A-LEVEL COMPUTER SCIENCE • EXERCISE SHEET

20.1 Programming Paradigms

Name: _____ Class: _____ Date: _____ **Total: 18 marks**

KEY WORDS attributes 属性 • methods 方法 • objects 对象 • inheritance 继承 • polymorphism 多态

Objective

Build the skills to answer exam questions on **programming paradigms** 编程范式 — low-level, imperative, object-oriented and declarative.

You must be able to:

- explain what a **paradigm** is and the four kinds
- describe the **OOP** features (encapsulation, inheritance, polymorphism, abstraction)
- give examples of **declarative** (functional, logic, SQL) programming

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 paradigms

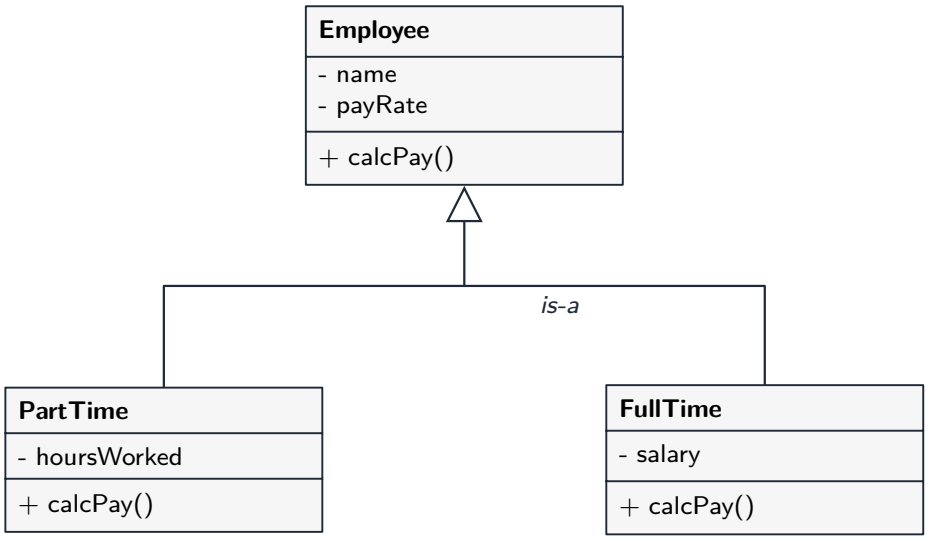
A **paradigm** is a style of structuring programs.

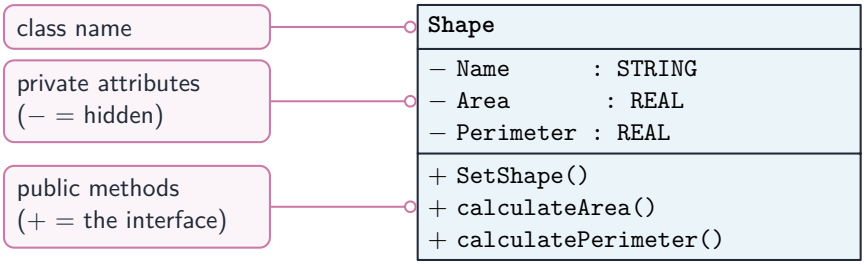
- **Low-level** — machine/assembly code, close to the hardware (fast, but architecture-specific).
- **Imperative (procedural)** — a **sequence of commands** that change state (C, Python).
- **Object-oriented (OOP)** — programs built from **objects** (data + methods).
- **Declarative** — say **what**, not **how** (SQL, Prolog, Haskell).

■ OOP features

An **object** is an **instance** of a **class** (data = **attributes**, operations = **methods**). The pillars:

- **encapsulation** — data is **hidden** behind methods (outside code uses public methods only).
- **inheritance** — a **subclass** specialises a **superclass** (an "is-a" relationship):





A class diagram models an object-oriented design

- **polymorphism** — the **same method call** behaves differently per object type (each `Shape` has its own `Area()`).
- **abstraction** — show a simple interface, hide the implementation.

Writing a class (pseudocode)

A class declares **private** attributes and **public** methods, including a **constructor** (`NEW`) that sets up a new object; a subclass uses **INHERITS**:

```
CLASS Employee
    PRIVATE Name : STRING
    PRIVATE PayRate : REAL

    PUBLIC PROCEDURE NEW(GivenName : STRING, GivenRate : REAL)
        Name ← GivenName
        PayRate ← GivenRate
    ENDPROCEDURE

    PUBLIC FUNCTION GetName() RETURNS STRING
        RETURN Name      // a "get" method reads a private attribute
    ENDFUNCTION
ENDCLASS

CLASS Manager INHERITS Employee
    PRIVATE Bonus : REAL
ENDCLASS
```

Declarative

Functional uses **pure functions** (no side effects); **logic** states facts/rules (Prolog); **SQL** queries data — `SELECT * FROM Customer WHERE Country = 'UK'` says **what**, not **how**.

2 Practice

Now apply the methods above.

2.1 State what a **programming paradigm** is. [1]

2.2 Name the **four** features (pillars) of **OOP**. [2]

2.3 State what **encapsulation** means. [1]

2.4 Give **one** example of a **declarative** language. [1]

3 Exam-style questions

3.1 Describe what is meant by the OOP feature **inheritance**, with an **example**. [3]

3.2 Identify the OOP feature that **restricts external access to an object's data**, and state **one** benefit of it. [2]

3.3 Explain what is meant by **polymorphism**. [2]

3.4 State **one** characteristic of **low-level** programming and **one** of **declarative** programming. [2]

3.5 A class `Book` has a private attribute `Title` of type `STRING`. Write pseudocode for a **constructor** that sets `Title`, and a **get method** `GetTitle()` that returns it. [4]

Solutions

2.1 A **style/approach to structuring programs**, with its own concepts and language features.

2.2 Encapsulation, inheritance, polymorphism, abstraction.

2.3 An object's **data is hidden** and accessed **only through its methods** (not directly).

2.4 Any one: **SQL**, **Prolog**, **Haskell**, Lisp, F#.

3.1 A **subclass** inherits the **attributes and methods** of a **superclass** and can add or **override** its own; example: a `Manager` inherits from `Employee` ("is-a").

3.2 Encapsulation; benefit: it **protects the data** from invalid changes / lets the internals change without breaking other code.

3.3 Different object types respond to the **same method call** in their **own way**, so the caller need not know the exact type (e.g. `Circle` and `Rectangle` each implement `Area()`).

3.4 Low-level: any one — close to hardware, direct register/memory access, fast/compact, architecture-specific. Declarative: any one — you state **what** not **how**, no explicit step-by-step control flow.

3.5

```
PUBLIC PROCEDURE NEW(GivenTitle : STRING)
    Title ← GivenTitle
ENDPROCEDURE

PUBLIC FUNCTION GetTitle() RETURNS STRING
    RETURN Title
ENDFUNCTION
```