<table>
<tr><td>1</td><td>1</td><td>Mark is for AO1 (knowledge)

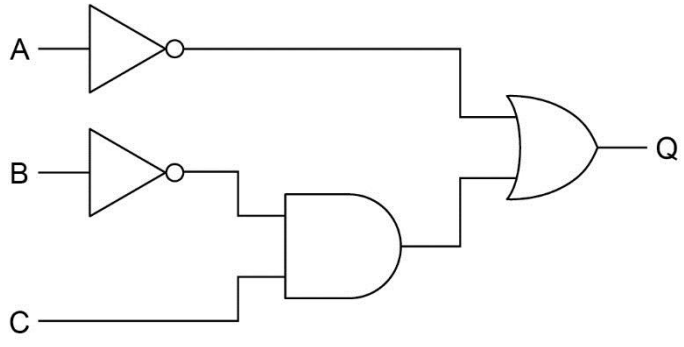
XOR // Exclusive OR // EOR // EXOR;</td><td>1</td></tr>
<tr><td>1</td><td>2</td><td>Mark is for AO1 (knowledge)

1 mark for correct column Q;

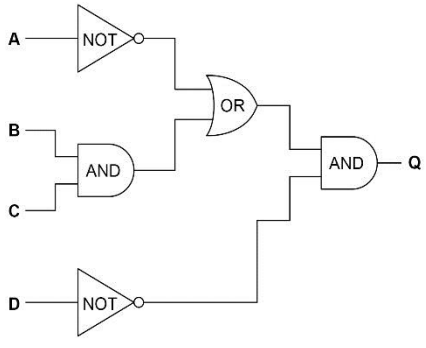
<table><tr><th>A</th><th>B</th><th>Q</th></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table></td><td>1</td></tr>
<tr><td>1</td><td>3</td><td>Marks are for AO2 (apply)

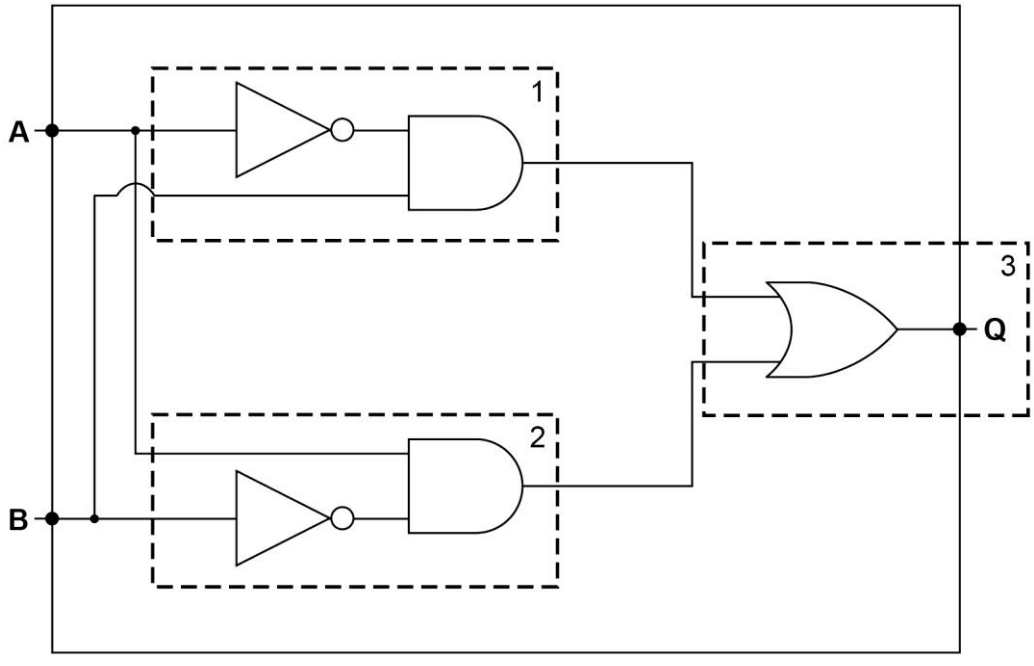
1 mark for having A and B connected to (different) NOT gates;

1 mark for an AND gate connected to C and to the output of a NOT gate;

