

1. variables operations = 1.30, speedup = 1.2

$$\text{Speedup} = 1.2 (1 - 0.3) + (0.3)$$

$$= 1.2 (0.7 + 0.3^x)$$

$$= 0.84 + 0.36 = 1^x$$

$$= 0.36 = 0.16$$

$$= 0.36^x = 0.16^x$$

$$(x = 2.25) \checkmark$$

2. $(0.3) / 2.25$

$$= 0.13$$

New execution time is 1.13

3. Variables: % = 25, 1 cycle

load and store = 30, 10 cycles

Jump = 15, 4 cycles

Non pipelined Average CPI = $(0.25 \cdot 1 + 0.3 \cdot 10 + 0.15 \cdot 3 + 0.3 \cdot 15)$

Average CPI = 4.15 ✓

4. If pipeline never stalls

CPI = 1 ✓

5. Load Store = 30, 1.1 stalls

Alu = 0.2, Jump = 1

Actual CPI = $[1 + 0.33 + 1 + 0.1]$

Actual CPI = 2.43 ✓

6. A superscalar Processor is a microprocessor that uses instruction-level parallelism to execute more than one instruction per cycle. It can do many at once.

Some of the functions it employs are multiple ALUs and FPU's while using multiple execution pipelines. It also uses units to find instruction dependencies, decode them, send to proper needed unit.

Other hardware is used to run instruction-level parallelism to execute multiple instructions at once.

7. It is faster to run matrix calculations.

Because GPU is much faster at calculations and running parallel processing. Processing words would require one instruction at a time while calculations can be done simultaneously.

8. True It comes fully compatible with legacy code and it can work fine because of more complex processing hardware.

9. False The 8080 came a long time before RISC and uses an 8-bit architecture. It was introduced in 1974 while RISC was introduced in 1980 and uses mostly 32-bit architecture.

10. size of memory blocks = 128

$$\text{offset bits} = \log_2 128 \\ = 7 \text{ bits}$$

$$\text{Number of memory blocks} = 32 \Rightarrow \text{Index bits} = \log_2 32 \\ = 5 \text{ bits}$$

$$\text{Physical address} = 24$$

$$\text{Tag bits} = 24 - (7 + 5) \\ = 12 \text{ bits} \checkmark$$

11. 1. $0x454012$, Tag = $0x454$, Index = $0x0$, offset = $0x12$
 $0x323232$, Tag = $0x323$, Index = $0x4$, offset = $0x32$
 $0xffff12$, Tag = $0xfff$, Index = $0x2$, offset = $0x12$

12. Hit time = 1, miss time = 8, miss rate = 0.3%.

Average time is $= (1 + 8 \cdot 0.003)$

Average time = 1.024

Memory reference time Per instruction = 1.6

Average time in cycles $= (1.024 \cdot 1.6)$

Average time in cycles = (1.6384), ✓