1.6a

$1.0\text{E}6 = 10^6$

$1\ \text{GHz} = 1 \times 10^9 Hz$

		10%	20%	50%	20%
P1	2.5GHz	1	2	3	3
P2	3GHz	2	2	2	2

$T_{P1} = \frac{(0.1\times10^6 + 0.2\times10^6\times2 + 0.5\times10^6\times3 + 0.2\times10^6\times3)}{2.5\times10^9} = 1.04 \times 10^{-3}s$

$T_{P2} = \frac{(0.1\times10^6\times2 + 0.2\times10^6\times2 + 0.5\times10^6\times2 + 0.2\times10^6\times2)}{3\times10^9} = 0.67 \times 10^{-3}s$

∵TP1 > TP2

∴P2 is faster than P1

CPI(P1) $= \frac{1.04\times10^{-3}\times2.5\times10^9}{10^6} = 2.6$

CPI(P2) $= \frac{0.67\times10^{-3}\times3\times10^9}{10^6} = 2.0$

∴P1’s global CPI is 2.0

P2’s global CPI is 2.6

1.6b

Clock CycleP1=$0.1\times10^6 + 0.2\times10^6\times2 + 0.5\times10^6\times3 + 0.2\times10^6\times3$

=2.6$\times 10^6$

Clock CycleP2=$0.1\times10^6\times2 + 0.2\times10^6\times2 + 0.5\times10^6\times2 + 0.2\times10^6\times2$

=2.0$\times 10^6$

∴P1 ‘s Clock Cycle is 2.6$\times 10^6$s and P2’s Clock Cycle is 2.0$\times 10^6$

1.9.1

1 Million $=10^6$

$T_{P1} = \frac{2.56\times10^9+1.28\times10^9\times12+2.56\times10^8\times5}{2\times10^9} = 9.60s$

$T_{P2} = \frac{\frac{2.56\times10^9}{0.7\times2}+\frac{1.28\times10^9}{0.7\times2}\times12+2.56\times10^8\times5}{2\times10^9} = 7.02s$

$R_{P2} = \frac{9.6}{7.02} = 1.37$

$T_{P4} = \frac{\frac{2.56\times10^9}{0.7\times4}+\frac{1.28\times10^9}{0.7\times4}\times12+2.56\times10^8\times5}{2\times10^9} = 3.86s$

$R_{P4} = \frac{9.6}{3.86} = 2.49$

$T_{P8} = \frac{\frac{2.56\times10^9}{0.7\times8}+\frac{1.28\times10^9}{0.7\times8}\times12+2.56\times10^8\times5}{2\times10^9} =2.25s$

$R_{P8} = \frac{9.6}{2.25} = 4.27$

The total execution time for this program on 1, 2, 4, and 8 processors is 9.6s,7.02s,3.86s and 2.25s. The relative speedup of the 2, 4, and 8 processor is 1.37,2.49 and 4.27.

1.9.2

$$T_{P1b} = \frac{2.56\times10^9\times2+1.28\times10^9\times12+2.56\times10^8\times5}{2\times10^9} = 10.88s$$

$$T_{P2b} = \frac{\frac{2.56\times10^9}{0.7\times2}\times2+\frac{1.28\times10^9}{0.7\times2}\times12+2.56\times10^8\times5}{2\times10^9} = 7.95s$$

$$T_{P4b} = \frac{\frac{2.56\times10^9}{0.7\times4}\times2+\frac{1.28\times10^9}{0.7\times4}\times12+2.56\times10^8\times5}{2\times10^9} = 4.29s$$

$$T_{P8b} = \frac{\frac{2.56\times10^9\times2}{0.7\times8}+\frac{1.28\times10^9}{0.7\times8}\times12+2.56\times10^8\times5}{2\times10^9} = 2.47s$$

$\because T_{P1b} > T_{P1} \quad T_{P2b} > T_{P2} \quad T_{P4b} > T_{P4} \quad T_{P8b} > T_{P8}$

$\therefore$The execution time of the program on 1, 2, 4, or 8 processors will increase.

1.9.3

$\because T_{P4} = \frac{\frac{2.56\times10^9}{0.7\times4}+\frac{1.28\times10^9}{0.7\times4}\times12+2.56\times10^8\times5}{2\times10^9} = 3.86s$

Let the new CPI of load/store instructions be x.

Then,

$\frac{2.56*10^9+1.28*10^9x+2.56*10^8*5}{2*10^9}=3.86$

$0.64x + 1.92=3.86$

$x=3.03$

$\therefore CPI_{reduced}=\frac{3.03}{12}=25\%$

The CPI of load/store instructions should be reduced to 25% in order for a single processor to match the performance of four processors using the original CPI values.

1.12.1

$5.0E9 = 5 \times 10^9$

T_{P1} = $\frac{5\times10^9}{4\times10^9}$= 1.225s

T_{P2} = $\frac{0.75\times10^9}{3\times10^9}$= 0. 25s

$\because T_{P2}<T_{P1}$

∴P1 has smaller performance than P2.
∴It’ s false that the computer with the largest clock rate as having the largest performance.

1.12.2

T_{P1} = $\frac{0.9\times10^9}{4\times10^9}$= 0.225s

Let instructions to execute in the same time as P1 be x.
Then

$\frac{0.75x}{3*10^9}$= 0.225

x $=0.9 * 10^9$
∴$x < 0.9 \times 10^9$
The number of instructions that P2 can execute in the same time that P1 needs to execute 1.0E9 instructions is 0.9×10^9.

1.14.1

T=$\frac{50\times10^{6}+110\times10^{6}+80\times10^{6}\times4+16\times2\times10^{6}}{2\times10^{9}}$=0.256s

If the program changed to be run 1 times faster than before:
Let us Consider the total number of clocks for FP instructions is x

0.178= $\frac{50*10^{6}x+110*10^{6}+80*10^{6}*4+16*2*10^{6}}{2*10^{9}}$

$x=-4.12$

∵x<0

∴The CPI of FP instructions can not be improve.

1.14.2

T=$\frac{50\times10^{6}+110\times10^{6}+80\times10^{6}\times4+16\times2\times10^{6}}{2\times10^{9}}$=0.256s

If the program changed to be run 1 times faster than before:
Let us Consider the total number of clocks for FP instructions is x

0.178= $\frac{50*10^{6}+110*10^{6}+80*10^{6}*x+16*2*10^{6}}{2*10^{9}}$

$x=0.8$

∵x>0

∴The CPI of L/S instructions can be improved by 0.8 times if the programs to be run two times faster.

1.14.3

T_2=$\frac{0.6\times50\times10^{6}+0.6\times110\times10^{6}+0.7\times80\times10^{6}\times4+0.7\times16\times2\times10^{6}}{2\times10^{9}}$=0.17s

$\frac{0.256}{0.17}$ =1.505

∴the improvement of the execution time of the program is 1.505 times.