OCR GCSE (J277)

Module Q: Boolean logic

Workbooklet mark scheme · 6 parts · 123 marks

Q2 is IGCSE (Cambridge) only and not on J277.

Contents

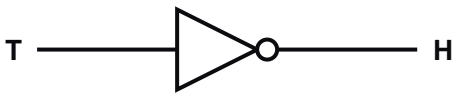
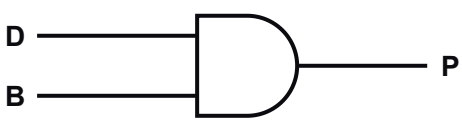
Part	Topic	Marks
Q1	Logic gates: AND, OR and NOT: mark scheme	20
Q3	Truth tables for single gates: mark scheme	21
Q4	Reading logic circuits: mark scheme	21
Q5	Completing a truth table for a logic circuit: mark scheme	21
Q6	Logic expressions: writing them and drawing them: mark scheme	21
Q7	From problem statement to logic circuit: mark scheme	19
	Total	**123**

MODULE Q BOOLEAN LOGIC · Q1

Logic gates: AND, OR and NOT: mark scheme

20 marks · OCR J277 spec 2.4.1 (simple logic diagrams using AND, OR and NOT; truth tables; recognition of each gate symbol)

How to use. 1 mark per bullet up to the Max shown. **/** separates alternative answers. Words in (brackets) are not needed for the mark. Other valid notation is accepted, as the J277 specification allows: T/F or True/False for 1/0, and symbols such as ∨ for OR, ∧ for AND, ¬ or a bar over the letter for NOT. Logic diagrams: gate **shapes** are marked; a box with the gate's name written in it is not a gate symbol (0 for that gate). A NOT gate must have its small circle; an AND or OR gate must not have one.

QUESTION	ANSWER	MARKS	GUIDANCE
1(a) J277 2.4.1	X: OR Y: NOT Z: AND	**3**	1 mark per correct gate. Accept disjunction / negation / conjunction. Accept "inverter" for Y.
1(b) J277 2.4.1	OR	**1**	Accept ∨. Do not accept AND or NOT.
2(a) J277 2.4.1	Only one input: NOT Output 1 when either or both inputs are 1: OR Output 0 if any input is 0: AND	**3**	1 mark per correct row. More than one tick in a row: 0 for that row.
3(a) J277 2.4.1	`A AND B`, A = 1, B = 0: **0** `A OR B`, A = 0, B = 1: **1** `NOT A`, A = 1: **0** `A OR B`, A = 0, B = 0: **0**	**4**	1 mark per correct row. Accept F/T or False/True for 0/1.
4(a) J277 2.4.1	A NOT gate symbol: triangle with a small circle at the output ... ... with T as its only input and H as its output (no other gates) 	**2**	Triangle without the circle (a buffer) = 0 for the first mark. The circle may be drawn at the input side of the triangle. Second mark: the connection mark is lost if any extra gate is drawn. Labels are already printed; do not penalise if the candidate also writes them.
4(b) J277 2.4.1	H = NOT T	**1**	Accept ¬T, T with a bar over it, NOT(T). Do not accept "T NOT" or "H = T".
5(a) J277 2.4.1	AND	**1**	Accept conjunction / ∧.
5(b) J277 2.4.1	An AND gate symbol (flat back, D shape, no circle) ... ... with D and B as its two inputs and P as its output (no other gates) 	**2**	An OR or NOT shape, or an AND with a circle at the output, = 0 for the first mark. The second mark can still be given for a single two-input gate wired D and B in, P out, only if the first mark is given. Max 1 if extra gates are drawn.

QUESTION	ANSWER	MARKS	GUIDANCE
5(c) J277 2.4.1	1 mark each to max 3: OR outputs 1 when either input is 1 / when at least one input is 1 / it does not need both inputs to be 1 A correct example where the inputs differ: D = 1, B = 0 (door closed, no bike) / D = 0, B = 1 (door open, bike plugged in) ... ... OR would give P = 1 so the charger would be on when it should be off / AND gives 0 for this combination The charger must only be on when both conditions are true / both inputs are 1, and only AND does this	**3**	The third bullet needs a correct example (the "..."). Accept the example described in words (e.g. "the door is open but a bike is plugged in"). An example with D = 1, B = 1 or D = 0, B = 0 earns no example mark (OR and AND give the same output). Do not credit "OR is wrong" or "it is less safe" with no reason. Credit any other valid explanation.

