Question 4

Now, while running your memory-user program, also (in a different terminal window, but on the same machine) run the free tool. How do the memory usage totals change when your program is running? How about when you kill the memory-user program? Do the numbers match your expectations? Try this for different amounts of memory usage. What happens when you use really large amounts of memory?

```
NOT RUNNING:
free -m
               total        used        free      shared  buff/cache   available
Mem:            6144         570        4997           0         575        5573
Swap:           6144           5        6138

RUNNING:
free -m
               total        used        free      shared  buff/cache   available
Mem:            6144        1582        3985           0         575        4561
Swap:           6144           5        6138
```

Question 7

To use pmap,you have to know theprocess ID of the process you're interested in. Thus, first run ps auxw to see a list of all processes; then, pick an interesting one, such as a browser. You can also use your memory-user program in this case (indeed, you can even have that program call getpid() and print out its PID for your convenience).

using the pid of memory-user.c

pmap 2779743

```
2779743:   ./a.out 10 10000
0000555616f9d000      4K r---- a.out
0000555616f9e000      4K r-x-- a.out
0000555616f9f000      4K r---- a.out
0000555616fa0000      4K r---- a.out
0000555616fa1000      4K rw--- a.out
0000555618769000    132K rw---   [ anon ]
00007f2d9457d000  10256K rw---   [ anon ]
00007f2d94f81000    160K r---- libc.so.6
00007f2d94fa9000   1620K r-x-- libc.so.6
00007f2d9513e000    352K r---- libc.so.6
00007f2d95196000     16K r---- libc.so.6
00007f2d9519a000      8K rw--- libc.so.6
00007f2d9519c000     52K rw---   [ anon ]
00007f2d951b4000      8K rw---   [ anon ]
00007f2d951b6000      8K r---- ld-linux-x86-64.so.2
00007f2d951b8000    168K r-x-- ld-linux-x86-64.so.2
00007f2d951e2000     44K r---- ld-linux-x86-64.so.2
00007f2d951ee000      8K r---- ld-linux-x86-64.so.2
00007f2d951f0000      8K rw--- ld-linux-x86-64.so.2
00007ffcb7a53000    132K rw---   [ stack ]
00007ffcb7bf2000     16K r----   [ anon ]
00007ffcb7bf6000      8K r-x--   [ anon ]
ffffffffff600000      4K --x--   [ anon ]
---------------- ------- ------- -------
total            13020K
```

pmap -x 2779743

```
2779743:   ./a.out 10 10000
Address           Kbytes     RSS   Dirty Mode  Mapping
0000555616f9d000       4       4       0 r---- a.out
0000555616f9e000       4       4       0 r-x-- a.out
0000555616f9f000       4       4       0 r---- a.out
0000555616fa0000       4       4       4 r---- a.out
0000555616fa1000       4       4       4 rw--- a.out
0000555618769000     132       4       4 rw---   [ anon ]
00007f2d9457d000   10256   10252   10252 rw---   [ anon ]
00007f2d94f81000     160     160       0 r---- libc.so.6
00007f2d94fa9000    1620    1088       0 r-x-- libc.so.6
00007f2d9513e000     352     108       0 r---- libc.so.6
00007f2d95196000      16      16      16 r---- libc.so.6
00007f2d9519a000       8       8       8 rw--- libc.so.6
00007f2d9519c000      52      20      20 rw---   [ anon ]
00007f2d951b4000       8       4       4 rw---   [ anon ]
00007f2d951b6000       8       8       0 r---- ld-linux-x86-64.so.2
00007f2d951b8000     168     168       0 r-x-- ld-linux-x86-64.so.2
00007f2d951e2000      44      40       0 r---- ld-linux-x86-64.so.2
00007f2d951ee000       8       8       8 r---- ld-linux-x86-64.so.2
00007f2d951f0000       8       8       8 rw--- ld-linux-x86-64.so.2
00007ffcb7a53000     132      12      12 rw---   [ stack ]
00007ffcb7bf2000      16       0       0 r----   [ anon ]
00007ffcb7bf6000       8       4       0 r-x--   [ anon ]
ffffffffff600000       4       0       0 --x--   [ anon ]
---------------- ------- ------- -------
total kB           13020   11928   10340
```

