**Problem 1.** Caches are important to providing a high-performance memory hierarchy to processors. Below is a list of 32-bit memory address references, given as word addresses.

254, 187, 45, 182, 15, 191, 89, 192, 3, 44, 181, 4

For each of these references, identify the binary address, the tag, and the index given a direct-mapped cache with 16 one-word blocks. Also list if each reference is a hit or a miss, assuming the cache is initially empty.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Reference | Binary Address | Tag | Index | Hit/Miss |
| 254 | 1111 1110 | 1111 | 1110 | Miss |
| 187 | 1011 1011 | 1011 | 1011 | Miss |
| 45 | 0010 1101 | 0010 | 1101 | Miss |
| 182 | 1011 0110 | 1011 | 0110 | Miss |
| 15 | 0000 1111 | 0000 | 1111 | Miss |
| 191 | 1011 1111 | 1011 | 1111 | Miss |
| 89 | 0101 1001 | 0101 | 1001 | Miss |
| 192 | 1100 0000 | 1100 | 0000 | Miss |
| 3 | 0000 0011 | 0000 | 0011 | Miss |
| 44 | 0010 1100 | 0010 | 1100 | Miss |
| 181 | 1011 0101 | 1011 | 0101 | Miss |
| 4 | 0000 0100 | 0000 | 0100 | Miss |