

1.

	0	1	2	3	4	0	1	5	0	1	2	3	4	5	4	ratio
FIFO	M	M	M	M	M	M	M	M	H	H	M	M	M	H	H	$\frac{4}{15} = 26.7\%$
LRU	M	M	M	M	M	M	M	M	H	H	M	M	M	M	H	$\frac{3}{15} = 20\%$
MRU	M	M	M	M	M	H	H	M	H	M	H	M	H	H	H	$\frac{7}{15} = 46.7\%$

2.

Block Reference String: 0, 1, 2, 3, 0, 4, 1, 2, 5, 4, 3, 0, 5, 1, 4, 3

	0	1	2	3	0	4	1	2	5	4	3	0	5	1	4	3
DMC	M	M	M	M	H	M	H	H	M	H	H	M	H	M	H	H
FIFO	M	M	M	M	H	M	H	H	M	H	H	M	H	M	H	M
LRU	M	M	M	M	H	M	M	M	M	H	M	M	H	M	H	H
MRU	M	M	M	M	H	M	H	H	M	H	H	M	H	H	H	M

with this string there will be and a direct mapped cache there will be 9 misses.
so the time for instruction fetches will be

$$16 * 50 + 9 * 400 = 4400\text{ns}$$

b)

there are 10 misses with the FIFO replacement so the instruction fetch time will be

$$16 * 50 + 10 * 400 = 4800\text{ns}$$

c)

there are 11 misses with the LRU replacement policy so the instruction fetch time will be

$$16 * 50 + 11 * 400 = 5200\text{ns}$$

d)

there are 11 misses with the MRU replacement policy so the instruction fetch time will be

$$16 * 50 + 8 * 400 = 4000\text{ns}$$

3.

WORD/BLOCK	H/M	STATE
1	M	$\emptyset, 1, \emptyset, \emptyset, \emptyset, \emptyset, \emptyset, \emptyset, \emptyset, \emptyset, \emptyset, \emptyset, \emptyset, \emptyset$
4	M	$\emptyset, 1, \emptyset, \emptyset, 4, \emptyset, \emptyset, \emptyset, \emptyset, \emptyset, \emptyset, \emptyset, \emptyset, \emptyset$
8	M	$\emptyset, 1, \emptyset, \emptyset, 4, \emptyset, \emptyset, \emptyset, 8, \emptyset, \emptyset, \emptyset, \emptyset, \emptyset$
5	M	$\emptyset, 1, \emptyset, \emptyset, 4, 5, \emptyset, \emptyset, 8, \emptyset, \emptyset, \emptyset, \emptyset, \emptyset$
20	M	$\emptyset, 1, \emptyset, \emptyset, 20, 5, \emptyset, \emptyset, 8, \emptyset, \emptyset, \emptyset, \emptyset, \emptyset$
17	M	$\emptyset, 17, \emptyset, \emptyset, 20, 5, \emptyset, \emptyset, 8, \emptyset, \emptyset, \emptyset, \emptyset, \emptyset$
19	M	$\emptyset, 17, \emptyset, 19, 20, 5, \emptyset, \emptyset, 8, \emptyset, \emptyset, \emptyset, \emptyset, \emptyset$
56	M	$\emptyset, 17, \emptyset, 19, 20, 5, \emptyset, \emptyset, 56, \emptyset, \emptyset, \emptyset, \emptyset, \emptyset$
9	M	$\emptyset, 17, \emptyset, 19, 20, 5, \emptyset, \emptyset, 56, 9, \emptyset, \emptyset, \emptyset, \emptyset$
11	M	$\emptyset, 17, \emptyset, 19, 20, 5, \emptyset, \emptyset, 56, 9, \emptyset, 11, \emptyset, \emptyset$
4	M	$\emptyset, 17, \emptyset, 19, 4, 5, \emptyset, \emptyset, 56, 9, \emptyset, 11, \emptyset, \emptyset$
43	M	$\emptyset, 17, \emptyset, 19, 4, 5, \emptyset, \emptyset, 56, 9, \emptyset, 43, \emptyset, \emptyset$
5	H	$\emptyset, 17, \emptyset, 19, 4, 5, \emptyset, \emptyset, 56, 9, \emptyset, 43, \emptyset, \emptyset$
6	M	$\emptyset, 17, \emptyset, 19, 4, 5, 6, \emptyset, 56, 9, \emptyset, 43, \emptyset, \emptyset$
9	H	$\emptyset, 17, \emptyset, 19, 4, 5, 6, \emptyset, 56, 9, \emptyset, 43, \emptyset, \emptyset$
17	H	$\emptyset, 17, \emptyset, 19, 4, 5, 6, \emptyset, 56, 9, \emptyset, 43, \emptyset, \emptyset$

4.

