

**Question 1:** (15 points)

Apple has just hired you as a performance engineer to help them design their next-generation A series chip. On average, the current chip executes a program that includes a majority of memory-access and multiplication instructions in 100 milliseconds. The distribution of the instructions in such a program is 50% memory access instructions, 20% multiplication instructions, and 30% instructions for other tasks. Your team came up with three possible enhancements to the hardware to better suit Apple's needs. Offer your suggestion based solely on the speedup that the program will experience from these enhancements. Report the speedups for each of these cases as well.

- a. (5 points) make multiplication hardware four times faster than before
- b. (5 points) make memory-access instructions two times faster than before
- c. (5 points) include both of these enhancements