Week 6

A-Level Computer Science

Homework bundle for this week

本周作业合集

exercises.lol

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3. Hardware

Starter Quiz · 课前小测

A-Level Computer Science Name: _____ Score: _____

1. Which of these is an input device?

   ☐ a scanner

   ☐ a monitor

   ☐ a speaker

   ☐ a printer

2. How does an SSD differ from a magnetic hard disk?

   ☐ it has no moving parts and gives faster random access

   ☐ it uses spinning platters

   ☐ it is always cheaper per gigabyte

   ☐ it stores data as pits read by a laser

3. Which statement is true?

   ☐ RAM is volatile; ROM is non-volatile

   ☐ RAM is non-volatile; ROM is volatile

   ☐ both are volatile

   ☐ both are non-volatile

4. The key difference between a monitoring system and a control system is that a control system:

   ☐ acts on the data through actuators, not just reports it

   ☐ has no sensors

   ☐ cannot read temperature

   ☐ only logs readings

5. A NOT gate outputs 1 when its input is 0.

   ☐ True ☐ False

6. For $X = (A \cdot B) + \overline{C}$ with $A = 1, B = 1, C = 1$, what is X?

   ☐ 1

   ☐ 0

   ☐ cannot tell

   ☐ 2

7. A pure monitoring system takes action through actuators to change its environment.

   ☐ True ☐ False

8. How many rows does a truth table have for a circuit with 3 inputs?

   _____

9. RAM is volatile (its contents are lost without power), while secondary storage keeps data when the power is off.

   ☐ True ☐ False

10. How many rows for 4 inputs?

    _____

A-Level Computer Science

1. **a scanner**

   A scanner brings data in. Monitors, speakers and printers are output devices.

2. **it has no moving parts and gives faster random access**

   SSDs store charge in flash transistors — no moving parts, faster and tougher, but dearer per GB and cells wear out.

3. **RAM is volatile; ROM is non-volatile**

   RAM loses its contents without power (volatile); ROM keeps them (non-volatile).

4. **acts on the data through actuators, not just reports it**

   Both read sensors, but a control system uses the data to act (via actuators), while monitoring only collects and reports.

5. **True**

   NOT inverts: $0 \to 1$ and $1 \to 0$.

6. **1**

   $A \cdot B = 1$, and $\overline{C} = 0$. $X = 1 + 0 = 1$.

7. **False**

   Monitoring only collects and reports data — it does not act. Acting through actuators is what makes it a control system.

8. **8**

   2^n rows; for 3 inputs, $2^3 = 8$.

9. **True**

   That is why your work must be saved to storage — RAM only holds it while the computer is on.

10. **16**

    $2^4 = 16$ rows.

A-LEVEL COMPUTER SCIENCE • EXERCISE SHEET

3.1 Computers and their components

Name: _____ Class: _____ Date: _____ **Total: 42 marks**

KEY WORDS sensor 传感器 • buffer 缓冲区 • sram 静态 RAM • control system 控制系统 • embedded system 嵌入

Objective

Build the skills to answer exam questions on **computer components** 计算机组件 — input, output, memory and storage; the types of RAM and ROM; embedded systems; and monitoring and control systems.

You must be able to:

- explain the need for **input**, **output**, **primary memory** 主存储器 and **secondary storage** 辅助存储器
- explain the differences between **RAM** and **ROM**, **SRAM** and **DRAM**, and the types of ROM
- describe **embedded systems** 嵌入式系统 and their benefits and drawbacks
- describe **monitoring and control** systems using **sensors** 传感器, **actuators** 执行器 and **feedback** 反馈

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ The four building blocks

Block	Job	Examples
input	get data in	keyboard, mouse, sensor
output	give results out	monitor, speaker, actuator
primary memory	fast store the CPU uses directly	RAM, ROM
secondary storage	large, keeps data when off	hard disk, SSD, USB

■ RAM, ROM and their types

RAM holds the running program and data and is **volatile** (lost when power is off). **ROM** holds fixed start-up data and is **non-volatile** (kept).

	RAM	ROM
Keeps data without power?	no (volatile)	yes
Can the CPU write to it?	yes	normally no
Used for	running programs	start-up / firmware

- **SRAM vs DRAM:** SRAM is faster and needs no refreshing, so it is used for **cache**; DRAM is cheaper and denser, so it is used for **main memory** (but must be refreshed).
- **ROM types: PROM** is written once; **EPROM** is erased by UV light and rewritten; **EEPROM** is erased and rewritten **electrically**, in place.

■ Processor performance

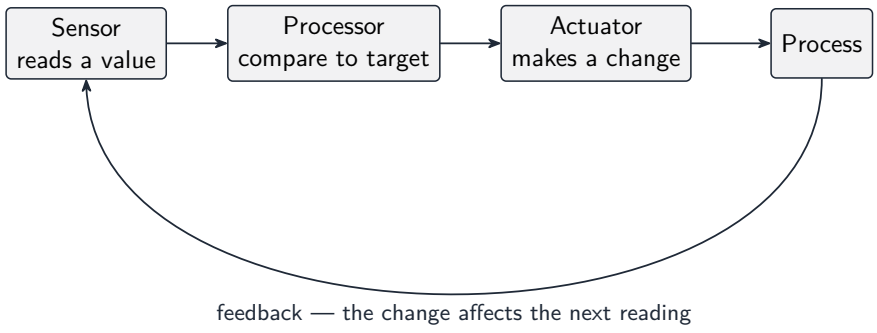
Three things make a CPU run programs faster:

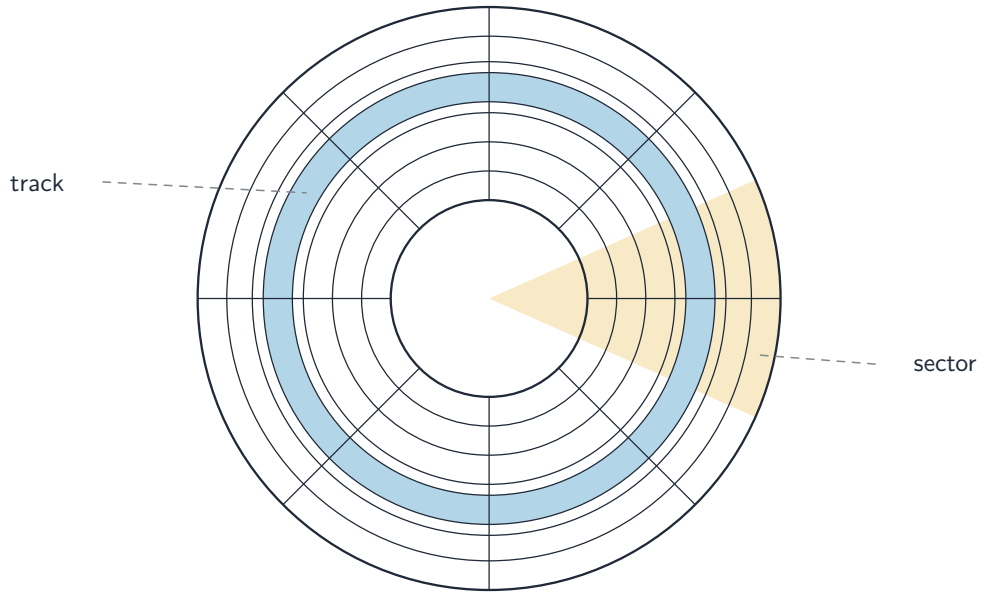
- **clock speed** 时钟速度 — more cycles per second means more instructions per second.
- **number of cores** 核心 — each core can run instructions, so more cores do more work **at the same time** — *but only if the software is written to use them*, and more cores cost more and make more heat.
- **cache** 缓存 — a small, very fast memory near the CPU; more cache means fewer slow trips to main memory.

