1. **Exercise 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.

2. **Exercise 4.7**
   a. Time = (Seconds/cycle) * (Cycles/instruction) * (Number of instructions)
      Therefore the expected CPU time is
      \( \frac{1 \text{ second}}{5 \times 10^9 \text{ cycles}} \times (0.8 \text{ cycles/instruction}) \times (7.5 \times 10^9 \text{ instructions}) = 1.2 \text{ seconds} \)
   b. P received 1.2 seconds/3 seconds or 40% of the total CPU time.

3. **Exercise 4.9**
   The average CPI of P1 is \( \frac{1 \times 2 + 2 + 3 + 4 + 3}{6} = \frac{7}{3} \). P1 clock rate = 4 GHz.
   The average CPI of P2 is \( \frac{2 \times 2 + 2 + 2 + 4 + 4}{6} = \frac{8}{3} \). P2 clock rate = 6 GHz.
   \[ \frac{P2\_CPU\_TIME}{P1\_CPU\_TIME} = \frac{((8/3)/(6 \times 10^9))}{((7/3)/(4 \times 10^9))} \]
   Speed up P2 vs P1 = \( \frac{(6 \times 10^9)}{8/3} \) / \( \frac{(4 \times 10^9)}{7/3} \) = 1.3125

4. **Exercise 4.10**
   Using C1, the average CPI for I1 is \( 0.4 \times 2 + 0.4 \times 3 + 0.2 \times 5 = 3 \),
   and the average CPI for I2 is \( 0.4 \times 1 + 0.4 \times 2 + 0.2 \times 2 = 1.6 \).
   CPU time = Instruction count x CPI x Clock cycle time
   Thus, with C1, I1 is CPU_tihm_withC1onI2 / CPU_time_withC1onI1 = \[ 1.6/(3 \times 10^9) \] / \[ 3/(6 \times 10^9) \] = 1.06 times as fast as I2.
   Using C2, the average CPI for I1 is \( 0.4 \times 2 + 0.2 \times 3 + 0.4 \times 5 = 3.4 \), and the average
   CPI for I2 is \( 0.4 \times 1 + 0.2 \times 2 + 0.4 \times 2 = 1.6 \).
   So with C2, I2 is faster than I1 by factor \[ 3.4/(6 \times 10^9) \] / \[ 1.6/(3 \times 10^9) \] = 1.0625
   For the rest of the questions, it will be necessary to have the CPIs of I1 and I2 on programs compiled
   by C3. For I1, C3 produces programs with CPI \( 0.5 \times 2 + 0.25 \times 3 + 0.25 \times 5 = 3 \).
   For C3, I2 has CPI \( 0.5 \times 1 + 0.25 \times 2 + 0.25 \times 2 = 1.5 \).
   The best compiler for each machine is the one which produces programs with the lowest average CPI.
   Thus, if you purchased I1, you would use C3 or C1. If you purchased I2, you would use C3.
   CPU time of C3 on I1 = \( 3/(6 \times 10^9) \) sec \times \#_of_inst = 0.5 nsec \times \#_of_inst
   CPU time of C3 on I2 = \( 1.5/(3 \times 10^9) \) sec \times \#_of_inst = 0.5 nsec \times \#_of_inst
   Thus, purchase C3 and either I1 or I2.

5. **Exercise 4.14**
   The total execution times for the machines are as follows:
   Computer A = 2 + 20 + 200 seconds = 222 seconds
Computer B = 5 + 20 + 50 seconds = 75 seconds
Computer C = 10 + 20 + 15 seconds = 45 seconds
Thus computer C is faster. It is 75/45 = 5/3 = 1.67 times faster than computer B and 222/45 = 74/15 = 4.93 times faster than computer A.

6. Exercise 4.17

We know CPI is equal to (Cycles/second)/(Instructions/second).
P1 on M1 is (5 \times 10^9 \text{ instructions} / 2 \text{ seconds}) = 2.5 \times 10^9 \text{ instructions/second}
P1 on M2 is (6 \times 10^9 \text{ instructions} / 1.5 \text{ seconds}) = 4 \times 10^9 \text{ instructions/second}
So,
the CPI of P1 on M1 = (4 \times 10^9 \text{ cycles/second})/(2.5 \times 10^9 \text{ instructions/second}) = 1.6 CPI,
and the CPI of P1 on M2 is (6 \times 10^9 \text{ cycles/second})/(4 \times 10^9 \text{ instructions/second}) = 1.5 CPI.

7. Exercise 4.45

The average CPI is 0.15 \times 12 \text{ cycles/instruction} + 0.85 \times 4 \text{ cycles/instruction} = 5.2 \text{ cycles/instructions},
of which 0.15 \times 12 = 1.8 \text{ cycles/instructions} of that is due to multiplication instructions. This means that multiplications take up 1.8/5.2 = 34.6\% of the CPU time.