

To understand how to:

- Identify and use the standard symbols for logic gates
- Define the functions of logic gates
- Explain the functions of logic gates
- Use logic gates to create logic circuits from a given problem
- Complete truth tables from a given problem
- Write a logic expression from a given problem.

10.1 Types of logic gates

Logic gates are part of many different computer systems. They receive binary data, apply a Boolean operation, then output a binary value.

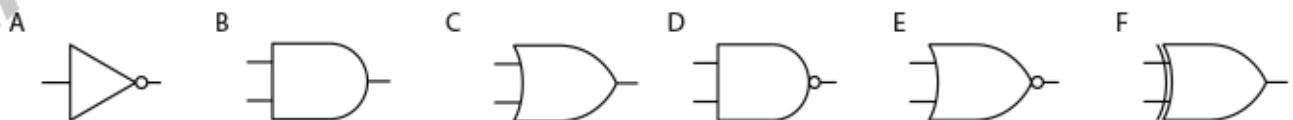
Exercise 1

1 Complete the table:

	Binary value	Boolean
On – positive		
Off – negative		

Exercise 2

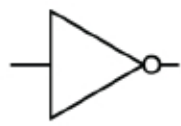
1 It is essential that you know about each type of logic gate. Fill in the name of each of these common logic gates. Tip: Think about common Boolean operators).



A	B	C	D	E	F
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Exercise 3

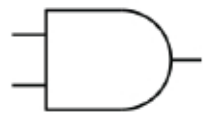
- 1 NOT gates take a single input and return a single output. The output value is always opposite to the input value. Complete the truth table for this NOT gate:



Input (A)	Output (X)

- 2 AND gates take two inputs and return one output. If both inputs are positive, then a positive output will be returned. For example, inputs of 1 AND 1 would return an output of 1.

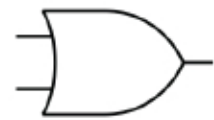
Complete the table by adding all the possible combinations for both inputs (A AND B) and then the corresponding output:



Input (A)	Input (B)	Output (X)

- 3 OR gates take two inputs and return one output. If either input is positive, then a positive output will be returned. For example, inputs of 1 OR 0 would return an output of 1.

Complete the table by adding all possible combinations for both inputs (A OR B) and then the corresponding output:



Input (A)	Input (B)	Output (X)

- 4 NAND gates take two inputs and return one output. If both inputs are positive, then a negative output will be returned.

Complete the table by adding all possible combinations for both inputs (A NAND B) and then the corresponding output:



Input (A)	Input (B)	Output (X)

- 5 NOR gates take two inputs and return one output. If both inputs are negative, then a positive output will be returned.

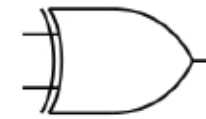
Complete the table by adding all possible combinations for both inputs (A NOR B) and then the corresponding output:



Input (A)	Input (B)	Output (X)

- 6 XOR (exclusive OR) gates take two inputs and return one output. If either input is positive, then a positive output will be returned. However, if both inputs are positive then the output is negative. This logic gate only produces a positive output if 'exclusively' one input is positive.

Complete the table by adding all possible combinations for both inputs (A XOR B) and then the corresponding output:



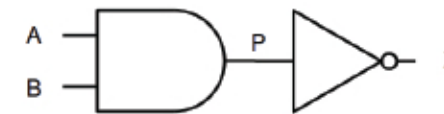
Input (A)	Input (B)	Output (X)

Exercise 4

Multiple logic gates can be combined to carry out different operations. You can work out truth tables by working through each gate in order.

- 1 Complete this truth table by filling in the gaps.

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



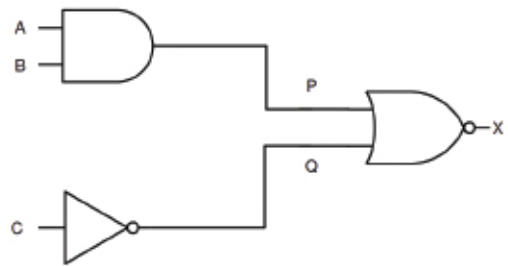
Input		Intermediate Output	Output
A	B	$P = A \text{ AND } B$	$X = \text{NOT } P$
1	1		
1			1
	1	0	
0			1

- 2 Complete the truth table for this logic circuit.



Exercise 5

1 Logic circuits with three inputs are known as two-level logic circuits. Complete the truth table for this combined logic circuit.

