

QUESTION 6.



4 (a) (i)	Circuit 1			1
	A	B	X	
	0	0	1	
	0	1	1	
	1	0	1	
	1	1	0	



(ii)	<table border="1"> <tr> <th colspan="3">Circuit 2</th></tr> <tr> <th>A</th><th>B</th><th>X</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>	Circuit 2			A	B	X	0	0	1	0	1	1	1	0	1	1	1	0	1
Circuit 2																				
A	B	X																		
0	0	1																		
0	1	1																		
1	0	1																		
1	1	0																		
(b) (i)	- circuit 1: $\overline{A.B}$ - circuit 2: $\overline{A} + \overline{B}$	1 1																		
(ii)	$\overline{A.B} \equiv \overline{A} + \overline{B}$	1																		
(c)	$\overline{\overline{(A+B).B}}$ Mark as follows: $\overline{(A+B)}$ $\overline{.B}$ bar over whole expression	1 1 1 1																		
(d)	$\overline{\overline{(A+B).B}}$ $= \overline{\overline{(A+B)} + \overline{B}}$ $= (A+B) + \overline{B}$ $= A + (B + \overline{B})$ $= A + 1$ $= 1$ allow ft from (c)	1 1 1 1 1 1 [max 3]																		

QUESTION 7.

Cambridge International A Level – October/November 2016



4 (a) (i)

Input		Output	
X	Y	A	B
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

1 mark for each
correct column
(A and B)

[2]

(ii) Half adder

[1]

(iii) C // Carry
S // Sum

[1]

[1]

represents the carry part of the addition of two bits

[1]

represents the sum part of the addition of two bits

[1]

(b) (i) A.

[1]

(A.B + C)

[1]

(ii) Allow follow through from (b)(i)

A.(A.B+C)

= A.A.B + A.C

= A.B + A.C

= A.(B+C)

1 mark for each correct simplification line – max 2

[2]

1 mark for A.(B+C) if correct answer to part (b)(i)

[1]

QUESTION 8.

Cambridge International A Level – October/November 2016



5 (a) (i)

Input			Working space	Output	
P	Q	R		J	K
0	0	0		0	0
0	0	1		0	1
0	1	0		0	1
0	1	1		1	0
1	0	0		0	1
1	0	1		1	0
1	1	0		1	0
1	1	1		1	1

1 mark each column

If zero marks then
6 or 7 pairs correct – 1 mark

[2]

(ii) Full adder

[1]

(iii) C / Carry

[1]

S / Sum

[1]

represents the carry part of the addition of three bits

[1]

represents the sum part of the addition of three bits

[1]

(b) (i) A.

[1]

$$(A+B).C$$

[1]

(ii) Allow follow through from (b)(i)

$$A. ((A+B).C)$$

$$= A.(A.C + B.C)$$

$$= A.A.C + A.B.C$$

$$= A.C + A.B.C$$

$$= A.C (1 + B)$$

$$= A.C.1$$

$$= A.C$$

1 mark for each correct simplification line – max 3 [3]

1 mark for A.C if correct answer to part (b)(i) [1]

[4]

QUESTION 9.



Question	Answer																																																		
3(a)	$X = A.(\bar{B} + (B . C))$ $B.C$ $\bar{B} + B.C$ $A.$					1 1 1																																													
3(b)	<table border="1"><thead><tr><th>A</th><th>B</th><th>C</th><th>Working Space</th><th>X</th></tr></thead><tbody><tr><td>0</td><td>0</td><td>0</td><td></td><td>0</td></tr><tr><td>0</td><td>0</td><td>1</td><td></td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td><td></td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td><td></td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td><td></td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td><td></td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td><td></td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td></td><td>1</td></tr></tbody></table> 1 mark first four entries, 1 mark for the last four entries					A	B	C	Working Space	X	0	0	0		0	0	0	1		0	0	1	0		0	0	1	1		0	1	0	0		1	1	0	1		1	1	1	0		0	1	1	1		1	2
A	B	C	Working Space	X																																															
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1	1	1		1																																															
3(c)(i)	AB <table border="1"><tr><td></td><td></td><td>00</td><td>01</td><td>11</td><td>10</td></tr><tr><td>C</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td></tr><tr><td></td><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td></tr></table>							00	01	11	10	C	0	0	0	0	1		1	0	0	1	1	1																											
		00	01	11	10																																														
C	0	0	0	0	1																																														
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3(c)(ii)	AB <table border="1"><tr><td></td><td></td><td>00</td><td>01</td><td>11</td><td>10</td></tr><tr><td>C</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td></tr><tr><td></td><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td></tr></table>							00	01	11	10	C	0	0	0	0	1		1	0	0	1	1	2																											
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C	0	0	0	0	1																																														
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3(c)(iii)	$X = A.\bar{B} + A.C$ 1 1					2																																													
3(d)	$X = A.(\bar{B} + (B . C))$ $X = A.(\bar{B} + C)$ $X = A.\bar{B} + A.C$					1 2 1 (dependent mark – must be correct outcome from previous line)																																													

