Chapter 21

1.
When men is running:
Cpu:
id decreased from 100 to 80-90
us changed from 0 to to 10-15

us: Time spent running non-kernel code.(https://man7.org/linux/man-pages/man8/vmstat.8.html)

With one more process, us increased by double.

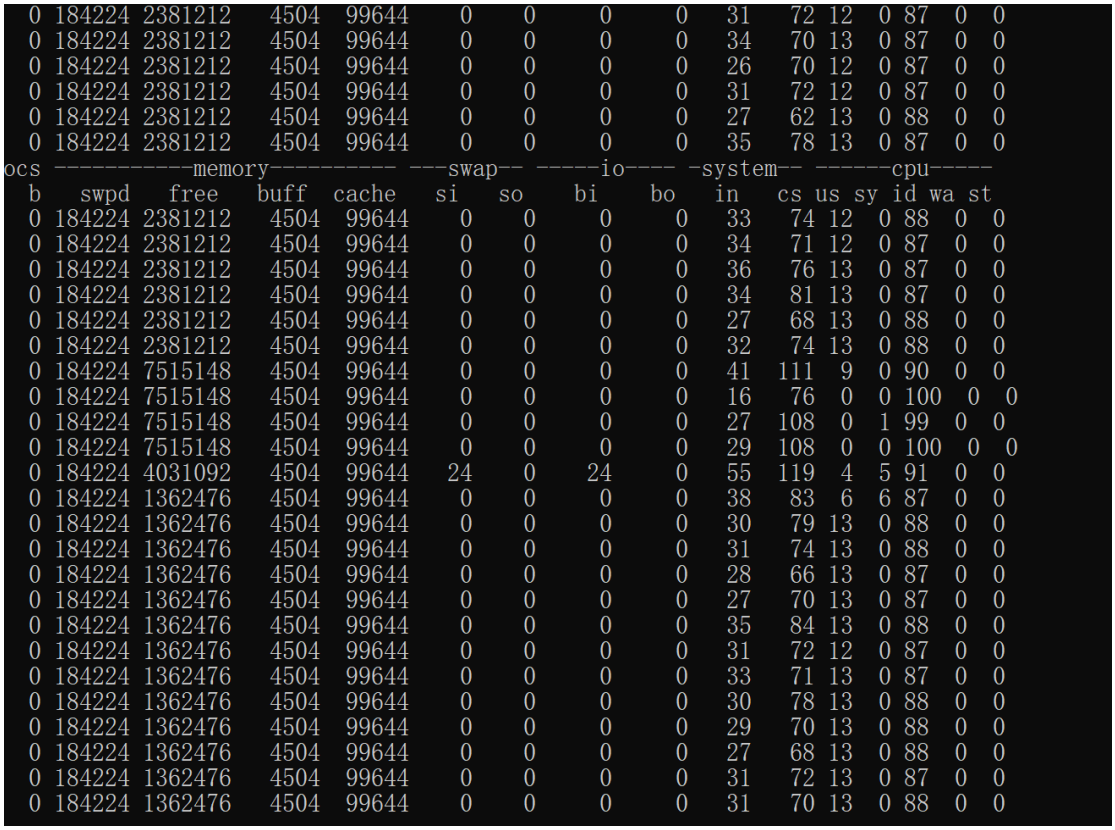
2.
swpd remains 0.
free decreased from 58xxxxx to 48xxxxx by about 1,000,000, almost equal to 1024 * 1024.
So the free should be in unit KB, when 1GB (1024 * 1024 KB) is allocated, this amount of memory is in use.

Yes, it returns from 48xxxxx to 58xxxxx.

