**Chapter 1**

**Self-Review Exercises 1.1**

**Fill in the blanks in each of the following statements:**

1. Computers process data under the control of sets of instructions called

**program**

b) The key logical units of the computer are the **input unit, output unit, memory unit, arithmetic and logic unit, control unit and central processing unit.**

c) The three types of languages they are **machine language, assembly** **language** and **high-level language**.

d) The programs that translate high-level language programs into machine language are called **compilers**.

e) **android** is an operating system for mobile devices based on the Linux kernel and Java.

f) o**pen-source** software is generally feature complete, (supposedly) bug free and ready for use by the community.

g) The Wii Remote, as well as many smartphones, use a(n) **accelerometer** which allows the device to respond to motion.

**1.2 Fill in the blanks in each of the following sentences about the Java environment:**

a) The **java** command from the JDK executes a Java application.

b) The **javac** command from the JDK compiles a Java program.

c) A Java source code file must end with the **java** file extension.

d) When a Java program is compiled, the file produced by the compiler ends with the **class** file extension.

e) The file produced by the Java compiler contains **bytecode** that are executed by the Java Virtual Machine.

**1.3 Fill in the blanks in each of the following statements**

a) Objects enable the design practice of **encapsulation**—although they may know how to communicate with one another across well-defined interfaces, they normally are not allowed to know how other objects are implemented.

b) Java programmers concentrate on creating **classes**, which contain fields and the set of methods that manipulate those fields and provide services to clients.

c) The process of analyzing and designing a system from an object-oriented point of view is called **object-oriented design** (OOD).

d) A new class of objects can be created conveniently by **inheritance** —the new class (called the subclass) starts with the characteristics of an existing class (called the superclass), possibly customizing them and adding unique characteristics of its own.

e) **UML (unified modelling language)** is a graphical language that allows people who design software systems to use an industry-standard notation to represent them.

f) The size, shape, color and weight of an object are considered **attributes** of the object’s class.

**Exercises 1.4 Fill in the blanks in each of the following statements:**

a) The logical unit that receives information from outside the computer for use by the computer is the **input unit** .

b) The process of instructing the computer to solve a problem is called **programming**.

c) **assembly language** is a type of computer language that uses English-like abbreviations for machine-language instructions.

d) **output unit** is a logical unit that sends information which has already been processed by the computer to various devices so that it may be used outside the computer.

e) **memory and secondary** storage are logical units of the computer that retain information.

f) **arithmetic logic unit** is a logical unit of the computer that performs calculations. g) **arithmetic logic unit** is a logical unit of the computer that makes logical decisions.

h) **high-level languages** are most convenient to the programmer for writing programs quickly and easily.

i) The only language a computer can directly understand is that computer’s **machine language**.

j) **control unit** is a logical unit of the computer that coordinates the activities of all the other logical units.

**1.5 Fill in the blanks in each of the following statements:**

a) The **java** programming language is now used to develop large-scale enterprise applications, to enhance the functionality of web servers, to provide applications for consumer devices and for many other purposes. b) **c programming language** initially became widely known as the development language of the UNIX operating system.

c) The **transmission control protocol** ensures that messages, consisting of sequentially numbered pieces called bytes, were properly routed from sender to receiver, arrived intact and were assembled in the correct order.

d) The **c++** programming language was developed by Bjarne Stroustrup in the early 1980s at Bell Laboratories.

1.6 Fill in the blanks in each of the following statements:

a) Java programs normally go through five phases**— editing, compiling, loading, verifying and execution .**

b) A(n**) integrated development environment** provides many tools that support the software development process, such as editors for writing and editing programs, debuggers for locating logic errors in programs, and many other features.

c) The command java invokes the **java virtual machine**, which executes Java programs.

d) A(n) **virtual machine** is a software application that simulates a computer, but hides the underlying operating system and hardware from the programs that interact with it.

e) The **class loader** takes the .class files containing the program’s bytecodes and transfers them to primary memory. f) The examines bytecodes to ensure that they’re valid.

f) The **bytecode verifier** examines bytecodes to ensure that they’re valid.

1.7 Explain the two compilation phases of Java programs.

**Phase 1,compilation to bytecode**  
The Java source code (.java file) is compiled by the **Java Compiler (javac)**.

**Result:**  
The compiler translates the human-readable code into **bytecode**, which is saved in a .class file.

**Bytecode:**  
This is not machine code — it’s an **intermediate code** that can be run on any computer that has a **Java Virtual Machine (JVM)**.

**Phase 2: Execution by the JVM (Interpretation or JIT Compilation)**

The **Java Virtual Machine (JVM)** reads the .class file and translates the bytecode into **machine code** that your computer’s CPU can understand.

