	rs	rt	rd
1	sl	/	[a1]
2	a2	a0	[a2]
3	a2	(a2)	[a1]
4	s2		a2
5	[a1]	(a√)	a3
6	a3 12	s3	

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

4. /1) $CPI_A = \dfrac{6}{5}$ $CPI_B = \dfrac{3+8}{8} = \dfrac{11}{8}$

$$S = \frac{CPI_A \cdot T_A}{CPI_B \cdot T_B} = \frac{6/5 \times 1}{11/8 \times 0.6} = 1.45$$

2)

$$CPI = 20\% \, CPI_{Branch} + 80\% \, CPI_{not Branch}$$

$$CPI_A = 1.2 \times (0.8 + 0.2 \times 96\%) + 3.2 \times 0.2 \times 5\%$$
$$= 1.22$$

$$CPI_B = \frac{11}{8} \times (0.8 + 0.2 \times 95\%) + \left(\frac{11}{8} + 5\right) \times 0.2 \times 5\%$$
$$= 1.425$$

6.1) Loop:

```
Loop:   ld   a1,0(a2)    编号为 ①
        addi a1,a1,1            ②
        sd   a1,0(a2)           ③
        addi a2,a2,4           ④
        sub  a4,a3,a2          ⑤
        bnez a4,Loop          ⑥
```

	rs	rt	rd
①	/	a2	a1
②	a1	/	a1
③	a1	a2	/
④	a2	/	a2
⑤	a3	a2	a4
⑥	a4	/	/

② ① RAW   ④③ WAR   ①② WAW

③② RAW

⑤④ RAW

⑥⑤ 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)			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	

一次循环 18个周期

共25个循环 ∴ 25×18 = 450

CPI: $\dfrac{450}{6 \times 25} = 3$

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	

共需要 $25 \times 11 = 275$ 周期 $CPI = \dfrac{275}{150} = 1.83$

2) 即 bnez IF ID

  ld   IF ID

∴ 共需要 $24 \times 8 + 11 = 203$

  $CPI = \dfrac{203}{150} = 1.353$

8.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
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	M1	M2	WB1	WB2						
sd a1,0(a2)			IF1	IF2	ID1	s	s	s	ID2	s	EX1	EX2	M1	M2	WB1	WB2				
addi a2,a2,4				IF1	IF2	s	s	s	ID1	s	ID2	EX1	EX2	M1	M2	WB1	WB2			
sub a4,a3,a2					IF1	s	s	s	IF2	s	ID1	ID2	EX1	EX2	M1	M2	WB1	WB2		
bnez a4,Loop									IF1	s	IF2	ID1	ID2	s	EX1	EX2	M1	M2	WB1	WB2

$11 + 23 \times 13 + 20 = 330$

后续流水线会多停顿2个周期

$CPI : \dfrac{330}{150} = 2.2$

19./1) add 是
　　addi 否
　　ld 否
　　sd 是
　　bne 是
　　jal 否
　　jalr 是

2) Loop: lw　a4,0(a3)
　　　addw　a1,a4,a1
　　　addiw　a2,a2,-1
　　　addiw　a3,a3,4
　　　bnez　a2,Loop

单次需要周期数　12

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

3). 单次周期数 10

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