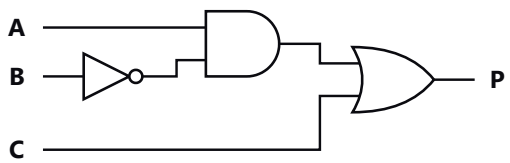
MODULE Q BOOLEAN LOGIC · Q6

Logic expressions: writing them and drawing them: mark scheme

21 marks · OCR J277 spec 2.4.1 (simple logic diagrams using AND, OR and NOT; truth tables; combining Boolean operators; working with more than one gate)

How to use. 1 mark per bullet up to the Max shown. **/** and **//** separate alternative answers. Words in (brackets) are not needed for the mark. Accept any valid notation for logic expressions (e.g. ∧ for AND, ∨ for OR, ¬ or a bar for NOT, T/F for 1/0) and lower case. Accept any expression that is logically the same as the circuit, unless the guidance says otherwise. Credit any other valid answer that shows the same understanding. In diagrams, gates are marked on their shape and inputs; labels are not needed.

QUESTION	ANSWER	MARKS	GUIDANCE
1(a) J277 2.4.1	• Circuit (i): 3 • Circuit (ii): 1 • Circuit (iii): 2	**3**	1 mark per correct row. Expression 4 is not used. If one number is used twice, mark each row on its own merit.
2(a) J277 2.4.1	• `B AND C` (as one part) ... • ... combined with `A` using `OR` Example: `P = A OR (B AND C)`	**2**	Accept `(B AND C) OR A`. Accept `A OR B AND C` (AND is applied before OR). `(A OR B) AND C` = max 1. Accept other valid notation, e.g. `A ∨ (B ∧ C)`, `A + B.C`, lower case. `P =` not required.
2(b) J277 2.4.1	• `A OR B` (as one part) • `(A OR B) AND C` • `NOT` applied to the whole of `(A OR B) AND C` Example: `P = NOT ((A OR B) AND C)`	**3**	1 mark per bullet. `NOT (A OR B) AND C` (NOT on the OR part only) = max 2. `NOT ((A OR B) AND C)` with brackets missing round A OR B, e.g. `NOT (A OR B AND C)` (the AND is then done first) = max 1. Accept other valid notation, e.g. `¬((A ∨ B) ∧ C)`.
3(a) J277 2.4.1	• NOT gate with input B (only) • AND gate with inputs A and NOT B • OR gate with inputs from the AND gate and C 	**3**	1 mark per correct gate with the correct inputs. Gates must be drawn with the correct shapes: NOT must have its circle; AND and OR must not have circles. A box with the gate name written in it is not a gate symbol: no mark for that gate. Max 2 if any extra gates are drawn or a gate is missing. Ignore labels on wires.

QUESTION	ANSWER	MARKS	GUIDANCE
4(a) J277 2.4.1	<table><tr><th>A</th><th>B</th><th>P</th><th>Q</th></tr><tr><td>0</td><td>0</td><td>1</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>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td></tr></table>	**4**	1 mark per correct row (both P and Q correct). Accept T/F for 1/0. Working: P is 1 unless A and B are both 1; Q is 1 only when A is 0 and B is 1.
4(b) J277 2.4.1	• In P the NOT is applied to the result of `A AND B` (the whole bracket) // in Q the NOT is applied to A only (before the AND) • Correct row where P and Q differ, with both outputs, e.g. A = 0, B = 0 gives P = 1 but Q = 0 // A = 1, B = 0 gives P = 1 but Q = 0	**2**	1 mark per bullet. The first mark needs what the NOT applies to in at least one expression, set against the other. "The NOT is in a different place" alone (given in the question) = 0. Allow follow-through for the row from the candidate's table in (a) only if P and Q differ in that row of their table.
5(a) J277 2.4.1	Any **two** from: • The NOT should apply to B only // NOT has been applied to `(B AND C)` instead of just B • B and C are not joined by an AND gate in the circuit // the AND gate combines the OR output with C • The last gate (giving P) is AND, not OR // OR combines A with NOT B (not with the rest) • C should be ANDed with `(A OR NOT B)` // brackets are in the wrong place so the gates are in the wrong order	**2**	Max 2. Credit any other valid description of a mismatch between the expression and the circuit. "It is wrong" or "the brackets are wrong" with no detail = 0.
5(b) J277 2.4.1	• `A OR NOT B` // `A OR (NOT B)` (as one part) ... • ... ANDed with C, with brackets so the OR is done first Example: `P = (A OR (NOT B)) AND C`	**2**	Accept `C AND (A OR NOT B)`, `(A OR NOT B) AND C`. `A OR NOT B AND C` (no brackets: the AND is done first, which is a different circuit) = max 1. `A OR NOT (B) AND C` = max 1. Accept other valid notation.

Total: 21 marks