Solutions for Chapter 4 Exercises

4.1 For P1, M2 is 4/3 (2 sec/1.5 sec) times as fast as M1. For P2, M1 is 2 times as fast (10 sec/5 sec) as M2.

4.2 We know the number of instructions and the total time to execute the program. The execution rate for each machine is simply the ratio of the two values. Thus, the instructions per second for P1 on M1 is (5×10^9 instructions/2 seconds) = 2.5×10^9 IPS, and the instructions for P1 on M2 is (6×10^9 instructions/1.5 seconds) = 4×10^9 IPS.

4.3 M2 runs 4/3 as fast as M1, but it costs 8/5 as much. As 8/5 is more than 4/3, M1 has the better value.

4.6 Running P1 1600 times on M1 and M2 requires 3200 and 2400 seconds respectively. This leaves 400 seconds left for M1 and 1200 seconds left for M2. In that time M1 can run (400 seconds/(5 seconds/iteration)) = 80 iterations of P2. M2 can run (1200 seconds/(10 seconds/iteration)) = 120 iterations. Thus M2 performs better on this workload.

Looking at cost-effectiveness, we see it costs ($500/(80 iterations/hour)) = $6.25 per (iteration/hour) for M1, while it costs ($800/(120 iterations/hour)) = $6.67 per (iteration/hour) for M2. Thus M1 is most cost-effective.

4.7

a. Time = (Seconds/cycle) * (Cycles/instruction) * (Number of instructions)

   Therefore the expected CPU time is (1 second/5×10^9 cycles) * (0.8 cycles/instruction) * (7.5×10^9 instructions) = 1.2 seconds

b. P received 1.2 seconds/3 seconds or 40% of the total CPU time.

4.8 The ideal instruction sequence for P1 is one composed entirely of instructions from class A (which have CPI of 1). So M1's peak performance is (4×10^9 cycles/second)/(1 cycle/instruction) = 4000 MIPS.

Similarly, the ideal sequence for M2 contains only instructions from A, B, and C (which all have a CPI of 2). So M2's peak performance is (6×10^9 cycles/second)/(2 cycles/instruction) = 3000 MIPS.

4.9 The average CPI of P1 is ($1 \times 2 + 2 + 3 + 4 + 3$)/6 = 7/3. The average CPI of P2 is ($2 \times 2 + 2 + 2 + 4 + 4$)/6 = 8/3. P2 then is (($6 \times 10^9$ cycles/second)/(8/3 cycles/instruction))/((4×10^9 cycles/second)/(7/3 cycles/instruction)) = 21/16 times faster than P1.