Solutions

2.1

- $2^{20}/2^{10} = 2^{10} = 1024$ pages; VPN = 10 bits ✓.

2.2

- Offset $0x05$; physical $= 3 \times 256 + 5 = 0x305$ ✓.

2.3

- Invalid = the page was never mapped (error); a fault = mapped but not resident (fetch it) ✓.

3.1

- Pages: $2^{24}/2^{11} = 2^{13} = 8192$ ✓.
- Frames: $1\,\text{MiB}/2\,\text{KiB} = 512$ – frame bits 9; VPN bits $= 24 - 11 = 13$ ✓.
- Entries: one per page = 8192 ✓.
- Entry size $= 9 + 3 = 12$ bits; table $= 8192 \times 12 = 98\,304$ bits ✓.
- $0x123456$: offset $= 0x456$ (low 11 bits); VPN $= 0x123456 >> 11 = 0x246$ ✓.

3.2

- Walk time per miss: 20 ns; faults add $0.01 \times 4\,\text{ms} = 40\,\mu\text{s}$ per walk ✓.
- AMAT $= 0.98 \times 1 + 0.02 \times (20 + 40\,000) \approx 801$ ns ✓.
- At 0.1%: $0.02 \times (20 + 4000) \to$ AMAT $= 0.98 + 80.4 \approx 81.4$ ns ✓.
- The fault term dominates both answers; lesson: the hierarchy tolerates rarity, not frequency – locality is the budget ✓.

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