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Boolean Algebra

Questions Booklet

Boolean laws, simplification and proofs.

GCSE & A-Level Computer Science

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Boolean Algebra

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	$A \text{ AND } 1$		
2	$A \text{ OR } 0$		
3	$A \text{ AND } 0$		
4	$A \text{ OR } 1$		
5	$A \text{ AND } A$		
6	$A \text{ OR } A$		
7	$A \text{ AND NOT}(A)$		
8	$A \text{ OR NOT}(A)$		
9	$\text{NOT}(\text{NOT}(A))$		
10	$A \text{ AND } B$		
11	$A \text{ OR } (B \text{ OR } C)$		
12	$A \text{ AND } (A \text{ OR } B)$		
13	$A \text{ OR } (A \text{ AND } B)$		
14	$\text{NOT}(A \text{ AND } B)$		
15	$\text{NOT}(A \text{ OR } B)$		
16	$A \text{ AND } (B \text{ OR } C)$		
17	$(A \text{ OR } B)(A \text{ OR } C)$		
18	$A \text{ AND } 1 \text{ AND } A$		
19	$\text{NOT}(\text{NOT}(A) \text{ OR } \text{NOT}(B))$		
20	$(A \text{ AND } B) \text{ OR } (A \text{ AND } \text{NOT}(B))$		

Boolean Algebra

Q21-Q40

Section B: Truth Table Completion (20 marks)

Complete the output column for each Boolean expression.

21. $A \text{ XOR } B$

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

22. $\text{NOT}(A) \text{ XOR } B$

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

23. $\text{NOT}(A \text{ XOR } B)$

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

24. $A \text{ XNOR } \text{NOT}(B)$

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

25. $(A \text{ AND } B) \text{ OR } C$

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 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	

35. $(A \text{ XOR } B) \text{ AND } (C \text{ XOR } D)$

A	B	C	D	$(A \text{ XOR } B) \text{ AND } (C \text{ XOR } D)$
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. $A \text{ AND } B \text{ AND } C \text{ AND } D$

A	B	C	D	$A \text{ AND } B \text{ AND } C \text{ AND } D$
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 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	

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) 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	

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	$\text{NOT}(A \text{ AND } B)$	
42	$\text{NOT}(A \text{ OR } B)$	
43	$\text{NOT}(A \text{ AND } B \text{ AND } C)$	
44	$\text{NOT}(A \text{ OR } B \text{ OR } C)$	
45	$\text{NOT}(A) \text{ AND } \text{NOT}(B)$	
46	$\text{NOT}(A) \text{ OR } \text{NOT}(B)$	
47	$\text{NOT}((A \text{ AND } B) \text{ OR } C)$	
48	$\text{NOT}(A \text{ AND } (B \text{ OR } C))$	
49	$\text{NOT}((A \text{ OR } B) \text{ AND } (C \text{ OR } D))$	
50	$\text{NOT}(\text{NOT}(A) \text{ OR } \text{NOT}(B))$	
51	$\text{NOT}(\text{NOT}(A) \text{ AND } \text{NOT}(B))$	
52	$\text{NOT}(\text{NOT}(A) \text{ AND } \text{NOT}(B) \text{ AND } \text{NOT}(C))$	
53	$\text{NOT}(A \text{ OR } B) \text{ AND } \text{NOT}(C \text{ OR } D)$	
54	$\text{NOT}((A \text{ XOR } B) \text{ AND } C)$	
55	$\text{NOT}(A \text{ NAND } B)$	
56	$\text{NOT}(A \text{ NOR } B)$	
57	$\text{NOT}(A \text{ OR } B \text{ OR } C \text{ OR } D)$	
58	$\text{NOT}((A \text{ AND } B) \text{ AND } (C \text{ AND } D))$	
59	$\text{NOT}(A) \text{ AND } \text{NOT}(B) \text{ AND } \text{NOT}(C)$	
60	$\text{NOT}(A) \text{ AND } \text{NOT}(B) \text{ AND } \text{NOT}(C) \text{ AND } \text{NOT}(D)$	

