2.4 Boolean Logic: 30-minute Pack

OCR J277 · Calculators not allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 The AND and OR operators combine two Boolean inputs, A and B, to produce a single output.

(a) Complete the truth table for the AND operator. **(4)**

A	B	A AND B
0	0	
0	1	
1	0	
1	1	

(b) Complete the truth table for the OR operator. **(4)**

A	B	A OR B
0	0	
0	1	
1	0	
1	1	

(Total for Question 1 is 8 marks)

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2 A smart heating system has a temperature sensor that outputs tempLow = True when the room temperature is below 18C, a window sensor windowClosed = True when the window is shut, and a manual override switch override, which the user can set to True to force the heating on regardless of the other sensors.

(a) Write a Boolean expression for heatingOn that turns the heating on when the temperature is low AND the window is closed, or when the override switch is on. **(2)**

(b) State the value of heatingOn when tempLow = True, windowClosed = False and override = False. **(1)**

(Total for Question 2 is 3 marks)

3 Complete the truth table below for the expression Output = A AND (B OR C).

A	B	C	B OR C	Output
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

(Total for Question 3 is 4 marks)

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4 A logic circuit has two inputs, P and Q. Input P is connected to the input of a NOT gate. The output of the NOT gate, together with input Q, are the two inputs to an AND gate. The output of the AND gate is X.

(a) Write the Boolean expression for X in terms of P and Q. **(1)**

(b) Complete the truth table for the circuit. **(4)**

P	Q	X
0	0	
0	1	
1	0	
1	1	

(c) State the input values of P and Q that produce X = 1. **(1)**

(Total for Question 4 is 6 marks)

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5 A programmer wants to build a logic circuit that produces the output of the Boolean expression X = A OR NOT B, using two inputs A and B.

(a) State the two logic gates that are needed to build this circuit. **(2)**

(b) Describe how the two gates would be connected to produce the correct output X. **(2)**

(Total for Question 5 is 4 marks)

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6 A programmer is designing a form-validation routine for a website that collects a user's age (which must be an integer between 5 and 100 inclusive) and a consent Boolean (True if the user has ticked a consent box).

Explain how Boolean logic operators (AND, OR, NOT) could be used to validate this data, including at least one example of a condition that combines more than one operator.

(Total for Question 6 is 4 marks)

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Mark scheme · 2.4 Boolean Logic: 30-minute Pack

Question 1

(a) Row 1 (0,0) -> 0	**B1**
(a) Row 2 (0,1) -> 0	**B1**
(a) Row 3 (1,0) -> 0	**B1**
(a) Row 4 (1,1) -> 1	**B1**

(a) Answer: 0, 0, 0, 1

(b) Row 1 (0,0) -> 0	**B1**
(b) Row 2 (0,1) -> 1	**B1**
(b) Row 3 (1,0) -> 1	**B1**
(b) Row 4 (1,1) -> 1	**B1**

(b) Answer: 0, 1, 1, 1

Question 2

(a) tempLow AND windowClosed combined correctly, oe	**M1**
(a) Full expression: heatingOn = (tempLow AND windowClosed) OR override, oe, brackets not required	**A1**

(a) Answer: heatingOn = (tempLow AND windowClosed) OR override

(b) False (heating off), cao, ft from part (a) expression	**B1**

(b) Answer: False (heating stays off)

Question 3

Correct Output for rows 1-2 (A=0): 0, 0	**B1**
Correct Output for rows 3-4 (A=0): 0, 0	**B1**
Correct Output for rows 5-6 (A=1): 0, 1	**B1**
Correct Output for rows 7-8 (A=1): 1, 1	**B1**

Answer: Output column in row order: 0, 0, 0, 0, 0, 1, 1, 1

Question 4

(a) X = NOT P AND Q, oe	**B1**

(a) Answer: X = NOT PAND Q

(b) Row (0,0) -> 0	**B1**
(b) Row (0,1) -> 1	**B1**
(b) Row (1,0) -> 0	**B1**
(b) Row (1,1) -> 0	**B1**

(b) Answer: X values in row order: 0, 1, 0, 0

(c) P=0 and Q=1, cao, ft from part (b)	**B1**

(c) Answer: P = 0, Q = 1

Question 5

(a) NOT gate identified	**B1**
(a) OR gate identified	**B1**

(a) Answer: A NOT gate and an OR gate

(b) Input B is connected to the input of the NOT gate	**B1**
(b) The output of the NOT gate and input A are connected to the two inputs of the OR gate, producing output X	**B1**

(b) Answer: B feeds into the NOT gate; the NOT gate's output and A both feed into the OR gate, which outputs X.

Question 6

Level 1 Basic or partial explanation of how a single Boolean operator could be used in validation. Little or no reference to combining conditions, or an example given without explanation. **1-2**

Level 2 Clear explanation of how AND, OR and/or NOT can be combined to validate both fields, supported by at least one correctly constructed combined condition (e.g. using AND to require the age to be in range and consent to be given). **3-4**

Indicative content:

- AND can be used to require the age to be within range AND consent to be True at the same time, e.g. age >= 5 AND age <= 100 AND consent == True.
- The two boundary checks (age >= 5 and age <= 100) must both be True, which is exactly what AND tests for.
- OR could be used if there were multiple acceptable ways to satisfy a rule, e.g. accepting the record if consent == True OR an adult override flag is set.
- NOT could be used to invert a check, e.g. NOT consent to flag records where consent has not been given.
- A single combined condition reduces the need for multiple nested IF statements and makes the validation clearer and more efficient.

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