Problem 1

1. How many data blocks are utilized for a file with 734.15 GB of data?
   Assume 4KB blocks.

datablocks = filesize / blocksize
1 GB = 2^30 B
1024 B = 2^10
4096 B = 2^12
ceil() = round up to even out

ceil(734.15 GB / 4 KB) = ceil(734.15 * 2^30 B / 2^12 B) = ceil(734.15 * 2^18)
= ceil(192,453,017.6) = 192,453,018 data blocks

check:
192,453,017.6/2^30 = 734.15

192,453,018 data blocks <-> 192,453,018 direct pointers
a data block is pointed to only by a direct pointer
and a direct pointer, when in use, is pointing to a single data block

2. How many blocks of direct pointers are necessary to reference the data
   blocks in question 1? Assume 4-byte addresses.

Since I have 192,453,018 direct pointers; how many blocks do I need? I can't answer this without the size of a pointer/block address, which is given via "4-byte addresses."

Pointers per block = block_size / pointer_size
2^12 B / 2^2 B = 2^10 = 1,024 pointers/block or 4 KB / 4 B = 1,024
All pointers and blocks are the same size.

ceil((192,453,018 - 12)/1024) = ceil(187,942.389) = 187,943 blocks of direct pointers

3. How many blocks of indirect pointers are necessary to reference the direct
   pointer blocks in question 2?

187,943 blocks of direct pointers <-> 187,943 indirect pointers needed

ceil((187,943 - 1)/1024 = ceil(183.537) = 184 blocks of indirect pointers

4. How many blocks of double indirect pointers are necessary to reference the
   indirect pointer blocks in question 3?

184 blocks of indirect pointers <-> 184 double indirect pointers

ceil((184 - 1)/1024 = ceil(0.999) = 1 block of double indirect pointers

1 block of double indirect pointers <-> 1 triple indirect pointer

5. How many total blocks are needed (not including the inode)?
192,453,018 + 187,943 + 184 + 1 = 192,641,146 total blocks needed

calculate waste:
192,453,018 - 192,641,146 = 188,128 blocks
188,128 blocks * 4096 KB = 770,572,288 bytes overhead
770,572,288/2^20 = 734.875 MB of overhead

Most of the overhead comes from blocks of direct pointers
If it was just direct pointers (192,453,018/1024) = (187,942.4 * 4096)/2^20 = 734.15

Problem 2

1. How many data blocks are utilized for a file with 4 GB of data? Assume 4KB blocks

ceil(4GB / 4KB) = ceil(2^32 B / 2^12 B) = 2^20 = 1,048,576 data blocks are needed

2. How many blocks of direct pointers are necessary to reference the data blocks in question 1? Assume 4-byte addresses.

1,048,576 data blocks <-> 1,048,576 direct pointers needed

pointers per block = block_size/pointer_size = 4KB/4B = 1,024 pointers/block

ceil((1,048,576 - 12)/1024) = ceil(1,023.988) = 1,024 blocks of direct pointers

3. How many blocks of indirect pointers are needed to reference the direct pointer blocks in question 2?

1,024 blocks of direct pointers <-> 1,024 indirect pointers needed
ceil((1024 - 1)/1024 = 1 block of indirect pointers

3. How many blocks of double indirect pointers are needed to reference the indirect pointer blocks in question 3?

1 block of indirect pointers <-> 1 double indirect pointer needed
ceil((1-1)/1024) = 0 blocks of double indirect pointers <-> 0 triple indirect pointers needed

5. How many total blocks are needed (not including the inode)?

1,048,576 + 1,024 + 1 = 1,049,601 total blocks needed

overhead:
1,048,576 - 1,049,601 = 1,025
1,025 * 4096 = 4,198,400/1,048,576 = 4.00390625
4MB + 4KB of overhead