A mixed chamber: differential equations and numerical stability — review sheet

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

Key ideas

- Amount and rate have different units; change = rate × elapsed time.
- Equilibrium balances input and removal; r/k only applies when k>0.
- Explicit Euler uses the old state in the rate.
- Compare solutions at the same physical time.
- Conservation, positivity, stability and accuracy are different properties.

Common errors and repairs

Adding mg/min directly to mg. Multiply the entire net rate by a time interval.

Calling a conserved but negative amount acceptable. Check physical admissibility separately from bookkeeping.

Calling the circulation code explicit Euler. This chamber is an explicit teaching example; the source circulation solver is implicit with a valve-consistency loop.

Retrieve without your notes

- What does 1/k measure?
- Why might Euler fill too quickly from an empty chamber?
- What happens if k=0?

Readiness check

- Distinguish an amount from a rate and convert a rate into a change over a time interval.
- Build an explicit Euler update from a conservation statement.
- Predict equilibrium and compare a numerical trajectory with an exact reference.
- Recognize that conservation alone does not guarantee positivity or accuracy.