A **buffer** 缓冲区 is a small temporary store that holds data while a slow device (such as a printer) catches up, so the CPU does not have to wait for it.

■ Monitoring and control

In **monitoring** the system only reports readings; in **control** it also acts to change the process. A control system uses **feedback** — the change it makes affects the next reading:





A hard disk drive stores data in tracks and sectors

An **embedded system** is a computer built into another device for one fixed job (washing machine, car engine unit). It is small, cheap and reliable, but limited to that task and hard to update.

2 Practice

Now apply the methods above.

2.1 State the difference between **primary memory** and **secondary storage**. [2]

2.2 State **two** differences between **RAM** and **ROM**. [2]

2.3 Give one **benefit** and one **drawback** of an embedded system. [2]

2.4 Name the component in a control system that **makes a physical change** to the process. [1]

3 Exam-style questions

3.1 (a) Explain the difference between RAM and ROM. [2]

(b) Give one use of ROM in a computer. [1]

3.2 Explain why **SRAM** is used for cache memory while **DRAM** is used for main memory. [3]

3.3 State the difference between **PROM**, **EPROM** and **EEPROM**. [3]

3.4 A greenhouse control system keeps the temperature near 25 °C.

(a) Name a suitable **sensor** for this system. [1]

(b) Describe how the system uses **feedback** to keep the temperature steady. [3]

3.5 Describe the principal operation of **either** a laser printer **or** a 3D printer. [3]

3.6 A computer is upgraded from a single-core to a quad-core processor.

(a) Explain how having more **cores** can improve performance. [2]

(b) State **one** reason the performance may **not** improve as much as expected. [1]

3.7 A computer sends documents to a printer, which prints much more slowly than the computer can send. State why the printer needs a **buffer**. [2]

3.8 A greenhouse uses a computer system to look after tomato plants. Sensors measure temperature, humidity and soil moisture. A separate 3D printer in the same building makes replacement clips for the plant supports.

(a) **Describe** the difference between a **monitoring** system and a **control** system, using this greenhouse as your example. [3]

(b) The greenhouse system opens a vent when the temperature exceeds 28 °C. **Explain** the role of the **actuator** and of the **ADC** in this system. [3]

(c) **Explain** why the system takes readings **continuously** in a loop rather than once an hour. [2]

(d) **Explain** how the 3D printer produces a clip from a design file. [3]

(e) **State** why the 3D printer needs a **buffer**, and **explain** what would happen without one. [3]

Solutions

2.1 Primary memory is fast and reached **directly** by the CPU (holds the running program); secondary storage is larger, slower, and **keeps data when the power is off**.

2.2 Any two of: RAM is volatile / ROM is non-volatile; the CPU can write to RAM / normally not to ROM; RAM holds running programs / ROM holds start-up data.

2.3 Benefit e.g. small / cheap / low-power / reliable. Drawback e.g. limited to one task / hard to update / hard to repair.

2.4 Actuator.

3.1 (a) RAM is **volatile** and the CPU can read **and write** it (running programs); ROM is **non-volatile** and normally only read.
(b) e.g. it stores the **boot/start-up program** (BIOS).

3.2 SRAM is **faster** and needs no refreshing, so it suits the small, speed-critical cache; DRAM is **cheaper and denser** per bit, so it suits the large main memory, even though it must be refreshed.

3.3 PROM can be written **once**; **EPROM** can be erased (by UV light) and rewritten; **EEPROM** can be erased and rewritten **electrically**, in place.

3.4 (a) A **temperature sensor**.
(b) The sensor reads the temperature; the processor compares it with 25 °C and switches a heater/cooler (actuator) on or off; this changes the temperature, which the sensor reads again — the feedback keeps it near the target.

3.5 Laser printer: a laser draws the page image as charge on a photosensitive drum; toner sticks to the charged areas and transfers to the paper; a fuser melts the toner onto the paper. *(Or a correct layer-by-layer description of a 3D printer.)*

3.6 (a) Each core can execute instructions, so a quad-core CPU can run up to four tasks (or threads) at the same time, doing more work per second.
(b) The software (or task) must be written to split across cores; a single-threaded program still uses only one core.

3.7 The printer is much slower than the computer; the buffer holds the data waiting to be printed so the computer (CPU) is freed to do other work instead of waiting for the printer.

3.8 (a) A **monitoring** system reads the sensors and reports or records the values — it displays the greenhouse temperature and logs it, but changes nothing. A **control** system reads the same sensors and **acts** on the result, opening the vent or switching on the irrigation. So a control system contains a monitoring system plus the output devices that change the conditions.
(b) The **ADC** converts the sensor's continuously varying analogue voltage into the binary values the processor can work with. The **actuator** is the device that carries out the processor's decision — here the motor that drives the vent open.
(c) Conditions change quickly in a greenhouse, and a plant can be damaged within minutes of overheating; reading in a continuous loop means the system responds as soon as the threshold is crossed rather than up to an hour later.
(d) The design file is sliced into many thin horizontal **layers**; the printer deposits or

solidifies material one layer at a time, each layer bonding to the one beneath, building the clip from the bottom up.
(e) The printer works far more slowly than the computer can send data, so the buffer stores the data waiting to be printed. Without it the computer would have to wait for the printer, unable to do anything else, and data arriving faster than it was consumed would be lost.

9 Describe the differences between a monitoring system and a control system.

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..... [3]

10 An architect needs a model of a building.

(a) Explain how the model will be printed using a 3D printer.

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..... [3]

(b) State why a 3D printer needs a buffer.

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..... [1]

11 An automated system opens doors when a person is detected within 2 metres. The system closes the doors when there is no longer a person within 2 metres.

Identify whether the automated system is an example of a monitoring system or a control system.

Justify your choice.

Monitoring or Control .....

Justification .....

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..... [3]

4 A shop installs a new system that allows users to purchase items without going through a manual checkout.

The new system:

- identifies customers when they enter the shop and matches them to their account
- prevents a customer from walking through the automatic barriers if they do not have an account
- automatically detects the items that a customer has taken from a shelf and charges these to the customer's account.