Total: 20 marks

MODULE Q BOOLEAN LOGIC · Q3

Truth tables for single gates: mark scheme

21 marks · OCR J277 specification 2.4.1 (truth tables for each logic gate; recognition of each gate symbol; create, complete or edit truth tables for given scenarios; applying logical operators in truth tables to solve problems)

How to use. 1 mark per bullet up to the maximum shown. **/** separates alternative words or answers. Words in (brackets) are not needed for the mark. **...** means the mark depends on the point before it. Allow other valid notation for truth table values, e.g. T/F for 1/0 (J277 2.4.1). 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)
J277 2.4.1</td><td>The output (of a logic gate / circuit) for every possible combination of inputs</td><td>1</td><td>Allow “all possible inputs and their outputs”.
Do not allow “the inputs and outputs” without the idea of all combinations / possibilities.</td></tr>
<tr><td>1(b)
J277 2.4.1</td><td>4 (rows)
Each input can be 0 or 1 / has 2 possible values ... so there are 2 × 2 / 2^2 = 4 combinations (and each needs a row)</td><td>2</td><td>Mark each point on its own.
Allow “00, 01, 10 and 11 are the only combinations” for mark 2.
Do not allow “because there are two inputs” on its own.</td></tr>
<tr><td>2(a)
J277 2.4.1</td><td>Gate 1 (AND): 1 mark for rows 1–2 correct, 1 mark for rows 3–4 correct
Gate 2 (OR): 1 mark for rows 1–2 correct, 1 mark for rows 3–4 correct
Gate 3 (NOT): 1 mark for both rows correct
Gate 1 (AND)
<table><tr><th>A</th><th>B</th><th>P</th></tr><tr><td>0</td><td>0</td><td>0</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>1</td></tr></table>Gate 2 (OR)
<table><tr><th>A</th><th>B</th><th>P</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>1</td></tr></table>Gate 3 (NOT)
<table><tr><th>A</th><th>P</th></tr><tr><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td></tr></table></td><td>5</td><td>Max 2 for gate 1, max 2 for gate 2, max 1 for gate 3.
Allow T/F, True/False or Yes/No in place of 1/0.
Mark each pair of rows on its own; the outputs must match the symbol shown.</td></tr>
<tr><td>3(a)
J277 2.4.1</td><td>J: OR
K: AND
L: NOT</td><td>3</td><td>Allow disjunction for OR, conjunction for AND, negation for NOT.
Allow a correct gate symbol drawn in place of the name.</td></tr>
<tr><td>4(a)
J277 2.4.1</td><td>OR (gate)</td><td>1</td><td>Allow disjunction. Allow a correct OR symbol. Do not allow “either” on its own.</td></tr>
</table>

