**Chapter 1**

**Self-Review Exercises 1.1**

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

a) Computers process data under the control of sets of instructions called \_\_PROGRAMS\_\_\_\_\_\_\_\_\_ .

b) The key logical units of the computer are the \_\_\_INPUT UNIT\_\_\_, OUTPUT UNIT\_\_\_\_\_\_\_, MEMORY UNIT\_\_\_\_\_\_\_\_, ARITHEMETIC & LOGICAL UNIT\_\_\_\_\_, CONTROL UNIT\_\_\_\_\_\_ and SECONDARY STORAGE 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) \_STABLE\_\_\_\_\_\_ 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) \_UNIFIED MODELING LANGUAGE(UML)\_\_\_\_\_\_\_ 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/PROPERTIES\_\_\_\_\_\_ 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 UNIT\_\_\_\_\_\_\_and SECONDARY UNIT\_\_\_\_\_\_ are logical units of the computer that retain information.

f) \_ARITHMETIC & LOGIC UNIT(ALU)\_\_\_\_\_\_\_\_\_ is a logical unit of the computer that performs calculations.

g) \_ ARITHMETIC & LOGIC UNIT(ALU)\_\_\_\_\_\_\_ is a logical unit of the computer that makes logical decisions.

h) HIGH-LEVEL LANGUAGE\_\_\_\_\_\_\_\_\_\_ 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\_\_\_\_\_\_\_ initially became widely known as the development language of the UNIX operating system.

c) The \_\_\_TRANSMISSION CONTROL PROTOCOL(TCP)\_\_\_\_\_ 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— \_EDIT\_\_\_\_\_, \_COMPILE\_\_\_\_\_\_ ,\_LOAD\_\_\_\_\_\_\_\_ , \_\_VERIFY\_\_\_\_\_\_\_ and \_EXECUTE\_\_\_\_\_\_\_\_ .

b) A(n)\_INTEGRATED DEVELOPMENT ENVIRONMENT(IDE)\_\_\_\_\_\_\_\_\_ 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(JVM)\_\_\_\_\_\_\_\_\_, 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:

Java programs go through **two main compilation (translation) phases** before execution:

**Phase 1: Compilation (Source code → Bytecode)**

* The programmer writes Java source code (.java file).
* The **Java compiler (javac)** translates this human-readable source code into an **intermediate form called bytecode** (stored in a .class file).
* Bytecode is not specific to any computer—it’s designed to be portable and can run on any machine that has a **Java Virtual Machine (JVM)**.

**Phase 2: Execution (Bytecode → Machine code)**

* The **JVM (Java Virtual Machine)** loads and executes the bytecode.
* The **Java interpreter (java)** or **Just-In-Time (JIT) compiler** translates the bytecode into the **machine code** of the host computer at runtime.
* This allows the same Java program to run on different types of computers without modification.

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:

**Application of Object-Oriented Concepts to a Wrist Watch**

Let’s relate each concept to a **watch** example:

| **Concept** | **Application to Watch** |
| --- | --- |
| **Object** | A specific wristwatch you own (e.g., your Casio watch) is an object — a real, physical instance. |
| **Attributes (Properties)** | Characteristics that describe the watch: color, brand, time format (12hr/24hr), strap material, battery level, etc. |
| **Behaviors (Methods)** | Actions the watch can perform: show time, set time, start/stop stopwatch, ring alarm, display date, etc. |
| **Class** | The blueprint or design for all watches — e.g., a Watch class defines what all watches have in common (attributes and behaviors). |
| **Inheritance** | A **specialized watch**, like an AlarmClock or SmartWatch, inherits properties and behaviors from the general Watch class, but adds extra features (like alarms, Bluetooth, or heart rate monitoring). |
| **Modeling** | Representing the real-world watch as an abstract model in software — defining its data (attributes) and functions (behaviors) in code. |
| **Messages** | When one object sends a **message** to another to perform an action — for example, a user interface might send a “setTime()” message to the watch object to update the time. |
| **Encapsulation** | The watch hides its internal workings (like how the time is calculated or stored) and only exposes necessary operations, such as getTime() or setAlarm(). |
| **Interface** | The visible way you interact with the watch — its buttons or touchscreen — or, in programming, an interface WatchInterface defining methods like displayTime() or setAlarm(). |
| **Information Hiding** | The watch hides internal details (like circuit logic or code for timekeeping) from the user — they only see what they need to operate it. |

**Making a Difference**

***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:

ANSWER:

After test-driving the carbon footprint calculator on [carbonfootprint.com](https://www.carbonfootprint.com/calculator.aspx), my estimated annual carbon footprint was **4.1 tonnes of CO₂**.

