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** $\rightarrow$ **XOR**

2.3

- X is 1 when A is 1 **or** B is 0
- $X = A$ OR (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 $\rightarrow X$

(b) $X = 1$ only when (A 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 $\rightarrow$ NOT A; OR the manual switch B
- $X =$ (NOT A) 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 $\rightarrow$ 0), or add two bits in a half-adder

3.4

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