(a) The new system uses digital cameras and Artificial Intelligence (AI) to identify the customers.

Explain how the new system uses AI to identify each customer.

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..... [4]

(b) The new system uses sensors to identify the items taken from a shelf.

Identify **one** type of sensor that can be used in this new system.

State how the sensor can be used to identify the items taken from a shelf.

Sensor .....

Use .....

.....

[2]

6 A programmer is buying a new computer.

(a) The programmer is considering the following two computers:

Computer 1	Quad-core 2.2 GHz processor 16-bit architecture 1 GB Random Access Memory (RAM) 500 GB magnetic hard disk
Computer 2	Dual-core 3.8 GHz processor 32-bit architecture 2 GB RAM 500 GB solid state drive (SSD)

(i) Computer 1 has a magnetic hard disk.

Complete the description of the principal operation of a magnetic hard disk by writing the missing words.

The magnetic hard disk has one or more ..... that can be magnetised. These are mounted on a ..... and rotate at high speed.

A ..... is moved across the surface on an arm.

When data is read, the changes in the ..... produce a change in the electric current.

[4]

(ii) The two computers have different amounts of RAM.

Explain how different amounts of RAM affect the performance of a computer.

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..... [3]

(iii) The two computers have different bus widths.

Explain how different bus widths affect the performance of a computer.

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..... [2]

(b) Both computers have an Operating System (OS).

Describe the purpose of an OS in a computer.

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..... [5]

2 Embedded systems are used in many electronic devices.

(a) Describe the drawbacks of embedded systems.

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..... [3]

(b) An embedded system has Dynamic RAM (DRAM).

Identify **one** benefit of using DRAM instead of Static RAM (SRAM) in an embedded system.

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..... [1]

(c) Give **two** differences between Erasable Programmable ROM (EPROM) and Electrically Erasable Programmable ROM (EEPROM).

Difference 1 .....

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.....

Difference 2 .....

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[2]

9 A road bridge has a weight limit and a height limit for vehicles. For example, a vehicle must weigh less than 10 000 kg and must have a height of less than 3 m.

The bridge has a warning system. If a vehicle is approaching the bridge and it exceeds one or both limits, a sign displays a warning telling the driver of the vehicle to stop.

(a) The bridge warning system uses sensors to detect if a vehicle exceeds the limits.

Complete the table by identifying **two** different sensors that could be used by the system **and** describe how each sensor is used by the system.

Sensor	Use in bridge warning system
....	....
....	....

[2]

(b) Explain whether the bridge warning system is an example of a monitoring system or of a control system.

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..... [2]

2 A memory buffer uses Dynamic RAM (DRAM).

(a) Identify **two** differences between DRAM and Static RAM (SRAM).

Difference 1 .....

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Difference 2 .....

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[2]

(b) Explain how a memory buffer is used when a computer is transferring data to its magnetic hard disk drive.

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..... [4]

3 A car has an automatic braking system.

A sensor is used to measure the distance to objects that are in front of the car.

The car automatically brakes if an object is too close to the front of the car or the distance between the car and the object is decreasing too quickly. The closer the object is to the front of the car, the harder the car brakes so that the car slows down more quickly.

Explain the reasons why the automatic braking system of the car is a control system.

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..... [3]

2 A video doorbell is attached to the front door of a house. The doorbell uses a motion sensor to detect when a visitor walks in front of the door. When the motion sensor is activated:

- The digital camera in the doorbell starts recording a video.
- A message is transmitted to a smartphone so that the person who lives in the house can watch the video.

The doorbell also has a button that can be pressed. When the button is pressed, a message is transmitted to a smartphone to play the doorbell sound.

The videos are stored on the doorbell's internal secondary storage device and overwritten when the secondary storage device is full.

(a) The video doorbell can be considered an example of an embedded system.

Identify **two** characteristics of the doorbell that suggest it is an embedded system.

1 .....

.....

2 .....

.....

[2]

(b) State whether the video doorbell is a monitoring system or a control system.
Justify your choice.

Monitoring or control system .....

Justification .....

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[2]

(c) The video doorbell has both primary memory and secondary storage.

(i) Identify **two** items of data that the video doorbell will store in primary memory.

1 .....

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2 .....

.....

[2]

(ii) The video doorbell has a solid state (flash) secondary storage device.

Complete the table by writing the answer or answers to each statement about the principal operation of solid state (flash) memory.

Statement	Answer
the **two** types of logic gate that can be used to create solid state devices	1 ..... 2 .....
the number of transistors contained in each cell	.....
the type of gate that can retain electrons without power	.....
the type of gate that allows or stops current from passing through	.....

[4]

(iii) The video doorbell uses a buffer.

Describe how the video doorbell will use the buffer.

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..... [2]

(d) The digital camera has a microphone which is used to record the sound for the video.

The user changes the sampling rate that the microphone uses from 44.1 kHz to 88.2 kHz.

Describe how this change in sampling rate will affect the performance of the video doorbell.

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..... [3]

(e) The video doorbell allows both real-time and on-demand bit streaming.

(i) State what is meant by bit streaming.

.....

..... [1]

(ii) Give **two** differences between real-time and on-demand bit streaming.

1 .....

.....

.....

2 .....

.....

.....

[2]

A-LEVEL COMPUTER SCIENCE • EXERCISE SHEET

3.2 Logic Gates and Logic Circuits

Name: _____ Class: _____ Date: _____ **Total: 20 marks**

KEY WORDS logic circuit 逻辑电路 • truth table 真值表 • logic gate 逻辑门 • boolean 布尔 • rom 只读存储器

Objective

Build the skills to answer exam questions on **logic gates** 逻辑门 and **logic circuits** 逻辑电路 — the six gates and their truth tables, and converting between a problem, a logic expression, a circuit and a truth table.

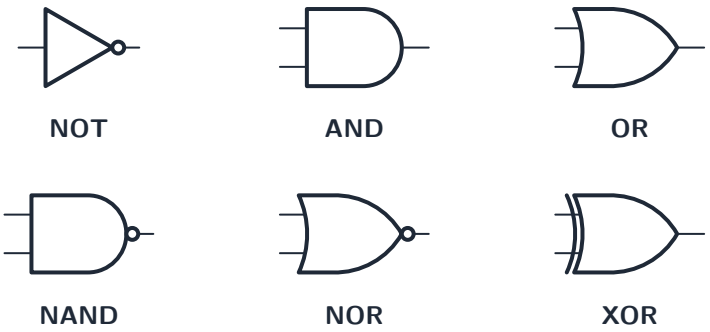
You must be able to:

- recognise and define **NOT, AND, OR, NAND, NOR** and **XOR**
- construct the **truth table** 真值表 for any gate or circuit
- build a **logic expression** and a **logic circuit** from a problem statement, and convert between expression, circuit and truth table

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ The six gates



- **NOT** — output is the opposite of the input.
- **AND** — output 1 only if **all** inputs are 1. **OR** — output 1 if **at least one** input is 1.
- **NAND** = NOT AND; **NOR** = NOT OR (so their outputs are the AND/OR output flipped).
- **XOR** — output 1 only when the inputs are **different**.