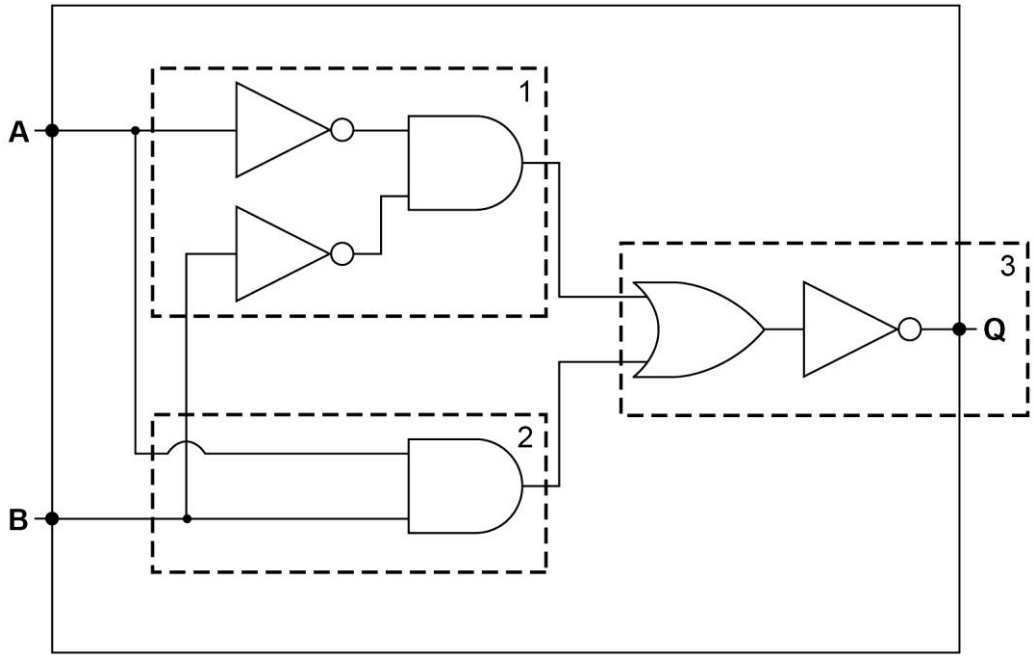
1 mark for an OR gate connected to NOT A and NOT B AND C and outputting to Q;</td><td>3</td></tr>
<tr><td></td><td></td><td> 

Max 2 if circuit not fully correct.</td><td></td></tr>
</table>

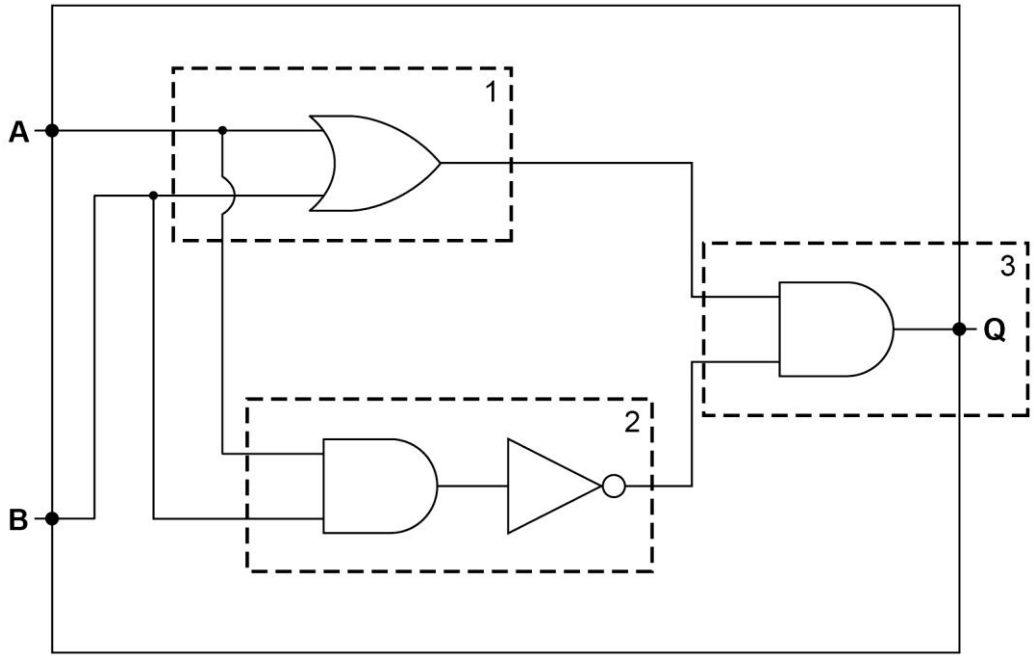
2	1	**Mark is for AO1 (knowledge)** NOR;	1
2	2	**Marks are for AO2 (apply)** **Mark as follows** **1 mark** for B and C into AND gate **1 mark** for the result of B and C (**I.** incorrect gate) as one input and a NOT gated A as a second input to an OR gate **1 mark** D connected to NOT gate and output of this to an AND gate, the results of A, B and C (**I.** previously incorrect gates) as the other input, with the output going into Q **MAX 2** if not fully correct  	3
2	3	**Mark is for AO1 (understanding)** OR; **A**. A+B // +	1

