MATH 417 502
Homework 3

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Problem 1

Initially our memory space looks like:
16 byte free list: [0, ..., 15]
8 byte free list: []
4 byte free list: []
2 byte free list: []
1 byte free list: []
after 1 byte is requested:
16 byte free list: []
8 byte free list: [8,..., 15]
4 byte free list: [4,..., 7]
2 byte free list: [2, 3]
1 byte free list: [1]
after 2 byte requested (so now 3 bytes in total requested):
16 byte free list: []
8 byte free list: [8,..,15]
4 byte free list: [4,..., 7]
2 byte free list: []
1 byte free list: [1]
after 4 byte requested (so now 7 bytes in total requested):
16 byte free list: []
8 byte free list: [8,..,15]
4 byte free list: []
2 byte free list: []
1 byte free list: [1]
after 2 byte requested (so now 9 bytes in total requested):
16 byte free list: []
8 byte free list: []
4 byte free list: [12,...,15]
2 byte free list: [10,11]
1 byte free list: [1]

Problem 2

a) There are $\frac{2^{36}}{2^{13}} = 2^{23}$ pages in the virtual address space.

b) If each page table entry is 4 bytes $= 2^5 = 32$ bits, then there must be 2^{32} physical pages. Thus the total addressable memory should be that times the size of a page: $2^{32} \cdot 2^{13} = 2^{45}$ bytes.

c) I would use a 1 level page table because an 8GB process would be using most of the memory anyways. A 2 or 3 level page table would only serve to obfuscate things as you would still have to allocate memory for pretty much all of the 2nd and 3rd level pages.

d) For a single page table, the number of page table entries would be $\frac{2^33}{2^13} = 2^{20}$.

Problem 3

a) The page size would be 2^8 bytes

b) A process that has 2^{18} bytes would be using $\frac{2^{18}}{2^8} = 2^{10}$ pages. This means that the number of allocated page table entries in the third level table must be 2^{10}. Each third level page table has 2^6 entries, so there must have been $\frac{2^{10}}{2^6} = 2^4$ 2nd level page entries allocated. There are 2^8 total 2nd level page tables, so there must have been $\frac{2^8}{2^4} = 2^4$ 1st level page entries allocated. The number of pages is $\frac{2^{32}}{2^8} = 2^{24}$ bytes, so the size of each page entry must be 24 bits, or 3 bytes. Thus we have a final answer of $(2^{10} + 2^5) \cdot 3 = 3168$ bytes.