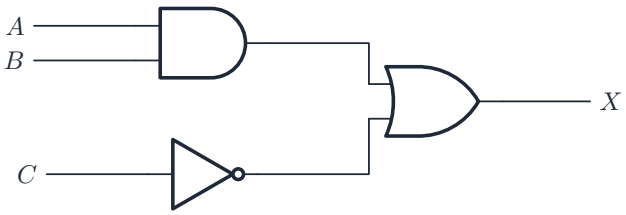
■ Building a truth table

List **every** input combination (2 inputs → $2^2 = 4$ rows; 3 inputs → $2^3 = 8$ rows), then work out the output for each. For example, AND and XOR:

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

■ Circuit, expression and truth table

These three describe the same logic. From this circuit you can read the expression $X = (A \text{ AND } B) \text{ OR } (\text{NOT } C)$, then build the truth table by filling each gate's output column.



A	B	C	A AND B	NOT C	X
0	0	0	0	1	1
0	0	1	0	0	0
0	1	0	0	1	1
0	1	1	0	0	0
1	0	0	0	1	1
1	0	1	0	0	0
1	1	0	1	1	1
1	1	1	1	0	1

2 Practice

Now apply the methods above.

2.1 Complete the truth table for a **NAND** gate. [2]

A	B	A NAND B
0	0	
0	1	
1	0	
1	1	

2.2 Name the gate that outputs 1 only when its two inputs are **different**. [1]

2.3 Write the logic expression for: *"X is 1 when A is 1 OR B is 0."* [2]

2.4 Complete the truth table for $X = A$ AND (NOT B). [2]

A	B	X
0	0	
0	1	
1	0	
1	1	

3 Exam-style questions

3.1 A circuit has the expression $X = (A$ OR $B)$ AND (NOT $C)$.

(a) Draw the logic circuit for X. [3]

(b) Complete the truth table for X. [3]

A	B	C	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	

3.2 A pump X turns on when the tank is **not full** ($A = 0$) **or** the manual switch B is on. Write the logic expression for X. [2]

3.3 Construct the truth table for A XOR B, and give one use of an XOR gate. [3]

3.4 Write the Boolean expression for the logic described by this truth table. [2]

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

Solutions

2.1 NAND outputs: $1, 1, 1, 0$ (top to bottom).

2.2 XOR.

2.3 $X = A$ OR (NOT B).

2.4 X outputs: $0, 0, 1, 0$ — X is 1 only when $A = 1$ and $B = 0$.

3.1 (a) A and B into an **OR** gate; C into a **NOT** gate; the OR output and the NOT output into an **AND** gate → X.
(b) X outputs (top to bottom): $0, 0, 1, 0, 1, 0, 1, 0$ — i.e. X = 1 only when (A or B) is 1 **and** C = 0.

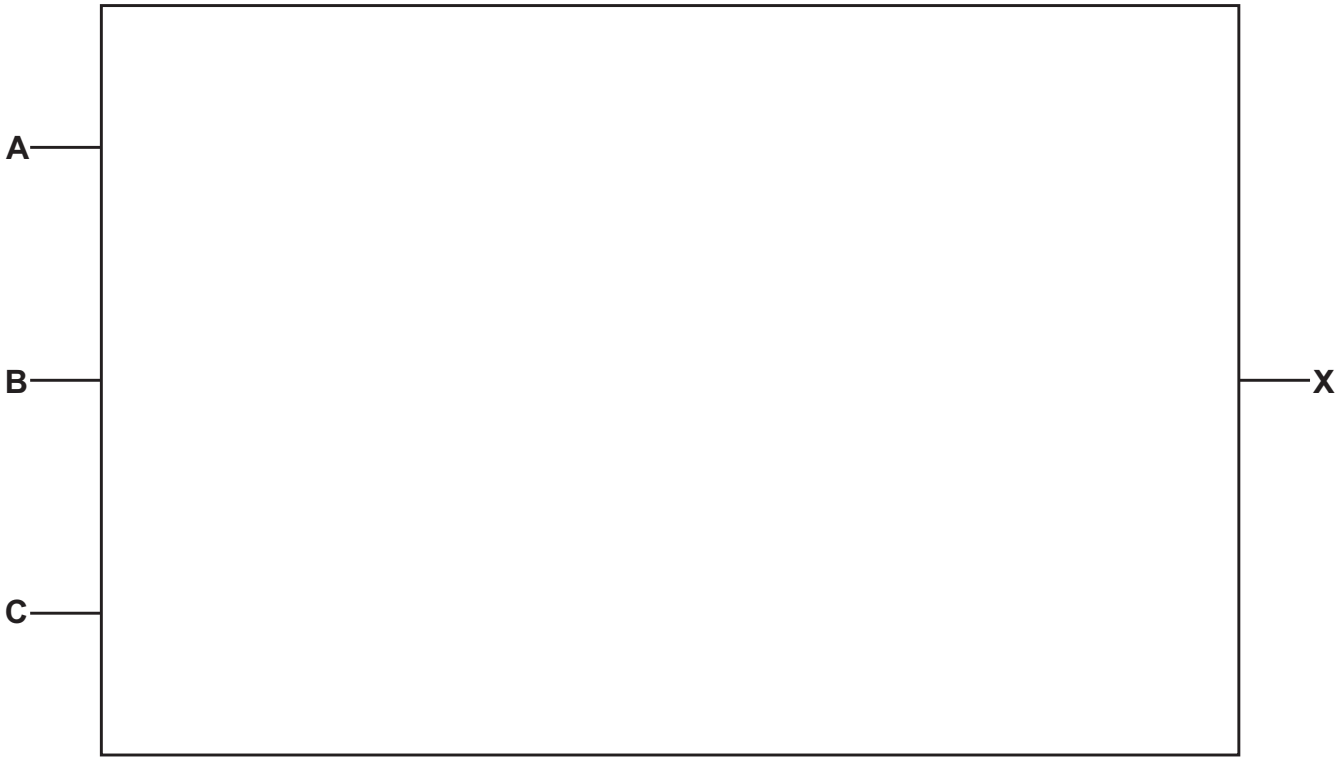
3.2 $X =$ (NOT A) OR B.

3.3 A XOR B: $0, 1, 1, 0$. Use: e.g. compare two bits (equal → 0), or add two bits in a half-adder.

3.4 $X =$ (NOT A) OR B — X is 0 only on the row $A = 1, B = 0$.

3 **(a)** Draw a logic circuit for the logic expression:

X = NOT ((**A** NAND **B**) XOR (NOT **A** OR NOT **C**))



[2]

(b) Write the logic expression for the following truth table.