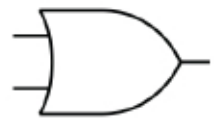


A	B	C	$P = A \text{ AND } B$	$Q = (\text{NOT } C)$	$X = \text{NOT } (P \text{ OR } Q)$

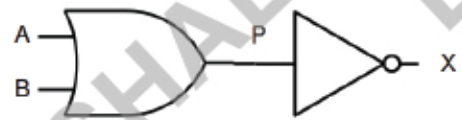
Exercise 6

This logic circuit is for an OR gate. This OR gate can be written as $X = A \text{ OR } B$.

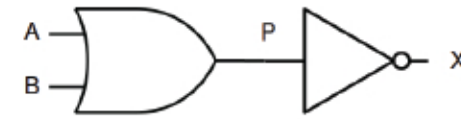
1 Write the correct statement for this logic circuit.



Statement:



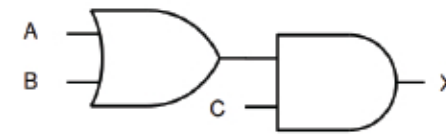
2 Complete the logic statements for this circuit.



Statement:

Exercise 7

You can draw a logic circuit directly from a logic statement. For example, the logic circuit for the statement $X = C \text{ AND } (A \text{ OR } B)$ would look like this:



1 Draw the logic circuit for $X = C \text{ OR } (A \text{ AND } B)$.

Exercise 8

Opening a bank's secure vault requires two employees from the management team to hold down the open button (true, positive, 1). However, if the panic button has been pressed, for safety reasons the vault will not open.

1 Draw the logic circuit for the above problem.

2 Draw the complete truth table for all possible combinations.

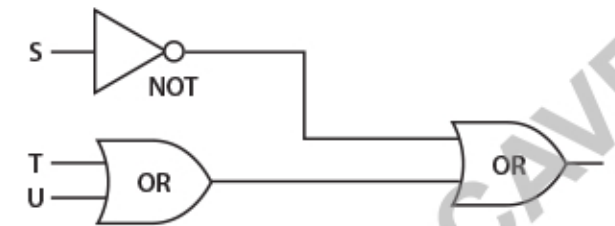
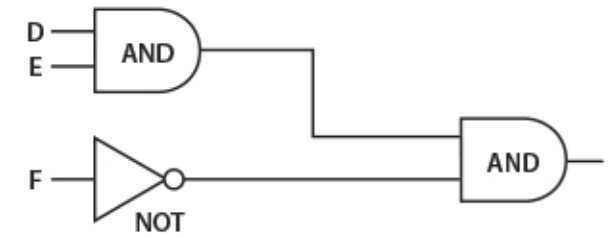
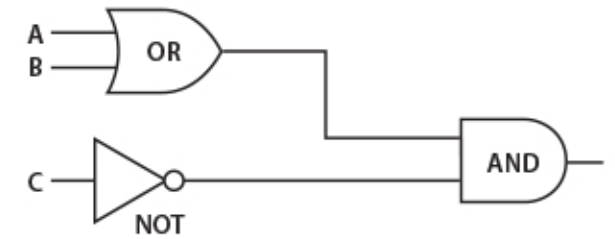
3 Write the final statement for this logic circuit.

Statement:

Exam style questions

Exercise 9

Write the Boolean algebra expression for the following combined logic circuits and complete the corresponding truth tables including the intermediate outputs.



Exercise 10

1 A release valve, Y, sends a signal (Y=1) when certain fault conditions in a gas tank are detected. The inputs are:

Input	Binary Value	Condition
A	1	Carbon Dioxide > 3000ppm
	0	Carbon Dioxide <= 3000ppm
C	1	Temperature >= 100 degrees
	0	Temperature < 100 degrees
E	1	Fan ON
	0	Fan OFF

The release valve, Y returns a value of 1 if:

Either temperature >= 100 degrees AND Fan is OFF

Or Carbon Dioxide >3000ppm AND temperature < 100 degrees

Application software

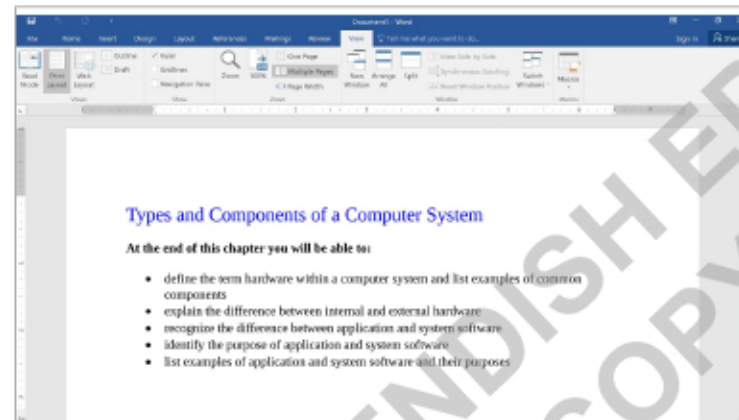
Application software is programs that we can use to perform certain functions and tasks. There are several types of application software.

