Yang, Jack
30062393
T05

Assignment 1

Q1:

a. 40 000 000 instructions/s
b. 100 000 000 instructions/s

Q2:

a. Saves cost on multiple hardware needed for multiple users.
b. Easy to switch between different OS to program on.
c. Safer to use when exploring dangerous territory i.e VM can act as a safety net.
d. All systems can be administered at once.

Q3:

a. Signals sent to the CPU to know when a device/processes is done.
b. Intentional software interrupt.
c. Hardware interrupts are external events and traps are software interrupts that handles internal events.
d. Because the kernel handles all interrupts that are invoked by system calls that needs to do I/O, user mode cannot talk to hardware.

Q4:

a. simple_wc:

```
real    0m1.343s
user    0m0.378s
sys     0m0.956s
```

wc:

```
real    0m0.020s
user    0m0.019s
sys     0m0.000s
```

b. The C++ program spent 0.956s in kernel mode and 0.378s in user mode
The wc program spent less than 0.001s in kernel mode and 0.019s in user mode
c. The wc program is faster because it uses less system calls therefore less time spent with interrupts.

Q6:

a. I think my program from Q5 is faster than simple_wc.cpp because it makes less system calls.
b. My program is faster than wc because myWc makes less system calls than wc.

myWc:

```
  16272  138883  804335
% time     seconds  usecs/call     calls    errors syscall
------ ----------- ----------- --------- --------- ----------------
 45.21    0.000543          90         6           read
 17.65    0.000212          15        14           mmap
 14.74    0.000177          17        10           mprotect
  7.33    0.000088          17         5           openat
  3.66    0.000044           8         5           close
  3.58    0.000043           7         6           fstat
  2.58    0.000031          31         1           munmap
  2.08    0.000025           8         3           brk
  1.33    0.000016          16         1         1 access
  1.17    0.000014          14         1           execve
  0.67    0.000008           8         1           arch_prctl
  0.00    0.000000           0         1           write
------ ----------- ----------- --------- --------- ----------------
100.00    0.001201                    54         1 total
```

Simple_wc:

```
  16272  138883  804335
% time     seconds  usecs/call     calls    errors syscall
------ ----------- ----------- --------- --------- ----------------
 99.99    6.843205           8    804340           read
  0.00    0.000207          14        14           mmap
  0.00    0.000160          16        10           mprotect
  0.00    0.000063          12         5           openat
  0.00    0.000056           9         6           fstat
  0.00    0.000037           7         5           close
  0.00    0.000025          25         1           write
  0.00    0.000017          17         1           munmap
  0.00    0.000012           4         3           brk
  0.00    0.000008           8         1           arch_prctl
  0.00    0.000000           0         1         1 access
  0.00    0.000000           0         1           execve
------ ----------- ----------- --------- --------- ----------------
100.00    6.843790                804388         1 total
```

Wc:

```
 16272 138883 804335
% time     seconds  usecs/call     calls    errors syscall
------ ----------- ----------- --------- --------- ----------------
 35.35    0.000503          13        36        19 openat
 17.43    0.000248          13        18           mmap
 14.27    0.000203           3        54           read
 10.96    0.000156           8        19           fstat
  8.85    0.000126           6        20           close
  5.13    0.000073          18         4           mprotect
  3.09    0.000044          11         4           brk
  1.41    0.000020          20         1         1 access
  1.26    0.000018          18         1           munmap
  1.26    0.000018          18         1           execve
  0.56    0.000008           8         1           arch_prctl
  0.42    0.000006           6         1           fadvise64
  0.00    0.000000           0         1           write
------ ----------- ----------- --------- --------- ----------------
100.00    0.001423                   161        20 total
```