6. Section 1.11 (textbook) cites as a pitfall the utilization of a subset of the performance equation as a performance metric. To illustrate this, consider two processors. P1 has a clock rate of 4GHz, average CPI of 0.9 and requires the execution of 5.0E9 instructions. P2 has a clock rate of 3GHz, an average of CPI of 0.75, and requires the execution of 1.0E9 instructions.

   (a) [6 points] One usual fallacy is to consider the computer with the largest clock rate as having the largest performance. Check if this is true for P1 and P2.

Given

$P_1 \rightarrow cr = 4GHz = 4\times10^{9}$

Average $CPI = 0.9$

exc-time $= 5.0\times10^{9}$

$P_2 \rightarrow cr = 3GHz = 3\times10^{9}$

average $CPI = 0.75$

exec-time $= 1.0\times10^{9}$

$$P_{1\text{-}2} = \frac{IC \times CPI}{\text{Clock rate}}$$

$$P_1 = \frac{5\times10^9 \times 0.9}{4\times10^9} = 1.125_s$$

$$P_2 = \frac{10^9 \times 0.75}{3\times10^9} = 0.25_s$$

clock rate (P_1) > clock rate (P_2), Performance $(P_1) < P_2$

   (b) [6 points] Another fallacy is to consider that the processor executing with the largest number of instructions will need a larger CPU time. Consider that processor P1 is executing a sequence of 1.0E9 instructions and that the CPI of processors P1 and P2 do not change, determine the number of instructions that P2 can execute in the same time that P1 needs to execute 1.0E9 instructions.

$$P_1 \text{ CPU time} = \frac{10^9 \times 0.9}{4\,GHz} = \frac{0.9\times10^9}{4\times10^9 Hz} = 0.225_s$$

$$P_2 \rightarrow \frac{\#\text{ of instructions} \times 0.75}{3\,GHz} = 0.225_s$$

$$\#\text{ of instructions} = \frac{0.225\times3\times10^9}{0.75} = 9\times10^8$$

It is clearly that P_1 can process more instructions than P_2 and most importanly at the same period time

(c) [6 points] A common fallacy is to use MIPS (millions of instructions per second) to compare the performance of two different processors, and consider that the processor with the largest MIPS has the largest performance. Check if this is true for P1 and P2.

$$MIPS = \frac{\text{clock rate}}{CPI \times 10^6}$$

$$P_1 = \frac{4\,GHz}{0.9 \times 10^6} = \frac{4 \times 10^9\,Hz}{0.9 \times 10^6} = 4444$$

$$P_2 = \frac{3\,GHz}{0.75 \times 10^6} = \frac{3 \times 10^9\,Hz}{0.75 \times 10^6} = 4000$$

P_1 has bigger MIPs