Development project: Ideal Gases

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Context

This simulation will provide first-year engineering undergraduates (henceforth: the ***users***) with hands-on experience of ideal gases. Users explore the behaviour of a closed ideal gas system by setting its thermodynamic state variables/constants (e.g., p, V, T, E_I, S), applying work and/or heat to the system, and observing the consequences of these manipulations.

Requirements

- Users can supply or remove energy to/from the system in the form of heat or work.
- Users can change the mass and the type of gas in the system.
- The simulation displays values (in SI units; pressure also in [bar]) of all thermodynamic variables, including entropy, for the start- and end-points of system changes.
- The simulation initialises the ideal gas system with values that are reasonable, given the geometric dimensions of its graphical representation.
- To provide meaningful learning support for users, all values that result from the simulation must match exactly those that result from the calculation equations for changes of state of the ideal gas.
- The simulation displays all changes (e.g., reduction in volume) in a qualitatively correct graphical representation, for example based on a piston-cylinder system.
- The following link illustrates the desired simulation software, but does not allow users to supply work to the ideal gas system and is too rich in functionality for our purposes: https://phet.colorado.edu/sims/html/gas-properties/latest/gas-properties_de.html .
- The simulation is coded in compact, modular, pedagogically simple julia, using *only* the Anatta toolset.

Use-cases

- The user specifies that the temperature of the gas should remain constant, and then changes the volume in stages. With each change, she can read the resulting changes in pressure and how much heat and/or work has been added or removed. The user runs the virtual experiment several times, changing the mass of gas before each run.
- The user specifies that the gas volume remains constant and supplies a certain quantity of heat to the system, and the simulation displays how other quantities change.
- The user sets the pressure to remain constant and adds or removes a specific amount of heat to/from the system. The simulation displays how other quantities change, for example displaying graphically the correct resulting volume change.
- The user sets the pressure to remain constant and adds or removes a specific amount of work to/from the system. The simulation displays the associated change in volume and all other accompanying changes in thermodynamic quantities.
- The user runs several such use-cases consecutively without being required to reset the system to an initial state between individual runs.