Exercise Series 1

1. Specific heat and entropy

The specific heat of solid copper above 300 K is given by $C_p = 22.64 + 6.28.10^{-3}\ T$ in J mol^{-1} K^{-1}

a) By how much does the entropy of copper increase on heating from 300 to 1358 K?
b) What would have been the result by assuming that C_p keeps its value at 300 K ?

2. Salt on the road

In winters (some time ago), the temperature used to be -10°C. Look at Fig,1 below.

a) How much salt is needed to melt the ice?
b) What happens if more salt is used?
c) What happens if salt is used when the temperature is -25°C?

3. Ice-Salt mixtures

We place ice cubes (glace in French) of initial mass m_g at a temperature of 0ºC inside an adiabatic container. Then, we add a mass m_s of salt, also at the initial temperature of 0°C. We wait for a long time until the final equilibrium state is reached. With the numerical values below, what will happen and what will be the final state? What is the mass of salt water (brine) that has been formed and what is the final temperature?
To solve this problem, make the enthalpy balance by considering only the initial state and the final state (without considering the intermediate states) and assume that

- the formation of the salt-water mixture does neither generate nor consume any heat,
- the specific heat capacity c_p^l of the brine is the same as that of pure water,
- the slope of the liquidus line is $m \approx$ -90°C,
- all the salt you put will be dissolved into the water formed by the melting ice (check at the end of the calculations that this hypothesis is indeed correct).
- solve the quadratic equation you found with your favorite program (Mathematica, MatLab, Python…).

m_g = 970 g
m_s = 30 g
c_p^g = 2 kJ kg^{-1} K^{-1}
$c_p^l = c_p^{water}$ = 4.18 kJ kg^{-1} K^{-1}
L = 334 kJ kg^{-1} (latent heat of ice melting)

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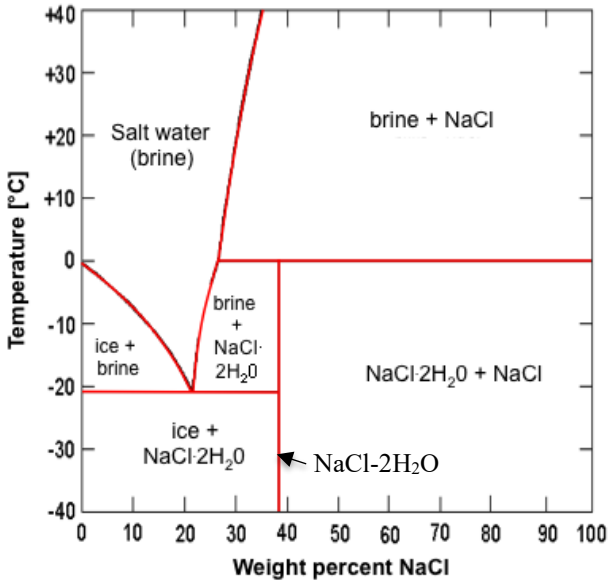

Fig. 1: *Phase diagram of NaCl-water*