R	S	T	Q
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	0

Q = ... [2]

3 **(a)** Complete the truth table for the following logic expression:

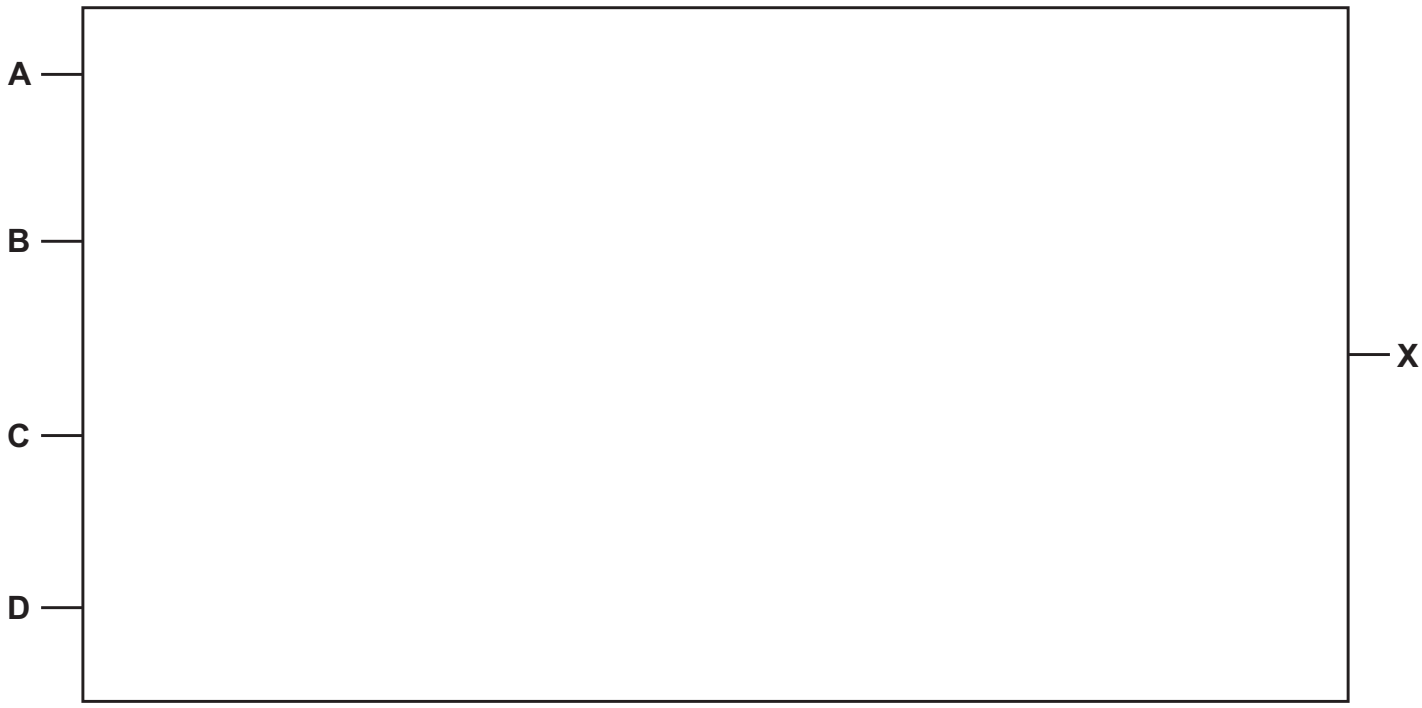
X = (**A** NOR **B**) NAND (**C** XOR **B**)

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		

[2]

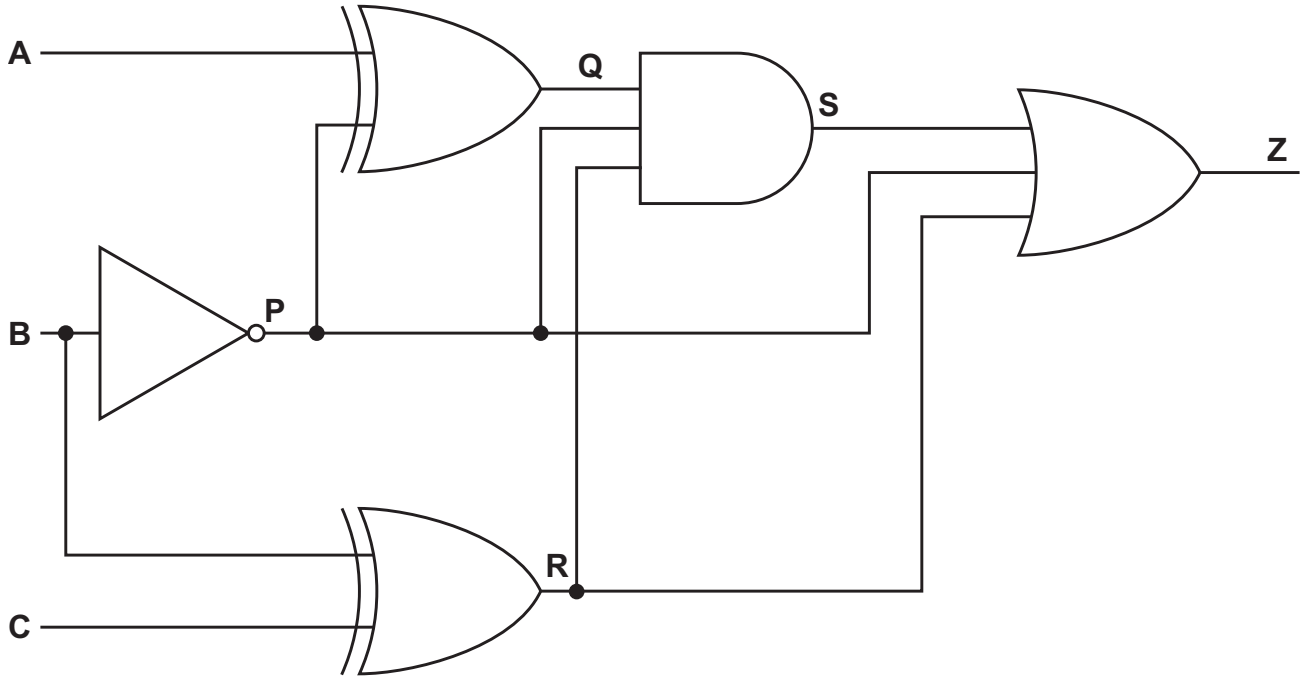
(b) Draw a logic circuit for the logic expression:

X = NOT (((**A** AND **B**) OR **C**) AND (**C** NOR **D**))



[2]

6 **(a)** The diagram shows a logic circuit.



Complete the truth table for the given logic circuit.
Show your working.