pmap -X 2779743

```
2779743:   ./a.out 10 10000
         Address Perm   Offset Device  Inode  Size   Rss   Pss Referenced Anonymous Mapping
    555616f9d000 r--p 00000000  00:87   8276     4     4     4          4         0  a.out
    555616f9e000 r-xp 00001000  00:87   8276     4     4     4          4         0  a.out
    555616f9f000 r--p 00002000  00:87   8276     4     4     4          4         0  a.out
    555616fa0000 r--p 00002000  00:87   8276     4     4     4          4         4  a.out
    555616fa1000 rw-p 00003000  00:87   8276     4     4     4          4         4  a.out
    555618769000 rw-p 00000000  00:00      0   132     4     4          4         4  [heap]
    7f2d9457d000 rw-p 00000000  00:00      0 10256 10252 10252      10252     10252
    7f2d94f81000 r--p 00000000  fd:14 429640   160   160     3        160         0  libc.so.6
    7f2d94fa9000 r-xp 00028000  fd:14 429640  1620  1088    21       1088         0  libc.so.6
    7f2d9513e000 r--p 001bd000  fd:14 429640   352   108     1        108         0  libc.so.6
    7f2d95196000 r--p 00214000  fd:14 429640    16    16    16         16        16  libc.so.6
    7f2d9519a000 rw-p 00218000  fd:14 429640     8     8     8          8         8  libc.so.6
    7f2d9519c000 rw-p 00000000  00:00      0    52    20    20         20        20
    7f2d951b4000 rw-p 00000000  00:00      0     8     4     4          4         4
    7f2d951b6000 r--p 00000000  fd:14 429189     8     8     0          8         0  ld-linux-x86-64.so.2
    7f2d951b8000 r-xp 00002000  fd:14 429189   168   168     3        168         0  ld-linux-x86-64.so.2
    7f2d951e2000 r--p 0002c000  fd:14 429189    44    40     0         40         0  ld-linux-x86-64.so.2
    7f2d951ee000 r--p 00037000  fd:14 429189     8     8     8          8         8  ld-linux-x86-64.so.2
    7f2d951f0000 rw-p 00039000  fd:14 429189     8     8     8          8         8  ld-linux-x86-64.so.2
    7ffcb7a53000 rw-p 00000000  00:00      0   132    12    12         12        12  [stack]
    7ffcb7bf2000 r--p 00000000  00:00      0    16     0     0          0         0  [vvar]
    7ffcb7bf6000 r-xp 00000000  00:00      0     8     4     0          4         0  [vdso]
ffffffffff600000 --xp 00000000  00:00      0     4     0     0          0         0  [vsyscall]
                                             ===== ===== ===== ========== ========= ==========
                                             13020 11928 10380      11928     10340          0 KB
```

Question 8

Finally, let's run pmap on your memory-user program, with different amounts of used memory.
What do you see here? Does the output from pmap match your expectations?

Using 1000 Megabytes

```
to121sau@ct-bsys-12:~$ pmap -x 2780658
2780658:   ./a.out 1000 1000
Address           Kbytes     RSS   Dirty Mode  Mapping
0000564c3a982000       4       4       0 r---- a.out
0000564c3a983000       4       4       0 r-x-- a.out
0000564c3a984000       4       4       0 r---- a.out
0000564c3a985000       4       4       4 r---- a.out
0000564c3a986000       4       4       4 rw--- a.out
0000564c3bd65000     132       4       4 rw---   [ anon ]
00007fc2a69d2000 1024016 1024012 1024012 rw---   [ anon ]
00007fc2e51d6000     160     160       0 r---- libc.so.6
00007fc2e51fe000    1620     896       0 r-x-- libc.so.6
00007fc2e5393000     352     156       0 r---- libc.so.6
00007fc2e53eb000      16      16      16 r---- libc.so.6
00007fc2e53ef000       8       8       8 rw--- libc.so.6
00007fc2e53f1000      52      20      20 rw---   [ anon ]
00007fc2e5409000       8       4       4 rw---   [ anon ]
00007fc2e540b000       8       8       0 r---- ld-linux-x86-64.so.2
00007fc2e540d000     168     168       0 r-x-- ld-linux-x86-64.so.2
00007fc2e5437000      44      40       0 r---- ld-linux-x86-64.so.2
00007fc2e5443000       8       8       8 r---- ld-linux-x86-64.so.2
00007fc2e5445000       8       8       8 rw--- ld-linux-x86-64.so.2
00007ffcfb1e6000     132      12      12 rw---   [ stack ]
00007ffcfb3ae000      16       0       0 r----   [ anon ]
00007ffcfb3b2000       8       4       0 r-x--   [ anon ]
ffffffffff600000       4       0       0 --x--   [ anon ]
---------------- ------- ------- -------
total kB         1026780 1025544 1024100
```

Using 1 Megabyte

pmap -x 2780720

```
2780720:   ./a.out 1 1000
Address           Kbytes     RSS   Dirty Mode  Mapping
000055dd55134000       4       4       0 r---- a.out
000055dd55135000       4       4       0 r-x-- a.out
000055dd55136000       4       4       0 r---- a.out
000055dd55137000       4       4       4 r---- a.out
000055dd55138000       4       4       4 rw--- a.out
000055dd55ac5000     132       4       4 rw---   [ anon ]
00007f1969c39000    1040    1036    1036 rw---   [ anon ]
00007f1969d3d000     160     160       0 r---- libc.so.6
00007f1969d65000    1620     964       0 r-x-- libc.so.6
00007f1969efa000     352     132       0 r---- libc.so.6
00007f1969f52000      16      16      16 r---- libc.so.6
00007f1969f56000       8       8       8 rw--- libc.so.6
00007f1969f58000      52      20      20 rw---   [ anon ]
00007f1969f70000       8       4       4 rw---   [ anon ]
00007f1969f72000       8       8       0 r---- ld-linux-x86-64.so.2
00007f1969f74000     168     168       0 r-x-- ld-linux-x86-64.so.2
00007f1969f9e000      44      40       0 r---- ld-linux-x86-64.so.2
00007f1969faa000       8       8       8 r---- ld-linux-x86-64.so.2
00007f1969fac000       8       8       8 rw--- ld-linux-x86-64.so.2
00007ffc237e2000     132      12      12 rw---   [ stack ]
00007ffc2382e000      16       0       0 r----   [ anon ]
00007ffc23832000       8       4       0 r-x--   [ anon ]
ffffffffff600000       4       0       0 --x--   [ anon ]
---------------- ------- ------- -------
total kB            3804    2612    1124
```