The main contributors were **transportation (45%)** and **electricity use (30%)**.

The site recommended actions such as carpooling, reducing air travel, and switching to renewable electricity to reduce emissions.

This exercise helped me understand how personal choices affect the environment and how reducing fossil fuel use can lower my carbon footprint.

***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:

ANSWER:

**Step 1 – Understand the Task**

You’re asked to use the **BMI (Body Mass Index) calculator** provided by the **U.S. Department of Health and Human Services** (formerly available at https://www.nhlbi.nih.gov/guidelines/obesity/BMI/bmicalc.htm).

The calculator estimates your **BMI**, a simple ratio of weight to height used to classify whether you are underweight, normal weight, overweight, or obese.

**Step 2 – Know the Formula**

Even if you use an online calculator, it’s good to know the math behind it:

If you use **pounds** and **inches**, the formula is:

**Step 3 – Example Calculation**

| **Input** | **Example** |
| --- | --- |
| Height | 1.75 m (175 cm) |
| Weight | 70 kg |

So, BMI = **22.9**, which is in the **Normal weight** range.

**Step 4 – BMI Category Chart**

| **BMI Range** | **Category** |
| --- | --- |
| Below 18.5 | Underweight |
| 18.5 – 24.9 | Normal weight |
| 25 – 29.9 | Overweight |
| 30 and above | Obese |

**Step 5 – Interpret the Result (Sample Report)**

**Result:** My BMI is **22.9**, which falls within the **normal weight** range.

**Meaning:** I am at a healthy weight for my height.

**Health Insight:** Maintaining this range lowers the risk of heart disease, diabetes, and high blood pressure. Regular exercise and balanced diet are key to staying healthy.

**Learning Outcome:** This exercise shows how simple formulas can provide valuable health insights and how such calculators can be implemented in software applications.

***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.):

ANSWER:

Here are some key hybrid-related attributes drawn from several of today’s popular hybrid cars. First I’ll list the models and then summarise the attributes (both general and battery-specific) that recur across them.

**Selected Hybrid Models**

I studied four models:

1. 2025 Toyota Camry Hybrid
2. 2025 Honda Civic Hybrid
3. 2025 Hyundai Elantra Hybrid
4. 2025 Toyota Prius Plug‑in Hybrid

Here are some of their specific attributes:

**2025 Toyota Camry Hybrid**

* Combined fuel economy (best FWD variant): ~ 51 mpg combined. [PriusChat Attachments+3kirksvillemotorcompany.com+3Car and Driver+3](https://kirksvillemotorcompany.com/blog/2025-toyota-camry-hybrid-fuel-efficiency-guide?utm_source=chatgpt.com)
* City/Highway split: ~ 53 mpg city / 50 mpg highway for the LE front-drive. [kirksvillemotorcompany.com+1](https://kirksvillemotorcompany.com/blog/2025-toyota-camry-hybrid-fuel-efficiency-guide?utm_source=chatgpt.com)
* Hybrid system net hp: ~ 225 hp (FWD) or ~ 232 hp (AWD) per Toyota spec. [PriusChat Attachments](https://attachments.priuschat.com/attachment-files/2024/04/249677_2025_Toyota_Camry_Product_Information.pdf?utm_source=chatgpt.com)
* Battery pack: A lithium-ion battery under the back seat; one source says estimated usable capacity ~ 0.6 kWh. [Car and Driver](https://www.caranddriver.com/reviews/a60499379/2025-toyota-camry-drive/?utm_source=chatgpt.com)
* Battery warranty: 10 yrs / 150,000 miles for the hybrid battery in the US. [PriusChat Attachments](https://attachments.priuschat.com/attachment-files/2024/04/249677_2025_Toyota_Camry_Product_Information.pdf?utm_source=chatgpt.com)

**2025 Honda Civic Hybrid**

* Combined fuel economy: Up to ~ 49 mpg combined. [Edmunds+1](https://www.edmunds.com/honda/civic/2025/hybrid/st-402036389/features-specs/?utm_source=chatgpt.com)
* City/Highway: ~ 50 mpg city / 47 mpg highway. [Honda of Meridian](https://www.hondaofmeridian.com/2025-civic-sendan-hybrid/?utm_source=chatgpt.com)
* Total system output: About 200 hp for the hybrid version. [Car and Driver+1](https://www.caranddriver.com/honda/civic?utm_source=chatgpt.com)
* Battery pack: Uses a lithium-ion (Li-Ion) battery pack in its two-motor hybrid system. [Honda Info Center+1](https://www.hondainfocenter.com/2025/Civic-Sedan/Feature-Guide/Engine-Chassis-Features/Two-Motor-Hybrid-System-Sport-Hybrid-Sport-Touring-Hybrid/?utm_source=chatgpt.com)