			Working space				
A	**B**	**C**	**P**	**Q**	**R**	**S**	**Z**
0	0	0					
0	0	1					
0	1	0					
0	1	1					
1	0	0					
1	0	1					
1	1	0					
1	1	1					

[3]

(b) (i) Complete the Karnaugh map (K-map) for the Boolean expression:

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

A \ BC	00	01	11	10
0				
1				

[2]

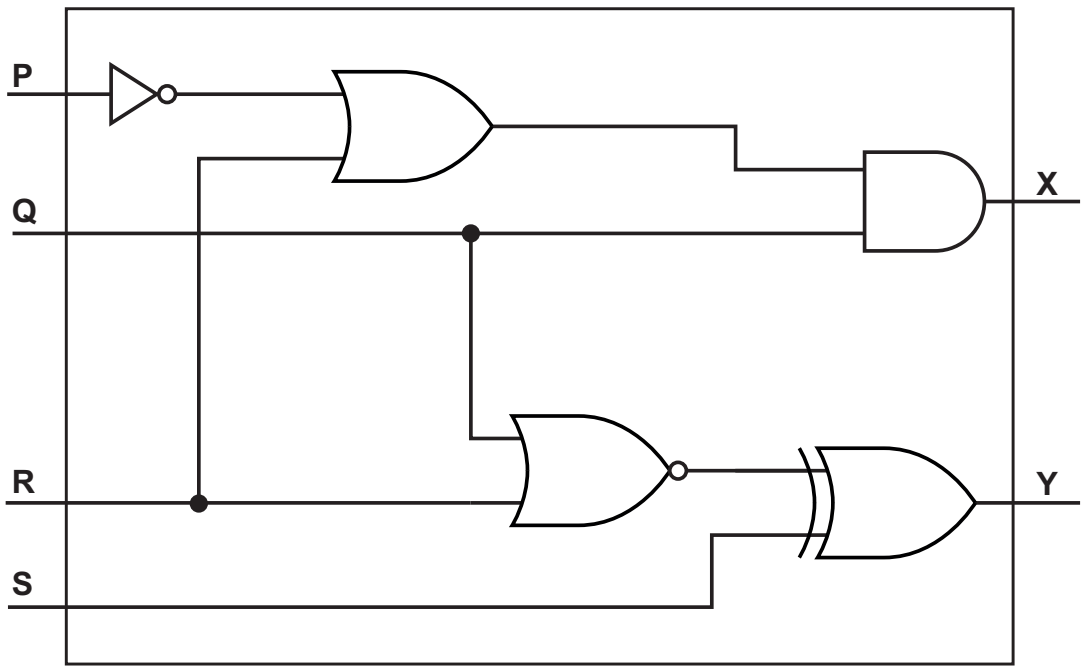
(ii) Draw loop(s) around appropriate group(s) in the K-map to produce an optimal sum-of-products. [2]

(iii) Write the Boolean expression from your answer to part **b(ii)** as a simplified sum-of-products. Do **not** carry out any further simplification.

.....

..... [2]

1 (a) Write the logic expressions for the following logic circuit.

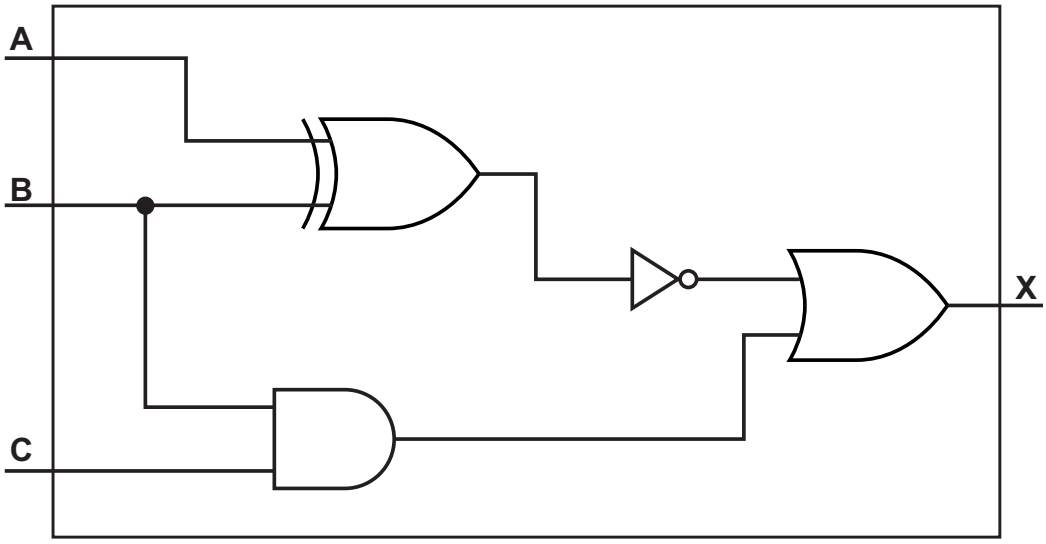


X = ...

Y = ...

[2]

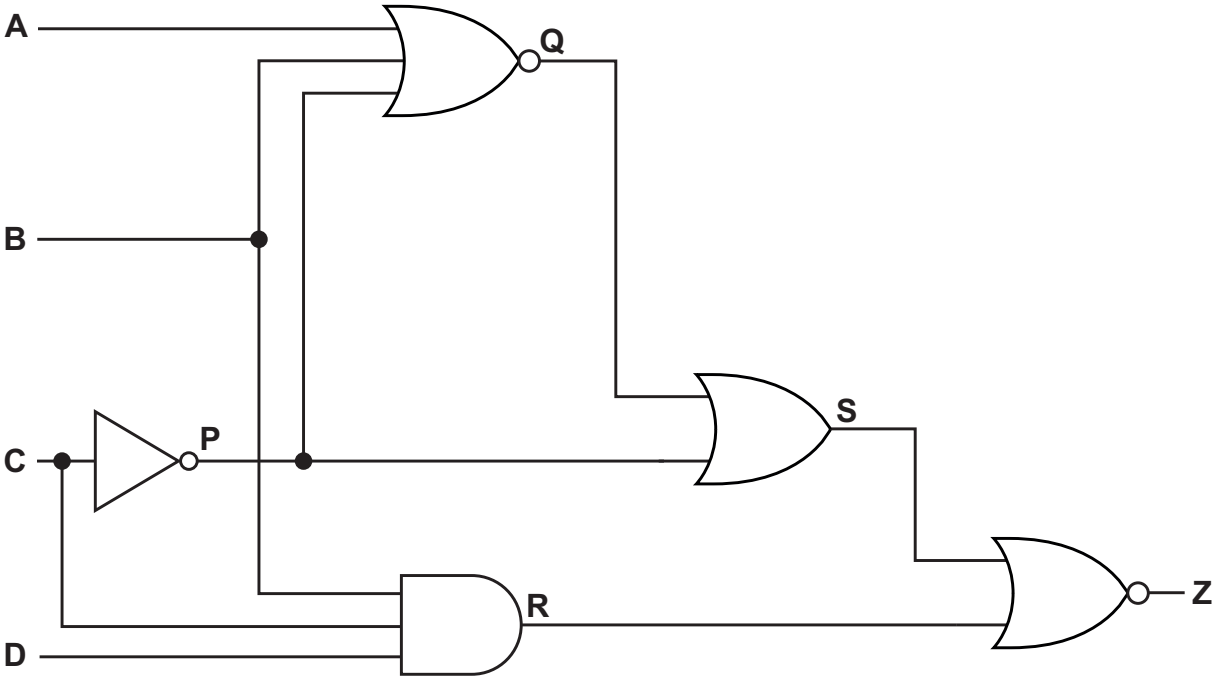
(b) Complete the truth table for the following logic circuit.



