**Exam 3: Chemistry 1984**

**Fall 2013 Alfred State College**

**100 points**

Your name: \_\_\_\_\_\_\_\_\_\_answers\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 1 pt B

**3.1. Extended Lewis Rule Problems (16 pts)**

Draw the **best, extended** Lewis rule predictions for the compound below. Recall that **the octet rule may be broken for elements starting with Si** to minimize formal charge. **You must show all formal charges and all lone pairs on all elements !!! (4 pts each)**









**SO2 PF5 SO3 PO43-**

**3.2. Resonance (12 pts)**

Draw the likely Lewis structures for the compounds or anions below and if they exhibit resonance, circle the **R?** beneath your structure. As above, include any formal charges and all lone pairs







**NO3- SO32- O3  (structure 3 pts)**

**R?? R?? R?? (1 pt) all show resonance**

**3.3. VSEPR Geometries (6 pts)**

For each of the molecules below, predict the geometric shape

1. NH3 \_trigonal pyramid\_\_\_\_ b) H2O\_\_\_\_bent\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. BF3 \_trigonal plane\_\_\_\_\_ d) SF6 \_\_\_\_octahedron\_\_\_\_\_\_\_\_\_

e) SiH4 \_\_\_pyramid\_\_\_\_\_\_\_\_\_\_ f) CO2 \_\_\_\_\_linear\_\_\_

\_\_\_\_\_/35 (includes name)

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**3.4. Bond Order (8 pts/2 pts each)**

Predict the bond order for the indicated bonds in the molecules below: (you will need to decide what the best Lewis structure is for each compound or anion before proceeding). You can leave answers as fractions.

Also allowed 1.5,2 Also allowed: 1; 5/4 , 1.5 and 2

P-O bond order in PO43- \_\_\_\_\_5/4\_\_\_\_\_\_\_\_\_\_\_\_\_ Cl-O bond order in ClO4-\_\_\_7/4\_\_\_\_\_\_\_\_\_\_

Also allowed: 4/3

C-O bond order in CO32- \_\_\_\_\_4/3\_\_\_\_\_\_\_\_\_\_\_\_\_ S-O bond order in SO3 \_\_\_\_\_2\_\_\_\_\_\_\_\_\_\_

**3.5. Hybridization (8 pts/ 2 pts each)**

Predict the hybridization on the central atom of each compound below:

hybridization on the C in CH4 \_\_sp3\_\_\_\_\_ hybridization on the Si in SiO2 \_\_\_sp\_\_\_\_\_

hybridization on the B in BH3 \_\_sp2\_\_\_\_\_ hybridization on O in H2O \_\_\_\_\_sp3\_\_\_\_

**3.6. Specific Heat Calculations (12 pts total) show work !**

a) A 10.0 gram sample of metal with a specific heat of 8.0 J/g oC is heated from 25oC to 50o C.

How much energy has the sample absorbed?

**Q=C\*m\*ΔT=8\*10\*(50-25) =2000 J**

\_\_2000\_\_\_\_\_\_ Joules(J)

(3 pts)

b) A 20 gram sample with a specific heat of 10.0 J/g oC is initially at 25oC. It absorbs 1000 J.

What is the final temperature, Tf, of the sample if the energy is absorbed without loss.

**Q=C\*m\*ΔT**

1000=10\*20\*(Tf-25)=200(Tf-25)

1000/200 = Tf-25

5=Tf-25

30=Tf

\_\_\_30\_\_\_\_\_ =Tf

(4 pts)

c) A 100.00 gram sample of water in an thick-walled styro-foam cup is initially at 25.00 oC. A 30.00 gram sample of metal initially at Ti = 100.00 C is dropped into the water. The final temperature attained by the combined system at equilibrium is Tf= 30.0 C. What is the metal’s specific heat to the nearest 0.1 J/g oC ? Assume the specific heat of water = 4.184 J/g oC.

Assuming perfect insulation: -Qm = Qw

Qm =Cm\*30\*(30-100) = -2100Cm

Qw = 4.184\*100\*(30-25)=2092 J

-Qm = 2100Cm =Qw=2092 J

Cm =2092/2100 ~ 1.0

\_\_\_1.0\_\_\_ =Csp (J/goC)

\_\_\_\_/28 (5 pts) to nearest 0.1

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**3.7. Hess Law Calculations (4 pts each, 8 pts total)**

1. Given the standard state heats of ΔHfo for the combustion products below,

Compound ΔHfo

CO2 (g) -393.5 kJ/mol

H2O(l) -285.8

Compute ΔHfo for ethene, C2H4 (g) which undergoes the reaction below, to produce -1411 kJ/mol C2H4

