Question 2 (18 points): For a benchmark program executing in the Nindle e-reader 20% of the instructions are load/store, 50% of the instructions are ALU operations and 30% of the instructions are branches. On average load/store instructions take 10 cycles to execute, ALU instructions execute in 1 cycle and branch instructions take 3 cycles to execute. The clock frequency for this processor is 4 GHz (1 GHz = 10^9 Hz). This benchmark takes 20 seconds to execute.

a. (**4 points)** What is the average number of clocks per instruction (CPI) for this benchmark?

b. (**5 points)** How many instructions are executed by this benchmark?

c. (**6 points)** A revision of the architecture for the Nindle processor adds a new level to the memory hierarchy and thus reduces the average execution time of each load/store instruction to 5 cycles. Also an improvement to the compiler reduces the number of load/store instructions required to execute this benchmark by half. How much time does it take to execute the same benchmark in this revised Nindle processor?

d. (**3 points)** How much faster is this benchmark in the improved Nindle (with both the revised architecture and the improved compiler) in comparison with the original Nindle?