Chapter 4: Logic Gates and Logic Circuits
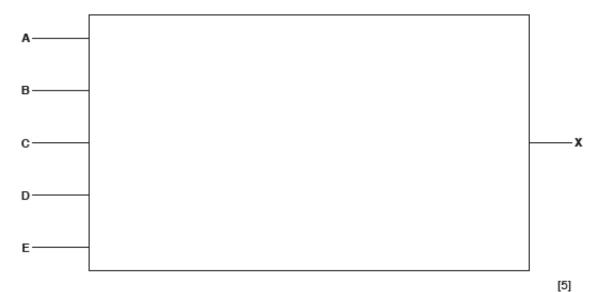
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3 (a) A bank approves a customer for an account based on the criteria in the following table.

Parameter	Description of parameter	Binary value	Condition
A	Employed	1	True
		0	False
B	Self-employed	1	True
		0	False
C	Over 21	1	True
		0	False
D	Earn more than 30 000	1	True
		0	False
E	Another account	1	True
		0	False

A customer is approved (**X** = 1) if the person:

- is over 21 **and** employed
  or
- is over 21 **and** self-employed **and**

  ○ **either** earns more than 30 000
     or
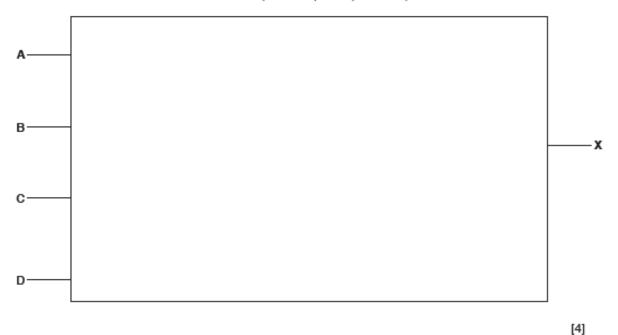 ○ has another account.

Draw a logic circuit to represent the model.

[5]

(b) Complete the truth table for the logic expression:

$$X = (A \text{ AND } C) \text{ OR } (\text{NOT } A \text{ AND } (B \text{ XOR } C))$$

A	B	C	Working space	X
0	0	0		0
0	0	1		1
0	1	0		1
0	1	1		0
1	0	0		0
1	0	1		1
1	1	0		0
1	1	1		1

[4]

2   (a)   Draw a logic circuit to represent the following logic expression:

$$X = \text{NOT (A AND B) AND (C XOR D)}$$

[4]

(b)   Complete the truth table for the logic expression:

$$X = \text{NOT (A AND B) OR (A AND (B XOR C))}$$

A	B	C	Working space	X
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

[4]

5 **(a)** Draw a logic circuit to represent the logic expression:

$$X = \text{NOT } (A \text{ OR } C) \text{ OR } (A \text{ AND NOT } B)$$

A —

B — X

C —

[5]

(b) Complete the truth table for the logic expression:

$$X = \text{NOT } (A \text{ OR } C) \text{ OR } (A \text{ AND NOT } B)$$

A	B	C	Working space	X
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

[4]

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- No question

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6 (a) Draw a logic circuit to represent the logic expression:

$$X = A \text{ OR } (B \text{ AND NOT } C) \text{ OR } (A \text{ AND } B)$$

A

B ── X

C

[5]

(b) Complete the truth table for the logic expression in **part (a)**.

A	B	C	Working space	X
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

[4]

May/June 2019 - 9608/13

- No question

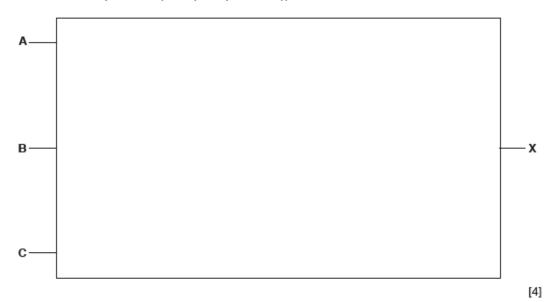**October/November 2018 - 9608/11**

- No question

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- No question

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8 (a) Draw a logic circuit to represent the logic expression:

$$X = (A \text{ XOR } B) \text{ OR } (\text{NOT}(C \text{ AND } A))$$

[4]

(b) Complete the truth table for the logic expression in **part (a)**.

A	B	C	Working space	X
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

[4]

4 (a) An alarm system (X) is enabled and disabled using either a switch (A) or a remote control (B). There are **two** infra-red sensors (C, D) and **one** door pressure sensor (E).

Parameter	Description of parameter	Binary value	Condition
A	Switch	1	Switch enabled
		0	Switch disabled
B	Remote control	1	Remote enabled
		0	Remote disabled
C	Infra-red sensor	1	Activated
		0	Not activated
D	Infra-red sensor	1	Activated
		0	Not activated
E	Door pressure sensor	1	Activated
		0	Not activated

The alarm sounds (X = 1) if the alarm is enabled **and** any one or more of the sensors is activated.

Draw a logic circuit to represent the alarm system.

A ——

B ——

C ——   —— X

D ——

E ——

[3]

(b) Complete the truth table for the logic expression: **X** = **A** OR (B XOR C)

A	B	C	Working space	X
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

[4]

2 (a) A greenhouse control system has four input parameters (H, D, T, W) and two outputs (X, Y).

Parameter	Description of parameter	Binary value	Condition
H	Humidity	0	Too low
		1	Acceptable
D	Day	0	Night
		1	Day
T	Temperature	0	Too high
		1	Acceptable
W	Windows	0	Closed
		1	Open

The watering system turns on (X = 1) if:

either   it is daytime **and** the temperature is too high

or   the humidity is too low.

The fan turns on (Y = 1) if the temperature is too high **and** the windows are closed.

Draw a logic circuit to represent the greenhouse control system.

[6]

(b) Complete the truth table for the logic expression: X = NOT A AND (B NAND C)

A	B	C	Working space	X
0	0	0		1
0	0	1		1
0	1	0		1
0	1	1		0
1	0	0		0
1	0	1		0
1	1	0		0
1	1	1		0

[4]

5   (a) A student needs to design a logic circuit to model the requirements for membership of a snooker club. Membership (X) depends on four criteria, as shown in the table:

Parameter	Description of parameter	Binary value	Condition
A	Over 18	1	True
		0	False
B	Recommended	1	True
		0	False
C	Full-time	1	True
		0	False
D	Retired	1	True
		0	False

Membership is approved (X = 1) if the person:

- is over the age of 18 **and** has been recommended by a pre-existing member **and**
- **either** is working full-time **or** is retired, but not both.

Draw a logic circuit to represent the membership requirements.

A———

B———

C———

D———

——— X

[3]

(b) Complete the truth table for the logic expression: **X** = (**A** XOR B) AND NOT C

A	B	C	Working space	X
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

[4]

October/November 2017 - 9608/11

- No question

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- No question

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- No question

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- No question

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- No question

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