3	1	**Mark is for AO1 (knowledge)** **A** | **B** | **A NAND B** 0 | 0 | 1 0 | 1 | 1 1 | 0 | 1 1 | 1 | 0	1
3	2	**3 marks are for AO2 (apply)** **1 mark** for getting Part 1 **or** Part 2 correct on any of the three diagrams. **1 mark** for getting **corresponding** Part 1 **or** Part 2 correct on the same diagram. **1 mark** for getting **corresponding** Part 3 correct on the same diagram. **MAX 2** if not fully correct Mark response against diagram that will give the highest mark. Mark point 3 can only be awarded if at least one other mark point has been awarded. di Alternative Diagram 1  	3

Alternative Diagram 2

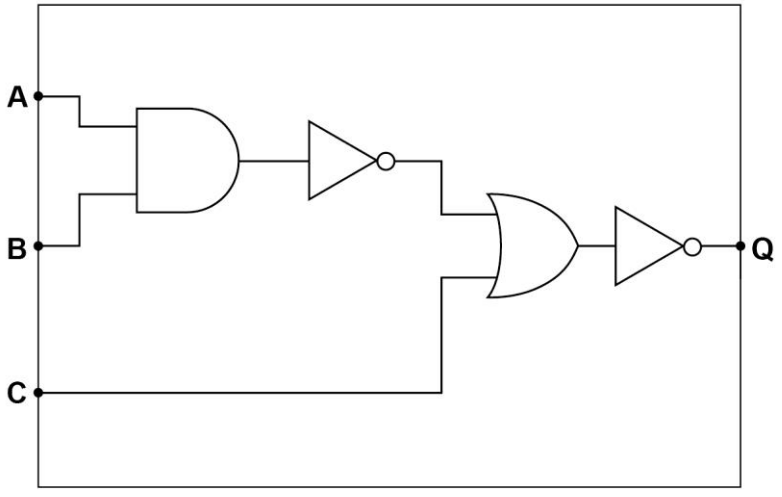
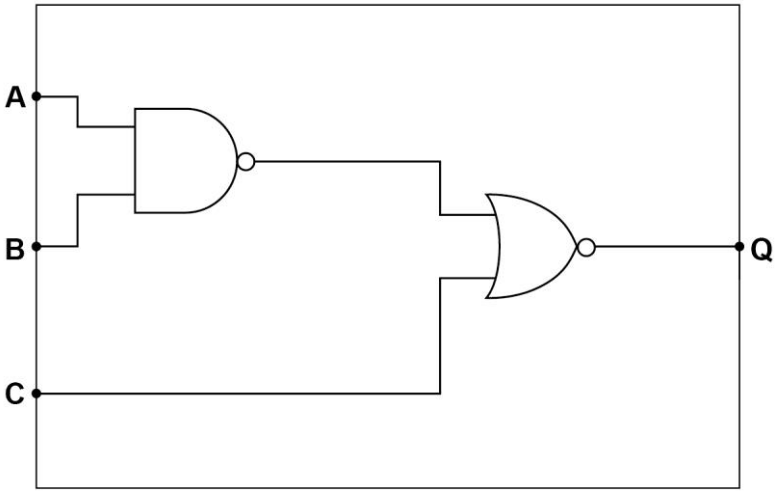