<table>
<tr><th>QUESTION</th><th>ANSWER</th><th>MARKS</th><th>GUIDANCE</th></tr>
<tr><td>4(b)
J277 2.4.1</td><td>1 mark for rows 1–2 correct, 1 mark for rows 3–4 correct
<table><tr><th>H</th><th>F</th><th>E</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>1</td></tr></table></td><td>2</td><td>Allow T/F in place of 1/0.
FT from an incorrect gate in (a) is not allowed: the table must match the scenario.</td></tr>
<tr><td>4(c)
J277 2.4.1</td><td>H = 0 and F = 0 (both inputs 0)</td><td>1</td><td>Allow “neither sensor is on / the room is not too hot and no fumes are detected”.
Allow FT from the candidate’s table in (b) only if it has exactly one row with E = 0.</td></tr>
<tr><td>5(a)
J277 2.4.1</td><td>Error 1:
Row 3 / the third row is a repeat of row 2 (0 1) / the input combination 1 0 is missing …
… row 3 should be A = 1, B = 0 (with output 0)
Error 2:
Row 4 / the row where A = 1 and B = 1 has the wrong output / output 0 …
… the output should be 1</td><td>4</td><td>1 mark for identifying each error, 1 mark for its correction.
For error 1 allow “row 2 should be 1 0” (the table is then still complete and correct).
Allow the errors in either order.
Do not allow “row 3 output should be 1” (A = 0, B = 1 gives 0 for AND).</td></tr>
<tr><td>6(a)
J277 2.4.1</td><td>Max 2 from:
AND gives 0 … because AND only outputs 1 when both inputs are 1 / B is 0
OR gives 1 … because OR outputs 1 when at least one input is 1 / A is 1</td><td>2</td><td>Each mark needs the output and the reason.
Allow “AND needs both, OR needs either / one” with the correct outputs stated.
Credit any other valid answer that shows the same understanding.</td></tr>
</table>

Total: 21 marks

MODULE Q BOOLEAN LOGIC · Q4

Reading logic circuits: mark scheme

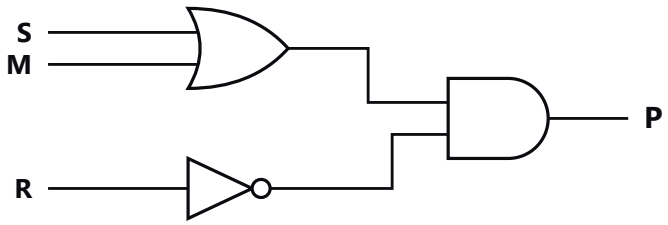
21 marks · OCR J277 spec 2.4.1: simple logic diagrams using AND, OR and NOT; truth tables; combining Boolean operators; working with more than one gate in a logic diagram; creating, completing or editing logic diagrams for given scenarios

How to use. 1 mark per bullet up to the maximum shown. **/** separates alternative answers. Words in (brackets) are not needed for the mark. Credit any other valid answer that shows the same understanding. T/F (True/False) may be used in place of 1/0. Drawn gates are marked on shape, not label: a NOT gate must have its circle; AND and OR gates must not. A box with the gate name written inside scores 0.

<table>
<tr><th>QUESTION</th><th>ANSWER</th><th>MARKS</th><th>GUIDANCE</th></tr>
<tr><td>1(a)
J277 2.4.1</td><td>Gate 1: AND
Gate 2: OR</td><td>2</td><td>Accept conjunction for AND and disjunction for OR.</td></tr>
<tr><td>1(b)
J277 2.4.1</td><td>X = 0
P = 1</td><td>2</td><td>1 mark each. Accept False / True. A = 1 AND B = 0 gives 0; 0 OR C (1) gives 1.</td></tr>
<tr><td>2(a)
J277 2.4.1</td><td>1 mark per correct row (D, E, F and P all correct):
<table><tr><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th><th>P</th></tr><tr><td>0</td><td>1</td><td>0</td><td>1</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><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>1</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><td>0</td><td>0</td></tr></table></td><td>4</td><td>D = NOT A; E = D AND B; F = A AND C; P = E OR F. A row with any wrong value scores 0 for that row. Accept T/F.</td></tr>
<tr><td>3(a)
J277 2.4.1</td><td>P = 1
Q = 0</td><td>2</td><td>1 mark each. Circuit 1: A AND B = 0, then NOT gives 1. Circuit 2: NOT A = 0, then 0 AND B gives 0. The NOT gate only changes the one signal it is placed on.</td></tr>
<tr><td>4(a)
J277 2.4.1</td><td>0 / heater off</td><td>1</td><td>Accept False.</td></tr>
<tr><td>4(b)
J277 2.4.1</td><td>1 mark each:
the door is closed / D = 1
the timer is running / T = 1
the oven is not too hot / K = 0</td><td>3</td><td>All three conditions must be needed together (joined by “and”); if the answer says any one condition is enough, max 1. Do not accept “K = 1” or “the oven is hot” for the third mark. “When D, T and NOT K are all 1” scores 3.</td></tr>
<tr><td>5(a)
J277 2.4.1</td><td>AND gate drawn in the box, with S and the output of the NOT gate as its two inputs and its output going to the OR gate</td><td>1</td><td>Shape marked, label ignored. Do not accept an AND gate with a circle (that is not an AND gate) or an OR gate.</td></tr>
</table>

