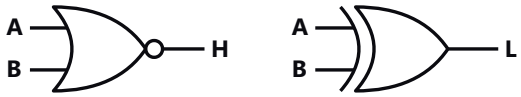
MODULE Q BOOLEAN LOGIC · Q2

NAND, NOR and XOR gates: mark scheme

21 marks · Cambridge 0478 syllabus 10.1 (logic gate symbols), 10.2 (functions of logic gates), 10.3(a)(i) (circuit from a problem statement), 10.3(b)(iii) (truth table from a logic circuit), 10.3(c)(i) and (ii) (logic expression from a problem statement and from a logic circuit)

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. Gate symbols are marked on shape, not on any name written inside them. Accept EOR for XOR throughout. Accept TRUE/FALSE or T/F for 1/0 in truth tables. 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 10.1</td><td>One mark for each correct gate:
• Gate 1: NOR
• Gate 2: XOR // EOR
• Gate 3: NAND</td><td>3</td><td>Accept NOT OR for NOR and NOT AND for NAND. Accept “exclusive OR” for XOR. Do not accept OR, AND or NOT alone.</td></tr>
<tr><td>2(a)
0478 10.2</td><td>One mark for each correct column:
<table><tr><th>A</th><th>B</th><th>A NAND B</th><th>A NOR B</th><th>A XOR B</th></tr><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>1</td></tr><tr><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td></tr></table></td><td>3</td><td>A column must have all four values correct to score its mark.</td></tr>
<tr><td>3(a)
0478 10.2</td><td>Any two from:
• output is 0 only when both inputs are 1
• output is 1 when either input or both inputs are 0 // output is 1 when the inputs are not both 1
• it gives the opposite/inverse of an AND gate // it is an AND gate followed by a NOT gate</td><td>2</td><td>A correct four-row truth table for NAND scores 2. “Output is 0 when both inputs are 1” and “output is 1 when either input is 0” are separate marks. Do not accept descriptions of NOR (e.g. “1 only when both inputs are 0”). “Opposite of AND” with no further detail = 1 mark only.</td></tr>
<tr><td>3(b)
0478 10.2</td><td>Any two from:
• when both inputs are 1, an OR gate outputs 1 …
• … but an XOR gate outputs 0
• an OR gate outputs 1 when either or both inputs are 1
• an XOR gate outputs 1 only when the inputs are different // when exactly one input is 1</td><td>2</td><td>Award the second bullet on its own (“XOR gives 0 when both inputs are 1”) even without the first. “XOR is exclusive” alone = 0. Do not accept answers saying the two gates differ when only one input is 1 (they both output 1).</td></tr>
</table>

QUESTION	ANSWER	MARKS	GUIDANCE
4(a) 0478 10.3(c)(i)	One mark for each correct expression: • H = A NOR B • L = A XOR B • R = A NAND B	**3**	Accept correct equivalent expressions: H = NOT (A OR B) // (NOT A) AND (NOT B); L = (A AND NOT B) OR (NOT A AND B) // (A OR B) AND NOT (A AND B); R = NOT (A AND B) // (NOT A) OR (NOT B). Accept with or without the "H =" etc. Do not accept L = A OR B or R = NOT A AND B. Ignore missing brackets only when the meaning is still clear.
4(b) 0478 10.1, 10.3(a)(i)	One mark for each correct gate with inputs A and B: • H: NOR gate • L: XOR gate 	**2**	NOR must be the OR shape with the small circle at the output. XOR must have the extra curved line on the input side. A box with the gate name written in it = 0. The question asks for one gate per output: an OR gate followed by a NOT gate for H = 0. No follow-through from 4(a).
5(a) 0478 10.3(c)(ii)	One mark per correct part: • (A NOR B) • … XOR C Answer: X = (A NOR B) XOR C	**2**	Accept NOT (A OR B) for A NOR B. Accept C XOR (A NOR B). The second mark needs XOR joining C to the output of the first gate. A NOR B XOR C with no brackets: max 1.
5(b) 0478 10.3(b)(iii)	<table><tr><th>A</th><th>B</th><th>C</th><th>Working: A NOR B</th><th>X</th></tr><tr><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td></tr><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>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td></tr></table> 4 marks for 8 correct outputs 3 marks for 6 or 7 correct outputs 2 marks for 4 or 5 correct outputs 1 mark for 2 or 3 correct outputs	**4**	Mark the X column only. The working space is not marked.

Total: 21 marks