 but NAND outputs 0 // when any input is 0, AND outputs 0 but NAND outputs 1</td><td>2</td><td>Accept “NAND is the opposite / NOT of AND” for the first point.
The first point can only be credited once.
Credit any other valid answer that shows the same understanding.</td></tr>
<tr><td>5(a)
0478 10.3(a)(i), 10.2</td><td>• NOR</td><td>1</td><td>Accept a correct NOR symbol.</td></tr>
<tr><td>5(b)
0478 10.3(b)(i)</td><td>2 marks for 4 correct outputs; 1 mark for 2 or 3 correct outputs
<table><tr><th>P</th><th>Q</th><th>W</th></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table></td><td>2</td><td>The table must match the scenario: no FT from (a).</td></tr>
<tr><td>5(c)
0478 10.3(c)(i)</td><td>• W = P NOR Q // W = NOT (P OR Q) // W = (NOT P) AND (NOT Q)</td><td>1</td><td>Accept the inputs in either order (Q NOR P).
Accept the expression without “W =”.
Do not accept NOT P OR Q without brackets, or symbols such as + or · in place of the operator words.</td></tr>
<tr><td>6(a)
0478 10.2</td><td>One mark for each:
• OR … A = 0 and B = 0
• NAND … A = 1 and B = 1</td><td>2</td><td>Each mark needs the gate and its matching inputs.
Either order. If more than two gates are given, mark the first two only.</td></tr>
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Total: 22 marks