First Examination
February 4, 2009

First Page: Useful information and equations:

Law IA: $\Delta U = q + w$

$U = U(T,V)$

Law IB: $dU = \left(\frac{\partial U}{\partial T}\right)_V dT + \left(\frac{\partial U}{\partial V}\right)_T dV$

$H = U + PV$

Heat Capacity

$C_V = \left(\frac{\partial U}{\partial T}\right)_V$ *and* $C_P = \left(\frac{\partial H}{\partial T}\right)_P$

Work:

$w = -P_{ext}\Delta V$ *or* $w = -P_{ext}dV$

$w = mgh$ *and* $w = IQt$

Kinetic Energy: $\varepsilon = \frac{mv^2}{2}$

Isothermal Reversible work:

$w = -nRT\ln\left(\frac{V_f}{V_i}\right)$

$PV = Const$

Adiabatic Reversible work: $w = -PdV$

$P\left(V^{\gamma}\right) = Const$; where $\gamma = \frac{C_{P,m}}{C_{V,m}}$

Integral Identity:

$\Delta Z = \int_{x_i}^{x_f}\left(\frac{\partial Z}{\partial x}\right)_y dx$

$\frac{d(yz)}{dx} = z\frac{d(y)}{dx} + y\frac{d(z)}{dx}$

$\frac{dx}{dz} = \frac{dy}{dz}\frac{dx}{dy}$

Equations of State (EoS)

I.G.: $PV_m = RT$

$C_{P,m} = C_{V,m} + R$

$\Delta U = C_V\Delta T$ *and* $\Delta H = C_P\Delta T$

VdW EoS: $P = \frac{RT}{V_m - b} - \frac{a}{V_m^{\,2}}$

Thermodyanamic EoS

$\left(\frac{\partial U}{\partial V}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_V - P$

Cyclic rule:

$\left(\frac{dx}{dy}\right)_z\left(\frac{dz}{dx}\right)_y\left(\frac{dy}{dz}\right)_x = -1$

Reaction Enthalpies

$\Delta H^o_{rxn} = \sum_i \nu_i \Delta H^o_{f,i}$

$dn_i = n_i - n_i^o = \nu_i dx$

$\Delta C_{P,rxn} = \sum_i \nu_i C_{P,i}$

$\Delta H^o = \Delta H^o_{rxn} dx$

Constants:

$R = 8.314 J / mol - K$

$R = 0.082 L - atm / mol - K$

$R \cdot 298.13 = 2.48 kJ / mol$

$1 Cal = 4.18 kJ$

$1 cal = 4.18 J$

$1 bar = 10^5 Pa$

$T(K) = T(C) + 273.15$

$g = 9.8\ m/\sec^2$

Name _____

ID_____

Show your work throughout, and always show units for computed quantities. There will be no credit if there is no work to show how the answer is obtained. You may use your calculators but you must show what integrals you are doing, and the analytic form of the integral result.

There are 4 problems.
1) Heats of reactions.
2) Consequences and practical applications of energy.
3) Ideal Gas changes, computing q,w,DU and DH.
4) A derivation of a needed energy quantity; and an application of that derivation to compute energy changes.