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	$A \text{ AND } A \text{ AND } B$	
62	$A \text{ OR } A \text{ OR } B$	
63	$A \text{ AND } (A \text{ OR } B)$	
64	$A \text{ OR } (A \text{ AND } B)$	
65	$(A \text{ AND } B) \text{ OR } (A \text{ AND } \text{NOT}(B))$	
66	$A \text{ AND } 1 \text{ OR } A \text{ AND } 0$	
67	$\text{NOT}(\text{NOT}(A \text{ AND } B))$	
68	$(A \text{ OR } B) \text{ AND } (A \text{ OR } \text{NOT}(B))$	
69	$A \text{ AND } B \text{ AND } 1 \text{ AND } A$	
70	$(A \text{ AND } \text{NOT}(A)) \text{ OR } B$	
71	$\text{NOT}(A) \text{ AND } (A \text{ OR } B)$	
72	$A \text{ OR } (\text{NOT}(A) \text{ AND } B)$	
73	$(A \text{ OR } B) \text{ AND } (\text{NOT}(A) \text{ OR } B)$	
74	$\text{NOT}(\text{NOT}(A) \text{ OR } \text{NOT}(B))$	
75	$(A \text{ AND } B) \text{ OR } (\text{NOT}(A) \text{ AND } B)$	
76	$\text{NOT}(A \text{ AND } B) \text{ AND } B$	
77	$A \text{ AND } (\text{NOT}(A) \text{ OR } B)$	
78	$(A \text{ AND } B) \text{ OR } (A \text{ AND } B \text{ AND } C)$	
79	$\text{NOT}(A \text{ OR } B) \text{ OR } (\text{NOT}(A) \text{ AND } B)$	
80	$A \text{ AND } B \text{ OR } \text{NOT}(A) \text{ AND } B$	
81	$(A \text{ OR } \text{NOT}(A)) \text{ AND } B$	
82	$\text{NOT}(A) \text{ OR } A$	
83	$A \text{ AND } B \text{ AND } \text{NOT}(A \text{ OR } B)$	
84	$(A \text{ AND } B) \text{ OR } \text{NOT}(A \text{ AND } B)$	
85	$\text{NOT}(A) \text{ AND } \text{NOT}(B) \text{ AND } (A \text{ OR } B)$	
86	$(A \text{ OR } B) \text{ AND } \text{NOT}(A) \text{ AND } \text{NOT}(B)$	

87	$A \text{ AND } B \text{ OR NOT}(A) \text{ AND NOT}(B)$	
88	$\text{NOT}(A) \text{ AND } (A \text{ OR } B \text{ OR } C)$	
89	$\text{NOT}(A) \text{ AND } B \text{ OR } A \text{ AND NOT}(B)$	
90	$\text{NOT}(A \text{ XOR } B)$	

Boolean Algebra

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
9 1	Show $A \text{ AND } (B \text{ OR } C) = (A \text{ AND } B) \text{ OR } (A \text{ AND } C)$	
9 2	Show $\text{NOT}(\text{NOT}(A)) = A$	
9 3	Show $(A \text{ AND } B) \text{ OR } A = A$	
9 4	Show $A \text{ AND } (A \text{ OR } B) = A$	
9 5	Show $\text{NOT}(A) \text{ AND } (A \text{ OR } B) = \text{NOT}(A) \text{ AND } B$	
9 6	Show $(A \text{ OR } B) \text{ AND } (A \text{ OR } \text{NOT}(B)) = A$	
9 7	Show $\text{NOT}(A \text{ AND } B) = \text{NOT}(A) \text{ OR } \text{NOT}(B)$	
9 8	Show $\text{NOT}(A \text{ OR } B) = \text{NOT}(A) \text{ AND } \text{NOT}(B)$	
9 9	Show $A \text{ OR } (\text{NOT}(A) \text{ AND } B) = A \text{ OR } B$	
1 0 0	Show $(A \text{ XOR } B) = (A \text{ OR } B) \text{ AND } \text{NOT}(A \text{ AND } B)$	
1 0 1	Show $\text{NOT}(A) \text{ AND } \text{NOT}(B) = \text{NOT}(A \text{ OR } B)$	
1 0 2	Show $(A \text{ AND } B) \text{ OR } (A \text{ AND } B \text{ AND } C) = A \text{ AND } B$	
1 0 3	Show $A \text{ OR } (A \text{ AND } \text{NOT}(B)) = A$	