QUESTION	ANSWER	MARKS	GUIDANCE
5(b) J277 2.4.1	1 mark each: S and M are the inputs to an OR gate R is the input to a NOT gate the outputs of the OR gate and the NOT gate are the inputs to an AND gate, whose output is P *P = (S OR M) AND (NOT R). An example answer is drawn below the table.*	**3**	Accept any logically equivalent diagram that uses only AND, OR and NOT gates, e.g. (S AND NOT R) OR (M AND NOT R): award 3 if it is fully correct. If a gate is missing or an extra gate makes the logic wrong, max 2.
6(a) J277 2.4.1	Max 3: the technician is not correct, with a counter-example: A = 0, B = 1 (and C = 1) A AND B = 0 (because A is 0) NOT B = 0, so (NOT B) AND C = 0 (even though C is 1) ...so P = 0 OR 0 = 0	**3**	"Not correct" with no reason scores 0. For full marks the answer must give the inputs A = 0, B = 1, C = 1 (the only case where C = 1 gives P = 0) or describe them ("when B is 1 and A is 0"). Credit working shown as values written on the circuit. Do not accept "the technician is correct": this scores 0.

Example answer for 5(b)



Total for this mark scheme: 21 marks

MODULE Q BOOLEAN LOGIC · Q5

Completing a truth table for a logic circuit: mark scheme

21 marks · OCR J277 spec 2.4.1: truth tables; combining Boolean operators using AND, OR and NOT; applying logical operators in truth tables to solve problems; create, complete or edit truth tables for given scenarios; work with more than one gate in a logic diagram

How to use. 1 mark per bullet up to the maximum shown. **/** separates alternative answers. **Truth tables:** output columns are marked in pairs of rows (rows 1–2, 3–4, 5–6, 7–8): 1 mark for each pair where both values are correct. Working columns are not marked unless the question says so. T/F (or True/False) in place of 1/0 is accepted throughout, as the specification allows. Rows are listed in binary order 000 to 111 as printed on the question paper.

<table>
<tr><th>QUESTION</th><th>ANSWER</th><th>MARKS</th><th>GUIDANCE</th></tr>
<tr><td>1(a)
J277 2.4.1</td><td>8</td><td>1</td><td>Accept 2^3 = 8 / eight. Do not accept 9 (heading row counted) or 6.</td></tr>
<tr><td>1(b)
J277 2.4.1</td><td>C (top to bottom): 0, 1, 0, 1, 0, 1, 0, 1</td><td>1</td><td>All 8 values needed for the mark. 1, 0, 1, 0, … does not count up from 000 so = 0.</td></tr>
<tr><td>2(a)
J277 2.4.1</td><td>NOT A and NOT B columns both correct: 1, 1, 0, 0 and 1, 0, 1, 0
(NOT A) OR (NOT B) column: 1, 1, 1, 0
Q column: 0, 0, 0, 1
<table>
<tr><th>A</th><th>B</th><th>NOT A</th><th>NOT B</th><th>(NOT A) OR (NOT B)</th><th>Q</th></tr>
<tr><td>0</td><td>0</td><td>1</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><td>0</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
</table></td><td>3</td><td>1 mark per bullet. FT: (NOT A) OR (NOT B) correct for the candidate's NOT A and NOT B columns; Q correct as the inverse of the candidate's OR column.</td></tr>
<tr><td>2(b)
J277 2.4.1</td><td>AND (gate) / conjunction</td><td>1</td><td>Accept the AND gate symbol drawn. FT: if the candidate's Q column is 0, 1, 1, 1, accept OR. Do not accept NAND / NOR / XOR (not J277 gates) or "NOT".</td></tr>
<tr><td>3
J277 2.4.1</td><td>P column: 0, 1, 1, 1, 0, 1, 0, 1
1 mark for each correct pair of rows: rows 1–2 (0, 1); rows 3–4 (1, 1); rows 5–6 (0, 1); rows 7–8 (0, 1)
<table>
<tr><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>P</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td></tr>
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<tr><td>1</td><td>1</td><td>0</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>0</td><td>1</td></tr>
</table></td><td>4</td><td>Max 4. D (= NOT A) and E (= D AND B) are working and are not marked. Common error: leaving out the NOT gate on A (E worked as A AND B) gives P = 0 in row 3 and P = 1 in row 7.</td></tr>
</table>

