

**1.**

Cycle	#	Decoded	Iss	Ret	Dependence
1.	1	$R3 = R0 + R1$	1		RAW
	2	$R3 = R3 - R2$	-		
2.					
3.				1	
4.	3	$R2 = R0 * R1$	2		WAR
			-		
5.					
6.				2	
7.	4	$R0 = R2 + R5$	3		RAW
			-		
8.					
9.					
10.				3	
11.	5	$R6 = R3 / R0$	4		RAW
			-		
12.					
13.				4	
14.	6	$R3 = R8 + R9$	5		WAR
			-		
15.					
16.					
17.				5	
18.			6		
19.					
20.				6	

**2.**

Cycle	#	Decoded	Iss	Ret	Dependence
1.	1	$R3 = R0 + R1$	1		RAW
	2	$R3 = R3 - R2$	-		
2.	3	$S2 = R0 * R1$	3		RAW
	4	$S0 = S2 + R5$	-		
3.	5	$R6 = R3 / S0$	-		RAW
	6	$S3 = R8 + R9$	6	1	
4.			2		
5.				3	
				6	
6.			4	2	
7.					
8.				4	
9.			5		
10.					
11.					
12.				5	

3.

a. L1 is accessed, then L2 and then memory

Time for L1 is 5 nsec, L2 is 25 nsec(L1 + 20nsec), memory is 65 nsec(L1+L2+40nsec)

$$\text{Access time} = \frac{5*80 + 25*15 + 65*5}{100} \\ = 11 \text{ nsec}$$

b. L1 is accessed and at the same time memory is accessed, then L2 is accessed

Time for L1 is 5 nsec, memory is 40 nsec, and L2 is 25 nsec (L1 + 20 nsec)

$$\text{Access time} = \frac{5*80 + 25*15 + 40*5}{100} \\ = 9.75 \text{ nsec}$$

4.

a. 1111 1110 1011 0100 | 0011 0010 011 | 0 01 | 01

Tag: 1111 1110 1011 0100 = 0xFEB4

Line: 00110010011 = 0x193

b. 1111 1110 1011 0|100 0011 0010 0 | 110 0|1 0 1

Tag: 1111111010110 = 0x1FD6

Line: 100001100100 = 0x864

5.

Sequence of writes and reads:

W200

R3 = 200

R4 = 200

W100

R3 = 100

R4 = 100

Both CPUs see the write of 200, then both CPUs see the write of 100.

6.

Weakly consistent:

1. 3B, 1D, 1E

2. 3B, 1E, 1D

Weakly inconsistent:

1. 1D, 3B, 1E

2. 1E, 1D, 3B

7. All three are Shared.

**8.** CPU1 is Invalid. CPU 3 is Modified

**9.**  $32 \times 32 = 1024$

**10.**  $32/2 * \log 32 = 16 * 5 = 80$

**11.** a has diameter 2; c has diameter 6; d has diameter 4; e has diameter 6.

**12.** a cannot be split; d remove 2 arcs; e remove 4 arcs; f remove 8 arcs.

**13.** I will accept two sets of answers, based on how you interpreted maximum:  
maximum maximum: d remove 1 arc; e remove 9 arcs; f remove 17 arcs; g  
remove 5 arcs

or

minimum maximum: d remove 1 arc; e remove 1 arcs; f remove 3 arcs; g remove  
2 arcs