**Pb1.5**

**a.**

Performance of P1 = 3\*10^9/1.5 = 2\*10^9 (instruction/s)

Performance of P2 = 2.5\*10^9/1 = 2.5\*10^9 (instruction/s)

Performance of P3 = 4\*10^9/2.2 = 1.82\*10^9 (instruction/s)

**b.**

number of cycles of P1 = 3\*10^9 \* 10 = 3\*10^10

Instruction count of P1 = 10 \* 3\*10^9/1.5 = 2\*10^10

number of cycles of P2 = 2.5\*10^9 \* 10 = 2.5\*10^10

Instruction count of P2 = 10 \* 2.5\*10^9/1 = 2.5\*10^10

number of cycles of P3 = 4\*10^9 \* 10 = 4\*10^10

Instruction count of P3 = 10\*4\*10^9/2.2 = 1.82\*10^10

**c.**

1.2/0.7 = 1.71

P1 : 1.71 \* 3 = 5.13 GHz

P2 : 1.71 \* 2.5 = 4.28 GHz

P3 : 1.71 \* 4 = 6.84 GHz

**Pb1.6**

**a.**

Global CPI of P1:

(10^5\*1+2\*10^5\*2+5\*10^5\*3+2\*10^5\*3)/10^6 = (1+4+15+6)/10=2.6

Global CPI of P2:

(10^5\*2+2\*10^5\*2+5\*10^5\*2+2\*10^5\*2)/10^6 = (2+4+10+4)/10=2.0

**b.**

clock cycles of P1 = 2.6\*10^6

clock cycles of P2 = 2.0\*10^6

**Pb1.7**

**a.**

Average CPI of compiler A : 1.1/10^9/10^-9 = 1.1

Average CPI of compiler B : 1.5/(1.2\*10^9)/10^-9 = 1.25

**b.**

time ratio A/B : (10^9\*1.1)/(1.2\*10^9\*1.25)=11/15

speed ratio A/B: 1/(A/B) = 15/11 =1.36

A is 1.36 times faster than B

**c.**

time versus A : (6\*10^8\*1.1)/(10^9\*1.1) = 0.6

speedup versus A : 1/0.6 = 1.67

time versus B : (6\*10^8\*1.1)/(1.2\*10^9\*1.25) = 0.44

speedup versus B : 1/0.44 = 2.27

**1.11**

**1.11.1**

750/(0.333\*10^-9)/2.389\*10^12 = 0.94

**1.11.2**

SPEC ratio = ref time/exe time = 9650/750 = 12.87

**1.11.3**

CPU time = number of instruction \*CPI / clock rate

🡺CPU time is increased by 10%

**1.11.4**

CPU time = number of instruction \*CPI / clock rate

1.1\*1.05 = 1.155

🡺CPU time is increased by 15.5%

**1.11.5**

Ratio\_new : 9650/(750\*1.155) = 11.14

Ratio\_new/Ratio\_old : 11.14/12.87= 0.86

🡺SPEC ratio decrease 14%

**1.11.6**

700\*4\*10^9/(0.85\*2.389\*10^12) = 1.38

**1.11.7**

Clock rate ratio new/old : 4/3 = 1.33

CPI ratio new/old : 1.38/0.94 = 1.47

They are dissimilar because, although the number of instructions is decreased by 15%, CPU time is only decreased about 7%. Therefore, the change ratio of clock rate and CPI is different.

**1.11.8**

700/750 = 0.93

CPU time is decreased 7%

**1.11.9**

960\*10^-9\*0.9\*4\*10^9/1.61 = 2146.6

**1.11.10**

1/0.9 = 1.11

1.11\*3 GHz = 3.33 GHz

**1.11.11**

0.85/0.8 = 1.06

1.06 \* 3 GHz = 3.18 GHz

**1.14**

**1.14.1**

(50\*1+110\*1+80\*4+16\*2)\*10^6/2 = (50\*CPI\_FP+110\*1+80\*4+16\*2)\*10^6

🡺25\*1+55\*1+80\*2+16 = 50\*CPI\_FP+110\*1+80\*4+16\*2

🡺256=50\*CPI\_FP+110+320+32

🡺CPI\_FP = (256-462)/50 < 0

🡺 impossible to reach the result

**1.14.2**

(50\*1+110\*1+80\*4+16\*2)\*10^6/2 = (50\*1+110\*1+80\*CPI\_L/S+16\*2)\*10^6

**🡺**(50\*1+110\*1+80\*4+16\*2)/2 = (50\*1+110\*1+80\*CPI\_L/S+16\*2)

**🡺**256=50+110+80\*CPI\_L/S+32

🡺CPI\_L/S = 0.8

CPI\_L/S should be improved from 4 to 0.8

**1.14.3**

(50\*1+110\*1+80\*4+16\*2)\*10^6/(2\*10^9) = 0.256 (s)

(50\*0.6+110\*0.6+80\*2.8+16\*1.4)\*10^6/(2\*10^9) = 0.171 (s)

Execution time will be improved from 0.256 seconds to 0.171 seconds