Questions 1-3

Suppose a computer using direct mapped cache has 2^20 bytes of byte-addressable memory, and a cache of 32 blocks. Each cache block contains 16 bytes.

1. How many blocks of main memory are there? (answer in power of 2)

   (1 Point)

   $2^{20} - 2^4 = 2^{16}$

2. What are the sizes of the tag, block and offset fields in the memory address as seen by the cache? Answer as three numbers separated by a comma and space, e.g. t, b, o

   (3 Points)

   offset = 16 bytes / block = 2^4
   block = 32 bytes / block = 2^5
   tag (what left) = 16

   16, 5, 4

3. To which block with the memory address 0x0DB63 mapped?

   (1 Point)

   10110

   0000 1101 1011 0110 0011
   tag block offset

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Questions 4-6

A direct-mapped cache consists of eight blocks. A byte-addressable main memory contains 4K blocks of eight bytes each. If a block is missing from cache, the entire block is brought into the cache and the access is restarted. Initially, the cache is empty.

4. Show the main memory address sizes for the tag, block and offset fields. Answer as three numbers separated by commas. e.g. t, b, o

9, 3, 3

block = 8 block/cache = 2^3

offset = 8 byte/block = 2^3

tags = $\frac{2^{12}}{2^3} = 2^9$

5. How many misses and hits will occur for Block 0 in main memory if a program loops 4 times from address locations 0 to 67 (decimal) in memory? Answer as two numbers separated by a comma i.e., n-misses, n-hits

Note: Block 0 and block 8 in main memory are both mapped to the same cache block.
Hint: count how many hits and misses for each block in each loop.

(2 Points)

32, 240

Block 0 in main memory : 0000 → 0111 (0-8)

hits in 1 loop = 8 misses in 1 loop : 64 - 8 = 60

4 loops = 32 4 loops = 240

6. How many misses and hits will occur for Block 8 in main memory if a program loops 4 times from address locations 0 to 67 (decimal) in memory? Answer as two numbers separated by a comma i.e., n-misses, n-hits

Block 8 in memory = 111 000 → 111 111 (56 - 64)

(2 Points)

32, 240

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Questions 7-11

Assume a direct-mapped cache that holds 4096 bytes, where each block is 16 bytes. Assuming an address is 32 bits and that cache is initially empty. (You should use hexadecimal numbers for all answers.)

7. What are the tag, block and offset values for the following address? 0x0FF0FABA
Answer as three hexadecimal numbers separated by a comma and a space, i.e., 0xAAAAA, 0xAA, 0xA

(1 Point)

0x0FF0, 0xFAB, 0xA

8. What are the tag, block and offset values for the following address? 0x00000011
Answer as three hexadecimal numbers separated by a comma and a space.

(1 Point)

0x0000, 0x001, 0x1

9. What are the tag, block and offset values for the following address? 0x0FFFFFFE
Answer as three hexadecimal numbers separated by a comma and a space.

(1 Point)

0x0FFF, 0xFFF, 0xE

10. What are the tag, block and offset values for the following address? 0xCAFEBABE
Answer as three hexadecimal numbers separated by a comma and a space.

(1 Point)

0x CAFE BAB E
tag block offset

0xCAFE , 0xBAB , 0xE

11. Which questions above (from 7-10) have addresses that will cause a collision?
Answer as two numbers separated by a comma.

(1 Point)

9 , 10