A-LEVEL COMPUTER SCIENCE • EXERCISE SHEET

5.2 Language Translators

Name: _____ Class: _____ Date: _____ **Total: 30 marks**

KEY WORDS interpreter 解释器 • compiler 编译器 • integrated development environment (ide) 集成开发环境 • assembler 汇编器 • assembly language 汇编语言

Objective

Build the skills to answer exam questions on **language translators** 翻译器 — assemblers, compilers and interpreters, when to use each, and the features of an IDE.

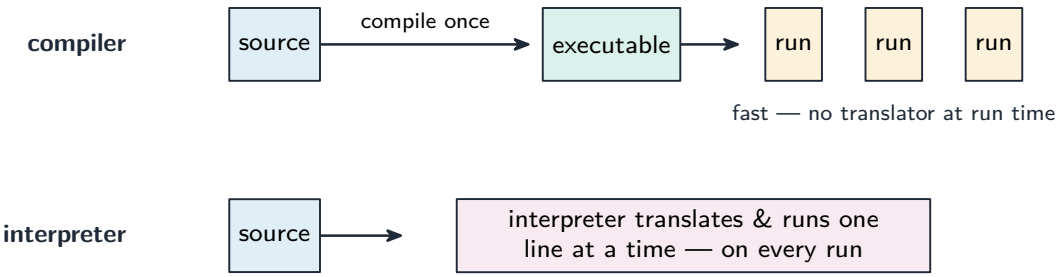
You must be able to:

- explain the need for an **assembler**, a **compiler** 编译器 and an **interpreter** 解释器
- compare and justify the use of a compiler or an interpreter
- explain the **hybrid** (bytecode) approach used by Java
- describe features of an **Integrated Development Environment (IDE)** 集成开发环境

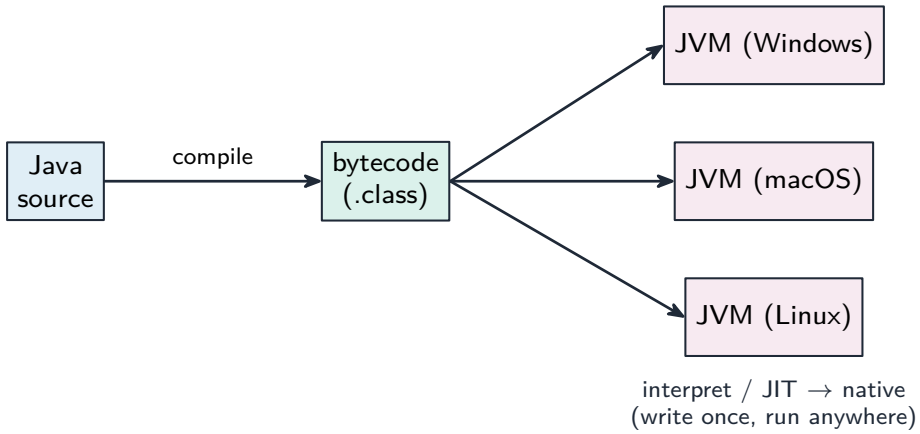
1 Worked examples

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.

■ Three translators



Compiler: translate all at once, then run. Interpreter: translate and run line by line.



Java compiles to bytecode run by a virtual machine

You write source code; the CPU runs **machine code** 机器码. A translator converts between them.

- **assembler** — translates **assembly language** to machine code (one-to-one).
- **compiler** — translates a whole **high-level** program to machine code **once, before it runs**.
- **interpreter** — translates and runs a high-level program **one line at a time**.

Compiler vs interpreter

	compiler	**interpreter**
When translated	all at once, before running	line by line, while running
Errors	reports **all** at compile time	stops at the **first** error reached
Output	a stand-alone **executable**	none — re-translates each run
Needs the translator to run?	no	yes
Run-time speed	faster	slower
Portable across platforms?	recompile per platform	yes (if interpreter exists)

Choosing: use a **compiler** for speed and to distribute finished software; use an **interpreter** for quick development and cross-platform scripts.