QUESTION 10.



Question	Answer																																														
3(a)	$S = (\overline{P} + (\overline{Q+R})) \cdot R$ $\overline{P}$ $(\overline{Q+R})$ $(\overline{P} + (\overline{Q+R}))$ $\cdot R$ (must be outside final brackets) Or $\overline{P}$ $(\overline{Q+R})$ $\overline{P} + (\overline{Q+R})$ $(\dots\dots\dots) \cdot R$	1 1 1 1 1 1 1 1																																													
3(b)	<table><tr><th>P</th><th>Q</th><th>R</th><th>Working space</th><th>S</th></tr><tr><td>0</td><td>0</td><td>0</td><td></td><td>0</td></tr><tr><td>0</td><td>0</td><td>1</td><td></td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td><td></td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td><td></td><td>1</td></tr><tr><td>1</td><td>0</td><td>0</td><td></td><td>0</td></tr><tr><td>1</td><td>0</td><td>1</td><td></td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td><td></td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td></td><td>0</td></tr></table> 2 marks all correct, 1 mark seven correct, 0 marks six or fewer correct	P	Q	R	Working space	S	0	0	0		0	0	0	1		1	0	1	0		0	0	1	1		1	1	0	0		0	1	0	1		0	1	1	0		0	1	1	1		0	2
P	Q	R	Working space	S																																											
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3(c)(i)	<table><tr><th colspan="2"></th><th colspan="4">PQ</th></tr><tr><th colspan="2"></th><th>00</th><th>01</th><th>11</th><th>10</th></tr><tr><th rowspan="2">R</th><th>0</th><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><th>1</th><td>1</td><td>1</td><td>0</td><td>0</td></tr></table>			PQ						00	01	11	10	R	0	0	0	0	0	1	1	1	0	0	1																						
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		00	01	11	10																																										
R	0	0	0	0	0																																										
	1	1	1	0	0																																										
3(c)(ii)	<table><tr><th colspan="2"></th><th colspan="4">PQ</th></tr><tr><th colspan="2"></th><th>00</th><th>01</th><th>11</th><th>10</th></tr><tr><th rowspan="2">R</th><th>0</th><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><th>1</th><td>1</td><td>1</td><td>0</td><td>0</td></tr></table>			PQ						00	01	11	10	R	0	0	0	0	0	1	1	1	0	0	1																						
		PQ																																													
		00	01	11	10																																										
R	0	0	0	0	0																																										
	1	1	1	0	0																																										
3(c)(iii)	$S = \overline{P} \cdot R$	1																																													



Question	Answer	
3(d)	$S = (\bar{P} + (\overline{Q+R})) \cdot R$ $S = (\bar{P} + (\bar{Q} \cdot \bar{R})) \cdot R \quad // \quad \bar{P} \cdot R + (\overline{Q+R}) \cdot R$ $S = (\bar{P} \cdot R) + (\bar{Q} \cdot \bar{R} \cdot R)$ $S = \bar{P} \cdot R + \bar{Q} \cdot 0$ $S = \bar{P} \cdot R + 0$ $S = \bar{P} \cdot R$	1 1)) 1

