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HW-1
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Answer 1: 1)Better processes (faster devices) ~20%.
2)Better circuits/pipelines ~ 15%.
3) Better organization/architecture ~15%.

Answer 2: 1)The power wall is limited; as a result, the architectural innovations of processor has been moderate .
2) Voltage reductions became much harder; as a result, the frequency improvement has gone away. To sum up, first, developers are running out of ideas to improve single thread performance; second, power wall makes it harder to add complex features and to increase frequency.

Answer 3: 1)The speedup of system B over system A is **1.25** (the ratio) = perf B / perf A = exectime A / exectime B.
2) The performance improvement of B over A is 1.25 -1 = 0.25 = **25%** = (perf B – perf A) / perf A = speedup - 1

Answer 4: For smartphone A, it needs 10W * 10s = 100J energy to execute the app. For smartphone B, it needs 12W * 9s = 108J energy to execute the app.
As a result, the app is a bigger drain on the battery on **smartphone B** because 108 J is bigger than 100J.

Answer 5: Since Dynamic Power is proportional to frequency whereas leakage power is independent of frequency.
Therefore, new dynamic power = (3/2.5) * 60 = **72 W**.
and new leakage power = **15 W**.

Answer 6: I would pick **system A** if I cared about overall system throughput. The reason is that system A has two systems and they can both can execute at one time, so it only takes 10s to finish all. However, system B needs 6 + 6 = 12s to finish all which is slower than system A.

Answer 7: Execution time = clock cycle time * number of instrs * avg CPI
Since we have the clock frequency is 4.0 GHz, so we also know that the clock cycle time is 1/(4*10^9)s.

So the execution time = (1/(4*10^9)) s * 100*10^9 instructions * 1.1 = 27.5 s
The program takes **27.5 s** to execute.

The cycle time of this IBM processor is 1/clock frequency = 1/(4*10^9) hz = **2.5*10^(-10) s**

The speedup provided by the IBM processor, relative to the ARM processor is = 30s / 27.5s = **1.09**

Answer 8: To solve this problem, we need this equation:
Execution time = clock cycle time * number of instrs * avg CPI
Ben's processor has 1 GHz frequency, which equals 1 ns cycle time. Also, Ben's processor must have the same execution time with Elaine's new processor. So we only need to compare their instruction times.
For program A, we could get this equation:
1 ns * instructions of Ben's processor * 2 = 1.2 ns * instructions of Elaine's processor * 1.5
So instructions of Ben's processor/instructions of Elaine's processor = 0.9

For program B, we could get this equation:
1 ns * instructions of Ben's processor * 2 = 1.2 ns * instructions of Elaine's processor * 1.8
So instructions of Ben's processor/instructions of Elaine's processor = 1.08

Therefore, Elaine's new processor out-perform Ben's processor on program A, but does Not out-perform Ben's processor on program B.

Answer 9: First, in a server, the processor accounts for 50% of total server power, the memory system accounts for 30%, the disk accounts for 10%, and miscellaneous components account for the remaining 10%.

Also, with that budget, I can either purchase a new memory module that consumes 20% less power than my old memory module, or a new disk that consumes 40% less power than my old disk.

If we calculate the percentage of memory saving or disk saving we will have:
30% * 20% = 6%
10% * 40% = 4%
6% > 4%

As a result, I will purchase a new memory module.