Thermodynamics

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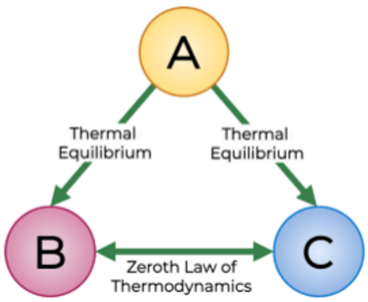
Indice

1 Week1

Z: Number of protons (protons and neutrons have roughly the same mass)
A: Atomic mass
Temperature: Measures how hot / cold a sistem is, it's a state variable, it's relative and absolute temperature scales.
Relative T scales:
Celsius:
· 0 → freezing point of water
· 100 → boiling point of water
Farhenneit:
· 0 → freezing point of brine
· 32 → freezing point of water
· 98 → Human body T
Conversion Celsius Farhenneit: celsius $\cdot \frac{9}{5} + 32 =$ Farhenneit Absolute T scales:
Kelvin:
· $0K$ is the lowest the T goes (always positive) $= 273.15C$
· Absolute zero: extrpolation of T of an ideal fas for zero volume
Therma equilibrium (TE):
Put two objects with different T in thermal contact → they will reach the same T said to be in thermal equilibrium.
· 0th law of TD:
if two systems are in TE with a third system, then they are in TE with each other.



(a) 0th law of TD

1.1 Thermal Expansions

Linear expansion:

$$\Delta l = \alpha l_0 \Delta T$$

where $\alpha\ \left[\frac{1}{K}\right]$ is the linear thermal expansion coefficient dependent on the material.
Volume expansion:

$$\Delta V = \beta V_0 \Delta T$$

where $\beta\ \left[\frac{1}{K}\right]$ is the volume thermal expansion coefficient dependent on the material.
For small ΔT we can use the following formula:

$$V(t) = l(t)^3 = (l_o + l(t))^3 = (l_0 + \alpha l_0 \Delta T)^3 = l_0^3(1 + \alpha \Delta T)^3$$

This formula is only usable for small ΔT

$$\begin{aligned} V(t) &= l_0^3\left(1 + 3\alpha\Delta T + 3\alpha^2\Delta T^2 + \alpha^3\Delta T^3\right), \left(3\alpha^2\Delta T^2 + \alpha^3\Delta T^3 \text{ are very small}\right) \\ &\approx l_0^3(1 + 3\alpha\Delta T) \\ &= V_0 + 3\alpha\Delta T V_0 \end{aligned} \tag{1}$$

$$\Delta V = 3\alpha\Delta T V_0 = \beta \Delta T V_0$$
$$3\alpha \approx \beta$$

Precise formula for lenght expansion: For an infinitesimaly small extension dl:

$$\begin{aligned} dl &= \alpha l dT \\ \int \frac{dl}{l} &= \int \alpha dT \\ \log(l) &= \alpha T + C \\ l &= \exp(\alpha T) \cdot C \end{aligned} \tag{2}$$

with initial conditions:

$$l = e^{\alpha \Delta T} \cdot l_0$$

1.2 Thermal stress

Expansion of bodies: push on each other. How much is a "pushed - on " object compressed? Juong's modulus E:

$$\Delta l = \frac{1}{E} P l_o$$

Example:

2 Allegati

2.1 Dimostrazione 1