Alternative Diagram 3



Qu	Pt	Marking Guidance	Marks
4	1	**Mark is for AO1 (knowledge)** NOR;	1

Qu	Pt	Marking Guidance	Marks
4	2	**Mark is for AO1 (knowledge)** NAND; **R.** NOT AND	1

Qu	Pt	Marking Guidance	Marks
4	3	**Marks are for AO2 (application)** **1 mark** for each design point A and B are connected to the inputs of an AND gate and the output of the AND gate connected to the input of a NOT gate // A and B connected to the inputs of a NAND gate; The final two gates in the circuit are an OR gate followed by a NOT gate // The final gate in the circuit is a NOR gate; **A.** award 2 marks if the candidate has correctly simplified the Boolean expression and drawn a fully correct logic circuit. **MAX 1** if circuit does not correctly reflect the Boolean expression. **Possible answers:**   	2

<table>
<tr><th>Qu</th><th>Pt</th><th>Marking Guidance</th><th>Marks</th></tr>
<tr><td>4</td><td>4</td><td>
Marks are for AO2 (analyse)

1 mark for showing the correct truth table column for $\left(\mathrm{A}+\overline{\mathrm{B}}\right)\cdot\mathrm{B}$;

1 mark for showing the correct truth table column for $\left(\mathrm{A}+\overline{\mathrm{B}}\right)$;

<table>
<tr><th>$\mathbf{A}$</th><th>$\mathbf{B}$</th><th>$\overline{\mathbf{B}}$</th><th>$\left(\mathbf{A}+\overline{\mathbf{B}}\right)$</th><th>$\left(\mathbf{A}+\overline{\mathbf{B}}\right)\cdot\mathbf{B}$</th></tr>
<tr><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td></tr>
</table>
1 mark for showing the correct answer as $\mathrm{A}\cdot\mathrm{B}$;
</td><td>3</td></tr>
</table>

Qu	Pt	Marking Guidance	Marks
5	1	**Marks are for AO2 (application)** **1 mark** for each highlighted column L, N and Y completed correctly. **A**. Follow through for Y if column N is completed incorrectly.	3

A	B	C	L	M	N	X	Y
0	0	0	0	0	0	0	0
0	0	1	0	0	0	1	0
0	1	0	1	0	0	1	0
0	1	1	1	1	0	0	1
1	0	0	1	0	0	1	0
1	0	1	1	1	0	0	1
1	1	0	0	0	1	0	1
1	1	1	0	0	1	1	1

Qu	Pt	Marking Guidance	Marks
5	2	**Marks are for AO2 (application)** **2 marks:** $(A \oplus B) \cdot C + A \cdot B$ // $((A \cdot \bar{B}) + (\bar{A} \cdot B)) \cdot C + A \cdot B$ // $(\bar{A} \cdot B \cdot C) + (A \cdot (B + C))$ // **1 mark** for one of the following somewhere in the expression: • $(A \oplus B) \cdot C$ **I.** presence / absence of brackets around $A \oplus B$ • $((A \cdot \bar{B}) + (\bar{A} \cdot B)) \cdot C$ • $A \cdot B$ **Note:** If using a different algebraic notation refer to team leader.	2

Qu	Pt	Marking Guidance	Marks
06	1	**Mark is for AO1 (knowledge)** XOR // EXOR // EX-OR // Exclusive-OR // EOR;	1

<table>
<tr><th>Qu</th><th>Pt</th><th>Marking Guidance</th><th>Marks</th></tr>
<tr><td>06</td><td>2</td><td>
Marks are for AO2 (application)

1 mark for columns L and M correct

1 mark for column Z correct
A. follow through of incorrect values in columns L and M
<table>
<tr><th>A</th><th>B</th><th>C</th><th>L</th><th>M</th><th>Z</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
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<tr><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
</table>
R. Entire column if more than one value shown in any cell of that column.
</td><td>2</td></tr>
</table>

<table>
<tr><th>Qu</th><th>Pt</th><th>Marking Guidance</th><th>Marks</th></tr>
<tr><td>06</td><td>3</td><td>
Marks are for AO2 (application)

Award full marks for showing correct expression:

$\mathrm{Q} = \overline{\overline{\mathrm{A}}.\,\mathrm{B}.\,(\mathrm{C}+\mathrm{D})}$

Max 2 marks for showing partially correct expression:

