1.

a. MIPS = clock rate / CPI * 10^6

P1 之 MIPS = 2.7 * 10^9 / 1.5 * 10^6 = 1.8 * 10^3

P2 之 MIPS = 3.0 * 10^9 / 2.0 * 10^6 = 1.5 * 10^3

P3 之 MIPS = 4.0 * 10^9 / 2.5 * 10^6 = 1.6 * 10^3

b. Extime = IC * CPI / clock rate

IC = Extime * clock rate / CPI

Total cycles = IC * CPI

P1 之 IC = 8 * 2.7 * 10^9 / 1.5 = 14.4 * 10^9 ; Total cycles = 14.4 * 10^9 * 1.5 = 21.6*10^9

P2 之 IC = 8 / 2.0 * 3.0 * 10^9 = 12 * 10^9 ; Total cycles = 12 * 10^9 * 2.0 = 24 * 10^9

P3 之 IC = 8 / 2.5 * 4.0 * 10^9 = 12.8 * 10^9 ; Total cycles = 12.8 * 10^9 * 2.5 = 32 * 10^9

c.因為 IC 不變，Extime 變成原來的 0.6 倍，CPI 變成原來的 1.35 倍

=> 0.6 * Extime = IC * 1.35 * CPI / new clock rate

P1 之 new clock rate = 21.6 * 10^9 * 1.35 / 0.6 * 8 = 6.075 GHz

P2 之 new clock rate = 24 * 10^9 * 1.35 / 0.6 * 8 = 6.75 GHz

P3 之 new clock rate = 32 * 10^9 * 1.35 / 0.6 * 8 = 9 GHz

2.

a. Extime on 1 processor = (2 * 2.6 * 10^9) + (11 * 1.3 * 10^9) + (7 * 3.9 * 10^8) / 2.4 * 10^9 = 9.2625 s

Extime on 2 processors = (((2 * 2.6 * 10^9) + (11 * 1.3 * 10^9)) / 1.3 + (7 * 3.9 * 10^8)) / 2.4 * 10^9 = 7.3875 s ; speedup = 9.2625 / 7.3875 = 1.2538

Extime on 4 processors = (((2 * 2.6 * 10^9) + (11 * 1.3 * 10^9)) / 2.6 + (7 * 3.9 * 10^8)) / 2.4 * 10^9 = 4.2625 s ; speedup = 9.2625 / 4.2625 = 2.173

Extime on 8 processors = (((2 * 2.6 * 10^9) + (11 * 1.3 * 10^9)) / 5.2 + (7 * 3.9 * 10^8)) / 2.4 * 10^9 = 2.7 s ; speedup = 9.2625 / 2.7 = 3.43

b. Extime on 1 processor = (1 * 2.6 * 10^9) + (22 * 1.3 * 10^9) + (7 * 3.9 * 10^8) / 2.4 * 10^9 = 14.1375 s

Extime on 2 processors = (((1 * 2.6 * 10^9) + (22 * 1.3 * 10^9)) / 1.3 + (7 * 3.9 * 10^8)) / 2.4 * 10^9 = 11.1375 s

Extime on 4 processors = (((1 * 2.6 * 10^9) + (22 * 1.3 * 10^9)) / 2.6 + (7 * 3.9 * 10^8)) / 2.4 * 10^9 = 6.1375 s

Extime on 8 processors = (((1 * 2.6 * 10^9) + (22 * 1.3 * 10^9)) / 5.2 + (7 * 3.9 * 10^8)) / 2.4 * 10^9 = 3.6375 s

c. (2 * 2.6 * 10^9) + (x * 1.3 * 10^9) + (7 * 3.9 * 10^8) / 2.4 * 10^9 = 7.3875 s

x = 7.538 . 7.538 / 11 * 100% = 68.5%

所以需要 reduce 31.5% CPI.

3.

a. CPI = Extime * clock rate / IC

CPI = 772 * 2.2 * 10^9 / 2.123 * 10^{12} = 0.8

b. SPECratio = reference time / Extime

SPECratio = 9650 / 772 = 12.5

c. new Extime = EXtime * 115% = 772 * 115% = 887.8 s

new Extime / Extime (%) = 887.8 / 772 * 100% = 1.15%

So Extime increased by 15%

4.

a. global CPI for P1 = 2 * 10^6 * (0.2 * 1 + 0.25 * 2 + 0.45 * 3 + 0.1 * 2) / 2 * 10^6 = 2.25

global CPI for P2 = 2 * 10^6 * (0.2 * 1.5 + 0.25 * 3 + 0.45 * 2 + 0.1 * 2) / 2 * 10^6 =2.15

b. Extime of P1 = 2 * 10^6 * 2.25 / 2.4 * 10^9 = 1.875 ms

Extime of P2 = 2 * 10^6 * 2.15 / 2.2 * 10^9 = 1.955 ms

So P1 is faster.