**C2H4 (g)+ 3O2(g) 🡪 2CO2(g) + 2H2O(l)** ΔH=**-1411 kJ**

**ΔHf(x) -2(393.5) -2\*(285.8)**

**-1411= -2(393.5) -2\*(285.8) - ΔHf(x)**

**-1411=-1358.6-ΔHf(x)**

**-1411+1358.6= -52.4 J/mol**

**\_\_\_-52.4\_\_\_\_\_\_=**ΔHfo(C2H4(g))

1. Given the following data, calculate the ΔH for the target reaction below.

Data

2O3 🡪3O2 ΔH=-427 kJ ~~3O~~~~2~~🡪~~2O~~~~3~~ +427

O2🡪2O(g) ΔH=+495 2O🡪~~O~~~~2~~ -495

NO+O3🡪NO2+ O2 ΔH=-199 2NO +~~2O~~~~3~~🡪2NO2 +~~2O~~~~2~~ 2\*(-199)

2NO +2O🡪 2NO2 -466

Target reaction- compute ΔH for: ½ above yields target reaction => -466/2=-233

NO + O 🡪 NO2 \_\_\_-233\_\_\_\_\_ =ΔH (kJ/mol NO2)

**3.8. Ideal Gas Computations (14 pts total)**

a) A sample of gas at constant temperature is compressed from 60 liters to 20 liters. If the final pressure Pf attained is 30 atm, what is Pi, the initial pressure?

PiVi =PfVf

Pi\*60=30\*20

Pi =600/60=10

\_\_\_\_10\_\_\_\_\_\_\_\_= Pi(atm)

(3 pts)

b) A sample of gas in a pressure cooker starts at Ti= 13.4oC and Pi= 1 atm. What temperature Tf in oC must the cooker be raised to in order to attain a final pressure Pf= 2 atm ?

(Recall: T(K) =273.15 + T(oC)).

Ti(K) =273.15+13.4=286.57

Pi/Ti(K) =Pf/Tf(K)

1/286.57=2/Tf(K)

Tf =286.57\*2 K=573.14 K= 300 oC

\_\_300\_\_\_\_\_\_\_\_= Tf(oC)

(3 pts)

\_\_\_\_/14

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**3.8. Ideal Gas Calculations (continued)**

c) A child’s balloon originally occupies Vi= 10 liters at sea level (Pi =1 atm) and room temperature

Ti= 300 K . It is released and is allowed to rise to an altitude where the final pressure Pf is 0.25 atm

and the final temperature is 150 K. What is the balloon’s new volume, Vf ?

PiVi/Ti =PfVf/Tf

1\*10/300=0.25\*Vf/150

(10/300) \* 150/0.25= Vf =20 L

\_\_\_\_20\_\_\_\_\_\_\_=Vf(L)

(4 pts)

d) A 5.50 gram sample of gas is found to occupy 1.0 liters at 2.0538 atm and 200 K. What is the

molecular mass of the gas ? Assume R= 0.08206 atm L/mol K.

n=PV/RT= 2.0538\*10/(0.08206\*200) = 0.125 mol

MW= mass/moles = 5.5/0.125= 44 g/mol

\_44\_\_\_\_\_\_\_\_ Molecular mass of gas

(4 pts) (g/mol)

**3.9 Phase Changes ( 9 pts)**

a) Name the three experimental techniques we discussed that are commonly used to explore phase change behavior:

**1)\_\_\_\_vaporization (P vs. T) curves\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**2)\_\_\_\_\_\_heating/cooling curves\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**3)\_\_\_\_\_\_phase diagrams\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

b) Given that a plot of ln P vs. 1/T for a clear, colorless liquid produced a slope, m = -4600 and a slope b=12.00, what is the heat of vaporization, ΔHvap and implied normal boiling point Tbp (K) for the liquid ? (Recall that the Clausius-Clapeyron equation is: ln P = **-**(ΔHvap/R)[1/T-1/Tbp]. Show work here !!! (6 pts) Assume R=8.314 J/K mol

m=-4600 = -(ΔHvap/R) = -(ΔHvap/8.314)

-8.314\*(-4600)= 38244 J=ΔHvap

**b=12.00=**ΔHvap/RTbp

**Tbp =(**ΔHvap/12.00\*R)=383.3 K

**\_38244\_\_\_\_\_\_\_=** ΔHvap(J/mol) 4 pts

\_\_/17 \_\_383.3\_\_\_\_\_\_\_= Tbp(K) 2 pts

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**3.10 Multiple Guess (4 pts)**

1.) The units for specific heat are:

a) g/mole b)J/mol\*s c) J/g oC d) J

2.) The Van der Waal corrections account for:

a) just molecular size b) molecular size and interaction c) vaporization temperature

d) quantum effects e) H-bonding interactions

3) The convention for heat and work adopted by the text:

a) Q and W are positive if the system receives it from the surroundings

b) Q and W are negative if the system receives if from the surroundings

c) Q is positive if the system absorbs it from the surroundings and W is positive if the system does

work on the surroundings

d) Q and W are positive if the surroundings receives both from the system

4) Any day doing chemistry is a great day:

a) true

b) very true

c) aber natürlich

d) yes yes yes

e) duh

\_\_\_\_\_\_/4