Exam 4

MULTIPLE CHOICE (3pts each): Write the ONE letter corresponding to the correct answer on the line next to each question. The LETTER ASSOCIATED WITH THE CORRECT ANSWER MUST BE WRITTEN ON THE LINE NEXT TO THE QUESTION in order to receive full credit.

1.) A reaction is conducted by dissolving 0.336 moles of a solid base, BsOH, in water and then reacting it with HCl. The overall process is given by the reaction: BsOH (s) + HCl(aq) -> BsCl (aq) + H_2O(l). Given the following enthalpies, what was the overall enthalpy change for the reaction using 0.336mol BsOH? 1.) B

BsOH(s) --> BsOH(aq) ΔH = 41.83kJ/mol $(0.336\,mol) = 14.05488\,kJ$

BsOH(aq) + HCl(aq) -> BsCl (aq) + H2O(l) ΔH = 68.24kJ/mol $(0.336\,mol) = +22.92864\,kJ$

$36.98352\,kJ$

a.) 110.07Kj (b.) 36.98kJ c.) 26.41kJ d.) 322.3kJ

2.) Which of the following gasses would be the **least** ideal? 2.) C

a.) Ne b.) N_2 (c.) H_2O d.) CH_4

3.) A 3.21L baloon under 2.36atm of pressure is moved to a chamber where the pressure is 0.578atm. What is the new volume of the baloon? 3.) A

(a.) 13.1L b.) 4.38L c.) 0.786L d.) 9.64L

$(3.21L)(2.36atm) = (L)(0.578atm)$ $L = 13.10666\,L$

4.) Given the equation 2 $H_2(g) + O_2(g) \rightarrow 2\,H_2O(g)$, if 3.4 L of oxygen reacts with an excess of hydrogen at constant temperature and pressure, how many liters of water vapor will be produced? 4.) D

a.) 3.4L b.) 2.0 L c.) 1.7L (d.) 6.8L

$3.4\,L\,O_2\left(\frac{2\,L\,H_2O}{1\,L\,O_2}\right) = 6.8\,L$

5.) Crystals that are hard and brittle with high melting points and lattice points generally occupied by anions are 5.) D

a.) covalent crystals b.) metallic crystals c.) molecular crystals (d.) ionic crystals

6.) Carbon dioxide (44.0098g/mol) can be formed from carbon monoxide and oxygen according to the equation: $2CO(g) + O_2(g) \rightarrow 2CO_2$ ΔH = -566.0kJ/mol Which response best represents the enthalpy of the decomposition of 5.00g of carbon dioxide into carbon monoxide and oxygen? 6.) B

a.) -64.3kJ (b.) 64.3kJ c.) 2830kJ d.) -2830kJ

$5.00\,g\left(\frac{1\,mol}{44.0098\,g}\right) = 0.11361\,mol\,(+566.0\,kJ/mol) = +64.304\,kJ$

7.) Given the following enthalpies of formation, what is the enthalpy of the reaction: 7.) D

$2Li(s) + 2H_2O(l) \rightarrow 2LiOH(aq) + H_2(g)$ $\Delta H_f\ H_2O(l) = -285.8kJ/mol$

ΔH_f LiOH = -487.2kJ/mol Hydrogen and lithium are in there standard states.

a.) -773.0kJ b.) -201.4kJ c.) -386.5kJ (d.) -402.8kJ

$[2(-487.2) + 0] - [0 + 2(-285.8)] = -402.8$

8.) Which of the following compounds would have the highest melting point? 8.) B

a.) CH_4 (b.) KCl c.) CH_3O-H d.) CH_2O

9.) Which type of process best descrbes the melting of ice to form water? 9.) C

a.) isothermic b.) exothermic (c.) endothermic d.) adiabatic

10.) The best type of system to use for a calorimetry experiment is 10.) A

(a.) isolated b.) closed c.) open d.) exothermic

11.) If two moles of a gas are held in a 2500mL container at 0.998atm, what is the temperature of the gas in the containier? 11.) C

a.) 0.150°C b.) 15.2°C (c.) -258.0°C d.) 14900°C

$(0.998\,atm)(2.5\,L) = (2\,mol)\left(0.0821\,\frac{L\,atm}{mol\,K}\right)(T)$

2021F_D

$T = 15.195\,K - 273.15 = -257.96\,^{\circ}C$

SHORT ANSWER (10 pts each): Completely answer all of the following questions. Read all questions carefully!!! SHOW ALL WORK. Make sure to include units and report all mathematical answers to the correct number of significant figures. Write final answers in designated locations when indicated.