3.
Yes it's a 8GB memory, 4GB will not change the swap info.
5000 and 6000 generated some swaps from time to time

```
 0 184224 2381212   4504  99644    0    0     0     0   31   72 12  0 87  0  0
 0 184224 2381212   4504  99644    0    0     0     0   34   70 13  0 87  0  0
 0 184224 2381212   4504  99644    0    0     0     0   26   70 12  0 87  0  0
 0 184224 2381212   4504  99644    0    0     0     0   31   72 12  0 87  0  0
 0 184224 2381212   4504  99644    0    0     0     0   27   62 13  0 88  0  0
 0 184224 2381212   4504  99644    0    0     0     0   35   78 13  0 87  0  0
ocs ----------memory---------- ---swap-- -----io---- -system-- ------cpu-----
 b   swpd   free   buff  cache   si   so    bi    bo   in   cs us sy id wa st
 0 184224 2381212   4504  99644    0    0     0     0   33   74 12  0 88  0  0
 0 184224 2381212   4504  99644    0    0     0     0   34   71 12  0 87  0  0
 0 184224 2381212   4504  99644    0    0     0     0   36   76 13  0 87  0  0
 0 184224 2381212   4504  99644    0    0     0     0   34   81 13  0 87  0  0
 0 184224 2381212   4504  99644    0    0     0     0   27   68 13  0 88  0  0
 0 184224 2381212   4504  99644    0    0     0     0   32   74 13  0 88  0  0
 0 184224 7515148   4504  99644    0    0     0     0   41  111  9  0 90  0  0
 0 184224 7515148   4504  99644    0    0     0     0   16   76  0  0 100  0  0
 0 184224 7515148   4504  99644    0    0     0     0   27  108  0  1 99  0  0
 0 184224 7515148   4504  99644    0    0     0     0   29  108  0  0 100  0  0
 0 184224 4031092   4504  99644   24    0    24     0   55  119  4  5 91  0  0
 0 184224 1362476   4504  99644    0    0     0     0   38   83  6  6 87  0  0
 0 184224 1362476   4504  99644    0    0     0     0   30   79 13  0 88  0  0
 0 184224 1362476   4504  99644    0    0     0     0   31   74 13  0 88  0  0
 0 184224 1362476   4504  99644    0    0     0     0   28   66 13  0 87  0  0
 0 184224 1362476   4504  99644    0    0     0     0   27   70 13  0 87  0  0
 0 184224 1362476   4504  99644    0    0     0     0   35   84 13  0 88  0  0
 0 184224 1362476   4504  99644    0    0     0     0   31   72 12  0 87  0  0
 0 184224 1362476   4504  99644    0    0     0     0   33   71 13  0 87  0  0
 0 184224 1362476   4504  99644    0    0     0     0   30   78 13  0 88  0  0
 0 184224 1362476   4504  99644    0    0     0     0   29   70 13  0 88  0  0
 0 184224 1362476   4504  99644    0    0     0     0   27   68 13  0 88  0  0
 0 184224 1362476   4504  99644    0    0     0     0   31   72 13  0 87  0  0
 0 184224 1362476   4504  99644    0    0     0     0   31   70 13  0 88  0  0
```

