4.6.5 Boolean Algebra

NOTE: Only one example is shown for each answer, but multiple possible methods exist.

1) Using the rules of Boolean algebra, simplify the following Boolean expression.

$$\overline{\left(\overline{A} + A \cdot (A + B)\right)} + \left(\overline{B} \cdot \overline{C}\right)$$

You **must** show your working

[4 marks]

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2) Using the laws of Boolean algebra, show that:

$$(A + B) \cdot (B + C \cdot (D + \overline{D})) = A \cdot C + B$$

You **must** show your working

[4 marks]

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3) Identities are often applied to help simplify Boolean expressions. One such identity is:

$$A \cdot \overline{A} = 0$$

Without using a truth table, explain why this identity is true.

[2 marks]

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4) Using the laws of Boolean algebra, simplify the following Boolean expression.

$$\overline{\overline{\overline{B} \cdot A} \cdot \overline{B}} + A \cdot B$$

You **must** show your working

[4 marks]

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5) Using the laws of Boolean algebra, simplify the following Boolean expression.

$$\overline{\overline{\mathrm{A} \cdot (A + 1)} \cdot \overline{B}} \cdot \overline{\overline{\mathrm{A}} + \overline{B + 0}}$$

You **must** show your working

[4 marks]

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6)

a) Complete the truth table in **Figure 1** for the inputs A and B.

Figure 1

A	B	$A + B$	$\overline{A}$	$\overline{B}$	$\overline{A} \cdot \overline{B}$	$\overline{\overline{A} \cdot \overline{B}}$
0	0					
0	1					
1	0					
1	1					

[1 mark]

b) What law in Boolean algebra does this demonstrate?

[1 mark]

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7) Using the laws of Boolean algebra, simplify the following Boolean expression.

$$\overline{\overline{A} + B \cdot C + B \cdot \overline{C}} + C \cdot (A + \overline{A} \cdot (B + 1))$$

You **must** show your working

[4 marks]

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8) Using the laws of Boolean algebra, simplify the following Boolean expression.

$$A \cdot \overline{B} + B \cdot \overline{\overline{A} + (\overline{B} \cdot C)}$$

You **must** show your working

[4 marks]

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9) Using the rules of Boolean algebra, simplify the following Boolean expression.

$$\overline{A} \cdot (B \cdot C \cdot D + B \cdot C \cdot \overline{D} + B) + \overline{\overline{A} + B}$$

You **must** show your working

[4 marks]

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10) **Table 1** lists six Boolean equations. Three of them are correct, the others are not. Tick the cells next to the **three** equations are correct.

Table 1

Equation	Tick
$A \cdot \overline{A} = 1$	
$A + B = \overline{\overline{A} \cdot \overline{B}}$	
$A + 1 = 1$	
$A \cdot (A + B) = A$	
$A + (A \cdot B) = B$	
$A \cdot 1 = 1$	

[3 marks]

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11) Using the rules of Boolean algebra, simplify the following Boolean expression.

$$\overline{\overline{A} + \overline{B}} + B \cdot \overline{A}$$

You **must** show your working
