Problem set 1 solution
(Introduction to Computer Science)

Exercise 1:

Answering questions:

1. What are the 3 main aspects studied in Computer Science?
R: The 3 main aspects studied in Computer Science are: Information, Processing (Computing), and Computer.

2. What are the main components a "Computer System" is composed of? And how do they interact with each other?
R: A "Computer System" is mainly composed of two principal components: *Hardware* and *Software*. The relationship between the 2 is that the Software guides Hardware, and Hardware executes the Software.

3. Which architecture is most well-known for Personal Computers (PCs)? And list its main components?
R: The architecture most well-known for Personal Computers (PCs) is the Von Neumann architecture. The 3 main components are: the CPU (processor), the RAM (central memory), and the Input/Output Units (I/O Units).

4. What is the main function of the CPU (Central Processing Unit) in a computer architecture?
R: The CPU (or processor) is the engine of the architecture. It executes programs, processes information, and controls the entire architecture.

5. What is the RAM, and what are the two kinds of information stored in it?
R: RAM (Random Access Memory) is the central memory storage of the architecture. It is the computer's short-term working memory. Two kinds of information stored in RAM are *Data* and *Programs*.

6. What is the role of the I/O Units?
R: The I/O Unit is the interface of the architecture with the outer world. Many devices are connected and used to import and export information.

7. Explain the difference between 'data' and 'information'.
R: 'Data' refers to unstructured binary values without meaning. 'Information' consists of binary values structured to provide meaning and context.

8. What is the smallest possible unit of information, and what is its physical implementation in electricity?
R: The smallest possible unit of information is a bit (Binary Digit), which is a single digit (0 or 1). Physically, it is implemented by an "On state" and "Off state" in electricity (e.g., 0

volts for logical 0, 5 volts for logical 1).

9. What are the North Bridge and South Bridge, and what is their primary function? What are they collectively called?
R: North Bridge manages data transfer between the CPU and the RAM, and South Bridge manages data transfer between the CPU and the I/O Unit. They are collectively called *Chipset* (also known as Bus arbiters).

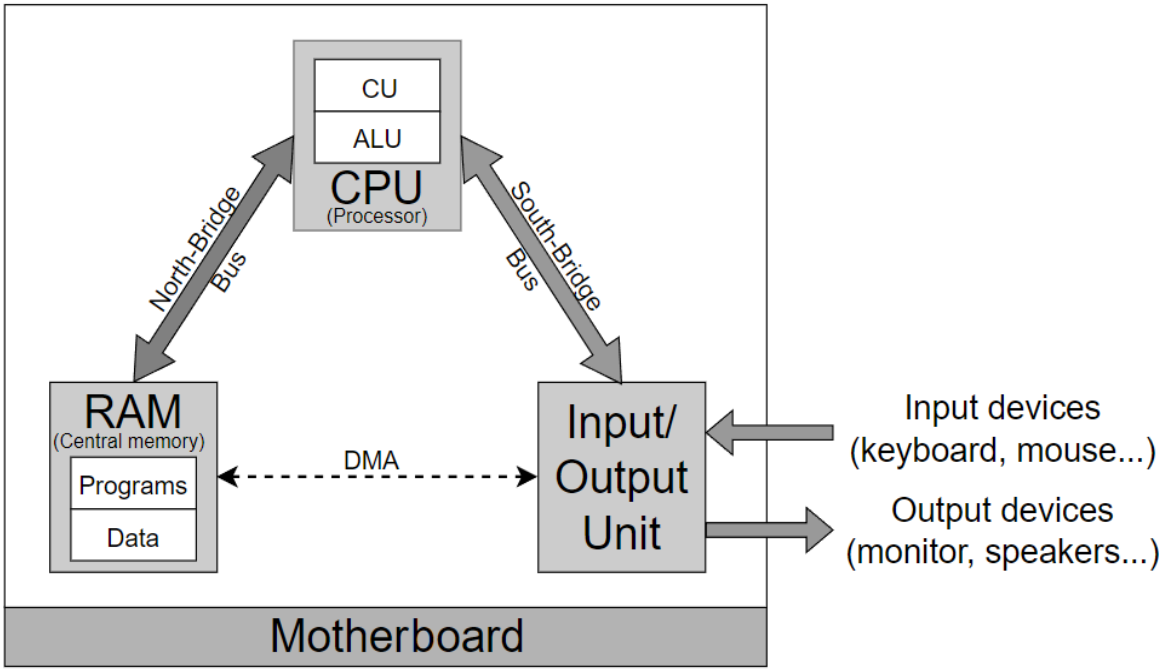
10. Explain the role and difference between the Primary memory and the Secondary memory.

R: The Primary Memory, or the RAM has a role to act as the computer's short-term working memory. It stores data and program instructions that the CPU is currently actively using or needs quick access to. This allows the CPU to work quickly and efficiently. It is a volatile memory that "forgets" its contents when the power is turned off. And has fast access designed for very fast read/write speeds, enabling quick retrieval by the CPU. Generally limited in capacity and smaller storage compared to the secondary memory. The CPU directly works with data stored in RAM.

The Secondary Memory (HDD or SSD). Its primary role is for non-volatile long-term storage of large amounts of data. This includes the operating system, applications/programs, and user files. It is where data persists even when the computer is turned off. It is a non-volatile memory retaining data even when the power is off. Slower to access compared to primary memory, accessing data from secondary memory is significantly slower. Characterized by a large capacity, designed to store large volumes of data. Can only be indirectly accessible by CPU, data from secondary memory must first be loaded into primary memory (RAM) before the CPU can process it.