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		

[2]

7 The diagram shows a logic circuit.



(a) Complete the truth table for the given logic circuit.
Show your working.

				Working space				
A	**B**	**C**	**D**	**P**	**Q**	**R**	**S**	**Z**
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					

[3]

(b) Write the Boolean logic expression that corresponds to the given logic circuit as the sum-of-products.

Z = ...

..... [1]

(c) Use Boolean algebra including De Morgan's laws to simplify the following expression. Show all working.

$$(\overline{\mathbf{A} + \mathbf{B}}) \mathbf{.} (\overline{\mathbf{A} \mathbf{.} \mathbf{B}} + \overline{\mathbf{B} \mathbf{.} \mathbf{C}})$$

Working .....

.....

.....

.....

.....

.....

Simplified expression .....

.....

[4]

3 This truth table represents a logic circuit.

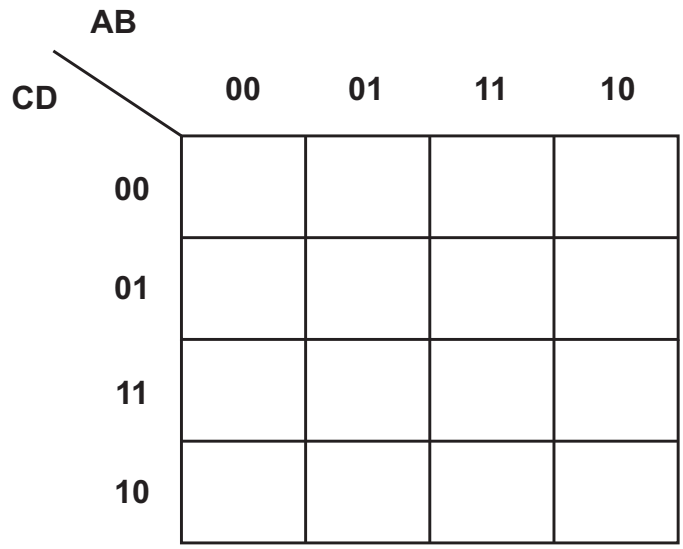
INPUT				OUTPUT
A	**B**	**C**	**D**	**Z**
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1
0	0	1	1	1
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

(a) Write the Boolean logic expression that corresponds to the given truth table as the sum-of-products.

Z = ...

..... [2]

(b) (i) Complete the Karnaugh map (K-map) for the given truth table.



[2]

(ii) Draw loop(s) around appropriate group(s) in the K-map to produce an optimal sum-of-products. [2]

(iii) Write the Boolean logic expression from your answer to part **(b)(ii)** as the simplified sum-of-products.

Z = ...

..... [2]

5 A security system has both a floodlight (very bright light) and an audio alarm.

The data from multiple sensors is analysed and used to:

- turn on the floodlight
- sound the audio alarm.

Sensors can be used to detect:

- if doors are open
- the external daylight level
- if people are detected within a set distance.

(a) Complete the table to identify the most appropriate type of sensor for each scenario.

Scenario	Type of sensor
A door is open.	
The external daylight level is below a set amount.	
A person is detected within 2 metres.	

[1]

(b) The floodlight (**X**) and audio alarm (**Y**) operate according to the following criteria:

Parameter	Description of parameter	Binary value	Condition
A	external daylight level	1	Low
		0	High
B	front door	1	Open
		0	Closed
C	person is within 2 m	1	Detected
		0	Not detected
D	back door	1	Open
		0	Closed
E	security system	1	Switched on
		0	Switched off

The floodlight turns on (**X = 1**) if:

- the security system is switched on
  and
- the external daylight level is low
  and
- a person is detected within 2 m.

The audio alarm turns on (**Y = 1**) if:

- the security system is switched on
  and
- one **or** more doors are open, **or** a person is detected within 2 m.

Write logic expressions for the security system.

X = ...

.....

Y = ...

.....

[2]

(c) Explain whether the security system is an example of a monitoring system or a control system.

.....

.....

.....

.....

.....

.....

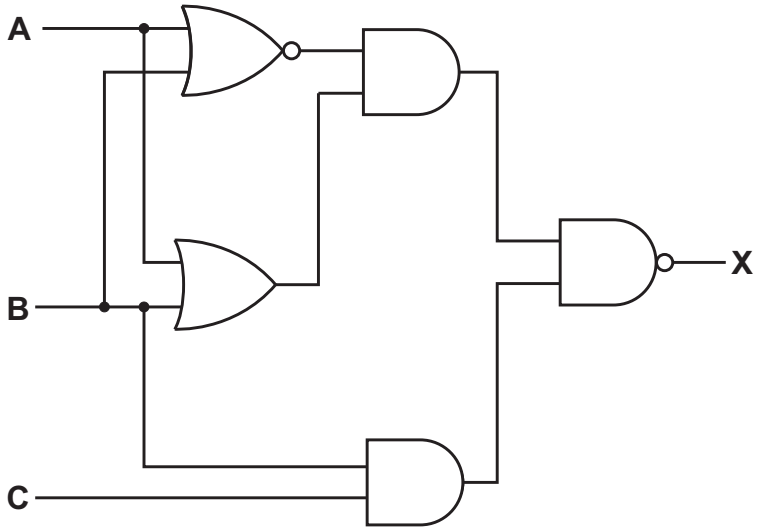
[3]

1 **(a)** Describe the operation of a 2-input XOR gate.

.....

..... [1]

(b) Write the logic expression for the following logic circuit.

