Finite-volume advection and diffusion — review sheet

Use this after attempting the worked examples and practice. Explain each claim in words before calculating.

Key ideas

- Store cell averages and update amounts through shared interface fluxes.
- Advection follows a prescribed velocity; diffusion follows a negative concentration gradient.
- Boundary flux determines the correct total-amount account.
- Conservation, positivity, direction and accuracy require separate checks.

Common errors and repairs

Treating all pulse smoothing as physical diffusion. Upwind discretization can smooth even with D=0; examine refinement.

Keeping the same time step after halving cell width. Recompute both the advective and diffusive restrictions.

Retrieve without your notes

- What survives when all cell balances are summed?
- Why can a stable conservative calculation still need refinement?

Readiness check

- Derive a cell balance with a single shared flux at each interface.
- Distinguish transport by bulk velocity from diffusion down a concentration gradient.
- Check a boundary budget, constant state and nonnegative solution separately.
- Implement a conservative update and predict the effects of changing velocity, diffusion or boundary conditions.