1. How much energy, in kJ, is required to convert 86.2g water (18.01528g/mol) at 35.0°C to steam at 146.0°C? ΔH_{vap} = 40.79kJ/mol

Answer: 227 kJ

heat water $q = (86.2g)(4.184\ J/g^{\circ}C)(100.0^{\circ}C - 35.0^{\circ}C) = 23442.952J \rightarrow 23.443kJ$ (65.0°C)

boil water $86.2g\left(\frac{1mol}{18.01528g}\right) = 4.7848\ mol\left(40.79\ kJ/mol\right) = 195.173kJ$

heat steam $q = (86.2g)(1.99\ J/g^{\circ}C)(146.0^{\circ}C - 100.0^{\circ}C) = 7890.748J \rightarrow 7.89075kJ$ (46°C)

$226.507kJ$

2. What mass of C_7H_8O (108.13992 g/mol) is needed to produce 568mL of CO_2 at 2.00atm and 280.0°C?

$+273.15$

$553.15K$

$2\ C_7H_8O\ (s) + 17\ O_2\ (g) \rightarrow 14\ CO_2\ (g) + 8\ H_2O(g)$

Answer: 0.386 g

moles CO_2: $PV = nRT$

$(2.00atm)(0.568L) = (n)\left(0.0821\frac{L\,atm}{mol\,K}\right)(553.15K)$

$n = 0.0250145\ mol\ CO_2\left(\frac{2\ mol\ C_7H_8O}{14\ mol\ CO_2}\right)$

$= 0.0035735\ mol\ C_7H_8O\left(\frac{108.13992g}{mol}\right)$

$= 0.38644\ g\ C_7H_8O$

3. A 0.569mol sample of a salt was dissolved in 50.0g water, causing the temperature of the water to decrease from 25.00°C to 14.36°C. What is the enthalpy of solvation in kJ per mole of the salt? (solvation is the dissolving process). Assume the specific heat of the solution is essentially the same as the specific heat of water. Include the appropriate sign in your answer.

Answer: $+3.91\ kJ/mol$

$$q_{water} = (50.0\,g)(4.184\,J/g^{\circ}C)(14.36^{\circ}C - 25.00^{\circ}C) = -2225.888\,J \quad (-10.64)$$

$$q_{sample} = -q_{water} = +2225.888\,J\left(\frac{1\,kJ}{1000\,J}\right)$$

$$= +2.225888\,kJ$$

$$\frac{}{0.569\,mol}$$

$$= +3.9119\ kJ/mol$$

$$\hookrightarrow +3.91\ kJ/mol$$

4. A sample of gas in a 2.55 L cylinder at 783 torr and 25.0°C was moved to a 3.78 L cylinder at 0.876 atm and 30.0°C. After the transfer, the second cylinder contained 12.58 mol of gas.
a.) How many moles of gas were in the original cylinder? Changing conditions

$$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2} \qquad 783\,torr\left(\frac{1\,atm}{760\,torr}\right) = 1.030263\,atm$$

Answer: 10.1 mol

$25.0^{\circ}C + 273.15 = 298.15$
$30.0^{\circ}C + 273.15 = 303.15$

$$\frac{(1.030263\,atm)(2.55L)}{(n_1)(298.15K)} = \frac{(0.876\,atm)(3.78L)}{(12.58)(303.15K)}$$

$$\frac{(0.0088116\,atm\cdot L/K)}{n_1} = 0.000868276\,\frac{atm\cdot L}{mol\,K}$$

$$n = \frac{0.0088116\,atm\cdot L/K}{0.000868276\,atm\cdot L/mol\,K} = 10.148\,mol$$

b.) How many moles of gas were gained or lost in the transfer? Include in your answer whether gas molecules were gained or lost.

$$12.58\,mol - 10.148\,mol = 2.432\,mol$$

Answer: 2.4 mol lost

5. a.) After a reaction, a 0.250mol sample of a gas in a piston had a pressure of 1.036atm at 30.0°C. What was the volume of gas in the piston? One set of conditions

+273.15
303.15K

Answer: 6.01L

$PV = nRT$

$(1.036\,atm)(V) = (0.250\,mol)(0.0821\frac{L\,atm}{mol\,K})(303.15K)$

$V = 6.00594L$

b.) If the original volume of gas in the piston was 4.50L, how much work was done on or by the system? Make sure to report your answer with the appropriate sign and units for work. The pressure remains constant over the course of the reaction.

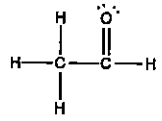
$w = -P\Delta V$

$w = -(1.036\,atm)(6.006L - 4.50L)$ Answer: −158 J

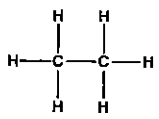
$= -(1.036\,atm)(1.50594L)$

$= -1.56015\,L\cdot atm\left(\frac{101.32J}{1L\cdot atm}\right) = -158.075\,J$

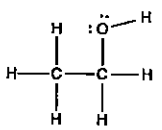
6. a.) For each of the following molecules, list the strongest intermolecular attractive force that the molecule can use to interact with other identical molecules.

a.) 

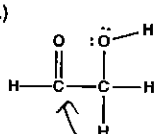
Strongest IMAF dipole-dipole

b.) 

Strongest IMAF dispersion

c.) 

Strongest IMAF H-bonding

d.) 

Strongest IMAF H bonding

has H-bond & dipole-dipole

b.) Which molecule (a, b, c, or d) would have the highest surface tension? D (highest IMAF)

c.) Which molecule (a, b, c, or d) would have the highest vapor pressure? B (lowest IMAF)