8000 generated swap in every moment



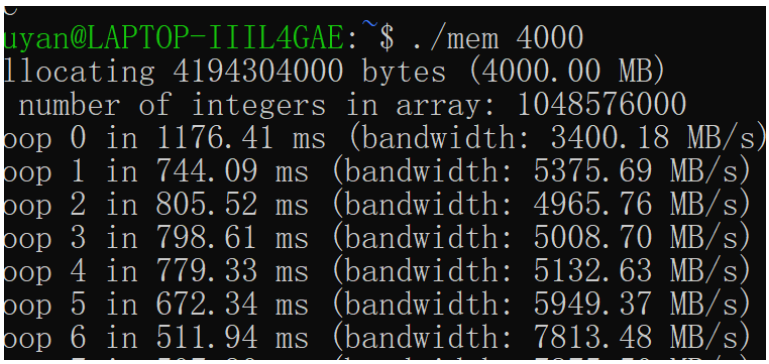
```
 0 184224 2381212   4504  99644    0    0     0     0   31   72 12  0 87  0  0
 0 184224 2381212   4504  99644    0    0     0     0   34   70 13  0 87  0  0
 0 184224 2381212   4504  99644    0    0     0     0   26   70 12  0 87  0  0
 0 184224 2381212   4504  99644    0    0     0     0   31   72 12  0 87  0  0
 0 184224 2381212   4504  99644    0    0     0     0   27   62 13  0 88  0  0
 0 184224 2381212   4504  99644    0    0     0     0   35   78 13  0 87  0  0
ocs ----------memory---------- ---swap-- -----io---- -system-- ------cpu-----
 b   swpd   free   buff  cache   si   so    bi    bo   in   cs us sy id wa st
 0 184224 2381212   4504  99644    0    0     0     0   33   74 12  0 88  0  0
 0 184224 2381212   4504  99644    0    0     0     0   34   71 12  0 87  0  0
 0 184224 2381212   4504  99644    0    0     0     0   36   76 13  0 87  0  0
 0 184224 2381212   4504  99644    0    0     0     0   34   81 13  0 87  0  0
 0 184224 2381212   4504  99644    0    0     0     0   27   68 13  0 88  0  0
 0 184224 2381212   4504  99644    0    0     0     0   32   74 13  0 88  0  0
 0 184224 7515148   4504  99644    0    0     0     0   41  111  9  0 90  0  0
 0 184224 7515148   4504  99644    0    0     0     0   16   76  0  0 100  0  0
 0 184224 7515148   4504  99644    0    0     0     0   27  108  0  1 99  0  0
 0 184224 7515148   4504  99644    0    0     0     0   29  108  0  0 100  0  0
 0 184224 4031092   4504  99644   24    0    24     0   55  119  4  5 91  0  0
 0 184224 1362476   4504  99644    0    0     0     0   38   83  6  6 87  0  0
 0 184224 1362476   4504  99644    0    0     0     0   30   79 13  0 88  0  0
 0 184224 1362476   4504  99644    0    0     0     0   31   74 13  0 88  0  0
 0 184224 1362476   4504  99644    0    0     0     0   28   66 13  0 87  0  0
 0 184224 1362476   4504  99644    0    0     0     0   27   70 13  0 87  0  0
 0 184224 1362476   4504  99644    0    0     0     0   35   84 13  0 88  0  0
 0 184224 1362476   4504  99644    0    0     0     0   31   72 12  0 87  0  0
 0 184224 1362476   4504  99644    0    0     0     0   33   71 13  0 87  0  0
 0 184224 1362476   4504  99644    0    0     0     0   30   78 13  0 88  0  0
 0 184224 1362476   4504  99644    0    0     0     0   29   70 13  0 88  0  0
 0 184224 1362476   4504  99644    0    0     0     0   27   68 13  0 88  0  0
 0 184224 1362476   4504  99644    0    0     0     0   31   72 13  0 87  0  0
 0 184224 1362476   4504  99644    0    0     0     0   31   70 13  0 88  0  0
```

4.

us and id don't vary much with 4000, 5000, 6000, but us decreased almost to 0-2 under 8000.

5.

With 4000:



```
uyan@LAPTOP-IIIL4GAE:~$ ./mem 4000
llocating 4194304000 bytes (4000.00 MB)
 number of integers in array: 1048576000
oop 0 in 1176.41 ms (bandwidth: 3400.18 MB/s)
oop 1 in 744.09 ms (bandwidth: 5375.69 MB/s)
oop 2 in 805.52 ms (bandwidth: 4965.76 MB/s)
oop 3 in 798.61 ms (bandwidth: 5008.70 MB/s)
oop 4 in 779.33 ms (bandwidth: 5132.63 MB/s)
oop 5 in 672.34 ms (bandwidth: 5949.37 MB/s)
oop 6 in 511.94 ms (bandwidth: 7813.48 MB/s)
```

With 9000:

```
uyan@LAPTOP-IIIL4GAE:~$ ./mem 9000
llocating 9437184000 bytes (9000.00 MB)
 number of integers in array: 2359296000
oop 0 in 4346.51 ms (bandwidth: 2070.63 MB/s)
oop 1 in 51676.98 ms (bandwidth: 174.16 MB/s)
oop 2 in 52170.24 ms (bandwidth: 172.51 MB/s)
```

With fitting in memory, the other loops are faster than the first one, while with extensive swapping, the 2nd, 3rd loops are much slower than the 1st one, because of I/Os.

6.

When I try to run men with 10000, if fails to allocate.

```
luyan@LAPTOP-IIIL4GAE:~$ ./mem 10000
allocating 10485760000 bytes (10000.00 MB)
memory allocation failed
```