Question	Answer	Marks
3(a)	1 mark per bullet point to max 3: • Correct use of Idempotent law $Y = Y.Y$ $Y = Y + Y$ • Correct use of Complement law $0 = Y.\bar{Y}$ $1 = Y + \bar{Y}$ • Correct use of Distributive law $X(Y + Z) = X.Y + X.Z$ • Correct use of Redundancy law $X.\bar{Y} + Y = X + Y$ • Correct use of identity law $X.1 = X$ 1 mark for the correct answer For example: $X = A.\bar{B}.\bar{C} + A.B.\bar{C} + A.B.C$ $X = A.\bar{B}.\bar{C} + A.B.\bar{C} + A.B.\bar{C} + A.B.C$ $X = A.\bar{C}.(B + \bar{B}) + A.B.(C + \bar{C})$ $X = A.\bar{C} + A.B$ $X = A.(C + \bar{C})$ Idempotent law Distributive law Complement/Inverse law Correct answer $X = A.\bar{B}.\bar{C} + A.B.\bar{C} + A.B.C$ $X = A.\bar{C}.(B + \bar{B}) + A.B.C$ $X = A.\bar{C} + A.B.C$ $X = A.(C + B.C)$ $X = A.(C + B)$ Distributive law Complement/Inverse law Redundancy Law Correct answer	4

Question	Answer	Marks																																				
3(b)(i)	1 mark for first four as 0, 1 mark for 1011 <table><tr><th>A</th><th>B</th><th>C</th><th>X</th></tr><tr><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></tr><tr><td>0</td><td>1</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td></tr></table> 1 mark 1 mark	A	B	C	X	0	0	0	0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	0	1	1	0	1	0	1	1	0	1	1	1	1	1	2
A	B	C	X																																			
0	0	0	0																																			
0	0	1	0																																			
0	1	0	0																																			
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1	0	0	1																																			
1	0	1	0																																			
1	1	0	1																																			
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3(b)(ii)	1 mark for correct K-map AB <table><tr><td></td><td>00</td><td>01</td><td>11</td><td>10</td></tr><tr><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td></tr></table> C		00	01	11	10	0	0	0	1	1	1	0	0	1	0	1																					
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0	0	0	1	1																																		
1	0	0	1	0																																		

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Question	Answer	Marks																									
3(b)(iii)	1 mark for each correct loop to max 2 AB <table><tr><td></td><td>00</td><td>01</td><td>11</td><td>10</td></tr><tr><td>C</td><td>0</td><td>0</td><td>0</td><td>1</td></tr><tr><td></td><td>0</td><td>0</td><td>1</td><td>1</td></tr><tr><td></td><td>1</td><td>0</td><td>0</td><td>1</td></tr></table>		00	01	11	10	C	0	0	0	1		0	0	1	1		1	0	0	1	2					
	00	01	11	10																							
C	0	0	0	1																							
	0	0	1	1																							
	1	0	0	1																							
3(b)(iv)	1 mark per bullet point: • $A\bar{C}$ • $+ A.B$ $X = A\bar{C} + A.B$	2																									
3(c)(i)	1 mark per bullet point to max 2: • Correct column headings and row headings – values only • Correct column headings and row headings – order 1 mark for 2 correct rows or columns, 2 marks for 4 correct rows or columns (based on headings) AB <table><tr><td></td><td>00</td><td>01</td><td>11</td><td>10</td></tr><tr><td>CD</td><td>00</td><td>0</td><td>1</td><td>1</td></tr><tr><td></td><td>01</td><td>0</td><td>0</td><td>1</td></tr><tr><td></td><td>11</td><td>0</td><td>0</td><td>1</td></tr><tr><td></td><td>10</td><td>0</td><td>0</td><td>1</td></tr></table>		00	01	11	10	CD	00	0	1	1		01	0	0	1		11	0	0	1		10	0	0	1	4
	00	01	11	10																							
CD	00	0	1	1																							
	01	0	0	1																							
	11	0	0	1																							
	10	0	0	1																							

Question	Answer	Marks																									
3(c)(ii)	1 mark for each correct loop to max 2: AB <table><tr><td></td><td>00</td><td>01</td><td>11</td><td>10</td></tr><tr><td>00</td><td>0</td><td>1</td><td>1</td><td>0</td></tr><tr><td>01</td><td>0</td><td>0</td><td>1</td><td>0</td></tr><tr><td>11</td><td>0</td><td>0</td><td>1</td><td>0</td></tr><tr><td>10</td><td>0</td><td>0</td><td>1</td><td>0</td></tr></table> CD		00	01	11	10	00	0	1	1	0	01	0	0	1	0	11	0	0	1	0	10	0	0	1	0	2
	00	01	11	10																							
00	0	1	1	0																							
01	0	0	1	0																							
11	0	0	1	0																							
10	0	0	1	0																							
3(c)(iii)	1 mark per bullet point: - A.B + B.C̄.D̄ X = A.B + B.C̄.D̄	2																									

QUESTION 12.



