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2.

	I1	I2	I3	I4	I5	I6
I1	-					
I2		-				
I3	WAW	RAW	-			
I4		WAW	WAR	-		
I5	RAW	RAW	RAW	RAW	-	
I6					WAW	-

4. (1) $\frac{CPI_B}{CPI_A} = \frac{N+12-1+N/8\times3}{N+5-1+N/5\times1}$ $N \gg (k-1)$时有 $\frac{CPI_B}{CPI_A} \approx \frac{(1+\frac{3}{8})N}{(1+\frac{1}{5})N} = \frac{55}{48}$

$S = \frac{T_A \times CPI_A}{T_B \times CPI_B} = \frac{1}{0.6} \times \frac{48}{55} \approx 1.45$

(2) $CPI_A = \sum CPI_i \times \frac{IC_i}{\text{Instruction count}}$

$CPI_A = (1-20\%) \times (1+1/5) + 20\% \times (95\% \times (1+1/5) + 5\% \times (1+1/5+2))$

$= 99\% \times 1.2 + 1\% \times (1.2+2) = 1.22$

$CPI_B = (1-20\%) \times (1+3/8) + 20\% \times (95\% \cdot (1+3/8) + 5\% \cdot (1+\frac{3}{8}+5))$

$= 99\% \times 1.375 + 1\% \times (1.375+5) = 1.425$

6. (1) ① ld a1, 0(a2)
addi a1, a1, 1
可能有 RAW, WAW

② addi a1, a1, 1
sd a1, 0(a2)
可能有 WAW

③ ld a1, 0(a2)
sd a1, 0(a2)
可能有 WAW

④ sd a1, 0(a2)
addi a2, a2, 4
可能 WAR

⑤ addi a2, a2, 4
sub a4, a3, a2
RAW

⑥ sub a4, a3, a2
bnez a4, Loop
RAW

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(2)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
ld a1,0(a2)	IF	ID	EX	MEM	WB													
addi a1,a1,1		IF	ID	s	s	EX	MEM	WB										
sd a1,0(a2)			IF	s	s	ID	s	s	EX	MEM	WB							
addi a2,a2,4						IF	s	s	ID	EX	MEM	WB						
sub a4,a3,a2									IF	ID	s	s	EX	MEM	WB			
bnez a4,Loop										IF	s	s	ID	s	s	EX	MEM	WB

单次循环需18周期 共需循环 $\frac{100}{4}=25$ 次 $T_{cycle}=18\times25=450$

7.(1)	1	2	3	4	5	6	7	8	9	10	11
ld a1,0(a2)	IF	ID	EX	MEM	WB						
addi a1,a1,1		IF	ID	s	EX	MEM	WB				
sd a1,0(a2)			IF	s	ID	EX	MEM	WB			
addi a2,a2,4					IF	ID	EX	MEM	WB		
sub a4,a3,a2						IF	ID	EX	MEM	WB	
bnez a4,Loop							IF	ID	EX	MEM	WB

单次循环共需11周期 共需循环25次 $T_{cycle}=11\times25=275$

(2) 预测固定跳转，则在bnez执行到ID段就可以开始下一循环的取指

单次循环只需7周期 $T_{cycle}=7\times24+11=179$

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8.(1)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
ld a1,0(a2)	IF1	IF2	ID1	ID2	EX1	EX2	MEM1	MEM2	WB1	WB2											
addi a1,a1,1		IF1	IF2	ID1	ID2	S	S	S	EX1	EX2	MEM1	MEM2	WB1	WB2							
sd a1,0(a2)			IF1	IF2	ID1	S	S	S	ID2	S	EX1	EX2	MEM1	MEM2	WB1	WB2					
addi a2,a2,4				IF1	IF2	S	S	S	ID1	S	ID2	EX1	EX2	MEM1	MEM2	WB1	WB2				
sub a4,a3,a2					IF1	S	S	S	IF2	S	ID1	ID2	S	EX1	EX2	MEM1	MEM2	WB1	WB2		
bnez a4,Loop									IF1	S	IF2	ID1	S	ID2	S	EX1	EX2	MEM1	MEM2	WB1	WB2
.....												IF1	IF2	S	ID1	S	ID2	.....			

21个周期

每个循环会引发6次停顿　循环25次时 $T_{cycle} = 25\times6 + 10 - 1 + 6\times25$

$= 309$

对第6题 $CPI_6 = \frac{450}{25\times6} = 3$　　对7-1 $CPI_{7-1} = \frac{275}{25\times6} = \frac{11}{6}$

对7-2 $CPI_{7-2} = \frac{179}{25\times6} \approx 1.19$　　对8题 $CPI_8 = \frac{309}{25\times6} \approx 2.06$

19.(1)需要2同期：add、sd、bne.

不需要2同期 addi、ld、jal、jalr

(2)

	1	2	3	4	5	6	7	8	9	10	11	12
lw a4,0(a3)	IF	ID	EX	MEM	WB							
addw a1,a4,a1		IF	ID1	ID2	S	EX	MEM	WB				
addiw a2,a2,-1			IF	S	S	ID	EX	MEM	WB			
addiw a3,a3,4						IF	ID	EX	MEM	WB		
bnez a2,Loop							IF	ID1	ID2	EX	MEM	WB.

单次循环需12个同期（无前馈，无预测）

(3)

	1	2	3	4	5	6	7	8	9	10
lw a4,0(a3)	IF	ID	EX	MEM	WB					
addw a1,a4,a1		IF	ID	S	EX	MEM	WB			
addiw a2,a2,-1			IF	S	ID	EX	MEM	WB		
addiw a3,a3,4					IF	ID	EX	MEM	WB	
bnez a2,Loop						IF	ID	EX	MEM	WB

单次循环需10同期.