CHEM 331
Physical Chemistry
Fall 2009 Name: ____________________

Practice Midterm 2

1. A resistor is immersed in a bath of crushed Ice in a Dewar flask. A current of 2 Amperes for 250 sec results in the melting of 56 g of Ice. The resistance is 18 Ω. Find Q, W and ΔU for the System. Take the System to be the Ice-Water.

2. What is ΔU for an isothermal compression of a block of Aluminum metal that results in a volume change of 0.01 cm^3? Experimentally it is estimated:

$$\left(\frac{\partial U}{\partial V}\right)_T = 10^5 \text{ atm}$$

for Aluminum.

3. The heat capacity of CuS is given by:

$$C_p = 44.35 + 0.01111T$$

What is ΔH for heating 1 mole of CuS from 300 K to 1000 K isobaricly?

4. A cartridge containing CO_2 at 7 MPa at 30°C is opened and the CO_2 expands adiabatically against a constant pressure of 0.1 MPa. What is the gas's final temperature? The Joule-Thomson Coefficient for CO_2 at 30°C is:

$$\mu = \left(\frac{\partial T}{\partial P}\right)_H = 2.62 \text{ K/MPa}$$

5. Bomb Calorimetric for the combustion of Tungsten Carbide (WC), Tungsten (W) and Graphite (C) gives the following thermochemical data:

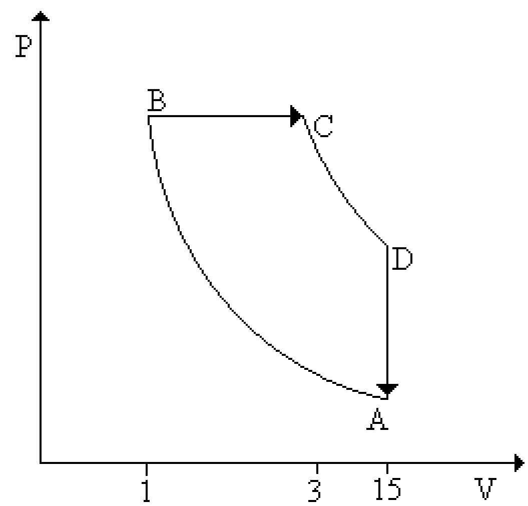
Reaction			$\Delta H^o(300)$ kJ/mol
$WC(s) + 5/2\ O_2(g)$	$\longrightarrow$	$WO_3(s) + CO_2(g)$	-1196
$W(s) + 3/2\ O_2(g)$	$\longrightarrow$	$WO_3(g)$	-837.5
$C(gr) + O_2(g)$	$\longrightarrow$	$CO_2(g)$	-393.5

What is $\Delta H_f^o(300K)$ for $WC(s)$?

6. At 4.073K the heat capacity for solid Cu is $C_v = 0.004366$ J/K mol. Use the Law of Debye to predict the heat capacity of Cu at 15.121K. What is the percentage error in this prediction given the experimental value is 0.1966 J/K mol?

For the following two questions, consider the Air-Standard Diesel Cycle, which approximately represents the operation of a diesel engine. A diesel engine operates similarly to a gasoline engine except the compression ratio for the adiabatic compression is high enough to heat the gas to its ignition temperature.

Step	Process	Notes
A – B	Adiabatic Compression	
B – C	Isobaric Heating	Fuel Injection & Ignition
C – D	Adiabatic Expansion	Power Stroke
D – A	Isochoric Cooling	Cylinder Exhausted & Recharged



Consider an engine with a Compression Ratio of (15/1) and an Expansion Ratio of (5/1), giving the relative volumes indicated in the diagram. Take the gas in the cylinder to be Ideal with a heat capacity of C_v ~ 21 Joule/K mole and the Engine to be operating Reversibly.

7. Assuming an operating temperature of 350K at *A*, what is the temperature of the gas at points *B*, *C* and *D*?

8. Calculate Q_h and Q_c for the engine. Determine the Work output of the engine.

9. What is the efficiency of this engine?

******* Have not covered this material yet. *******

10. Calculate ΔS for steps B-to-C and D-to-A. Recall,

$$dS = \frac{\delta Q_{rev}}{T}$$

******* Have not covered this material yet. *******

Useful Relations

Some Work Terms

$\delta W = - P_{op} dV$
$\delta W = f\, dL$
$W = I^2 R t$

Adiabats of an Ideal Gas

$T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$
$T_1^{\gamma} P_1^{1-\gamma} = T_2 P_2^{1-\gamma}$
$P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$

Some State Functions

$dU = C_v\, dT + \Pi_T\, dV$

$dH = C_p\, dT - C_p \mu\, dP$

$dS = \frac{C_v}{T} dT + \frac{\alpha}{\kappa} dV$

$dS = \frac{C_p}{T} dT - V\alpha\, dP$

Some Numeric Data

R = 8.314 J/K mol
= 0.08206 L atm/K mol

1 atm = 101325 Pa