Word processing software

Word processing software is used for creating, editing, formatting, and manipulating text documents. Hardware devices such as a keyboard or a mouse are used for typing and inputting text. Standard features of word processing software include the following:

- inserting, deleting, cutting, pasting, copying, searching and replacing text
- changing the size, colour and types of fonts
- checking spelling and grammar
- importing photos, images, pictures and simple drawing tools

Microsoft Word is a commonly used word processing program.



Example of word processing software.

Spreadsheet

Spreadsheet software is used to organize, analyze and manipulate numerical or text data in a tabular form. The data are arranged in a table based on a certain numbering format to denote the cells arranged in lettered columns and numbered rows. Spreadsheets use something called formulas to help manipulate and produce data. These formulas allow users to quickly compare and calculate data. Standard features of spreadsheet software include the following:

- inputting and formatting of data
- inserting formula and doing calculations
- sorting and graphing of data

Microsoft Excel is a commonly used example of spreadsheet software. Other programs include Google Sheets, Apache Open Office, and Libre Office.

	A	B	C	D	E	F	G
1	Name	Height	Age				
2	Anne	170	15				
3	Bob	172	15				
4	Christine	168	16				
5	David	170	18				
6	Ethan	174	14				
7	Fred	173	15				
8	George	169	16				
9	Hannah	175	14				
10	Inna	168	15				
11	Jo	165	16				
12	Kevin	171	14				
13	Leia	170	15				
14	Mariam	172	16				
15							
16							

Example of spreadsheet software.

ENRICHMENT

Although Microsoft Word is the most commonly used word processing software, there are other packages. Can you name them?

HELPFUL NOTES

Converting tabular data into line graphs, pie charts or other graphical representations makes data easier to understand.

REFLECT

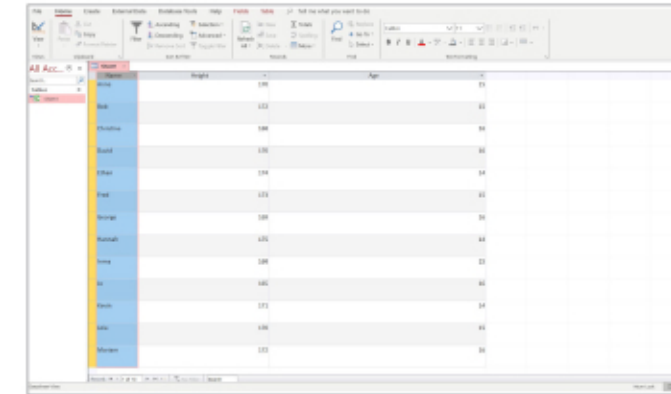
Other than pie charts and line graphs, what other sorts of graphical representation of data do you know of?

Database management software

Database management software is used to create, manage, organise, analyse and manipulate numerical and text data. The data is arranged in a table of rows and columns. Standard features of database management software include the following:

- retrieving and modifying records
- generating reports
- database enquiries and fetching of information

Libre Office Base is a commonly used database management software. Other programs include Microsoft Access and Kexi.



Example of database management software.

Measurement and control software

Measurement and control software captures data obtained from sensors so they can be sent to a computer for data recording and logging. Standard features of measurement and control software include the following:

- measuring physical quantities such as mass, temperature, and distances
- controlling physical processes, for example using a thermostat to regulate temperature fluctuations.

This is an example of data logger software measuring temperature.



Example of measurement and control software.

Presentation software

Presentation software is used to create presentations for personal or business purposes. The user can design their presentation in smaller, manageable sections, and run it as a manual or automatic slide show. Standard features of presentation software include the following:

- adding text, images, video and sound
- creating themes and layers
- adding transitions between sections
- creating charts and graphs from data

REFLECT

Which application software discussed in this section is proprietary and which is free or open source software (FOSS)?

DEFINITION

A database is a structured set of data stored on a computer system.