INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES LYON FIMI 1rst year 2019 March 22nd

SCAN

THERMODYNAMICS – Exam n°1 - Duration : 1 hour

No document authorized. All (non-connected) calculators authorized.
Do not spend more than 30 minutes on exercises I and II

Data for all 3 exercises:

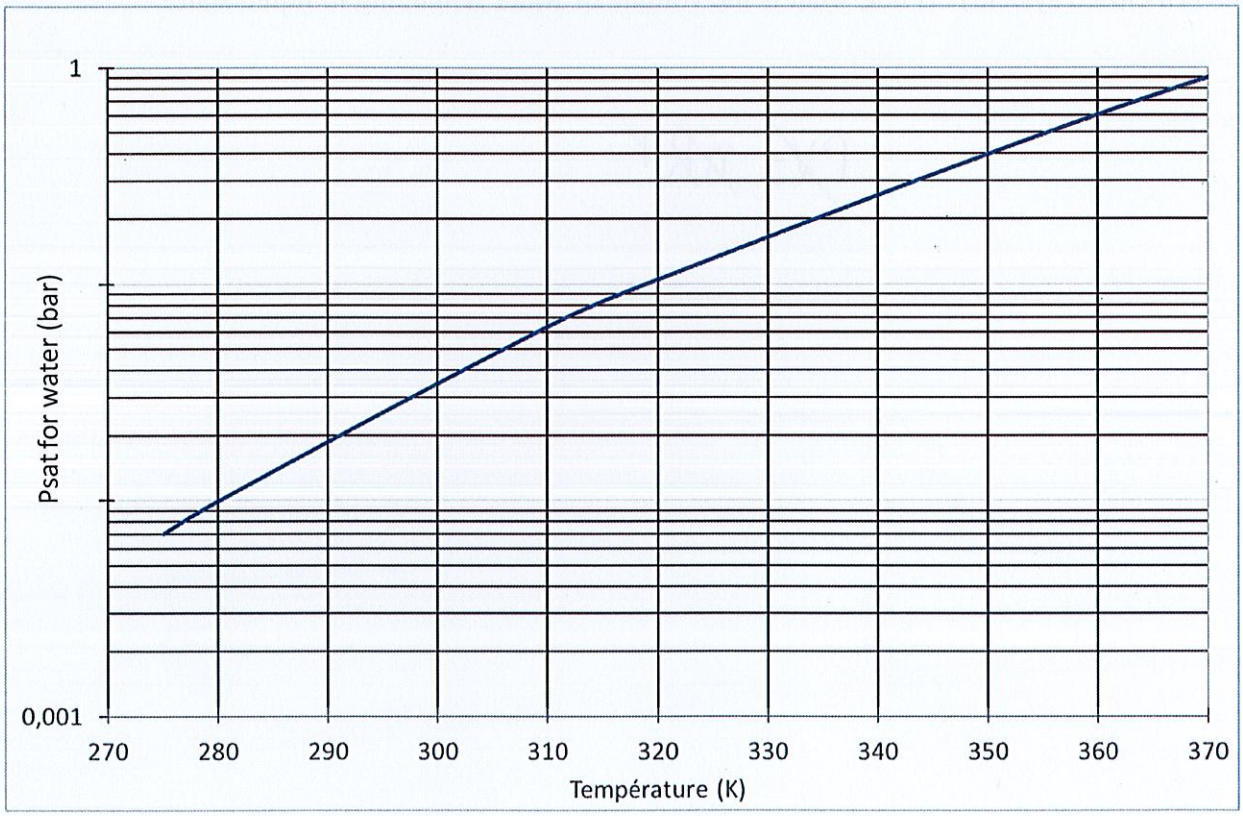
Air is made of 80% (in moles) of N_2 and 20% of O_2 and is assumed an ideal gas ($R = 8.31$ J·K^{-1}·mol^{-1})

M(H) = 1 g.mol^{-1} *M(C) = 12* g.mol^{-1} *M(N) = 14* g.mol^{-1} *M(O) = 16* g.mol^{-1}

Heat capacity of liquid water : $C_{water} = 4180\ J.K^{-1}.kg^{-1}$

Relative humidity $HR = \frac{P_{H_2O}}{P_{vs,H_2O}} \times 100$ *at a given temperature*

Saturating vapor pressure of water as a function of temperature :



Exercice I : *(8 points – wrong answers are counted negatively) :* See paper attached. Fill the answer form.

Exercice II : Energetic chain *(3 points)*

Schematize the energy chain associated with the operation of a LED (Light Emitting Diode) from fossil energy.

Exercise III: A coffee in a plane *(9 points)*

1. Plot the shape of pure water state diagram in coordinates (P, T) by specifying the names of the particular points and curves and the physical states (=phases) of water in the different domains.
2. The relative density (to the air) of water vapor ($H_2O_{(g)}$) is equal to 0.62. Find this result by specifying the assumptions made in your calculation.
3. Knowing that the interior volume of an airliner is $V = 260\ m^3$, that the air temperature is on average 20°C and that the relative humidity is HR = 10%, calculate the partial pressure of water vapor in the atmosphere of the aircraft.
4. Calculate the number of moles of water contained in the airplane's atmosphere.
5. A student travels aboard an airliner and is served a hot drink (assumed as being water); the drink is boiling and the measured temperature of the drink is 88 °C. What is the total pressure in the plane (justify the answer)?
6. The student falls asleep before finishing the hot drink. 10 cL remain in the cup and cool down to room temperature of 20 °C. Calculate the energy exchanged by the system {10 cL hot drink} with the surroundings. Comment on the sign of this energy.
7. When waking up, the student spills the cup on the floor. Does all the drink evaporate (considering that the plane is a closed system)? If not, what is the volume of water remaining in liquid state?

$PV = nRT$