

1. Order the following architectural layers from lowest to highest:

Operating System	Problem Oriented Language	Highest
Digital Logic	Assembly Language	
Assembly Language	Operating System	Lowest
Problem Oriented Language	Instruction Set Architecture	
Microarchitecture	Microarchitecture	
Instruction Set Architecture	Digital Logic	

2. Explain each of the following terms in your own words:

- a. Translator
- b. Interpreter

- a. A translator converts programs in one language to another.
- b. An interpreter carries out a program instruction by instruction.

3. Can you imagine any multilevel computer in which the device level and digital logic levels were not the lowest levels? Explain.

During the detailed design of a new computer, the device and digital logic levels of the new machine may well be simulated on an old machine, which puts them around level 5 or 6.

4. Identify the mechanism that is used by the following programming languages to convert a source file to the machine language code:

Java, C++, PHP, Python
C, JavaScript

Translator	Interpreter
C	Python
C++	PHP
Java	JavaScript

5. In what sense are hardware and software equivalent? In what sense are they not equivalent?

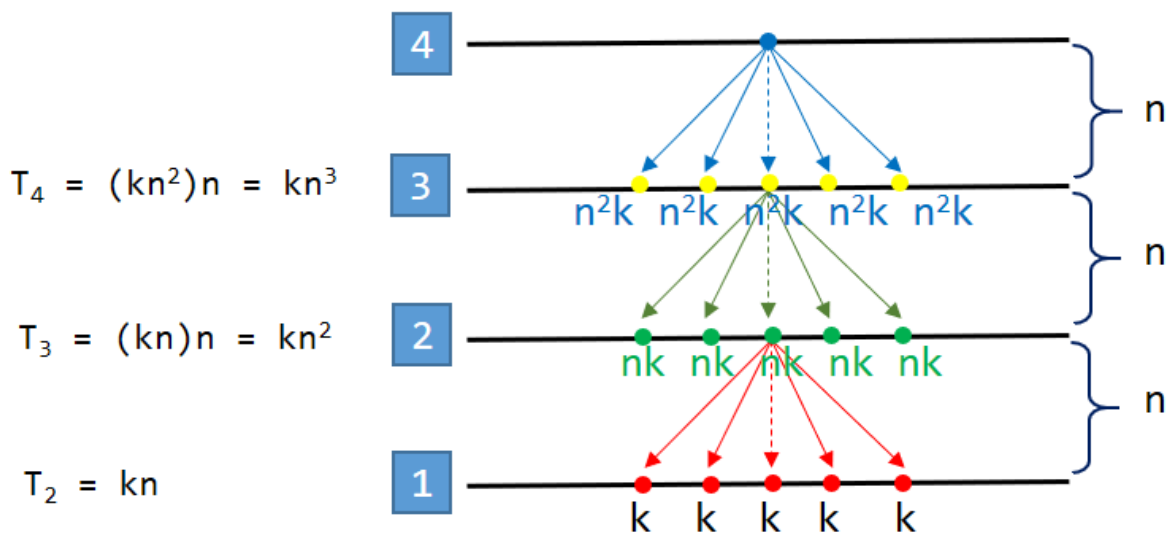
Hardware and software are functionally equivalent. Any function done by one can, in principle, be done by the other. They are not equivalent in the sense that to make the machine really run, the bottom level must be hardware, not software. They also differ in performance.

6. Babbage's difference engine had a fixed program that could not be changed. Is this essentially the same thing as a modern CD ROM that cannot be changed? Explain your answer.

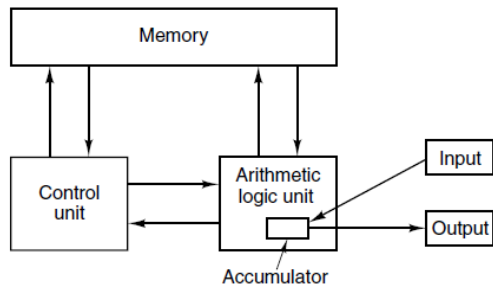
Not at all. If you wanted to change the program the difference engine ran, you had to throw the whole computer out and build a new one. A modern computer does not have to be replaced because you want to change the program. It can read many programs from many CD-ROMs.

7. Consider a computer with identical interpreters at levels 1, 2, and 3. It takes an interpreter n instructions to fetch, examine and execute one instruction. A level 1 instruction takes k nanoseconds to execute. How long does it take for an instructions at levels 2, 3 and 4?

You lose a factor of n at each level, so instruction execution times at levels 2, 3, and 4 are kn , kn^2 , and kn^3 , respectively.



8. Draw a diagram for the Von Neumann Machine.



9. Name two ways that a program written at a given architectural layer can be converted for execution by a lower layer.

Translator and Interpreter