

CHEM 401--Physical Chemistry
Exam #2
11 November 1998

Name _____

Glossary

$$\frac{\overline{C}_V}{R} = \frac{T}{\Theta_{el}} + \frac{12\pi^4}{5} \left(\frac{T}{\Theta_D} \right)^3 \quad \text{Debye equation for } C_V$$

$$MW(\text{Cu}) = 63.546 \text{ g mol}^{-1}$$

$$C_{p,298}(\text{Cu}) = 24.442 \text{ J mol}^{-1} \text{ K}^{-1}$$

$$\Theta_D(\text{Cu}) = 343 \text{ K}$$

$$\Theta_{el}(\text{Cu}) = 12\,000 \text{ K}$$

$$MW(\text{Fe}) = 55.847 \text{ g mol}^{-1}$$

$$C_{p,298}(\text{Fe}) = 25.094 \text{ J mol}^{-1} \text{ K}^{-1}$$

1. (40 points) A 100. g block of iron at $T = 250 \text{ K}$ is placed in thermal contact with a 250. g block of copper at $T = 350 \text{ K}$. What is the final temperature of the system (assume heat capacities are constant over this temperature range)? What principle dictates that the final temperature will be intermediate to the two initial temperatures?

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2. (40 points) For the Carnot cycle assuming an ideal gas and reversible processes, determine the change in entropy, dS_{sys} , of the system (not the surroundings) for each of the four steps.

3. (40 points) Consider gas phase acetylene, $\text{H-C}\equiv\text{C-H}$. The room temperature heat capacity is $\overline{C}_V = 4.30 R$. Determine \overline{C}_V in the limiting cases of low temperature and high temperature. What conclusions may be drawn from the value of the room temperature \overline{C}_V ?

4. (40 points) Determine the absolute entropy of 50.0 g of copper at 77.0 K. (Assume copper exists only in one phase over this temperature range, and $C_p = C_v$ for a solid.)

5. (40 points) The master equation for enthalpy is $dH = TdS + VdP$. From the master equation and the total differential of dH , derive the Maxwell relation resulting from these expressions for enthalpy.