South Dakota School of Mines and Technology
Department of Materials and Metallurgical Engineering

MET 320 **Final Exam** Dec.18, 2003
Closed book - No Calculators – No Notes 10:00 – 12:00

Data on 1) last sheet of exam and 2) unattached data sheets

1. Two moles of an ideal gas at 2 atm and 300 K are adiabatically compressed to 8 atm.
   a) What is the final temperature?

   b) How much heat was required?

   c) How much work was required?

2. How much work would be required to pump 1000 J of heat from a lake at 7 °C to a home at 27 °C?

3. Write the Fundamental Equations.
   $dU = TdS - PdV$

   $dH =$

   $dA =$

   $dG =$

4. Water for your mountain climbing party's tea boils at 90 °C. What is the atmospheric pressure at your location?

5. Find the adiabatic flame temperature for the combustion of C_2H_2 with pure O_2. The O_2 and the C_2H_2 start at 800 K. Use the data provided below only.

$$C_2H_2\,(g) + 2.5O_2(g) = 2CO_2\,(g) + H_2O(g)$$

Species	Heats of Formation (calories/g mole at 298°K)	C_p (cal/ gmole °K)
$C_2H_2(g)$	54,190	19.0
$H_2O(g)$	-57,800	10.5
$CO_2(g)$	-94,000	13.6
$O_2(g)$		8.6
$N_2(g)$		7.0

6. What pressure of O_2 would be required to oxidize pure, solid Ag to pure, solid Ag_2O at 400 K?

7. Pure, liquid PbO at 1200 K is to undergo electrolysis to form O_2 gas at a pressure of 0.003 atm and pure, liquid Pb. What cell potential is needed?

8. Use the data given below for the liquid Cu-Sn system at 1400 K to determine the enthalpy change when (assume all components start in the liquid state at 1400 K)

   a) 60 moles of Sn and 40 moles of Cu are mixed at 1400 K

   b) 2 moles of Sn are dissolved in a large quantity of Cu-Sn alloy having a mole fraction of Cu of 0.9.

Heats of Mixing for Liquid Cu-Sn Alloys at 1400 K

X_{Sn}	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
H^M (cal/mole)	-666	-979	-934	-715	-475	-264	-97	13	52
H_{Sn}^M (cal/mole)	-5233	-1901	252	706	681	506	311	176	49

9. Can one set both the temperature and the pressure in a system composed of $CaO_{(s)}$, $CaCO_{3(s)}$, $CO_{2(g)}$, and $N_{2\,(g)}$? Show work.

10. Short answer:

a) What condition must exist if one is to compute activities from the phase diagram using the formula?

$$\ln a_i = \frac{\Delta H^o_{fusion,T_f}}{R}\left[\frac{1}{T_f} - \frac{1}{T_l}\right] + \frac{A - C - BT_l}{R}\left[1 - \frac{T_f}{T_l}\right] + \frac{A - C}{R}\ln\left[\frac{T_f}{T_l}\right] + \frac{B}{2RT_l}\left[T_l^2 - T_f^2\right] ?$$

b) What is the difference between ΔG and ΔG^o?

c) How does one get one partial molar quantity from another?

d) What is the Relative partial molar heat of mixing for an Ideal solution?

DATA:

$H_2O_{(s)} = H_2O_{(l)}$	$\Delta H^\circ =$ 6,028 J/gmole
$H_2O_{(l)} = H_2O_{(g)}$	$\Delta H^\circ =$ 43,267 J/gmole

Constants:

R = 1.987 cal/K•gmole = 8.31 J/K•gmole

F = 23,059 cal/volt•gram equivalent = 96,487 Joule/volt•gram_equivalent

Scratch Paper: