Solve the following problems.

1. Suppose a computer using direct mapped cache has 2^{20} bytes of byte-addressable main memory, and a cache of 32 blocks, where each cache block contains 16 bytes.

    a) How many blocks of main memory are there?
    b) What is the format of a memory address as seen by the cache, i.e., what are the sizes of the tag, block, and offset fields?
    c) To which cache block will the memory address 0x0DB63 map?

2. Suppose a computer using direct mapped cache has 2^{32} bytes of byte-addressable main memory, and a cache of 1024 blocks, where each cache block contains 32 bytes.
    a) How many blocks of main memory are there?
    b) What is the format of a memory address as seen by the cache, i.e., what are the sizes of the tag, block, and offset fields?
    c) To which cache block will the memory address 0x000063FA map?

3. Suppose a computer using direct mapped cache has 2^{32} bytes of byte-addressable main memory and a cache size of 512 bytes, and each cache block contains 64 bytes.
    a) How many blocks of main memory are there?
    b) What is the format of a memory address as seen by cache, i.e., what are the sizes of the tag, block, and offset fields?
    c) To which cache block will the memory address 0x13A4498A map?

4. Suppose a computer using fully associative cache has 2^{16} bytes of byte-addressable main memory and a cache of 64 blocks, where each cache block contains 32 bytes.

    a) How many blocks of main memory are there?
    b) What is the format of a memory address as seen by the cache, i.e., what are the sizes of the tag and offset fields?
    c) To which cache block will the memory address 0xF8C9 map?

5. Suppose a computer using fully associative cache has 2^{24} bytes of byte-addressable main memory and a cache of 128 blocks, where each cache block contains 64 bytes.

    a) How many blocks of main memory are there?
    b) What is the format of a memory address as seen by the cache, i.e., what are the sizes of the tag and offset fields?
    c) To which cache block will the memory address 0x01D872 map?

6. Suppose a computer using fully associative cache has 2^{24} bytes of byte-addressable main memory and a cache of 128 blocks, where each block contains 64 bytes.

   a) How many blocks of main memory are there?
   b) What is the format of a memory address as seen by the cache, i.e., what are the sizes of the tag and offset fields?
   c) To which cache block will the memory address 0x01D872 map?

7. Assume a system's memory has 128M bytes. Blocks are 64 bytes in length and the cache consists of 32K blocks. Show the format for a main memory address assuming a 2-way set associative cache mapping scheme and byte addressing. Be sure to include the fields as well as their sizes.

8. A 2-way set-associative cache consists of four sets. Main memory contains 2K blocks of eight bytes each and byte addressing is used.

   a) Show the main memory address format that allows us to map addresses from main memory to cache. Be sure to include the fields as well as their sizes.
   b) Compute the hit ratio for a program that loops 3 times from addresses 0x8 to 0x33 in main memory. You may leave the hit ratio in terms of a fraction.

9. Suppose a byte-addressable computer using set associative cache has 2^{16} bytes of main memory and a cache of 32 blocks, and each cache block contains 8 bytes.

   a) If this cache is 2-way set associative, what is the format of a memory address as seen by the cache, that is, what are the sizes of the tag, set, and offset fields?
   b) If this cache is 4-way set associative, what is the format of a memory address as seen by the cache?

10. Suppose a byte-addressable computer using set associative cache has 2^{21} byes of main memory and a cache of 64 blocks, where each cache block contains 4 bytes.

   a) If this cache is 2-way set associative, what is the format of a memory address as seen by the cache, that is, what are the sizes of the tag, set, and offset fields?
   b) If this cache is 4-way set associative, what is the format of a memory address as seen by the cache?