

THEME A: CONCEPTS · A1.2

Data representation and computer logic

Original practice questions · 34 marks · about 50 minutes · covers A1.2.1–A1.2.5

Instructions. Answer all questions. The maximum mark for this paper is [34 marks]. The marks available are shown in brackets. Parts badged **HL** assess higher level only content; standard level students may leave these out. You may answer the logic questions using either word operators (AND, OR, NOT) or standard Boolean notation.

1**Total: 5 marks**

A microcontroller in a games console uses 8-bit registers.

(a) State the denary equivalent of the binary number 10110110. [1]

(b) State the hexadecimal equivalent of the binary number 10110110. [1]

(c) State the 8-bit binary equivalent of the hexadecimal number 5D. [1]

(d) Outline **one** reason why programmers use hexadecimal rather than binary to write down the contents of a register. [2]

2**Total: 5 marks**

A messaging app lets users send typed text messages and recorded voice notes. Both are stored on the user's phone.

(a) Outline how a single character typed by the user is stored in binary. [2]

(b) Explain the effect on a stored voice note of increasing the sampling rate used to record it. [3]

3

Total: 5 marks

Logic gates are the building blocks of every digital circuit.

(a) Define the **NAND** Boolean operator. [1]

(b) State the output of the Boolean expression $(1 \text{ AND } 0) \text{ OR } (\text{NOT } 0)$. [1]

(c) Outline the role of logic gates in binary computing. [3]

4

Total: 7 marks

A greenhouse has an automatic roof vent. The vent opens (output $V = 1$) when the temperature sensor reads high ($T = 1$) **and** the rain sensor reads dry ($R = 0$). The vent also opens whenever the gardener presses the manual override ($M = 1$), whatever the sensors read.

(a) Construct a Boolean expression for V in terms of T , R and M . [2]

(b) Copy and complete Table 1 to show the output V for every combination of inputs. [4]

Table 1: Truth table for the ventilation system

T	R	M	V
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

(c) State the value of V when $T = 0$, $R = 1$ and $M = 1$. [1]

A logic diagram shows how gates are connected together in a circuit.

- (a) Construct a logic diagram, using standard gate symbols, for the Boolean expression $Z = (A \text{ AND } B) \text{ OR } ((\text{NOT } A) \text{ AND } C)$. [4]

- (b) Identify the single logic gate whose output is 1 only when its two inputs have different values. [1]

- (c) Identify the single logic gate that is equivalent to a NOT gate connected to the output of an AND gate. [1]

A safety circuit has three inputs, A, B and C, and one output, Y. Table 2 shows the value of Y for every combination of inputs.

Table 2: Output Y of the safety circuit

A	B	C	Y
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

- (a) Construct a Karnaugh map for Y.

[2]

Karnaugh map for Y

Y	BC = 00	BC = 01	BC = 11	BC = 10
A = 0				
A = 1				

- (b) State the simplified Boolean expression for Y.

[2]

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- (c) Outline **one** benefit to a manufacturer of simplifying this expression before the circuit is built.

[2]

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END OF QUESTIONS