* + The **interpreter** inside the JVM executes bytecode instructions line by line.
  + The **Just-In-Time (JIT) compiler** may also optimize performance by converting frequently used code sections into native machine code.

1.8 One of the world’s most common objects is a wrist watch. Discuss how each of the following terms and concepts applies to the notion of a watch: object, attributes, behaviors, class, inheritance (consider, for example, an alarm clock), modeling, messages, encapsulation, interface and information hiding.

**Making a Difference**

**1. Object**

* **An object is a real-world entity that has attributes (data) and behaviors (functions).**
* **In this case, a wristwatch is the *object*.**
* **It’s a tangible thing you can interact with, just like an object in OOP represents something you can use in a program.**

**2. Attributes**

* **Attributes describe the *characteristics or properties* of an object.**
* **For a wristwatch, examples include:**
  + **Brand (e.g., Casio, Rolex)**
  + **Color (black, silver)**
  + **Type (analog or digital)**
  + **Battery level**
  + **Current time and date**

**These are like variables inside the object that hold information about it.**

**3. Behaviors**

* **Behaviors describe *what the object can do* — its actions or functions.**
* **For a wristwatch, behaviors include:**
  + **Displaying the time**
  + **Showing the date**
  + **Starting or stopping a stopwatch**
  + **Ringing an alarm**
  + **Adjusting time or date**

**In programming, these are represented by methods (functions defined inside a class).**

**4. Class**

* **A class is a *blueprint* or *template* used to create objects.**
* **For example, class Watch could define what all watches have in common (time, date, display methods, etc.).**
* **Each individual wristwatch you own is an object (instance) of the Watch class.**

**5. Inheritance**

* **Inheritance allows one class to reuse and extend the properties of another.**
* **Example:**
  + **A base class: Watch**
  + **A subclass: AlarmClock or SmartWatch**
  + **The subclass inherits features (like showing time and date) and adds new ones (like setting alarms or monitoring heart rate).**

**This prevents code duplication and models “is-a” relationships (a smartwatch *is a* watch).**

**6. Modeling**

* **Modeling means representing a real-world concept in an abstract or digital way.**
* **When we define a Watch class with data (attributes) and methods (behaviors), we are modeling how a real wristwatch works in software.**

**7. Messages**

* **Messages are how objects communicate with one another — usually by calling methods.**
* **For example, when a user presses the “set time” button:**
  + **A message might be sent to the watch object → watch.setTime(10, 30)**
* **In OOP, sending a message is just invoking a method on an object.**

**8. Encapsulation**

* **Encapsulation means bundling data (attributes) and methods (behaviors) that operate on that data inside one unit — the object.**
* **The watch keeps its data (time, battery) and the functions that modify it (setTime, showTime) together inside the Watch class.**

**This makes the object self-contained and easier to maintain.**

**9. Interface**

* **An interface defines *what an object can do*, but not *how it does it*.**
* **For example, every watch has buttons or a touchscreen — the interface — that allows users to interact (set alarm, view time).**
* **In programming, an interface might declare methods like setTime(), showTime(), or ringAlarm(), which any class implementing it must define.**

**🕶️ 10. Information Hiding**

* **Information hiding means keeping the internal details of an object private so that other parts of the program can use it without knowing how it works internally.**
* **For example, when you press a button on a digital watch to see the time, you don’t need to know how the circuits calculate or display it — that logic is hidden inside the watch.**

**In Java, this is achieved by using private fields and providing public methods to access or change data safely (getters and setters).**

***1.9 (Test-Drive: Carbon Footprint Calculator)***

Some scientists believe that carbon emissions, especially from the burning of fossil fuels, contribute significantly to global warming and that this can be combatted if individuals take steps to limit their use of carbon-based fuels. Organizations and individuals are increasingly concerned about their “carbon footprints.” Websites such as TerraPass http://www.terrapass.com/carbon-footprint-calculator/ and Carbon Footprint http://www.carbonfootprint.com/calculator.aspx provide carbon-footprint calculators. Test-drive these calculators to determine your carbon footprint. Exercises in later chapters will ask you to program your own carbon-footprint calculator. To prepare for this, use the web to research the formulas for calculating carbon footprints.

***1.10 (Test-Drive: Body Mass Index Calculator)***

Obesity causes significant increases in illnesses such as diabetes and heart disease. To determine whether a person is overweight or obese, you can use a measure called the body mass index (BMI). The United States Department of Health and Human Services provides a BMI calculator at http://www.nhlbi.nih.gov/guidelines/obesity/BMI/ bmicalc.htm. Use it to calculate your own BMI. A forthcoming exercise will ask you to program your own BMI calculator. To prepare for this, use the web to research the formulas for calculating BMI.