Question	Answer																										
3(a)	NOR																										
3(b)(i)	1 mark for X column, 1 mark for Y column <table><tr><th>A</th><th>B</th><th>Working Space</th><th>X</th><th>Y</th></tr><tr><td>0</td><td>0</td><td></td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td></td><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td><td></td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td></td><td>1</td><td>0</td></tr></table>	A	B	Working Space	X	Y	0	0		0	0	0	1		0	1	1	0		0	1	1	1		1	0	
A	B	Working Space	X	Y																							
0	0		0	0																							
0	1		0	1																							
1	0		0	1																							
1	1		1	0																							
3(b)(ii)	Half adder	1																									
3(b)(iii)	1 mark per bullet X is (used for) <u>carry</u> Y is (used for) <u>sum</u>	2																									
3(c)	1 mark per bullet for working (max 4) $\overline{A}.\overline{B}.\overline{C}.\overline{D} + \overline{A}.\overline{B}.\overline{C}.D + \overline{A}.\overline{B}.C.\overline{D} + \overline{A}.\overline{B}.C.D + \overline{A}.B.\overline{C}.\overline{D}$$= \overline{A}.\overline{B}.\overline{C}.\overline{D} + \overline{A}.\overline{B}.\overline{C}.D + \overline{A}.\overline{B}.C.\overline{D} + \overline{A}.\overline{B}.C.D + \overline{A}.B.\overline{C}.\overline{D} + \overline{A}.B.\overline{C}.\overline{D}$ • Adding in a second copy of the first term (Use of Idempotent Law) $= \overline{A}.\overline{B}.(\overline{C}.\overline{D} + \overline{C}.D + C.\overline{D} + C.D) + \overline{A}.\overline{C}.\overline{D}.(B + \overline{B})$ • Taking $\overline{A}.\overline{B}$ and $\overline{A}.\overline{C}.\overline{D}$ outside brackets (Associative Law) $= \overline{A}.\overline{B}.(\overline{C}.(\overline{D} + D) + C.(D + \overline{D})) + \overline{A}.\overline{C}.\overline{D}.(B + \overline{B})$ • Grouping $\overline{C}.(\overline{D} + D) + C.(D + \overline{D})$ (Associative Law and Commutative Law) $= \overline{A}.\overline{B}.(\overline{C}.(1) + C.(1)) + \overline{A}.\overline{C}.\overline{D}.(1)$$= \overline{A}.\overline{B}.(\overline{C} + C) + \overline{A}.\overline{C}.\overline{D}.(1)$$= \overline{A}.\overline{B}.(1) + \overline{A}.\overline{C}.\overline{D}.(1)$ • Replacing $(D + \overline{D})$ with 1 and replacing $(\overline{C} + C)$ with 1 (Use of Complement Law) $= \overline{A}.\overline{B} + \overline{A}.\overline{C}.\overline{D}$ • Reducing first four terms to $\overline{A}.\overline{B}$ and reducing last two terms to $\overline{A}.\overline{C}.\overline{D}$ (Use of Identity Law) 1 mark for correct answer $= \overline{A}.(\overline{B} + \overline{C}.\overline{D})$	5																									

QUESTION 13.