Java (hybrid) and IDEs

Java is **compiled to bytecode** 字节码, which a **virtual machine** (the JVM) interprets (or just-in-time compiles). So errors are caught early **and** the bytecode runs anywhere with a JVM ("write once, run anywhere"). An **IDE** brings the tools together, with features that help at each stage:

- **writing code:** an editor with **syntax highlighting**, **auto-complete** / context-sensitive prompts, and **prettyprinting** (auto-indenting).
- **finding errors: error diagnostics** that point to the line of a syntax error, and reports as you type.
- **debugging:** a **debugger** with **breakpoints**, **single-stepping**, and a **watch window** to inspect variable values while paused.

2 Practice

Now apply the methods above.

2.1 State the difference between a **compiler** and an **interpreter**. [2]

2.2 Give one situation in which an **interpreter** is more suitable than a compiler. [1]

2.3 State what an **assembler** translates. [1]

2.4 Name **two** features of an IDE. [2]

3 Exam-style questions

3.1 (a) State **two** benefits of using a **compiler** rather than an interpreter. [2]

(b) State **two** benefits of using an **interpreter** rather than a compiler. [2]

3.2 Explain how Java's "compile to bytecode, then run on a virtual machine" approach

lets the same program run on different computers. [3]

3.3 Describe **two** features an IDE provides to help a programmer **debug** a program. [2]

3.4 A company sells finished software to customers who do not have any programming tools installed. State which translator the company should use, and justify your choice. [2]

3.5 A programmer writes a program in a high-level language and releases it as **free software**.

(a) **Explain** how the programmer can use an **interpreter** first and then a **compiler** while developing the same program. [4]

(b) **State** two things an **Integrated Development Environment** provides beyond a translator. [2]

(c) A user downloads the program. **Describe** what "free software" allows the user to do that **freeware** does not. [3]

(d) **Explain** why the program still runs more slowly when interpreted than when compiled, even on the same computer. [3]

(e) The compiler reports a **syntax error** on a line that looks correct. **Suggest** one reason this can happen. [1]

Solutions

2.1 A compiler translates the **whole** program **once** into an executable; an interpreter translates and runs it **one line at a time**.

2.2 e.g. during development (quick edit–run cycles) / for a cross-platform script / a small or run-once program.

2.3 Assembly language (into machine code).

2.4 Any two of: syntax highlighting; auto-complete; one-key compile/run; debugger; version-control integration.

3.1 (a) Any two: runs faster (no translation at run time); produces a stand-alone executable; the translator is not needed to run it; the source code is not given away.
(b) Any two: reports errors as it reaches them (easier development); no need to recompile after each change; the same program runs on any platform with the interpreter.

3.2 The program is compiled once into **bytecode**, which is platform-independent; any computer with a **JVM** can interpret/run that bytecode; so it runs unchanged on different operating systems — "write once, run anywhere".

3.3 Any two: set **breakpoints** to pause execution; **step through** line by line; **inspect variable** values while paused.

3.4 A **compiler** — it produces a stand-alone executable that runs without any programming tools installed on the customer's computer.

3.5 (a) During development an **interpreter** translates and runs one statement at a time, so the programmer sees the effect of a change immediately and can stop at the first error. Once the program works, a **compiler** translates the whole source into machine code once, producing an executable that runs faster and can be distributed without the source.
(b) Any two: an editor with syntax highlighting and auto-complete; a debugger with breakpoints, single-stepping and variable watches; a project manager for multiple source files; built-in help and error reporting.
(c) Free software gives the user the source code and the right to **study**, **modify** and **redistribute** it, including modified versions. Freeware costs nothing to use but the source is not provided and the licence forbids changing or redistributing it.
(d) An interpreter must **translate each statement every time it is executed**, so a statement inside a loop is translated on every pass. Compiled code was translated once, before running, so the processor executes machine code directly with no translation overhead at all.
(e) The real error is on an **earlier** line — for example a missing closing bracket or quotation mark — and the compiler only notices when the statement fails to make sense.