

1.4 DATA TYPES & STRUCTURES · 1.4.3

Logic gates & truth tables — expanded worksheet

Original practice questions · 38 marks · about 55 minutes · spec 1.4.3(d)(a)

Instructions. Answer all questions. Marks are shown in brackets []. Notation: $\cdot$ = AND, $+$ = OR, $\neg$ = NOT, $\oplus$ = XOR. Use the standard gate symbols when drawing circuits.

1 Total: 2 marks

Draw a logic circuit representing the Boolean expression $Q = \neg(A \cdot B) + (C \cdot D)$. [2]

2 Total: 6 marks

A logic circuit produces output $P = (X \cdot \neg Y) + Z$.

(a) Complete the truth table for P. [4]

X	Y	Z	P
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

(b) State the value of P when $X = 1$, $Y = 0$, $Z = 1$. [1]

(c) Name the gate that produces $\neg Y$ from Y. [1]

3

Total: 3 marks

In a logic circuit, inputs A and B enter an AND gate. The output of that AND gate and input C enter an OR gate, giving output R.

(a) Write the Boolean expression for R. _____ **[2]**

(b) State the output R when $A = 1$, $B = 1$, $C = 0$. _____ **[1]**

4

Total: 8 marks

An incinerator has three pollution sensors S1, S2 and S3 (each outputs 1 if it detects unsafe levels). An alarm A must sound when **at least two** of the three sensors detect unsafe levels.

- (a) Draw a logic circuit for this system, showing inputs S1, S2, S3 and output A. [4]

- (b) Complete the truth table for the system. [4]

S1	S2	S3	A
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

5

Total: 6 marks

- (a) Complete the output of each gate for inputs A = 1, B = 0. [4]

Gate	AND	OR	XOR	NAND
Output				

- (b) Name the single gate that is equivalent to $\neg(A \cdot B)$. [1]

- (c) Name the gate that outputs 1 only when its two inputs are different. [1]

6

Total: 6 marks

A circuit produces output $M = (A \cdot B) + (\neg A \cdot C)$.

(a) Complete the truth table for M.

[4]

A	B	C	M
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

(b) This circuit is a 2-to-1 multiplexer with A as the selector. In words, describe what M outputs depending on A.

[2]

7

Total: 7 marks

A circuit must output 1 when **exactly one** of its two inputs A and B is 1.

(a) Name the single logic gate that does this. _____

[1]

(b) Write a Boolean expression for this output using only AND, OR and NOT. _____

[2]

(c) Draw a logic circuit for your expression in part (b), using only AND, OR and NOT gates.

[4]

END OF WORKSHEET · 38 MARKS