Exercise 2:

Response 1: Von Neumann's architecture schematic.



Response 2: The data flow of information through the architecture of a PC:

1. For a teacher using an application on his PC to calculate his student's average marks, 3 steps are involved:

a. Input of marks
b. Processing of averages
c. Displaying Results

a. Input of marks:
Input Device (keyboard/mouse) → Input Unit (keyboard/mouse controller) → South Bridge → CPU → North Bridge → RAM (data saved).

b. Calculation (Processing) of averages:
RAM (data) → North Bridge → CPU (processing) → North Bridge → RAM (results saved).

c. Displaying Results:
RAM (results) → North Bridge → CPU → South Bridge → Output Unit (GPU) → Monitor (results displayed).

2. For a person browsing the internet 4 steps are involved:

a. Requesting a Webpage
b. Internet inquiry
c. Webpage downloading
d. Displaying webpage

a. Requesting a Webpage:
Input Device (keyboard) → Input Unit (keyboard controller) → South Bridge → CPU → North Bridge → RAM (webpage address).

b. Requesting a Webpage:
RAM (internet inquiry) → North Bridge → CPU → South Bridge → Input/Output Unit (NIC) → Router (internet).

c. Webpage downloading:
Router (webpage) → Output/Input Unit (NIC) → South Bridge → CPU → North Bridge → RAM (webpage).

d. Displaying webpage
RAM (webpage) → North Bridge → CPU → South Bridge → Output Unit (GPU) → Monitor (webpage displayed).

3. For a person watching a movie with his PC (using DMA), 2 steps are involved:

a. Loading from the disk
b. Displaying the movie

a. Loading from the disk:
Input/Output Device (HDD/SSD drive) → Input/Output Unit (disk controller) → DMA (supervised by the CPU) → RAM (movie loaded).

b. Displaying the movie:
RAM (movie data) → DMA (supervised by the CPU) → Output Unit (GPU) → Monitor (movie displayed).

Remark 1: Many Input/Output Units are integrated with South Bridge chipset. And North Bridge is now integrated within the CPU chip (likewise the DMA, and in some cases the GPU).

Remark 2: North Bridge and South Bridge are asymmetric, North Bridge is much faster. This is why, for a long time now in motherboards, GPUs are passed directly through North Bridge and not South Bridge. Mainly for the heavy transfer speed needed for graphics.

Exercise 3:

Response 1: Conversion table:

Original Quantity	Bytes (B)	Kilobytes (KB)	Megabytes (MB)	Gigabytes (GB)	Terabytes (TB)
8 GB RAM	8589934592 B	8388608 KB	8192 MB	8 GB	0.0078125 TB
1 TB HDD	1099511627776 B	1073741824 KB	1048576 MB	1024 GB	1 TB
32 GB USB stick	34359738368 B	33554432 KB	32768 MB	32 GB	0.03125 TB

Calculations:

For 8 GB RAM:
GB to GB: 8 GB (given)
GB to MB: 8 GB x 1024 = 8 192 MB
MB to KB: 8192 MB x 1024 = 8 388 608 KB
KB to B: 8 388 608 KB x 1024 = 8 589 934 592 B
GB to TB: 8 GB / 1024 = 0.0078125 TB

For 1 TB HDD:
TB to TB: 1 TB (given)
TB to GB: 1 TB x 1024 = 1,024 GB
GB to MB: 1,024 GB x 1024 = 1,048,576 MB
MB to KB: 1,048,576 MB x 1024 = 1,073,741,824 KB
KB to B: 1,073,741,824 KB x 1024= 1,099,511,627,776 B

For 32 GB Flash Drive:
GB to GB: 32 GB (given)
GB to MB: 32 GB x 1024 = 32,768 MB
MB to KB: 32 768 MB x 1024 = 33 554 432 KB
KB to B: 33 554 432 KB x 1024 = 34 359 738 368 B
GB to TB: 32 GB / 1024 = 0.03125 TB

Response 2: Conversion table:

Original Speed	Bits/second (b)	Kilobits/second (Kb)	Megabits/second (Mb)
10 Mbps ADSL	10 000 000 b/s	10 000 Kb/s	10 Mb/s
5 Gbps USB 3.0	5 000 000 000 b/s	5 000 000 Kb/s	5 000 Mb/s

Calculations:

For 10 Mbps ADSL:

Mb to Mb: 10 Mb/s (given)
Mb to Kb: 10 Mb/s x 1000 = 10 000 Kb/s
Kb to b: 10,000 Kb/s x 1000 = 10 000 000 b/s

For 5 Gbps USB 3.0:

Gb to Mb: 5 Gb/s x 1000 = 5000 Mb/s
Mb to Kb: 5,000 Mb/s x 1000 = 5 000 000 Kb/s
Kb to b: 5,000,000 Kb/s x 1000 = 5 000 000 000 b/s

Remark 3: You can see that in the last table, the conversions are done by multiplying and dividing by 1000 instead of 1024, and using bit instead of Byte. This is common in transfer measurement.

Remark 4: Also in some different cases 1000 replaces 1024 like a measurement unit, and totally contextual, there is no absolute rule to determine which is used.