Thermodynamics

1   Simple systems

- at rest
- homogeneous and isotropic
- no chemistry
- pressure only

2   Properties

- *extensive* properties are proportional to the amount of fluid: mass, volume, mole number, ...
- *Intensive* properties are independent of the amount of fluid: pressure, temperature, density, specific volume, ...

We will be concentrating on intensive properties.

3   Parameters

To fix the state of a simple system, you need to know *any two* of $p, \rho, T, s, e, ...$

4   Entropy

For reversible processes,

$$\mathrm{d}S = \frac{\mathrm{d}Q}{T}$$

5   Second law

Two forms of the second law (combined with the first):

$$\boxed{T\,\mathrm{d}s = \mathrm{d}e + p\,\mathrm{d}\mathrm{v} \qquad T\,\mathrm{d}s = \mathrm{d}h - \mathrm{v}\,\mathrm{d}p}$$

Enthalpy:

$$\boxed{h = e + p\mathrm{v}}$$

Canonical equations of state:

$$\boxed{\left(\frac{\partial e}{\partial s}\right)_{\mathrm{v}} = T \qquad \left(\frac{\partial e}{\partial \mathrm{v}}\right)_{s} = -p}$$

Exercise:

Give the canonical equations for h instead of e.

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6   Ideal gas

$$\boxed{\frac{p}{\rho} = RT \qquad R = \frac{R_0}{M}}$$

where R is the gas constant and R_0 the universal gas constant.

$$\boxed{e, h, c_p, c_v = e, h, c_p, c_v(T) \qquad c_p - c_v = R \qquad \gamma \equiv \frac{c_p}{c_v}}$$