1 0 4	Show $(A \text{ AND } \text{NOT}(B)) \text{ OR } (\text{NOT}(A) \text{ AND } B) \text{ OR } (A \text{ AND } B) = A \text{ OR } B$	
1 0 5	Show $\text{NOT}(A) \text{ AND } (A \text{ OR } B) \text{ AND } (A \text{ OR } C) = \text{NOT}(A) \text{ AND } B \text{ AND } C$	
1 0 6	Show $A \text{ AND } B \text{ AND } C = \text{NOT}(\text{NOT}(A) \text{ OR } \text{NOT}(B) \text{ OR } \text{NOT}(C))$	
1 0 7	Show $(A \text{ OR } B) \text{ AND } (\text{NOT}(A) \text{ OR } C) \text{ AND } (B \text{ OR } C) = (A \text{ OR } B) \text{ AND } (\text{NOT}(A) \text{ OR } C)$	
1 0 8	Show $\text{NOT}(A \text{ AND } B) \text{ AND } A = \text{NOT}(B) \text{ AND } A$	
1 0 9	Show $A \text{ NAND } A = \text{NOT}(A)$	
1 1 0	Show $A \text{ NOR } A = \text{NOT}(A)$	

Boolean Algebra

Q111-Q130

Section F: Derive the Expression (20 marks)

Write a Boolean expression that satisfies each description.

Q	Description	Boolean Expression
1 1 1	Output is 1 only when A=1 AND B=1	
1 1 2	Output is 1 when A=0 AND B=0	
1 1 3	Output is 0 only when A=0 AND B=0	
1 1 4	Output is 0 only when A=1 AND B=1	
1 1 5	Output is 1 when A and B are different	
1 1 6	Output is 1 when A and B are the same	
1 1 7	Output is 1 when at least one of A,B,C is 1	
1 1 8	Output is 1 only when all of A,B,C are 1	
1 1 9	Output is 1 when exactly one of A,B is 1	
1 2 0	Output is 1 when A=1 and B=0	
1 2 1	Output is 1 when the number of 1s in A,B,C is odd	
1 2 2	Output is 0 when any input is 1	

1 2 3	Output is 1 unless all inputs are 1	
1 2 4	Output is 1 when A=1 OR when B=1 AND C=1	
1 2 5	Output is 1 when A=0 AND B=0 AND C=0	
1 2 6	Output is 1 when A differs from B, and C=1	
1 2 7	Output equals A when B=1; 0 when B=0	
1 2 8	Output is 1 when A=B AND C=1	
1 2 9	Output is NOT(A) when B=1; 1 when B=0	
1 3 0	Output is 1 when at least two of A,B,C are 1	

Boolean Algebra

Q131-Q150

Section G: Mixed Challenge (20 marks)

Fully simplify each expression. Multiple laws may be required.

Q	Expression	Simplified
1 3 1	$\text{NOT}(A \text{ OR } B) \text{ OR } (A \text{ AND NOT}(B))$	
1 3 2	$(A \text{ OR } B) \text{ AND } (\text{NOT}(A) \text{ OR NOT}(B))$	
1 3 3	$A \text{ AND } B \text{ OR NOT}(A) \text{ AND NOT}(B)$	
1 3 4	$\text{NOT}(\text{NOT}(A) \text{ AND } B) \text{ AND NOT}(A \text{ AND NOT}(B))$	
1 3 5	$(A \text{ AND } B \text{ AND } C) \text{ OR } (\text{NOT}(A) \text{ AND } B \text{ AND } C) \text{ OR NOT}(B \text{ AND } C)$	
1 3 6	$\text{NOT}(A \text{ NAND } B)$	
1 3 7	$\text{NOT}(A \text{ NOR } B)$	
1 3 8	$A \text{ XOR } 0$	
1 3 9	$A \text{ XOR } 1$	
1 4 0	$A \text{ XOR } A$	
1 4 1	$A \text{ XNOR } A$	
1 4 2	$(A \text{ AND } B) \text{ XOR } (A \text{ AND } B)$	
1 4 3	$A \text{ AND NOT}(A \text{ XOR } B)$	

1 4 4	$\text{NOT}(A \text{ AND } \text{NOT}(B)) \text{ AND } \text{NOT}(B)$	
1 4 5	$(A \text{ AND } B) \text{ OR } (\text{NOT}(A) \text{ AND } B) \text{ OR } (A \text{ AND } \text{NOT}(B))$	
1 4 6	$\text{NOT}(A) \text{ OR } (A \text{ AND } B)$	
1 4 7	$(A \text{ OR } B) \text{ AND } \text{NOT}(\text{NOT}(A) \text{ AND } \text{NOT}(B))$	
1 4 8	$\text{NOT}(A \text{ AND } B) \text{ AND } \text{NOT}(\text{NOT}(A) \text{ AND } \text{NOT}(B))$	
1 4 9	$A \text{ XOR } (A \text{ AND } B)$	
1 5 0	$(A \text{ OR } B \text{ OR } C) \text{ AND } \text{NOT}(A \text{ OR } B)$	

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