Solutions

Each answer shows the steps, then the **result**.

2.1

- an OR gate with A and B as its inputs
- a NOT gate with C as its input
- both outputs feeding an AND gate, whose output is labelled X
- the OR and the NOT must both come **before** the AND: the brackets say so

2.2

- A OR B column correct: 0, 0, 1, 1, 1, 1, 1, 1
- NOT C column correct: 1, 0, 1, 0, 1, 0, 1, 0
- X column correct

A	B	C	A **OR** B	**NOT** C	X
0	0	0	0	1	0
0	0	1	0	0	0
0	1	0	1	1	**1**
0	1	1	1	0	0
1	0	0	1	1	**1**
1	0	1	1	0	0
1	1	0	1	1	**1**
1	1	1	1	0	0

- $X = 1$ only when $C = 0$ and at least one of A, B is 1

2.3

(a) **NAND**

(b) **NOR**

2.4

- row 001 gives NOT A AND NOT B AND C; row 110 gives A AND B AND NOT C
- $X =$ (NOT A AND NOT B AND C) OR (A AND B AND NOT C)

2.5

- the wire from B **branches**, with a **junction dot** drawn at the branch point; B is still a single input

3.1

(a) "A reads 1 and B reads 0" is A AND NOT B

- "or C reads 1" adds an OR with C: $X = (A$ AND NOT $B)$ OR C

(b) a NOT gate with B as its input

- an AND gate taking A and the NOT gate's output

- an OR gate taking that AND output and C directly, giving X
- C goes straight into the OR gate: nothing in the sentence acts on it first

3.2

(a) P column correct – P is NOT (A AND B), so it is 1 everywhere except the last two rows

- Q column correct – Q is 1 when B and C **differ**
- X column correct, $X = P$ AND Q

A	B	C	P	Q	X
0	0	0	1	0	0
0	0	1	1	1	**1**
0	1	0	1	1	**1**
0	1	1	1	0	0
1	0	0	1	0	0
1	0	1	1	1	**1**
1	1	0	0	1	0
1	1	1	0	0	0

(b) $X = 1$ on $ABC = 001$, 010 and 101

- in words: B and C must differ, and A and B must not both be 1

3.3

- row 000: NOT A AND NOT B AND NOT C
- row 011: NOT A AND B AND C
- row 110: A AND B AND NOT C, and the three ORed together

$X =$ (NOT A AND NOT B AND NOT C) OR (NOT A AND B AND C) OR (A AND B AND NOT

3.4

- an XOR gate with A and B as its inputs
- a NOT gate with C as its input
- both feeding an AND gate whose output is X
- the XOR symbol is the OR shape with a **second curved line** across its back; drawing a plain OR loses the first mark

3.5

- the brackets change which gate comes first: A AND (B OR C) ORs B and C **before** the AND, while (A AND B) OR C ANDs first and lets C reach the output on its own
- so in the second circuit $C = 1$ forces $X = 1$ whatever A is, which the first circuit does not do
- any row with $A = 0$ and $C = 1$ shows it, for example $A = 0$, $B = 0$, $C = 1$: the correct circuit gives $X = 0$ and the student's gives $X = 1$

- $A = 0$, $B = 1$, $C = 1$ is also accepted; a row where the two agree proves nothing