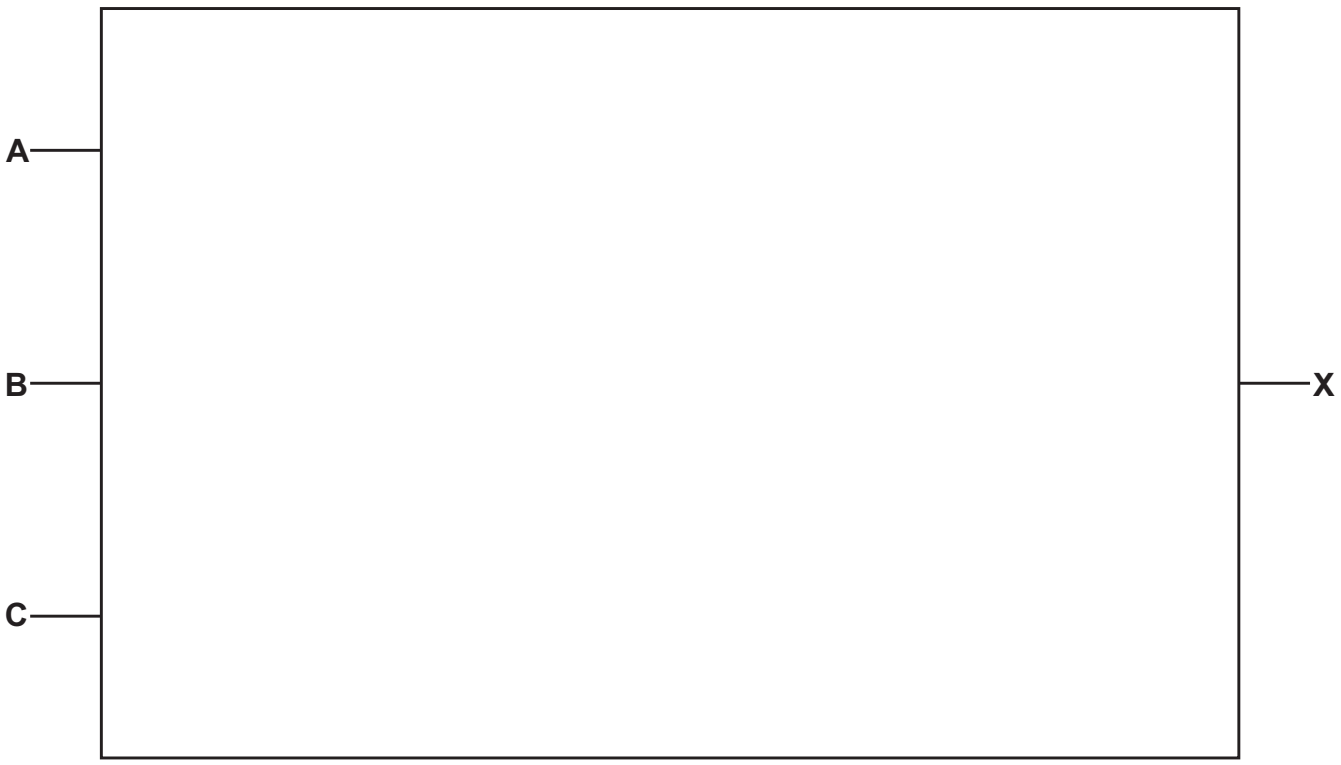


X = ...

..... [2]

(c) Draw the logic circuit for the logic expression:

X = ((NOT **A** AND (**B** AND **C**)) OR (**B** NAND **C**)) AND NOT **A**



[2]

1 **(a)** Describe the operation of each of the following logic gates:

NAND .....

.....

NOR .....

.....

XOR .....

.....

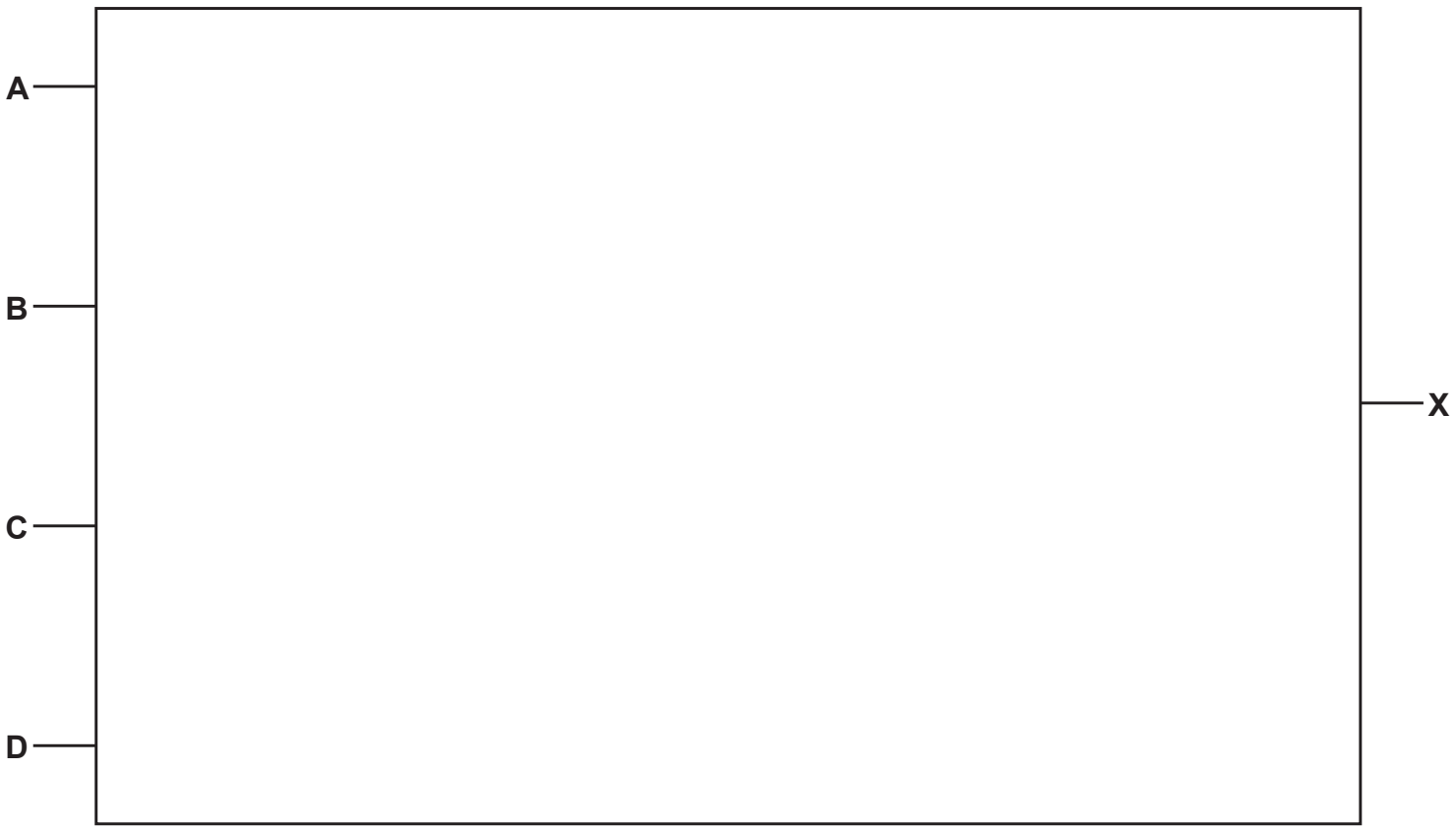
OR .....

.....

[4]

(b) Draw a logic circuit for this logic expression:

X = NOT ((**A** AND **B**) OR (**C** AND **D**))



[2]