Question	Answer	Marks															
3(a)(i)	AB <table><tr><td></td><td>00</td><td>01</td><td>11</td><td>10</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td></tr></table> C		00	01	11	10	0	1	1	0	1	1	1	1	0	1	1
	00	01	11	10													
0	1	1	0	1													
1	1	1	0	1													
3(a)(ii)	1 mark for each correct loop AB <table><tr><td></td><td>00</td><td>01</td><td>11</td><td>10</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td></tr></table> C		00	01	11	10	0	1	1	0	1	1	1	1	0	1	2
	00	01	11	10													
0	1	1	0	1													
1	1	1	0	1													
3(a)(iii)	1 mark per bullet point $\overline{A}$ $+ \overline{B}$ $X = \overline{A} + \overline{B}$	2															



Question	Answer																															
3(b)(i)	1 mark correct values and order of row and column headings 3 marks fully correct table entries (based on headings) or 2 marks table entries contain one error (based on headings) or 1 mark table entries contain two errors (based on headings) AB <table><tr><td></td><td></td><td>00</td><td>01</td><td>11</td><td>10</td></tr><tr><td></td><td>00</td><td>0</td><td>0</td><td>1</td><td>1</td></tr><tr><td></td><td>01</td><td>0</td><td>0</td><td>1</td><td>1</td></tr><tr><td>CD</td><td>11</td><td>1</td><td>1</td><td>0</td><td>0</td></tr><tr><td></td><td>10</td><td>1</td><td>1</td><td>0</td><td>0</td></tr></table>			00	01	11	10		00	0	0	1	1		01	0	0	1	1	CD	11	1	1	0	0		10	1	1	0	0	
		00	01	11	10																											
	00	0	0	1	1																											
	01	0	0	1	1																											
CD	11	1	1	0	0																											
	10	1	1	0	0																											
3(b)(ii)	1 mark per loop AB <table><tr><td></td><td></td><td>00</td><td>01</td><td>11</td><td>10</td></tr><tr><td></td><td>00</td><td>0</td><td>0</td><td>1</td><td>1</td></tr><tr><td></td><td>01</td><td>0</td><td>0</td><td>1</td><td>1</td></tr><tr><td>CD</td><td>11</td><td>1</td><td>1</td><td>0</td><td>0</td></tr><tr><td></td><td>10</td><td>1</td><td>1</td><td>0</td><td>0</td></tr></table>			00	01	11	10		00	0	0	1	1		01	0	0	1	1	CD	11	1	1	0	0		10	1	1	0	0	2
		00	01	11	10																											
	00	0	0	1	1																											
	01	0	0	1	1																											
CD	11	1	1	0	0																											
	10	1	1	0	0																											
3(b)(iii)	1 mark for each bullet point $\overline{A}.C$ $+ A.\overline{C}$ $X = \overline{A}.C + A.\overline{C}$	2																														

QUESTION 14.



Question	Answer																
2(a)(i)	1 mark for each 2 correct products, i.e. 3 marks for 6, 2 marks for 4 or 5, 1 mark for 2 or 3 $X = \overline{A}.\overline{B}.\overline{C} + \overline{A}.\overline{B}.C + \overline{A}.B.\overline{C} + \overline{A}.B.C + A.\overline{B}.\overline{C} + A.\overline{B}.C$																
2(a)(ii)	1 mark for the correct K-map AB <table><tr><td></td><td>00</td><td>01</td><td>11</td><td>10</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td></tr></table>		00	01	11	10	0	1	1	0	1	1	1	1	0	1	1
	00	01	11	10													
0	1	1	0	1													
1	1	1	0	1													
2(a)(iii)	1 mark for each correct loop AB <table><tr><td></td><td>00</td><td>01</td><td>11</td><td>10</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td></tr></table>		00	01	11	10	0	1	1	0	1	1	1	1	0	1	2
	00	01	11	10													
0	1	1	0	1													
1	1	1	0	1													
2(a)(iv)	1 mark per bullet point: • $\overline{A}$ • $+ \overline{B}$ $X = \overline{A} + \overline{B} // X = \overline{B} + \overline{A}$	2															
2(b)	$X = ((\overline{W} + X).(Y + \overline{Z}))$ One mark for correct use of <u>De Morgan's law</u> to + • $X = (\overline{W} + X) + (Y + \overline{Z})$ One mark for correct use of <u>De Morgan's law</u> + to • $X = \overline{\overline{W}}.\overline{\overline{X}} + \overline{\overline{Y}}.\overline{\overline{Z}}$ One mark for correct answer • $X = W.\overline{X} + \overline{Y}.Z$	3															