To determine whether a person is underweight, normal weight, overweight, or obese, the **Body Mass Index (BMI)** can be used. The BMI is calculated using the following formulas:

**Formula (Metric System):**

BMI=Weight (kg)[Height (m)]2\text{BMI} = \frac{\text{Weight (kg)}}{[\text{Height (m)}]^2}BMI=[Height (m)]2Weight (kg)​

or, using the **Imperial System**:

BMI=703×Weight (lb)[Height (in)]2\text{BMI} = 703 \times \frac{\text{Weight (lb)}}{[\text{Height (in)}]^2}BMI=703×[Height (in)]2Weight (lb)​

**Example Calculation**

Assume my BMI was calculated using my height and weight, and the result is **30**.

BMI=30\text{BMI} = 30BMI=30

**Interpretation**

According to the World Health Organization (WHO) classification:

| **Category** | **BMI Range** |
| --- | --- |
| Underweight | Less than 18.5 |
| Normal weight | 18.5 – 24.9 |
| Overweight | 25 – 29.9 |
| **Obese (Class I)** | **30 – 34.9** |
| Obese (Class II)\*\* | **35 – 39.9** |
| **Extreme Obesity (Class III)** | **40 and above** |

Since my BMI is **30**, I fall into the **Obese (Class I)** category.

**Conclusion**

My Body Mass Index (BMI) of **30** indicates that I am in the **obese range**, which suggests that my body weight is higher than recommended for my height. Maintaining a healthy lifestyle through **balanced nutrition and regular physical activity** is important to reduce the risk of conditions such as **heart disease, diabetes, and high blood pressure**.

***1.11 (Attributes of Hybrid Vehicles)***

Hybrid vehicles are becoming increasingly popular, because they often get much better mileage than purely gasoline-powered vehicles. Browse the web and study the features of four or five of today’s popular hybrid cars, then list as many of their hybrid-related attributes as you can. Some common attributes include city-miles-per-gallon and highway-miles-per-gallon. Also list the attributes of the batteries (type, weight, etc.).

**1. Toyota Prius (2025)**

* Fuel economy: quoted as up to **57 mpg combined** for some trims. [MotorTrend+3Car and Driver+3Forbes+3](https://www.caranddriver.com/toyota/prius?utm_source=chatgpt.com)
* It is a full hybrid (gasoline + electric motor) with FWD or AWD options. [Car and Driver](https://www.caranddriver.com/toyota/prius?utm_source=chatgpt.com)
* Battery attributes:
  + The hybrid battery is **lithium-ion (Li-ion)** type. [iSeeCars+2Le Guide de l'auto+2](https://www.iseecars.com/car/2025-toyota-prius-specs?utm_source=chatgpt.com)
  + Capacity of the battery: 0.9 kWh in some specs. [iSeeCars+1](https://www.iseecars.com/car/2025-toyota-prius-specs?utm_source=chatgpt.com)
  + Voltage ~222 V in one spec. [Le Guide de l'auto](https://www.guideautoweb.com/en/makes/toyota/prius/2025/specifications/xle/?utm_source=chatgpt.com)
* Other hybrid attributes: regenerative braking system, electric motor assist at low speeds, engine shut-off when electric motor sufficient.

**2. Toyota Camry Hybrid (2025)**

* Fuel economy: For front-wheel drive version, EPA estimates 53 mpg city / 50 mpg highway for the LE FWD. [Car and Driver+1](https://www.caranddriver.com/toyota/camry?utm_source=chatgpt.com)
* Powertrain: It’s hybrid-only for 2025 (gas + electric) with FWD or AWD. [Car and Driver](https://www.caranddriver.com/toyota/camry?utm_source=chatgpt.com)
* Battery attributes:
  + Battery type: Lithium-ion (Li-ion) pack cited: “HYBRID BATTERY PACK: Type Lithium-Ion (LI)” for one spec sheet. [attachments.priuschat.com](https://attachments.priuschat.com/attachment-files/2024/04/249677_2025_Toyota_Camry_Product_Information.pdf?utm_source=chatgpt.com)
  + Usable capacity: One review states ~0.6 kWh for the Li-ion pack under rear seat. [Car and Driver](https://www.caranddriver.com/reviews/a60499379/2025-toyota-camry-drive/?utm_source=chatgpt.com)
* Other hybrid attributes: Combined output ~225–232 hp depending on FWD/AWD. [Car and Driver](https://www.caranddriver.com/toyota/camry?utm_source=chatgpt.com)

**3. Kia Niro Hybrid**

* Battery attributes: For an earlier Niro Hybrid (not exactly 2025 but indicative): traction battery capacity ~1.56 kWh, weight ~33 kg. [Wikipedia](https://en.wikipedia.org/wiki/Kia_Niro?utm_source=chatgpt.com)
* Hybrid attributes: Electric motor + gasoline engine, lightweight materials to enhance efficiency. (From the same spec)
* Fuel economy: The specific current 2025 numbers weren’t in my quick capture, but the Niro is often cited as a high-efficiency hybrid SUV.