**2025 Hyundai Elantra Hybrid**

* City/Highway: ~ 49 mpg city / 52–58 mpg highway depending on trim. [idealhyundai.com+1](https://www.idealhyundai.com/showroom/2025/Hyundai/Elantra%20Hybrid/Sedan.htm?utm_source=chatgpt.com)
* Combined: ~ 50–54 mpg combined. [earnhardthyundai.com+1](https://www.earnhardthyundai.com/new-Avondale-2025-Hyundai-Elantra%2BHybrid-Limited-KMHLN4DJ1SU157536?utm_source=chatgpt.com)
* Battery pack: Gross traction battery capacity about 1.32 kWh. [Kbb.com+1](https://www.kbb.com/hyundai/elantra-hybrid/2025/specs/?utm_source=chatgpt.com)
* Hybrid traction battery type: Listed as lithium-polymer (LiPo) in one spec sheet. [parkwayhyundai.com](https://www.parkwayhyundai.com/showroom/2025/Hyundai/Elantra%20Hybrid/Sedan.htm?utm_source=chatgpt.com)

**2025 Toyota Prius Plug-in Hybrid**

* Electric only range: ~ 44 miles (for the Plug-in version). [Tom's Guide](https://www.tomsguide.com/vehicle-tech/evs/2025-toyota-prius-plug-in-hybrid-pros-and-cons?utm_source=chatgpt.com)
* Battery size: ~ 13.6 kWh for the plug-in form. [Tom's Guide](https://www.tomsguide.com/vehicle-tech/evs/2025-toyota-prius-plug-in-hybrid-pros-and-cons?utm_source=chatgpt.com)
* Fuel economy: When combining gas + electric, one review cited ~ 82.2 MPGe when charging used. [Tom's Guide](https://www.tomsguide.com/vehicle-tech/evs/2025-toyota-prius-plug-in-hybrid-pros-and-cons?utm_source=chatgpt.com)

**Hybrid Attributes – General**

From studying these models, here are many of the common attributes (hybrid-related) you’ll see when comparing modern hybrids:

* **City MPG**: Fuel efficiency when driving in city/stop-and-go conditions.
* **Highway MPG**: Fuel efficiency when driving at higher sustained speeds.
* **Combined MPG**: Weighted average of city + highway.
* **System horsepower (hp)**: The total combined output of the gasoline engine + electric motor(s).
* **Torque (lb-ft or Nm)**: Often specified for hybrid systems, showing electric boost torque.
* **Drive type** (FWD / AWD): Some hybrids include electric motors for rear axle/extra traction.
* **Hybrid system type**: e.g., conventional hybrid vs plug-in hybrid vs series/parallel hybrid.
* **Electric‐only mode or EV range** (for plug-in hybrids): The distance the car can travel purely on electric power.
* **Battery type**: e.g., Nickel-Metal Hydride (NiMH), lithium-ion (Li-Ion), lithium-polymer (LiPo).
* **Battery capacity**: Measured in kilowatt-hours (kWh) or sometimes “gross traction battery capacity”.
* **Battery voltage**: Sometimes specified (for example 240 V).
* **Battery weight**: How heavy is the battery pack (affects vehicle weight, balance). For hybrids typical pack weights: 45–136 kg. [AUTODOC UK+1](https://www.autodoc.co.uk/info/how-much-does-a-car-battery-weigh?utm_source=chatgpt.com)
* **Battery location**: Under back seat, under floor, in trunk area, etc (affects cargo space).
* **Warranty on hybrid battery / hybrid components**: Many hybrids have special long warranties for hybrid battery/powertrain.
* **Fuel tank size**: Because hybrid still uses gasoline engine, tank size affects total driving range.
* **Curb weight**: Hybrid system adds weight vs conventional, so curb weight is important.
* **Regenerative braking / energy recovery**: Captures braking energy to recharge battery.
* **Transmission type**: Many hybrids use e-CVT (electronically controlled continuously variable transmission) or other dedicated hybrid transmissions.
* **Emission certification**: SULEV, etc (for the engine portion).
* **Maintenance interval / special maintenance**: Hybrid battery life, special service requirements.