<table>
<tr><th>QUESTION</th><th>ANSWER</th><th>MARKS</th><th>GUIDANCE</th></tr>
<tr><td>4
J277 2.4.1</td><td>O column: 0, 1, 0, 1, 1, 1, 0, 1
1 mark for each correct pair of rows: rows 1–2 (0, 1); rows 3–4 (0, 1); rows 5–6 (1, 1); rows 7–8 (0, 1)
O = (L AND NOT F) OR M
<table><tr><th>L</th><th>F</th><th>M</th><th>L AND NOT F</th><th>O</th></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>0</td><td>1</td><td>0</td><td>1</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>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td><td>1</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></td><td>4</td><td>Max 4. The working column is not marked; any working headings may be used. Common errors: O = 1 in row 7 (NOT missed on F) or O = 0 in rows 2, 4 or 8 (override ignored).</td></tr>
<tr><td>5
J277 2.4.1</td><td>Row 2 (A=0, B=0, C=1) circled
Row 7 (A=1, B=1, C=0) circled
Row 8 (A=1, B=1, C=1) circled
Correct P column: 0, 1, 0, 1, 0, 1, 0, 0
<table><tr><th>A</th><th>B</th><th>C</th><th>Printed P</th><th>Correct P</th></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>0</td><td>1</td><td>0</td><td>1</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>1</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>1</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td></tr></table></td><td>3</td><td>1 mark per correct value circled, max 3. Deduct 1 mark for each extra value circled (minimum 0). Accept a row identified another clear way (e.g. ticked, crossed, or the correct value written beside it).</td></tr>
<tr><td>6
J277 2.4.1</td><td>P column: 1, 1, 0, 0, 1, 1, 0, 1
1 mark for each correct pair of rows: rows 1–2 (1, 1); rows 3–4 (0, 0); rows 5–6 (1, 1); rows 7–8 (0, 1)
<table><tr><th>A</th><th>B</th><th>C</th><th>A AND C</th><th>NOT B</th><th>P</th></tr><tr><td>0</td><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>0</td><td>1</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</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>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td></tr></table></td><td>4</td><td>Max 4. Working columns and their headings are not marked. Common error: row 8 given as 0 (A AND C is 1 even though NOT B is 0).</td></tr>
</table>

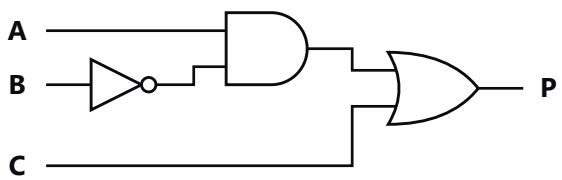
Total: 21 marks

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.

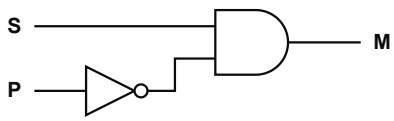
Total: 21 marks

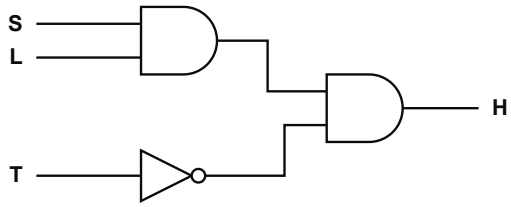
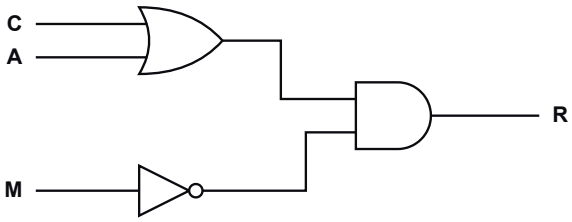
MODULE Q BOOLEAN LOGIC · Q7