**4. Hyundai Ioniq Hybrid**

* Battery attributes: The Ioniq Hybrid uses a 240 V, 1.56 kWh lithium-ion polymer battery (for the model referenced) located under rear seats. [Wikipedia](https://en.wikipedia.org/wiki/Hyundai_Ioniq?utm_source=chatgpt.com)
* Hybrid attributes: Aerodynamic design (drag coefficient ~0.24) helps reduce fuel consumption. [Wikipedia](https://en.wikipedia.org/wiki/Hyundai_Ioniq?utm_source=chatgpt.com)
* Fuel economy: The Ioniq Hybrid was expected to surpass earlier hybrids in mpg (citation says “expected combined fuel economy between ~57 or 58 mpg”). [Wikipedia](https://en.wikipedia.org/wiki/Hyundai_Ioniq?utm_source=chatgpt.com)

**5. Hyundai Tucson Hybrid (2025)**

* Fuel economy: Up to ~38 mpg combined cited for the 2025 Tucson Hybrid. [PA Auto Sales+1](https://www.paautosales.com/best-hybrid-cars-2025/?utm_source=chatgpt.com)
* Hybrid attributes: 226-hp turbocharged hybrid drivetrain; optional plug-in variant. [PA Auto Sales](https://www.paautosales.com/best-hybrid-cars-2025/?utm_source=chatgpt.com)
* Battery attributes: The specific battery capacity/weight not listed in my quick search results—so this is a limitation of this example.

**General list of hybrid-related attributes you should look for**

Here are attributes you can include when studying hybrid vehicles:

**Fuel & drivetrain attributes**

* City miles per gallon (mpg)
* Highway mpg
* Combined mpg
* Horsepower / combined output of engine + electric motor
* Drivetrain configuration (FWD/AWD)
* Hybrid type (full hybrid, mild hybrid, plug-in hybrid)
* Towing capacity (if applicable)
* Cargo/space trade-offs (battery placement, floor height)
* Regenerative braking or energy recovery system

**Battery / electric system attributes**

* Battery chemistry/type (e.g., Lithium-ion, Nickel-metal hydride)
* Battery capacity (kWh)
* Battery voltage (V)
* Battery weight (kg or lbs) if available
* Battery location in the vehicle (under seats, in cargo, etc)
* Electric-only driving range (for plug-in hybrids)
* Charging time / plug-in capability (if PHEV)
* Warranty coverage for hybrid battery

***1.12 (Gender Neutrality)***

Many people want to eliminate sexism in all forms of communication. You’ve been asked to create a program that can process a paragraph of text and replace gender-specific words with gender-neutral ones. Assuming that you’ve been given a list of gender-specific words and their gender-neutral replacements (e.g., replace both “wife” and “husband” with “spouse,” “man” and “woman” with “person,” “daughter” and “son” with “child”), explain the procedure you’d use to read through a paragraph of text and manually perform these replacements. How might your procedure generate a strange term like “woperchild?” You’ll soon learn

To eliminate gender-specific terms from written text, a program can be designed to **read through each word** in a paragraph and replace any gendered term with a **gender-neutral equivalent**.

**Step-by-Step Procedure**

1. **Create a replacement list (dictionary):**  
   Prepare a mapping of gender-specific words and their neutral replacements. For example:

wife → spouse

husband → spouse

man → person

woman → person

son → child

daughter → child

he → they

she → they

his/her → their

his/her → their

2.Read the input paragraph:

The program reads the entire text (line by line or word by word).

3.Split the text into words:

Break the paragraph into individual words using spaces or punctuation marks as separators.

Example: "The man loves his wife."

→ ["The", "man", "loves", "his", "wife."]

**4.Compare each word to the dictionary:**  
For each word, check if it exists in the replacement list.

* + If it does, replace it with the gender-neutral equivalent.
  + If not, leave it unchanged.

**5.Handle punctuation and capitalization:**  
The program should preserve punctuation (like commas and periods) and capitalization (e.g., “He” → “They”).

**6.Rebuild the paragraph:**  
After processing all words, combine them back into a full paragraph of gender-neutral text.

that a more formal term for “procedure” is “algorithm,” and that an algorithm specifies the steps to be performed and the order in which to perform them. We’ll show how to develop algorithms then convert them to Java programs which can be run on computers.