

Solutions

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

2.1

- NAND is the inverse of AND: output 0 only when both inputs are 1

A	B	NAND
0	0	1
0	1	1
1	0	1
1	1	0

- outputs (top to bottom): 1, 1, 1, 0

2.2

- output 1 when the two inputs are **different** → **XOR**

2.3

- X is 1 when A is 1 **or** B is 0
- $X = A \text{ OR } (\text{NOT } B)$

2.4

- AND of A with NOT B : $X = 1$ only when $A = 1$ and $B = 0$
- outputs (top to bottom): 0, 0, 1, 0

3.1

(a) A and B into an **OR** gate; C into a **NOT** gate

- the OR output and the NOT output into an **AND** gate → X

(b) $X = 1$ only when $(A \text{ or } B)$ is 1 **and** $C = 0$

A	B	C	X
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

- outputs (top to bottom): 0, 0, 1, 0, 1, 0, 1, 0

3.2

- tank not full → NOT A ; OR the manual switch B
- $X = (\text{NOT } A) \text{ OR } B$

3.3

- XOR is 1 when the inputs differ

A	B	XOR
0	0	0
0	1	1
1	0	1
1	1	0

- outputs: 0, 1, 1, 0
- use: e.g. compare two bits (equal → 0), or add two bits in a half-adder

3.4

- X is 0 only on the row $A = 1, B = 0$
- $X = (\text{NOT } A) \text{ OR } B$