1 mark for showing $\overline{\mathrm{A}}.\,\mathrm{B}$

1 mark for showing of $\mathrm{C}+\mathrm{D}$

1 mark for using AND and NOT gates to combine and invert subexpressions

Full marks should be awarded for equivalent expressions.
</td><td>3</td></tr>
</table>

Qu	Pt	Marking Guidance	Marks
06	4	**Marks are for AO2 (application)** Marking guidance for examiners • Award marks for working out until an incorrect step has been made. • If, in any one step, a candidate is simplifying different parts of an expression simultaneously award all relevant marks for this multiple stage but don't award any further marks for working in any parts simplified incorrectly. Example, if the expression P.P.(P+Q) + P.P.1 was changed to P.(P+Q) + P.0, the candidate would get one mark for simplifying the first part to P.(P+Q) and could get further marks for correctly simplifying this part of the expression further but should not be awarded marks for simplifying the incorrectly changed part P.0 (ie to 0). Award up to **3 marks** for working. **1 mark per application** of a technique that produces a simplified expression. Of the 3 working marks **award at most 1 mark for correctly applying the Distributive Law** to expand or introduce brackets. **Note:** A simpler expression is one that is logically equivalent to the original expression but uses fewer logical operators. **1 mark** for final answer: $X \cdot Z + X \cdot Y + W \cdot Z$ or $X \cdot (Z + Y) + W \cdot Z$ **Example working 1:** $\overline{W} \cdot X \cdot Z + W \cdot Z + X \cdot Y \cdot \overline{Z} + \overline{W} \cdot X \cdot Y \cdot 1$ $\overline{W} \cdot X \cdot Z + W \cdot Z + X \cdot Y \cdot \overline{Z} + \overline{W} \cdot X \cdot Y$ Identity $A.1 = A$ $Z \cdot (\overline{W} \cdot X + W) + X \cdot Y \cdot \overline{Z} + \overline{W} \cdot X \cdot Y$ Distributive, put into brackets $Z \cdot (X + W) + X \cdot Y \cdot \overline{Z} + \overline{W} \cdot X \cdot Y$ $\overline{A}.B + A = B + A$ $X \cdot Z + W \cdot Z + X \cdot Y \cdot \overline{Z} + \overline{W} \cdot X \cdot Y$ Distributive, expand brackets $X \cdot \left(Z + Y \cdot \overline{Z}\right) + W \cdot Z + \overline{W} \cdot X \cdot Y$ Distributive, put into brackets $X \cdot (Z + Y) + W \cdot Z + \overline{W} \cdot X \cdot Y$ $\overline{A}.B + A = B + A$ $X \cdot Z + X \cdot Y + W \cdot Z + \overline{W} \cdot X \cdot Y$ Distributive, expand brackets $X \cdot Z + X \cdot Y \cdot \left(1 + \overline{W}\right) + W \cdot Z$ Distributive $X \cdot Z + X \cdot Y + W \cdot Z$ Identity $1 + A = A$ $X \cdot (Z + Y) + W \cdot Z$ (optional step)	4

Example working 2 :

$\bar{W}.X.Z+W.Z+X.Y.\bar{Z}+\bar{W}.X.Y.1$	
$\bar{W}.X.Z+W.Z+X.Y.\bar{Z}+\bar{W}.X.Y$	Identity A.1 = A
$Z.(\bar{W}.X+W) + X.Y.\bar{Z}+\bar{W}.X.Y$	Distributive, put into brackets
$Z.(X+W) + X.Y.\bar{Z}+\bar{W}.X.Y$	Identity $\bar{A}.B + A = B + A$
$Z.X + Z.W + X.Y.\bar{Z}+\bar{W}.X.Y$	Distribution, expand brackets
$Z.W + Z.X + X.Y.\bar{Z}+\bar{W}.X.Y$	Re-arrange terms
$Z.W+ X(Z+\bar{Z}.Y) + \bar{W}.X.Y$	Distribution, put into brackets
$Z.W+ X(Y + Z) + \bar{W}.X.Y$	Identity $\bar{A}.B + A = B + A$
$Z.W + X.Y + X.Z + \bar{W}.X.Y$	Distribution, expand brackets
$X.Z + Z.W + X.Y + \bar{W}.X.Y$	Re-arrange terms
$X.Z + Z.W + X.Y$	Identity A + A.B = A