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Boolean Algebra

Questions Booklet

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GCSE/A-Level CS

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Boolean Algebra

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150 practice questions - laws, truth tables, De Morgan's, simplification, proofs

Name: _____ Date: _____ Score: /150

Boolean Algebra

Section A: Q1-Q20

Section A: Apply the Law (20 marks)

Simplify each expression and state the Boolean law used.

Q	Expression	Simplified to	Law Used
1	`A AND 1`		
2	`A OR 0`		
3	`A AND 0`		
4	`A OR 1`		
5	`A AND A`		
6	`A OR A`		
7	`A AND NOT(A)`		
8	`A OR NOT(A)`		
9	`NOT(NOT(A))`		
10	`A AND B`		
11	`A OR (B OR C)`		
12	`A AND (A OR B)`		
13	`A OR (A AND B)`		
14	`NOT(A AND B)`		
15	`NOT(A OR B)`		
16	`A AND (B OR C)`		
17	`(A OR B)(A OR C)`		
18	`A AND 1 AND A`		
19	`NOT(NOT(A) OR NOT(B))`		
20	`(A AND B) OR (A AND NOT(B))`		

Boolean Algebra

Section B: Truth Table Completion (20 marks)

Complete the output column for each Boolean expression.

21. `A XOR B`

A	B	A XOR B
0	0	
0	1	
1	0	
1	1	

22. `NOT(A) XOR B`

A	B	NOT(A) XOR B
0	0	
0	1	
1	0	
1	1	

23. `NOT(A XOR B)`

A	B	NOT(A XOR B)
0	0	
0	1	
1	0	
1	1	

24. `A XNOR NOT(B)`

A	B	A XNOR NOT(B)
0	0	
0	1	
1	0	
1	1	

25. `(A AND B) OR C`

A	B	C	(A AND B) OR C
0	0	0	
0	0	1	

0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

26. `A AND (B OR C)`

A	B	C	A AND (B OR C)
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

27. `NOT(A) AND B OR C`

A	B	C	NOT(A) AND B OR C
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

28. `NOT(A OR B) OR C`

A	B	C	NOT(A OR B) OR C
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

29. `A XOR (B AND C)`

A	B	C	A XOR (B AND C)
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

30. `NOT(A) AND NOT(B) OR C`

A	B	C	NOT(A) AND NOT(B) OR C
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

31. `(A OR B) AND (B OR C)`

A	B	C	(A OR B) AND (B OR C)
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

32. `A NAND (B OR C)`

A	B	C	A NAND (B OR C)
0	0	0	
0	0	1	
0	1	0	

0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

33. `(A AND B) OR (C AND D)`

A	B	C	D	(A AND B) OR (C AND D
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	
1	0	1	0	
1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	
1	1	1	1	

34. `NOT(A OR B) AND (C OR D)`

A	B	C	D	NOT(A OR B) AND (C OR
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	
1	0	1	0	

1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	
1	1	1	1	

35. `(A XOR B) AND (C XOR D)`

A	B	C	D	(A XOR B) AND (C XOR D
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	
1	0	1	0	
1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	
1	1	1	1	

36. `A AND B AND C AND D`

A	B	C	D	A AND B AND C AND D
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	
1	0	1	0	

1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	
1	1	1	1	

37. `NOT(A AND B) OR (C AND D)`

A	B	C	D	NOT(A AND B) OR (C AND
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	
1	0	1	0	
1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	
1	1	1	1	

38. `(A OR C) AND (B OR D)`

A	B	C	D	(A OR C) AND (B OR D)
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	
1	0	1	0	

1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	
1	1	1	1	

39. `NOT(A) AND B AND NOT(C) AND D`

A	B	C	D	NOT(A) AND B AND NOT(C) A
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	
1	0	1	0	
1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	
1	1	1	1	

40. `A XOR B XOR C XOR D`

A	B	C	D	A XOR B XOR C XOR D
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	
1	0	1	0	

1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	
1	1	1	1	

Boolean Algebra

Q41-Q60

Section C: De Morgan's Law (20 marks)

Apply De Morgan's Law to rewrite each expression in its equivalent form.

Q	Expression	Equivalent Form
41	`NOT(A AND B)`	
42	`NOT(A OR B)`	
43	`NOT(A AND B AND C)`	
44	`NOT(A OR B OR C)`	
45	`NOT(A) AND NOT(B)`	
46	`NOT(A) OR NOT(B)`	
47	`NOT((A AND B) OR C)`	
48	`NOT(A AND (B OR C))`	
49	`NOT((A OR B) AND (C OR D))`	
50	`NOT(NOT(A) OR NOT(B))`	
51	`NOT(NOT(A) AND NOT(B))`	
52	`NOT(NOT(A) AND NOT(B) AND NOT(C))`	
53	`NOT(A OR B) AND NOT(C OR D)`	
54	`NOT((A XOR B) AND C)`	
55	`NOT(A NAND B)`	
56	`NOT(A NOR B)`	
57	`NOT(A OR B OR C OR D)`	
58	`NOT((A AND B) AND (C AND D))`	
59	`NOT(A) AND NOT(B) AND NOT(C)`	
60	`NOT(A) AND NOT(B) AND NOT(C) AND NOT(D)`	

Boolean Algebra

Q61-Q90

Section D: Full Simplification (30 marks)

Fully simplify each Boolean expression. Show each step and state the law used.

