Foundations of Physics 2B/3C 2019-2020

Thermodynamics – Weekly Problem, Th. 4

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a) Two blocks of Nickel, each having mass $15.0\ \mathrm{kg}$ and heat capacity $C_p = 6{,}600\ \mathrm{J\ K^{-1}}$, are brought into thermal contact and allowed to come to thermal equilibrium, with no heat energy being lost to the environment. If one block is initially at a temperature of $527\ ^\circ\mathrm{C}$ and the other is at the temperature of the environment, taken to be room temperature at $300\ \mathrm{K}$, determine the following:

i) The blocks' common final temperature;

ii) The entropy change of each block and the entropy change of the Universe overall, commenting on the significance of each of your results;

iii) The irreversibility of the above process, defined by $I = T_0 \Delta S_U$.

[4 *marks*]

b) If instead, the two blocks are connected via a reversible heat engine, state the entropy change of the system. Then calculate the new equilibrium temperature attained.

[*3 marks*]

c) The combined block at the equilibrium temperature determined from part (b), is dropped into the River Wear, which has an autumnal temperature of $7\ ^\circ\mathrm{C}$. Determine any additional entropy change of the Universe during this process.

[3 *marks*]