Name: _____ Test 2

110 points Chemistry 361

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$\kappa_T = (\partial V/\partial p)_T / V$ $\alpha = (\partial V/\partial T)_p / V$ $C_{V,m} = 3\ R / 2$ (monatomic perfect gas)

$R = 8.31451\ J\ mol^{-1}\ K^{-1} = 0.0820578\ L\ atm\ mol^{-1}\ K^{-1} = 82.0578\ cm^3\ atm\ mol^{-1}\ K^{-1}$

Answer three of the following four multiple choice questions for 10 points each.

Must show complete work for full credit to be given:

1. Under what conditions is Gibb's free energy a valid measure of process spontaneity?

A) Never **B)** Constant pressure and volume

C) Constant temperature and volume **D)** Constant pressure and temperature

E) Constant pressure and entropy

2. $\Delta S = -20.066\ J\ mol^{-1}\ K^{-1}$ for the gas phase reaction of $H_2 + Cl_2 \longrightarrow 2\ HCl$ at 300K. At what temperature is $\Delta S = -18.00\ J\ mol^{-1}\ K^{-1}$ assuming $\Delta C_P = -4.491\ J\ mol^{-1}\ K^{-1}$ is constant from 100 to 700K.

A) 138 K **B)** 189 K **C)** 334 K **D)** 475 K **E)** 652 K

3. An ideal gas is compressed isothermally and reversibly from 15.0 L, 250.0 K and 1.00 atm. What final volume gives a net $\Delta S_{sys} = -5.00$ J/K

A) 6.59 L **B)** 34.1 L **C)** 8.22 L **D)** 27.3 L **E)** none of these

4. Calculate temperature of a cold bath used when a Carnot engine does 100 J of work from 400 J of input heat at 400 K.

A) 400 K **B)** 350 K **C)** 300 K **D)** 250 K **E)** none of these

Choose two of the following three exercises for 20 points each:

5. Calculate the change in the Gibbs energy of 1.00 mol of water (ρ = 1.0 g / cm^3) if the pressure is increased from 100 kPa to 900 kPa.

6. Calculate the change in entropy if 50.0 g of ethanol (C_2H_5OH) at 300 K is poured into 70.0 g of ethanol at 350 K in an insulated cup. For ethanol, $C_{p,m} = 111.5$ J / mol K.

7. A gas obeying p (Vm – b) = R T is subject to a Joule-Thompson expansion. What will the temperature do: increase, decrease or stay the same? Note that b > 0 and you need to use $\mu = (dT/dp)_H$ and $(dH/dp)_T = T\ (dV/dT)_p - V$.

Choose one of the following three problems for 40 points:

8. Let $\alpha_S = V^{-1}(\partial V/\partial T)_S$. Using the various derivative relations (such as $(\partial z/\partial x)_y = 1 / (\partial x/\partial z)_y$, $(dx/dy)_z (\partial y/\partial z)_x (\partial z/\partial x)_y = -1$ or $(\partial z/\partial u)_y = (\partial z/\partial x)_y (\partial x/\partial u)_y$) as well as the relations $(\partial T/\partial V)_S = -(\partial P/\partial S)_V$ and $C_V = T(\partial S/\partial T)_V$ to show that $\alpha_S = -C_V\kappa / TV\alpha$.

9. For a Carnot cycle, draw a graph of the process on a S (entropy) versus T (temperature) diagram. Show that the area enclosed by the curve is equal to the work done by the cycle.

10. Evaluate π_T for a Dieterici gas, $p = R\ T \exp(-a/RTV_m) / (V_m - b)$. Justify physically the form of the expression obtained.

11. For $CHCl_3$, $C_{p,m} = 91.47$ J/mol K + T (7.5×10^{-2} J/mol K^2) over the temperature region from 250K to 350K. Calculate the ΔS when 1 mol of $CHCl_3$ is heated from 270 to 310 K (assume that no phase transitions occur in this temperature region).