IGCSE COMPUTER SCIENCE • EXERCISE SHEET

6.3 Artificial intelligence

Name: _____ Class: _____ Date: _____ **Total: 25 marks**

KEY WORDS artificial intelligence 人工智能 • learn 学习 • adapt 适应 • narrow ai 弱人工智能 • general ai 通用人工

Objective

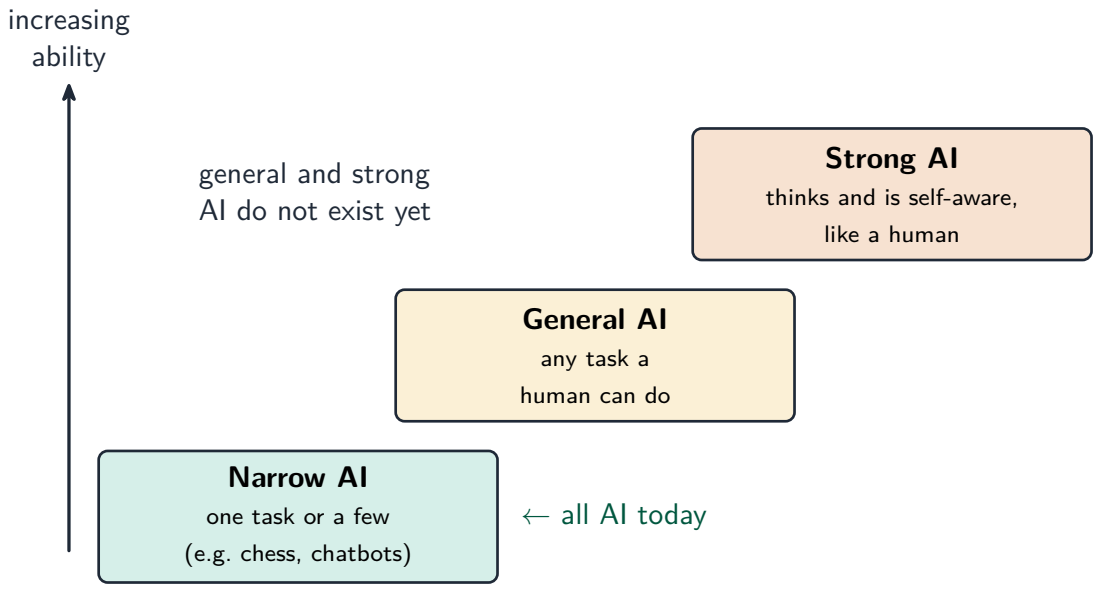
Build the skills to answer exam questions on **artificial intelligence** 人工智能 — what AI is, its characteristics, examples, and **narrow/general/strong AI** 弱/通用/强人工智能.

You must be able to:

- define AI and give its characteristics
- give examples of AI (expert systems, NLP, self-driving cars)
- distinguish narrow, general and strong AI

1 Worked examples

■ Levels of AI



Narrow AI: one task (all AI today). General AI: any human task. Strong AI: self-aware (does not exist yet)

- **AI:** the simulation of human intelligence by computers.

- **characteristics:** collect data + rules; reason; draw conclusions; learn; adapt.

■ Logic gates, expressions and truth tables

Six gates, with their symbols in words and their rule:

Gate	Output is 1 when	Expression
NOT	the input is 0	$\overline{A}$
AND	**both** inputs are 1	$A \cdot B$
OR	**at least one** input is 1	$A + B$
NAND	**not** both are 1	$\overline{A \cdot B}$
NOR	**neither** input is 1	$\overline{A + B}$
XOR	the inputs are **different**	$A \oplus B$

Building a truth table. With n inputs there are 2^n rows. Write the input columns in binary counting order, then add one working column per gate, in the order the signals flow, before the final output column. Working columns earn marks even if the last column is wrong.

Worked example. Complete a truth table for $X = (A \cdot B) + \overline{C}$.

A	**B**	**C**	$A \cdot B$	$\overline{C}$	**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

Turning a problem into a circuit. Read the sentence for the joining words. "The alarm sounds when the door is open **and** the system is armed" is AND. "…when the door **or** the window is open" is OR. "…when the system is **not** armed" is NOT. Write the expression first, then draw one gate per operator, feeding the outputs forward.

2 Practice

2.1 Define artificial intelligence. [1]

2.2 Give one example of an AI application. [1]

2.3 Give the logic expression for each: the output is 1 only when both inputs are 1; the output is 1 when the inputs are different. [2]

2.4 State how many rows a truth table needs for four inputs, and explain why. [2]

2.5 Identify the gate whose output is 1 unless both inputs are 1. [1]

3 Exam-style questions

3.1 A chess-playing program that can do only that one task is an example of: [1]

- **A** narrow AI
- **B** general AI
- **C** strong AI
- **D** an automated system

3.2 AI systems have several characteristics.

(a) State two characteristics of an AI system. [2]

(b) State the difference between narrow AI and general AI. [2]

3.3 A greenhouse system sounds an alarm. The alarm sounds when the temperature is too high **and** the window is closed, **or** when the water level is low.

Let $T = 1$ mean the temperature is too high, $W = 1$ mean the window is open, and $L = 1$ mean the water level is low.

(a) Write the logic expression for the alarm output X. [3]

(b) Complete the truth table for your expression. [4]

T	**W**	**L**	$\overline{W}$	$T \cdot \overline{W}$	**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			

(c) Explain, using a row of your table, what happens when the temperature is too high and the window is open. [2]

(d) Identify the single gate that could replace $\overline{T \cdot \overline{W}}$, and state its rule. [2]

(e) A second system sounds only when the two sensors disagree. Name the gate needed and give its expression. [2]

Solutions

2.1 the simulation of human intelligence by computer systems.

2.2 any of: expert system; natural language processing; self-driving car.

3.1 **A**. A single-task program is narrow AI.

3.2 (a) any two of: collect data and rules; reason; draw conclusions; learn; adapt.
(b) narrow AI can do only one (or a few) tasks; general AI could do any task a human can do.

2.3 $A \cdot B$ for AND; $A \oplus B$ for XOR.

2.4 16 rows; each input has two possible values, so there are $2^4 = 16$ combinations.

2.5 NAND.

3.3 (a) $X = (T \cdot \overline{W}) + L$.
(b) $\overline{W}$ column: 1, 1, 0, 0, 1, 1, 0, 0. $T \cdot \overline{W}$ column: 0, 0, 0, 0, 1, 1, 0, 0. X column: 0, 1, 0, 1, 1, 1, 0, 1.
(c) The row $T = 1$, $W = 1$, $L = 0$ gives $X = 0$; the alarm does not sound, because an open window already lets the heat escape, so no action is needed.
(d) A NAND gate; its output is 1 unless both of its inputs are 1.
(e) XOR; $X = T \oplus W$.