1. Consider placing a 10kg block of copper at 100°C into 100kg of water at 10°C. Please calculate the final temperature and the change of entropy of the system? The specific heats of copper and water are 387 and 4186 J/kg. (15%)

2. There are four state variables for an arbitrary pure gas: total moles of gas molecules, pressure, volume, and temperature.

How many independent state variables exist for a mole of an ideal gas? (5%)

Using different combinations of independent variables, write as many unique (but numerically equivalent) expressions for the molar internal energy of an ideal gas as possible. (10%)

3. If there is a Hell. is Hell exothermic (gives off heat) or endothermic (absorbs heat)? Support your answer with a proof. (20 %)

4. The original in vivo evidence for the thermodynamic model of cell adhesion came from studies of limb regeneration. The spreading of one tissue over another is a relatively common phenomenon in morphogenesis. Moreover, when different embryonic tissues come into contact, their movements are spontaneously initiated. Steinberg (1962) observed that all these tissue arrangements resembled those expected of immiscible liquids. These are known to spread over the surface of one another and to arrive at a particular equilibrium configuration. The spheroidal shape of embryonic tissue aggregates is another example of the tissue acting like a fluid. The determinants of fluid miscibility are their surface and interfacial tensions. Please write down the equation for the surface tension of a liquid droplet between parallel plates, assuming that it does not adhere to the plates. (10%) If two liquids are immiscible, what is the tension at their common surface? (5%) If the surface tension of limb bud and pigment epithelium is 20.1 dynes/cm and 12.6 dynes/cm respectively, what is the result when these two tissue come in contact? (5%) Why? (5%)

5. At 55 °C the azeotrope of ethanol (1) and tolune (2) contains 74.90% mole ethanol and exerts a vapor pressure of 308.2 mmHg. The vapor pressure of the pure components are $P_1^0 = 279.6\,\text{mmHg}$ and $P_2^0 = 114.7\,\text{mmHg}$. Calculate Margules' constant. (25%)

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