From problem statement to logic circuit: mark scheme

19 marks · OCR J277 spec 2.4.1: simple logic diagrams using AND, OR and NOT; truth tables; combining Boolean operators; applying logical operators in truth tables to solve problems; create, complete or edit logic diagrams and truth tables for given scenarios; more than one gate in a logic diagram

How to use. 1 mark per bullet up to the maximum shown. **/** separates alternative answers. Words in (brackets) are not needed for the mark. Other valid notation is accepted, as in the J277 specification: T/F for 1/0, ∧ for AND, ∨ for OR, ¬ or a bar for NOT. Diagrams are marked on the gate shapes, not on labels: a NOT gate must have its circle; an AND or OR gate with a circle is a different gate and scores 0 for that gate. A box with the gate name written inside scores 0.

QUESTION	ANSWER	MARKS	GUIDANCE
1 J277 2.4.1	Paper shredder: **AND** Doorbell: **OR** Freezer warning light: **NOT** Lift alarm: **OR**	**4**	1 mark per correct row. A row with more than one tick scores 0.
2(a) J277 2.4.1	Either: S = 1, P = 0 … … the diagram gives 0 and it should give 1 Or: S = 1, P = 1 … … the diagram gives 1 and it should give 0	**2**	1 mark for a set of input values that gives a wrong output; 1 mark for both outputs correct for that set. The second mark depends on the first. Accept the answer in words (e.g. "switch on and someone in the pool: the cover closes but it should not"). S = 0 (either value of P) scores 0: the diagram is correct for those inputs.
2(b) J277 2.4.1	NOT gate with input P AND gate with inputs S and the output of the NOT gate, giving output M Example answer:  	**2**	1 mark per bullet. The NOT gate must have its circle. A NOT gate on S instead of P scores 0. Max 1 if any extra gate is drawn.
3(a) J277 2.4.1	H: 1 = the heater is on; 0 = the heater is off	**1**	Both meanings are needed for the mark.
3(b) J277 2.4.1	S AND L … AND NOT T Example answer: `H = (S AND L) AND NOT T`	**2**	1 mark per bullet. Accept the inputs in any order and with or without brackets, e.g. `S AND L AND NOT T`, `(NOT T) AND (S AND L)`, S ∧ L ∧ ¬T. Do not award the second mark for `NOT (S AND L AND T)`, `OR NOT T` or `AND T`.

QUESTION	ANSWER	MARKS	GUIDANCE
3(c) J277 2.4.1	AND gate with inputs S and L NOT gate with input T AND gate with the outputs of the first AND gate and the NOT gate as inputs, giving output H Example answer:  	**3**	1 mark per bullet. Accept the gates in another arrangement that gives the same result, e.g. L AND NOT T first, then AND with S. Accept one 3-input AND gate with inputs S, L and the NOT gate's output for bullets 1 and 3. Max 2 if any extra gate is drawn.
4(a) J277 2.4.1	An AND gate (in the box) Completed diagram:  	**1**	The shape must be an AND gate with no circle on the output. Do not accept an OR gate, or AND with a circle (NAND). Ignore labels.
4(b) J277 2.4.1	1 mark for each pair of rows (rows 1–2, 3–4, 5–6, 7–8): C A M **R** 0 0 0 **0** 0 0 1 **0** 0 1 0 **1** 0 1 1 **0** 1 0 0 **1** 1 0 1 **0** 1 1 0 **1** 1 1 1 **0**	**4**	Both outputs in a pair must be correct for the mark. Accept T/F for 1/0. R is 1 only when (C or A is 1) and M is 0. Follow through from an incorrect gate in 4(a) is **not** allowed: the table must match the scenario.

Total: 19 marks