Block	H/M	STATE
0	M	0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
1	M	0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
2	M	0, 1, 2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
1	H	0, 1, 2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
5	M	0, 1, 2, 0, 0, 5, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
4	M	0, 1, 2, 0, 4, 5, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
4	H	0, 1, 2, 0, 4, 5, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
14	M	0, 1, 2, 0, 4, 5, 0, 0, 0, 0, 0, 0, 0, 0, 14, 0
2	H	0, 1, 2, 0, 4, 5, 0, 0, 0, 0, 0, 0, 0, 0, 14, 0
2	H	0, 1, 2, 0, 4, 5, 0, 0, 0, 0, 0, 0, 0, 0, 14, 0
1	H	0, 1, 2, 0, 4, 5, 0, 0, 0, 0, 0, 0, 0, 0, 14, 0
10	M	0, 1, 2, 0, 4, 5, 0, 0, 0, 0, 0, 10, 0, 0, 0, 14, 0
1	H	0, 1, 2, 0, 4, 5, 0, 0, 0, 0, 0, 10, 0, 0, 0, 14, 0
1	H	0, 1, 2, 0, 4, 5, 0, 0, 0, 0, 0, 10, 0, 0, 0, 14, 0
2	H	0, 1, 2, 0, 4, 5, 0, 0, 0, 0, 0, 10, 0, 0, 0, 14, 0
4	H	0, 1, 2, 0, 4, 5, 0, 0, 0, 0, 0, 10, 0, 0, 0, 14, 0

5.

WORD/BLOCK	H/M	STATE
1	M	$ 1, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset $
4	M	$ 1, \emptyset \emptyset, \emptyset 4, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset $
8	M	$ 1, \emptyset \emptyset, \emptyset 4, \emptyset \emptyset, \emptyset 8, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset $
5	M	$ 1, \emptyset \emptyset, \emptyset 4, 5 \emptyset, \emptyset 8, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset $
20	M	$ 1, \emptyset \emptyset, \emptyset 20, 5 \emptyset, \emptyset 8, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset $
17	M	$ 1, 17 \emptyset, \emptyset 20, 5 \emptyset, \emptyset 8, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset $
19	M	$ 1, 17 19, \emptyset 20, 5 \emptyset, \emptyset 8, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset $
56	M	$ 1, 17 19, \emptyset 20, 5 \emptyset, \emptyset 8, 56 \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset $
9	M	$ 1, 17 19, \emptyset 20, 5 \emptyset, \emptyset 9, 56 \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset $
11	M	$ 1, 17 19, \emptyset 20, 5 \emptyset, \emptyset 9, 56 11, \emptyset \emptyset, \emptyset \emptyset, \emptyset $
4	M	$ 1, 17 19, \emptyset 20, 4 \emptyset, \emptyset 9, 56 11, \emptyset \emptyset, \emptyset \emptyset, \emptyset $
43	M	$ 1, 17 19, \emptyset 20, 4 \emptyset, \emptyset 9, 56 11, 43 \emptyset, \emptyset \emptyset, \emptyset $
5	M	$ 1, 17 19, \emptyset 5, 4 \emptyset, \emptyset 9, 56 11, 43 \emptyset, \emptyset \emptyset, \emptyset $
6	M	$ 1, 17 19, \emptyset 5, 4 6, \emptyset 9, 56 11, 43 \emptyset, \emptyset \emptyset, \emptyset $
9	H	$ 1, 17 19, \emptyset 5, 4 6, \emptyset 9, 56 11, 43 \emptyset, \emptyset \emptyset, \emptyset $
17	H	$ 1, 17 19, \emptyset 5, 4 6, \emptyset 9, 56 11, 43 \emptyset, \emptyset \emptyset, \emptyset $

6.