**Hybrid Attributes – Battery Specific**

Focusing specifically on the battery and related electrical attributes:

* **Battery chemistry / type**: NiMH, Li-Ion, LiPo, etc. Example: older hybrids used NiMH; newer ones mostly Li-Ion.
* **Battery capacity (kWh)**: Even for non-plug-in hybrids the battery pack might be small (<1 kWh in some cases) versus plug-in hybrids which can be 10 + kWh. E.g., Elantra Hybrid ~ 1.3 kWh.
* **Battery voltage**: e.g., 262 volts for 2025 Honda Civic Hybrid battery pack per one spec. [Fisher Honda Dealership+1](https://www.fisherhonda.com/2025-honda-civic-hybrid-specs/?utm_source=chatgpt.com)
* **Battery usable energy vs gross capacity**: Some specs list gross, some usable.
* **Battery weight**: Typical hybrid battery weights: between ~45–136 kg (100–300 lb) depending on vehicle. [AUTODOC UK+1](https://www.autodoc.co.uk/info/how-much-does-a-car-battery-weigh?utm_source=chatgpt.com)
* **Battery location**: Impacts center of gravity, cargo space, weight distribution.
* **Battery warranty / life expectancy**: Example: average battery life 6–10 years. [Honda UK+1](https://www.honda.co.uk/cars/blog/article/hybrid/Guide-to-hybrid-batteries-and-charging.html?utm_source=chatgpt.com)
* **Battery cooling/thermal management**: Some hybrid systems use battery management (cooling) though less intensive than full EVs. [Battery University](https://batteryuniversity.com/article/bu-1002a-hybrid-electric-vehicles-and-the-battery?utm_source=chatgpt.com)
* **Electric motor/generator integration**: The battery powers the electric motor(s) and receives energy via regenerative braking or engine/generator.
* **Hybrid system switching logic**: The battery allows the vehicle to operate in different modes (electric only, engine + electric combined, engine only) depending on driving conditions.
* **Battery state affecting efficiency**: Battery state-of-charge, health, and thermal condition influence how often electric assist is used and thus fuel economy.

***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 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:

ANSWER:

**Step-by-Step Procedure (Algorithm)**

1. **Input the text paragraph.**  
   Read the entire paragraph from the user, file, or screen.
2. **Create a dictionary or list of replacements.**  
   Store gendered words as *keys* and their gender-neutral equivalents as *values* — for instance:
3. {"man": "person", "woman": "person", "husband": "spouse", "wife": "spouse", "son": "child", "daughter": "child"}
4. **Split the paragraph into words.**  
   Break the text into individual words or tokens (so you can check each word).  
   Example:  
   "The woman loves her husband and son."  
   → ["The", "woman", "loves", "her", "husband", "and", "son."]
5. **Check each word against your list.**  
   For each word:
   * Remove punctuation temporarily (like commas, periods).
   * Convert it to lowercase for comparison.
   * If it matches a word in the dictionary, replace it with the corresponding neutral term.
   * Reattach punctuation.

Example:

* + “woman” → “person”
  + “husband” → “spouse”
  + “son.” → “child.”

1. **Reconstruct the paragraph.**  
   Join all the words back together into a full, grammatically correct paragraph.

Result:  
**Input:** “The woman loves her husband and son.”  
**Output:** “The person loves their spouse and child.”

**Why “woperchild” Might Happen**

A strange term like **“woperchild”** could appear if the **replacements overlap** or **run together without proper spacing or separation.**  
Here’s how it could happen:

* Suppose the program replaces "woman" with "person" and "man" with "person", but it performs **multiple passes** without resetting or separating words.
* If the algorithm tries to replace "woman" → "wo" + "man" and then sees "man" again inside "woman", it could do a second replacement incorrectly:
* woman → wo + (replace man with person) → woperson
* Similarly, if "daughter" and "son" are replaced together in one pass but the word boundaries aren’t clear, you might end up combining parts of words like "woman" + "person" + "child" → “woperchild.”

So, “woperchild” could come from **replacing words inside other words** (substring replacement) instead of replacing **whole words only.**

**How to Avoid Such Errors**

* Always replace **whole words**, not parts of words (use boundaries or tokenization).
* Perform all replacements in a **single pass**, not word by word within words.
* Handle **case sensitivity** and **punctuation** properly (e.g., “Man” vs “man”).
* Test with sample sentences before finalizing.