Thermodynamic potential functions

P27. Is the rusting of iron a spontaneous process at room temperature? The process is accompanied by –824.2 kJ mol^{-1} change in enthalpy and –272 J K^{-1} mol^{-1} change in entropy. *[ΔG = –743.1 kJ/mol. Since this value is negative, the process is a spontaneous one (although the entropy of the system decreases!)]*

P28. Calculate how the Helmholtz free energy and the Gibbs free energy change for 1.00 mol water when it evaporates at 15 kPa. The boiling point of water at this pressure is 53.6 ºC, the specific volume of the water vapour is 10.21 m^3 kg^{-1}, the specific volume of the liquid is 1.01×10^{-3} m^3 kg^{-1}. *[$\Delta_{vap}G$ = 0 J, $\Delta_{vap}A$ = –2745 J]*

P29. Calculate the change in the chemical potential of the perfect gas when its pressure is increased from 1.00×10^5 Pa to 1.00 MPa at 25.0 ºC in an isothermal reversible process. *[Δμ = 5707.7 J/mol]*

P30. The fugacity coefficient of a certain gas at 200 K and 50 bar is γ = 0.72. Calculate the chemical potential difference between this real gas and the perfect gas in the same state. *[$\mu_{real} - \mu_{perfect}$ = –546 J/mol]*

One-component systems

P31. A 75 kg man is skating on a pair of skates whose length is 30 cm and width is 0.10 mm; the external temperature is –3 °C. Does the ice melt under his skate? The density of water is 1.00 g cm^{-3} and the density of ice is 0.90 g cm^{-3}. The entropy of melting for H_2O is $\Delta_{fus}H$ = 6.00 kJ mol^{-1}. *[It does not melt, the melting temperature for ice is under these conditions is –1.11 ºC.]*

P32. How much is the boiling point of water at the top of a mountain where the air pressure is 0.879 bar? The average heat of evaporation for water is 40.64 kJ mol^{-1}. *[96 ºC]*

P33. The temperature dependence of the equilibrium vapour pressure of chloroform is given in the following table:

T /K	272	293	298,8	322,3	327	335
p /(10^3 Pa)	6.7	20.0	26.7	66.7	80.0	106.7

Determine the vapour pressure of chloroform at 300 K and calculate its heat of evaporation. *[p = 27 kPa, $\Delta_{vap}H$ = 33.05 kJ/mol]*