WORD/BLOCK	H/M	STATE
1	M	1, 0 0, 0 0, 0 0, 0 0, 0 0, 0 0, 0
4	M	1, 0 0, 0 4, 0 0, 0 0, 0 0, 0 0, 0 0, 0
8	M	1, 0 0, 0 4, 0 0, 0 8, 0 0, 0 0, 0 0, 0
5	M	1, 0 0, 0 4, 5 0, 0 8, 0 0, 0 0, 0 0, 0
20	M	1, 0 0, 0 20, 5 0, 0 8, 0 0, 0 0, 0 0, 0
17	M	1, 17 0, 0 20, 5 0, 0 8, 0 0, 0 0, 0 0, 0
19	M	1, 17 19, 0 20, 5 0, 0 8, 0 0, 0 0, 0 0, 0
56	M	1, 17 19, 0 20, 5 0, 0 8, 56 0, 0 0, 0 0, 0
9	M	1, 17 19, 0 20, 5 0, 0 9, 56 0, 0 0, 0 0, 0
11	M	1, 17 19, 0 20, 5 0, 0 9, 56 11, 0 0, 0 0, 0
4	M	1, 17 19, 0 20, 4 0, 0 9, 56 11, 0 0, 0 0, 0
43	M	1, 17 19, 0 20, 4 0, 0 9, 56 11, 43 0, 0 0, 0
5	M	1, 17 19, 0 5, 4 0, 0 9, 56 11, 43 0, 0 0, 0
6	M	1, 17 19, 0 5, 4 6, 0 9, 56 11, 43 0, 0 0, 0
9	H	1, 17 19, 0 5, 4 6, 0 9, 56 11, 43 0, 0 0, 0
17	H	1, 17 19, 0 5, 4 6, 0 9, 56 11, 43 0, 0 0, 0

7.

WORD/BLOCK	H/M	STATE
1	M	$ 1, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset $
4	M	$ 1, \emptyset \emptyset, \emptyset 4, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset $
8	M	$ 1, \emptyset \emptyset, \emptyset 4, \emptyset \emptyset, \emptyset 8, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset $
5	M	$ 1, \emptyset \emptyset, \emptyset 4, 5 \emptyset, \emptyset 8, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset $
20	M	$ 1, \emptyset \emptyset, \emptyset 4, 20 \emptyset, \emptyset 8, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset $
17	M	$ 1, 17 \emptyset, \emptyset 4, 20 \emptyset, \emptyset 8, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset $
19	M	$ 1, 17 19, \emptyset 4, 20 \emptyset, \emptyset 8, \emptyset \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset $
56	M	$ 1, 17 19, \emptyset 4, 20 \emptyset, \emptyset 8, 56 \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset $
9	M	$ 1, 17 19, \emptyset 4, 20 \emptyset, \emptyset 8, 9 \emptyset, \emptyset \emptyset, \emptyset \emptyset, \emptyset $
11	M	$ 1, 17 19, \emptyset 4, 20 \emptyset, \emptyset 8, 9 11, \emptyset \emptyset, \emptyset \emptyset, \emptyset $
4	H	$ 1, 17 19, \emptyset 4, 20 \emptyset, \emptyset 8, 9 11, \emptyset \emptyset, \emptyset \emptyset, \emptyset $
43	M	$ 1, 17 19, \emptyset 4, 20 \emptyset, \emptyset 8, 9 11, 43 \emptyset, \emptyset \emptyset, \emptyset $
5	M	$ 1, 17 19, \emptyset 5, 20 \emptyset, \emptyset 8, 9 11, 43 \emptyset, \emptyset \emptyset, \emptyset $
6	M	$ 1, 17 19, \emptyset 5, 20 6, \emptyset 8, 9 11, 43 \emptyset, \emptyset \emptyset, \emptyset $
9	H	$ 1, 17 19, \emptyset 5, 20 6, \emptyset 8, 9 11, 43 \emptyset, \emptyset \emptyset, \emptyset $
17	H	$ 1, 17 19, \emptyset 5, 20 6, \emptyset 8, 9 11, 43 \emptyset, \emptyset \emptyset, \emptyset $