

1. (1). bit 1 to 0: byte offset

bit 6 to 2: word offset $\Rightarrow 2^5 = 32$ words in one block.bit 11 to 7: index $\Rightarrow 2^5 = 32$ sets

$$32 \times 2 (32 \times 32 + 1 + 1 + 20) = 66944 \text{ bits}$$

(2).

	Binary address	tag	index	Hit/Miss
0	0	0	00000	M
4	100	0	00000	H
20	10100	0	00000	H
136	10001000	0	00001	M
232	11101000	0	00001	H
164	10100100	0	00001	H
1024	10000000000	0	01000	M
30	11110	0	00000	H
140	10001100	0	00001	H
3100	110000011100	0	11000	M
176	10110000	0	00001	H
2180	100010000100	0	10001	M

$$\text{Hit ratio} = \frac{7}{12} = 58.3\%$$

(3). $\langle 00000, 0, \text{word}[0] \text{word}[1] \dots \text{word}[31] \rangle$ $\langle 00001, 0, \text{word}[32] \text{word}[33] \dots \text{word}[63] \rangle$ $\langle 01000, 0, \text{word}[64] \text{word}[65] \dots \text{word}[95] \rangle$ $\langle 10001, 0, \text{word}[96] \text{word}[97] \dots \text{word}[127] \rangle$ $\langle 11000, 0, \text{word}[128] \text{word}[129] \dots \text{word}[159] \rangle$

2. (1). P1: $\frac{1}{1.18 \times 10^{-9}} = 8.47 \times 10^8 \text{ Hz}$

P2: $\frac{1}{2.22 \times 10^{-9}} = 4.50 \times 10^8 \text{ Hz}$

(2). $\text{AMAT} = \text{Hit time} + \text{Miss rate} \times \text{Miss penalty}$

P1: $\text{AMAT} = 1.18 + 4.3\% \times 70 = 4.19 \text{ ns}$

P2: $\text{AMAT} = 2.22 + 2.7\% \times 70 = 4.11 \text{ ns}$

(3). P1: $\frac{70}{1.18} = 59.32 \text{ cc}$

$\text{CPI} = 1 + 59.32 \times 36\% \times 4.3\% = 1.92$

P2: $\frac{70}{2.22} = 31.53 \text{ cc}$

$\text{CPI} = 1 + 31.53 \times 36\% \times 2.7\% = 1.31$

Since $1.92 \times 1.18 = 2.27 < 1.31 \times 2.22 = 2.91$

Processor P1 is faster.

3. 11. bit 1-0: byte offset
 bit 2 : word offset
 bit 4-3 : index
 bit 31-5 : tag

	Binary address	tag	index	Hit/Miss	offset
3	11	0	00	M	011
180	10110100	101	10	M	100
43	101011	1	01	M	011
3	11	0	00	H	011
191	10111111	101	11	M	111
89	1011001	10	11	M	001
190	10111110	101	11	H	110
14	1110	0	01	M	110
181	10110101	101	10	H	101
44	101100	1	01	H	100
186	10111010	101	11	H	010
252	11111100	111	11	M	100

Set Idx	V	D	Tag	Data	Data
00	Y	X	0	word[0]	word[1]
	N				
	N				
01	Y	X	1	word[10]	word[11]
	Y	X	0	word[2]	word[3]
	N				
10	Y	X	101	word[44]	word[45]
	N				
	N				
11	Y	X	101	word[46]	word[47]
	Y	X	10	word[22]	word[23]
	Y	X	111	word[62]	word[63]

(2). bit 1-0 : byte offset
 bit 31-2: tag

	Binary address	tag	index	Hit/Miss
3	11	0	-	M
180	10110100	101101	-	M
43	101011	1010	-	M
3	11	0	-	H
191	10111111	101111	-	M
89	1011001	10110	-	M
190	10111110	101111	-	H
14	1110	11	-	M
181	10110101	101101	-	H
44	101100	1011	-	M
186	10111010	101110	-	M
252	11111100	111111	-	M

Idx	V	D	Tag	Data
	Y	X	0	word[0]
	Y	X	101101	word[45]
	Y	X	111111	word[63]
	Y	X	101111	word[47]
	Y	X	10110	word[22]
	Y	X	11	word[3]
	Y	X	1011	word[11]
	Y	X	101110	word[46]

(3) bit: 1-0: byte offset
 bit: 2 : word offset
 bit: 3-3: tag

	Binary address	tag	index	LRU Hit/Miss	MRU Hit/Miss	Best H/M
3	11	0	-	M	M	M
180	10110100	10110	-	M	M	M
43	101011	101	-	M	M	M
3	11	0	-	H	H	H
191	10111111	10111	-	M	M	M
89	1011001	1011	-	M	M	M
190	10111110	10111	-	H	M	H
14	1110	1	-	M	M	M
181	10110101	10110	-	M	H	H
44	101100	101	-	M	H	H
186	10111010	10111	-	H	M	H
252	11111100	11111	-	M	M	M

$$\text{LRU Miss Rate} = \frac{9}{12} = 75\%$$

$$\text{MRU Miss Rate} = \frac{9}{12} = 75\%$$

$$\text{Best Miss Rate} = \frac{7}{12} = 58.3\%$$