

2.

	I1	I2	I3	I4	I5	I6
ld a, d(s1) I1	-					
mul .a2 a0 a2 I2	-	-				
add a1 a1 a3 I3	WAW	RAW	-			
ld a2 d(s2) I4	-	WAW	WAR	-		
add a3 a1 a2 I5	RAW	RAW	RAW	RAW	-	
sd a3 d(s3) I6	-	-	-	-	WAW	-

4. (1) 设执行N条指令, N足够大. A需要: $\frac{N}{5} \times 6 + (5-1) = \frac{6}{5}N + 4$ 个周期

B需要 $\frac{N}{8} \times 11 + 12-1 = \frac{11}{8}N + 11$ 个周期

$$S = \lim_{N \rightarrow \infty} \frac{T_A}{T_B} \approx \frac{T_{cycle A} \cdot \frac{6}{5}N}{T_{cycle B} \cdot \frac{11}{8}N} = \frac{16}{11} \approx 1.45$$

(2) 执行N条指令, 分支指令均为0.2N条, AB平均处理错误 $0.2N \times 5\% = 0.01N$ 条

$$\frac{CPI_A}{CPI_B} = \lim_{N \rightarrow \infty} \frac{\frac{6}{5}N + 5-1 + 0.01N \times 2}{\frac{11}{8}N + 12-1 + 0.01N \times 5} = 0.856$$

6. 1)

		1	2	3	4	5	6
Loop: ld a1, 0(a2)	1	-	WAR	WAR	RAW	-	-
addi a1, a1, 1	2	RAW	-	WAW	-	-	-
sd a1, 0(a2)	3	RAW	WAW	-	RAW	-	-
addi a2, a2, 4	4	WAR	-	WAR	-	WAR	-
sub a4, a3, a2	5	-	-	-	RAW	-	WAR
bnez a4, Loop	6	-	-	-	-	RAW	-

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)			ID	S	S	S	S	ID	EX	MEM	WB						
addi a2, a2, 4								ID	EX	MEM	WB						
swb a4, a1, a2								ID	EX	MEM	WB						
bnez a4, Loop								ID	EX	MEM	WB						

一次循环18个周期, 共执行25次, 共 $18 \times 25 = 450$ 个周期

addi r1, r2, 4	S	ZF	ID	EX	MEM	WB
sub r4, r2, r2			IF	ID	EX	MEM WB
bneq r4, loop				IF	ID	EX MEM WB

(2)

[illegible]

故有总周期为: $24 \times 9 + 11 = 227$ 个周期

	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	M1	M2	WB1	WB2											
addi a1, a1, 1		IF1	IF2	ID1	ID2	s	s	s	EX1	EX2	...										
sd a, 0(a2)			ZF ₁	ZF ₂	ID ₁	s	s	s	ID ₂	s	EX ₁	EX ₂	...								
addi a1, a1, 4				ZF ₁	ZF ₂	s	s	s	ID ₁	s	ID ₂	EX ₁	EX ₂	...							
swb a4, a3, a1					ZF ₁	s	s	s	ZF ₂	s	ID ₁	ID ₂	s	EX ₁	EX ₂						
bne3 a4, Loop						s	s	s	ZF ₁	s	ZF ₂	ID ₁	s	ID ₂	s	EX ₁	EX ₂	MEM ₁	MEM ₂	WB ₁	WB ₂
ld a1, 0(a2)											s	s	s	s	s	s	s	ZF ₁			

共花费 $17 \times 24 + 21 = 429$ 个周期

(2)

$$CPI_b = \frac{475}{150} = 3.17$$

$$CPI_{7111} = \frac{275}{150} = 1.83$$

$$CPI_{1972} = \frac{227}{150} = 1.51$$

$$CpZ_8 = \frac{429}{150} = 2.86$$

	add	addi	ld	sd	bne	jal	jalr
是否需要 2 周期?	是	否	否	是	是	否	否

2.

[illegible]

addw	a1,a1,a1		IF	LD	S	S	LD	EX	MEM	WB						
addiw	a2,a2,-1		IF	S	S	LD	EX	MEM	WB							
addiw	a3,a3,4			S	S	IF	LD	EX	MEM	WB						
bnez	a2,Loop				S	S	IF	LD	S	EX	MEM	WB				

一次迭代 12周期

3.

			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Loop:	lw	a4,0(a3)	IF	LD	EX	MEM	WB											
	addw	a1,a4,a1		IF	LD	S	EX	MEM	WB									
	addiw	a2,a2,-1			IF	S	LD	EX	MEM	WB								
	addiw	a3,a3,4				S	IF	LD	EX	MEM	WB							
	bnez	a2,Loop						IF	LD	EX	MEM	WB						

需 10个周期