

CPSC 457
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Question 1

- a) If the stages are not parallelized, the CPU can only do $9.091e7$ instructions per second on average
- b) With parallelization, the CPU cycle will take as long as the longest stage, which is the fetch unit at 8 ns. Therefore, the CPU will now do $1.25e8$ instructions per second

Question 2

- a) A company will have many users, so it's often cheaper to have one large computer that can virtualize several computers than many smaller physical computers.
- b) A programmer who is making an application may want to develop it for multiple operating systems, so having a virtual machine can create those environments much easier than if they were to build a computer for each environment.
- c) A regular user can benefit from a virtual machine from the added security they can provide, as they are isolated from the main OS that is hosting it.
- d) A system administrator can easily manage all of the virtual machines remotely, so that they don't have to be physically at the computers to manage them.

Question 3

- a) An interrupt is an event that stops the CPU from doing prior, and giving priority to another device for some time.
- b) A trap is when a process runs into some kind of exception or fault and then stops the CPU from executing further instructions.
- c) The differences between traps and interrupts is that interrupts are asynchronous to the CPU and unpredictable when they occur, while a trap is the opposite.
- d) They go through kernel mode so that they don't stop whatever was occurring in user mode.

Question 4

a)

countLines.cpp	real 0m0.136s user 0m0.018s sys 0m0.117s
wc	real 0m0.002s user 0m0.000s sys 0m0.002s

- b) The C++ program `countLines.cpp` spent 117 milliseconds in kernel mode, whilst `wc` spent 2 milliseconds in kernel mode.
- c) The `wc` command is significantly faster possibly because it may use a buffer to which it stores the bytes read into memory so that it can use fewer system calls. The `countLines.cpp` program does a system call for each individual character, making it very slow.