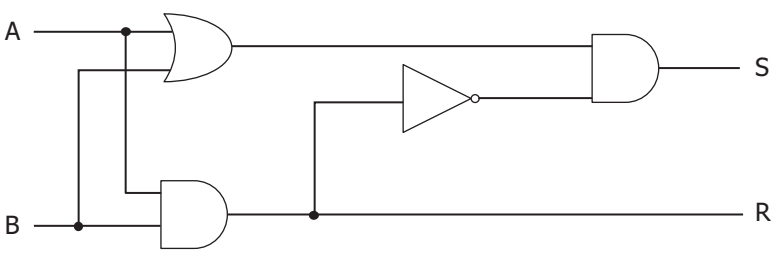
Summary

- Binary addition can be carried out using a half adder or a full adder circuit.
- SR or JK flip-flop circuits can be used to store a bit value.
- There are Boolean algebra laws that can be used to simplify logic expressions.
- The sum-of-products method can be used to create an equivalent logic expression containing minterms from a truth table.
- A Karnaugh map is a representation of a truth table that allows a simplified logic expression to be derived from a truth table.

Exam-style Questions

1 a Consider the following circuit:



i Identify the **three** different logic gates used. [2]

ii Complete the following truth table for the circuit for the inputs shown for A and B. [5]

Inputs		Workspace	Outputs	
A	B		S	R
0	0			
0	1			
1	0			
1	1			

b For the circuit shown in **part a**, identify the type of circuit and what the outputs represent. [3]

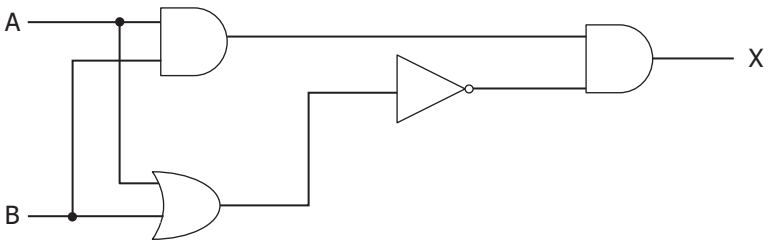
2 a Consider the following truth table:

A	B	X
0	0	1
0	1	0
1	0	1
1	1	1

i Using the sum-of-products approach, write a Boolean expression that matches the logic. [3]

ii For the rows that have A = 1, the output for X is 1. Explain how this would be reflected in a simplified form of Boolean expression matching the truth table. [2]

b Consider the following circuit:



i Using your knowledge of the truth table for an AND gate, write a Boolean algebra expression for the output from the first AND gate. [2]

ii Using your knowledge of the truth table for an OR gate write a Boolean algebra expression for the output from the OR gate. [3]

iii Using De Morgan's law, write the logic expression for the output from the NOT gate. [4]

3 a Consider the following truth table:

A	B	X
0	0	1
0	1	0
1	0	1
1	1	1

i Sketch a Karnaugh map to match this truth table. [4]

ii Use the Karnaugh map to write a Boolean algebra expression for this logic. [3]

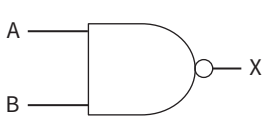
b Consider the truth table shown in **part a**.

i Use the sum-of-products method to write a Boolean algebra expression from the truth table. [3]

ii Use Boolean algebra to demonstrate that this expression can be simplified to give the same expression created from the Karnaugh map. Hint: you might wish to use the fact that

$$A.\overline{B} = A.\overline{B} + A.\overline{B}$$

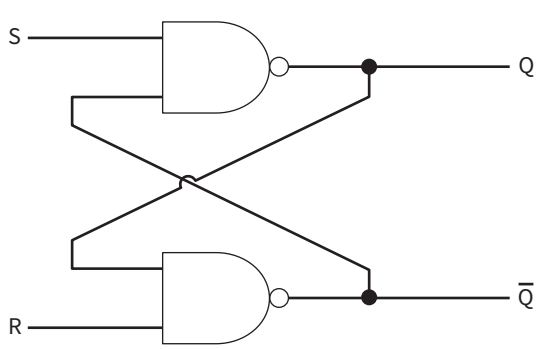
4 a Complete the truth table for this NAND gate:



A	B	X
0	0	
0	1	
1	0	
1	1	

[1]

An SR flip-flop is constructed using two NAND gates.



b **i** Complete the truth table for the SR flip-flop.

	S	R	Q	$\bar{Q}$
Initially	1	0	0	1
R change to 1	1	1		
S changed to 0	0	1		
S changed to 1	1	1		
S and R changed to 0	0	0		

[4]

ii One of the combinations in the truth table should not be allowed to occur.

State the values of S and R that should not be allowed. Justify your choice. [3]

Another type of flip-flop is the JK flip-flop.

c **i** Give **one** extra input present in the JK flip-flop. [1]

ii Give **one** advantage of the JK flip-flop. [1]

d Describe the role of flip-flops in a computer. [2]

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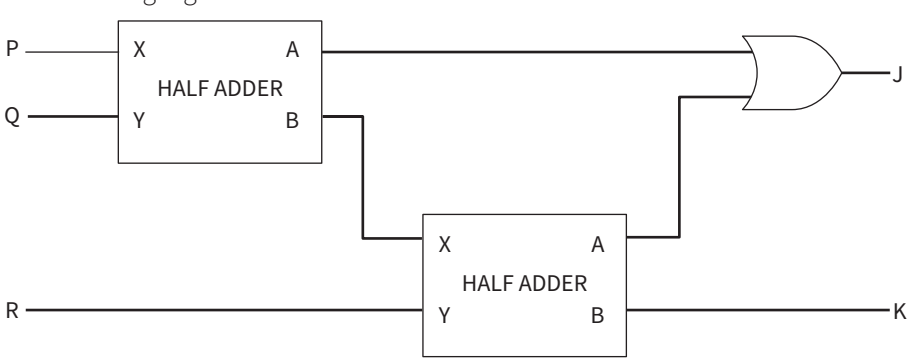
5 **a** **i** A half adder is a logic circuit with the following truth table.

Input		Output	
X	Y	A	B
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

The following logic circuit is constructed.



Complete the following truth table for this logic circuit.

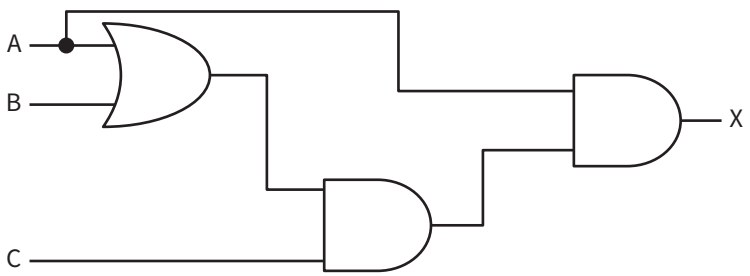
Input			Working space	Output	
P	Q	R		J	K
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			

[2]

ii State the name given to this logic circuit. [1]

iii Name the labels usually given to **J** and **K**.
Explain why your answers are appropriate labels for these outputs. [4]

b **i** Write down the Boolean expression corresponding to the following logic circuit:



[2]

ii Use Boolean algebra to simplify the expression given in **part b(i)**.
Show your working. [4]

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