1.6

P1: CPU TIME $= \frac{10^6(0.1*1+0.2*2+0.5*3+0.2*3)}{2.5GHZ} = \frac{2.6}{2.5} * 10^{-3} = 1.04\, milliseconds$

P2: CPU TIME $= \frac{10^6(0.1*2+0.2*2+0.5*2+0.2*2)}{3GHZ} = \frac{2}{3} * 10^{-3} \approx 0.67\, milliseconds$

a.

Global CPI P1 $= \frac{2.6*10^6}{10^6} = 2.6$

Global CPI P2 $= \frac{2*10^6}{10^6} = 2$

b.

clock cycles of P1 $= 2.6 * 10^6$

clock cycles of P2 $= 2 * 10^6$

1.9.1

1 processor:

$$\frac{1*2.56*10^9+12*1.28*10^9+5*2.56*10^8}{2GHz} = 9.6s$$

2 processors:

$$\frac{\frac{1*2.56*10^9+12*1.28*10^9}{2*0.7}+5*2.56*10^8}{2GHz} = 7.04s$$

$\frac{9.6}{7.04} = 1.36$ Speed up 1.36

4 processors:

$$\frac{\frac{1*2.56*10^9+12*1.28*10^9}{4*0.7}+5*2.56*10^8}{2GHz} = 3.84s$$

$\frac{9.6}{3.84} = 2.5$ Speed up 2.5

8 processors:

$$\frac{\frac{1*2.56*10^9+12*1.28*10^9}{8*0.7}+5*2.56*10^8}{2GHz} = 2.24s$$

$\frac{9.6}{2.24} = 4.29$ Speed up 4.29

1.9.2

1 processor:

$$\frac{1*2.56*10^9+12*1.28*10^9+5*2.56*10^8}{2GHz}+\frac{1*2.56*10^9}{2GHz}\ =10.88s$$

$\frac{10.88s}{9.6s}=1.13$ slow down 1.3

2 processors:

$$\frac{\frac{1*2.56*10^9+12*1.28*10^9}{2*0.7}+5*2.56*10^8}{2GHz}+\frac{1*2.56*10^9}{2*0.7*2GHz}=7.95s$$

$\frac{7.95s}{7.04s}=1.13$ slow down 1.3

4 processors:

$$\frac{\frac{1*2.56*10^9+12*1.28*10^9}{4*0.7}+5*2.56*10^8}{2GHz}+\frac{1*2.56*10^9}{4*0.7*2GHz}=4.30s$$

$\frac{4.3}{3.84}=1.12$ slow down 1.2

8 processors:

$$\frac{\frac{1*2.56*10^9+12*1.28*10^9}{8*0.7}+5*2.56*10^8}{2GHz}+\frac{1*2.56*10^9}{8*0.7*2GHz}=2.47s$$

$\frac{2.47}{2.24}=1.1$ slow down 1.1

1.9.3

Assume x is the reduced number

$$\frac{1*2.56*10^9+x*1.28*10^9}{0.7*4}+5*2.56*10^8=1*2.56*10^9+x*1.28*10^9+5*2.56*10^8$$

Compute the above equation, we finally get $x=\frac{3.84*10^9}{1.28*10^9}=3$

1.12.1

CPU time P1: $\frac{0.9*5*10^9}{4*10^9} = \frac{4.5}{4} = 1.125s$

CPU time P2: $\frac{0.75*1*10^9}{3*10^9} = \frac{0.75}{2} = 0.25s$

P2 runs faster than P1, but P1 has a larger clock rate than P2, in this case, it contradicts with the statement, the statement is false.

1.12.2

CPU time P1: $\frac{0.9*1*10^9}{4*10^9} = \frac{0.9}{4} = 0.225s$

CPU time P2: $\frac{0.75*1*10^9}{3*10^9} = \frac{0.75}{3} = 0.25s$

$$I = \frac{0.225 * 3 * 10^9}{0.75} = 9 * 10^8$$

P2 can execute $9 * 10^8$ *instructions when* $P1$ *execute* 10^9 *instructions*

1.14.1

$$execution\ time = \frac{clock\ cycles}{clock\ rate} = \frac{50 * 10^6 + 110 * 10^6 + 80 * 10^6 * 4 + 16 * 10^6 * 2}{2GHz}$$
$$= 256ms$$

$$128ms = \frac{50 * 10^6 * X + 110 * 10^6 + 80 * 10^6 * 4 + 16 * 10^6 * 2}{2GHz}$$

Compute the equation, we get x = -4.12, thus it cannot be improved as expected

1.14.2

$$128ms = \frac{50 * 10^6 + 110 * 10^6 + 80 * 10^6 * X + 16 * 10^6 * 2}{2GHz}$$

Compute the equation, we get x = 0.8

If we improve CPI of load and store by 0.8 times. It will run two times faster

1.14.3

ls: 4 * 0.7 = 2.8

br: 2*0.7 = 1.4

FP: 0.6

Int:0.6

$$execution\ time = \frac{clock\ cycles}{clock\ rate}$$
$$= \frac{50 * 10^6 * 0.6 + 110 * 10^6 * 0.6 + 80 * 10^6 * 2.8 + 16 * 10^6 * 1.4}{2GHz}$$
$$= 171.2ms$$

$$\frac{256}{171.2} = 1.495$$

Improves by 1.495 times.