High 3, 98 grades
Median 89

Chemistry – 4311
September 23, 2015

Exam #1 **Name** Key

(20) 1. Matching (use a letter only once)

log(xy) equals a.

The enthalpy H is defined as e.

According to the first law of thermodynamics the change in the internal energy ΔU equals d.

The average kinetic energy of an ideal gas molecule is s.

The relationship between q and heat capacity at constant volume is n.

With only P-V work and constant V, q equals j.

Cp – Cv for an ideal gas is i.

The average distance a molecule travels without a collision is called the c.

The expression for isothermal, reversible work is q.

In the van der Waals eq., $(P + an^2/V^2)(V - nb) = nRT$, the an^2/V^2 term corrects for l.

$c = 3.00 \times 10^8$ m/s

$h = 6.626 \times 10^{-34}$ J s

R= 8.314 J/mol-K

R= 1.987 cal/mol-K

R= 0.08206 L-atm/mol-K

$N_A = 6.02 \times 10^{23}$

1 atm = 101.325 kPa

$k_B = 1.381 \times 10^{-23}$ J/K

a. $\log(x) + \log(y)$

b. $mv^2/2$

c. mean free path

d. $q + w$

e. $H = U + PV$

f. $\log(x + y)$

g. $-nRT\ln(V_2/V_1)$

h. ΔH

i. nR

j. ΔU

k. PV

l. attractive forces

m. collision frequency

n. $q = C_V \Delta T$

o. volume of molecules

p. $C_V = q \Delta T$

q. w

r. $H = U - PV$

s. $3k_BT/2$

t. $-P_{ex}\Delta V$

correct R
correct M
correct V
correct N

(15) 2. The number of collisions a single molecule makes in one second is given by

$$Z_1 = \sqrt{2}\,\pi\, d^2 \langle c \rangle (N/V).$$

Calculate Z_1 for a mole of N_2 molecules in one liter at 300 K. d = 3.0×10^{-10} m, 1 L = 10^{-3} m^3, and

$$\langle c \rangle = (8RT/\pi M)^{1/2}.$$

$M = 28 \times 10^{-3}$ kg

$$\langle c \rangle = \left(\frac{8 \times 8.314 \times 300}{3.1416 \times 28 \times 10^{-3}\,kg}\right)^{1/2} = 4.76 \times 10^2 \text{ m/s}$$

$$Z_1 = \sqrt{2} \times \pi \times (3.0 \times 10^{-10})^2_{m^2} \times 4.76 \times 10^2 \text{ m/s} \times \frac{6.02 \times 10^{23} \text{ molecules}}{10^{-3}\ m^3}$$

$$= 1146 \times 10^8 \text{ collisions/sec} = 1.15 \times 10^{11} \text{ collisions/s}$$

(15) 3. Consider heating 1 mole of Ne from 200 to 400 K. Assume Ne is an ideal gas with $C_V = 3R/2$ for one mole.

(a) Calculate ΔU.

$$\Delta U = \bar{C}_V \Delta T = \frac{3R}{2} \times 200 = \frac{3 \times 8.314}{2} \times 200$$

$$= 2.49 \text{ kJ}$$

(b) What is C_P?

$$\bar{C}_p = 5/2\, R = 20.8 \frac{J}{mol\text{-}K}$$

(c) Calculate ΔH.

$$\Delta H = \bar{C}_p \Delta T = 4.16 \text{ kJ}$$

(15) 4. At 1 atm pressure and 298 K a certain gas has a density of 1.23 g/L. What is the molar mass of the gas?

$$PV = nRT = \frac{m}{M} RT$$

$$M = \frac{m}{V} \frac{RT}{P} = d \frac{RT}{P} = \frac{1.23\,g}{L} \times \frac{0.08206\ L\text{-}atm}{mol\text{-}K} \times \frac{298\ K}{1\ atm}$$

$$= 30.1\,g/mol$$

(10) 5. Please answer the following with q, w, ΔU, ΔH, or none of the above, if the only work is P-V work.

a. For an adiabatic process q is zero.

b. If the volume is constant, w is zero.

c. If T is constant for an ideal gas, ΔU and ΔH are zero.

d. If P is constant q equals ΔH.

e. For an isothermal, reversible expansion q equals −w., none of the above

(10) 6. Identify whether the following processes are exothermic or endothermic.

a. Protein folding – exo

b. Reaction with a negative ΔH_r° – exo

c. Breaking the H-H bond – endo

d. $H_2O(s) \rightarrow H_2O(l)$, melting – endo

e. $(H_2O)_2$ dimer $\rightarrow 2H_2O$ endo

(15) 7. The combustion of glucose is given by the reaction

$$C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6H_2O(l) + 6CO_2(g)$$

The heats of formation are: $C_6H_{12}O_6(s)$, -1274.5 kJ/mol; $H_2O(l)$, -285.8 kJ/mol; $CO_2(g)$, -393.5 kJ/mol. Calculate ΔH_r° for the combustion of glucose.

$$\Delta H_r^\circ = 6 \times [-393.5] + 6[-285.8] - [-1274.5]$$

$$= -2801.3 \text{ kJ}$$