# Worksheet 5 Logic Gates Answers

**Task 1**

1. Write the following Boolean expressions using Boolean notation:

 (a) (A AND B) OR NOT (D AND E) $(A • B) + (\overline{D • E})$

 (b) NOT A AND NOT (B OR C) $\overline{A} • (\overline{B + C})$

 (c) (A AND B) OR (B AND (NOT C)) $(A • B) + (B • \overline{C})$

2. (a) Complete the truth table for the following logic circuit.



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Input A** | **Input B** | **Input C** | **P = A OR B** | **Q = NOT C** | **Output R = (A OR B) AND (NOT C)** |
| 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 |

 (b) Write a Boolean expression to represent this circuit, using Boolean notation.

 $(A + B) • \overline{C}$

3. Draw logic circuits to represent the following Boolean expressions, and in each case say what is output if A = 1, B = 0 and C = 1, showing the output from each gate.

 (a) Q = NOT ((A OR B) AND C)



 Output: 0

 (b) Q = A  **•** (NOT (B + C))



 Output: 0

**Task 2**

1. Draw the truth tables for the following logic circuits:

 (a) $A ⊕ B$

|  |  |  |
| --- | --- | --- |
| **Input A** | **Input B** | **Output Q** |
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

 (b) $(\overline{A • B}) + \overline{C} $

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Input A** | **Input B** | **Input C** | **P = NOT (A AND B)** | **NOT C** | **Q = (NOT A AND B) OR NOT C** |
| 0 | 0 | 0 | 1 | 1 | 1 |
| 0 | 0 | 1 | 1 | 0 | 1 |
| 0 | 1 | 0 | 1 | 1 | 1 |
| 0 | 1 | 1 | 1 | 0 | 1 |
| 1 | 0 | 0 | 1 | 1 | 1 |
| 1 | 0 | 1 | 1 | 0 | 1 |
| 1 | 1 | 0 | 0 | 1 | 1 |
| 1 | 1 | 1 | 0 | 0 | 0 |

 (c) Draw the logic circuit for the expression: $(\overline{A • B}) + \overline{C}$



2. Draw truth tables for each of the following logic circuits to show that they are equivalent.



 (i) (ii)

 Truth table (i) Truth table (ii)

|  |  |  |
| --- | --- | --- |
| **Input A** | **Input B** | **Output Q** |
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

|  |  |  |  |
| --- | --- | --- | --- |
| **Input A** | **Input B** | **P =** **NOT (A AND B)** | **Q =** **NOT (P AND P)** |
| 0 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 1 |

3. (a) Write the following Boolean expression using Boolean notation:

 (A XOR B) AND (NOT (C XOR D))

 $(A ⊕ B) • (\overline{C ⊕ D})$

 (b) Draw the logic diagram using only XOR, NAND and NOR gates, showing the output from each gate if the inputs for A, B, C and D are all 1.