Q	Expression	Fully Simplified
61	`A AND A AND B`	
62	`A OR A OR B`	
63	`A AND (A OR B)`	
64	`A OR (A AND B)`	
65	`(A AND B) OR (A AND NOT(B))`	
66	`A AND 1 OR A AND 0`	
67	`NOT(NOT(A AND B))`	
68	`(A OR B) AND (A OR NOT(B))`	
69	`A AND B AND 1 AND A`	
70	`(A AND NOT(A)) OR B`	
71	`NOT(A) AND (A OR B)`	
72	`A OR (NOT(A) AND B)`	
73	`(A OR B) AND (NOT(A) OR B)`	
74	`NOT(NOT(A) OR NOT(B))`	
75	`(A AND B) OR (NOT(A) AND B)`	
76	`NOT(A AND B) AND B`	
77	`A AND (NOT(A) OR B)`	
78	`(A AND B) OR (A AND B AND C)`	
79	`NOT(A OR B) OR (NOT(A) AND B)`	
80	`A AND B OR NOT(A) AND B`	
81	`(A OR NOT(A)) AND B`	
82	`NOT(A) OR A`	
83	`A AND B AND NOT(A OR B)`	
84	`(A AND B) OR NOT(A AND B)`	
85	`NOT(A) AND NOT(B) AND (A OR B)`	
86	`(A OR B) AND NOT(A) AND NOT(B)`	

87	`A AND B OR NOT(A) AND NOT(B)`	
88	`NOT(A) AND (A OR B OR C)`	
89	`NOT(A) AND B OR A AND NOT(B)`	
90	`NOT(A XOR B)`	

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Q91-Q110

Section E: Prove the Equivalence (20 marks)

Show step-by-step that each pair of expressions is equivalent.

Q	Statement to Prove	Proof / Your Working
91	Show A AND (B OR C) = (A AND B) OR (A AND C)	
92	Show NOT(NOT(A)) = A	
93	Show (A AND B) OR A = A	
94	Show A AND (A OR B) = A	
95	Show NOT(A) AND (A OR B) = NOT(A) AND B	
96	Show (A OR B) AND (A OR NOT(B)) = A	
97	Show NOT(A AND B) = NOT(A) OR NOT(B)	
98	Show NOT(A OR B) = NOT(A) AND NOT(B)	
99	Show A OR (NOT(A) AND B) = A OR B	
100	Show (A XOR B) = (A OR B) AND NOT(A AND B)	
101	Show NOT(A) AND NOT(B) = NOT(A OR B)	
102	Show (A AND B) OR (A AND B AND C) = A AND B	
103	Show A OR (A AND NOT(B)) = A	

104	Show (A AND NOT(B)) OR (NOT(A) AND B) OR (A AND B) = A OR B	
105	Show NOT(A) AND (A OR B) AND (A OR C) = NOT(A) AND B AND C	
106	Show A AND B AND C = NOT(NOT(A) OR NOT(B) OR NOT(C))	
107	Show (A OR B) AND (NOT(A) OR C) AND (B OR C) = (A OR B) AND (NOT(A) OR C)	
108	Show NOT(A AND B) AND A = NOT(B) AND A	
109	Show A NAND A = NOT(A)	
110	Show A NOR A = NOT(A)	

Boolean Algebra

Q111-Q130

Section F: Derive the Expression (20 marks)

Write a Boolean expression that satisfies each description.

Q	Description	Boolean Expression
111	Output is 1 only when A=1 AND B=1	
112	Output is 1 when A=0 AND B=0	
113	Output is 0 only when A=0 AND B=0	
114	Output is 0 only when A=1 AND B=1	
115	Output is 1 when A and B are different	
116	Output is 1 when A and B are the same	
117	Output is 1 when at least one of A,B,C is 1	
118	Output is 1 only when all of A,B,C are 1	
119	Output is 1 when exactly one of A,B is 1	
120	Output is 1 when A=1 and B=0	
121	Output is 1 when the number of 1s in A,B,C is odd	
122	Output is 0 when any input is 1	

123	Output is 1 unless all inputs are 1	
124	Output is 1 when A=1 OR when B=1 AND C=1	
125	Output is 1 when A=0 AND B=0 AND C=0	
126	Output is 1 when A differs from B, and C=1	
127	Output equals A when B=1; 0 when B=0	
128	Output is 1 when A=B AND C=1	
129	Output is NOT(A) when B=1; 1 when B=0	
130	Output is 1 when at least two of A,B,C are 1	

Boolean Algebra

Section G: Mixed Challenge (20 marks)

Fully simplify each expression. Multiple laws may be required.

Q	Expression	Simplified
131	`NOT(A OR B) OR (A AND NOT(B))`	
132	`(A OR B) AND (NOT(A) OR NOT(B))`	
133	`A AND B OR NOT(A) AND NOT(B)`	
134	`NOT(NOT(A) AND B) AND NOT(A AND NOT(B))`	
135	`(A AND B AND C) OR (NOT(A) AND B AND C) OR NOT(B AND C)`	
136	`NOT(A NAND B)`	
137	`NOT(A NOR B)`	
138	`A XOR 0`	
139	`A XOR 1`	
140	`A XOR A`	
141	`A XNOR A`	
142	`(A AND B) XOR (A AND B)`	
143	`A AND NOT(A XOR B)`	

144	NOT(A AND NOT(B)) AND NOT(B)	
145	(A AND B) OR (NOT(A) AND B) OR (A AND NOT(B))	
146	NOT(A) OR (A AND B)	
147	(A OR B) AND NOT(NOT(A) AND NOT(B))	
148	NOT(A AND B) AND NOT(NOT(A) AND NOT(B))	
149	A XOR (A AND B)	
150	(A OR B OR C) AND NOT(A OR B)	

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