

Physics 3410 Homework #1

4 problems

Due by January 25

▷ 1.

An ideal gas with 10^{23} molecules is at temperature $T = 300$ K. What is its total thermal energy U if the gas is

(a) neon (Ne)?

(b) hydrogen (H_2)?

(c) water (H_2O)?

Assume that vibrational degrees of freedom are frozen out.

▷ 2.

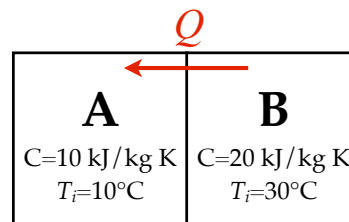
When 300 J of heat are added to a certain block of metal, its temperature increases by 10°C .

(a) What is the metal's heat capacity?

(b) How many metal atoms are in this block? (Hint: what is f for a solid? Assume that no modes are “frozen out”.)

▷ 3.

Block A, with heat capacity $C_A = 10$ kJ/kg/K and initial temperature $T = 10^\circ\text{C}$ is placed next to Block B, which has heat capacity $C_B = 20$ kJ/kg/K and initial temperature $T = 30^\circ\text{C}$. What is the final temperature T_f of both blocks, when they reach equilibrium, assuming that no heat is exchanged with the environment? Hint: start by calculating the total heat $-Q$ that flows out of B as a function of T_f , and then the heat Q that flows into A. That gives us two functions in two variables, Q and T_f .



▷ 4.

If I don't discuss latent heat by the end of Friday's class, this problem will be postponed to next week.

Suppose I have 1 kg of liquid water at 370 K (just below the boiling point). How much water ice (in kilograms) at 273 K do I have to add to bring the temperature down to 300 K? (Remember that you have to melt the ice and warm it up to 300 K.) The specific heat of liquid water is $c = 4.2$ kJ/kg/K and the latent heat of melting is $L = 333$ kJ/kg.