# 1.5 [4] <§1.6> Consider three different processors P1, P2, and P3 executing the same instruction set. P1 has a 3 GHz clock rate and a CPI of 1.5. P2 has a 2.5 GHz clock rate and a CPI of 1.0. P3 has a 4.0 GHz clock rate and has a CPI of 2.2.

## Which processor has the highest performance expressed in instructions per second?

Instructions Per Second = Clock Rate / CPI

P1: 3.0 GHz / 1.5 = 2.0G Instructions / Second

**P2: 2.5 GHz / 1.0 = 2.5G Instructions / Second**

P3: 4.0 GHz / 2.2 = 1.8G Instructions / Second

With 2.5\*10^9 Instructions per second, P2 has the highest performance in instructions per second.

## If the processors each execute a program in 10 seconds, find the number of cycles and the number of instructions.

Cycles = Execution Time \* Clock Rate

Instructions = Execution Time \* (Clock Rate / CPI)

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| Processor | Cycles | Instructions |
| P1 | 10s \* 3.0GHz = 30 \* 10^9 | (10s)\*(3.0GHz/1.5) = 20 \* 10^9 |
| P2 | 10s \* 2.5GHz = 25 \* 10^9 | (10s)\*(2.5GHz/1.0) = 25 \* 10^9 |
| P3 | 10s \* 4.0GHz = 40 \* 10^9 | (10s)\*(4.0GHz/2.2) = 18 \* 10^9 |

## We are trying to reduce the execution time by 30% but this leads to an increase of 20% in the CPI. What clock rate should we have to get this time reduction?

We will be assuming nothing has changed in the program. Thus the number of instructions will be used from the prior answer.

Execution time = 10s \* (70%) = 7s

CPI\_1 = 1.5 \* (120%) = 1.8

CPI\_2 = 1.0 \* (120%) = 1.2

CPI\_3 = 2.2 \* (120%) = 2.64

Clock Rate = (# Instructions \* CPI) / CPU Time

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| Processor | Mathematics | New Clock Rate | Old Clock Rate |
| P1 | (20\*10^9 \* 1.8) / 7 | 5.14 GHz | 3.0 GHz |
| P2 | (25\*10^9 \* 1.2) / 7 | 4.29 GHz | 2.5 GHz |
| P3 | (18\*10^9 \* 2.64) / 7 | 6.79 GHz | 4.0 GHz |