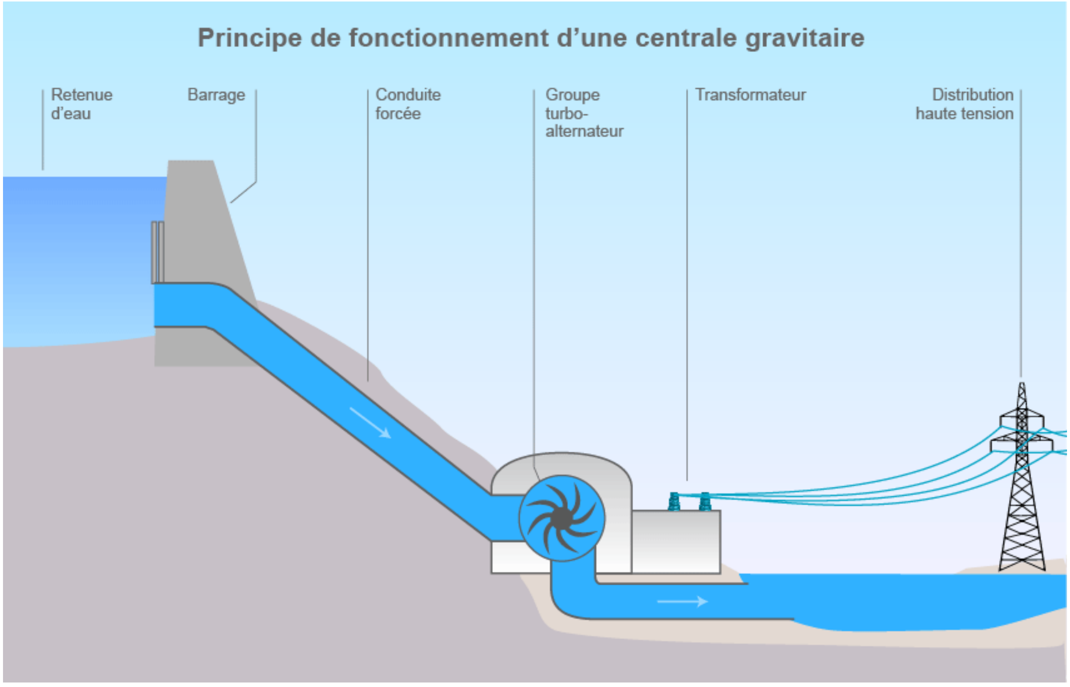
Thermodynamics tutorial 1

First principle of thermodynamics applied to hydroelectric plant



1. Define boundary of thermodynamic system *(Hint: make sure you will not have to cope with variations of kinetic energy).*
2. Write energy conservation of the fluid (water) traversing the system *(Hint: water is assumed non-compressible)*
3. Doesn't this suggest to introduce a new definition of enthalpy, called *I*, suited to gravity flow? Rewrite energy conservation using *I*

Thermodynamics tutorial 2

Specific heat of solids

1. Why are C_P and C_V not differentiated for solids?
2. Estimate numerically their difference for a metal, e.g. aluminium

Thermodynamics tutorial 3

Helium dewar boiloff and pressurization

1. Consider a 100-liter He dewar vessel initially filled at 90% with a 1 W heat inleak, vented to atmosphere. How long will it take for the liquid level to reach 80%?
2. At 80% level, the vessel is sealed: what happens? Which function of state is to be used to describe the evolution of the system?
3. Assuming equilibrium conditions, calculate the evolution of pressure and temperature in the vessel with time

Thermodynamics tutorial 4

Helium refrigeration and liquefaction work

1. Calculate the minimum work to produce 1 W isothermal refrigeration at liquid helium temperature (4.2 K), assuming a room temperature of 290 K
2. The most efficient helium refrigerators have a COP of 220 W/W: what is their efficiency relative to the Carnot cycle?
3. A liquefier is a non-isothermal refrigerator to which the vaporized helium is returned at room temperature (290 K, 1 bar) instead of cold (4.2 K, 1 bar). Calculate the minimum liquefaction work for 1 g/s liquefaction. How much isothermal refrigeration at 4.2 K can that work produce?

(Hint 1: Latent heat of vaporization of helium at 4.2 K = 20.8 J/g)

(Hint 2: Assume specific heat of helium at 1 bar is constant = 5.2 J/g.K)