Name:

Question 1 (9 points)

Using average bond energies the enthalpy change associated with the following reaction:

$$N_2(g) + 3H_2(g) \longrightarrow 2NH_3(aq)$$

Was determined to be –93 kJ.mol^{-1}. Knowing that the ΔH^0_f of for the elements in their standard state is 0 and ΔH^0_f NH_3(aq) = -80 kJ.mol^{-1}. Using heats of formation data, determine the enthalpy change for the reaction.

ΔH^o_{rxn} = $\Sigma\Delta H^0_f$(Products) - $\Sigma\Delta H^0_f$(Reactants)
= 2 $\Delta DH^0_f NH_3$(aq) – [$\Delta H^0_f N_2$(g) + 3 $\Delta H^0_f H_2$(g)]
= 2(-80.0) – [0 + 3(0)]
= -160 kJ.mol^{-1}

Give a simple explanation for the difference in values obtained. Which value do you think is closer to the real value?

Bond energies are averages and while they work well when all reactants and products are in the gas phase they do not take into account intermolecular forces. Enthalpies of formation do and thus they are a better estimate.

Question 2 (24 points)

For each of the following molecules give the **electron-pair** geometry, the **number of lone pairs** around the central atom and the **molecular geometry**.

A. CH_2O

electron-pair geometry Trigonal Planar

lone pairs 0

molecular geometry Trigonal Planar

B. ONCl

electron-pair geometry Trigonal Planar

lone pairs 1

molecular geometry Angular

C. NF_3?

electron-pair geometry Tetrahedron

lone pairs 1

molecular geometry Trigonal Pyramid

D. CS_2

electron-pair geometry Linear

lone pairs 0

molecular geometry Linear

Question 3 (8 points)

Classify each of the following molecules as **Polar** or **Non Polar**.

A. CH_2O Polar

B. ONCl Polar

C. NF_3 Polar

D. CS_2 Non Polar

Question 4 (10 Points)

Circle the intermolecular forces that are applicable to the following:

A. The solute-solvent interactions when **potassium fluoride** dissolves in water are primarily of the type:

dipole-induced dipole   ion-dipole   ion-ion   dipole-dipole   hydrogen bonding

B. The solute-solvent interactions when $\mathbf{Cl_2}$ dissolves in water are primarily of the type:

dipole-induced dipole   ion-dipole   ion-ion   dipole-dipole   hydrogen bonding

C. The type(s) of intermolecular forces expected between **HCl** molecules:

dispersion   ion-dipole   ion-ion   dipole-dipole   hydrogen bonding

D. The type(s) of intermolecular forces expected between $\mathbf{CH_3NH_3}$ molecules:

dispersion   ion-dipole   ion-ion   dipole-dipole   hydrogen bonding

Circle the molecule that is expected to have the higher boiling point.

CH_4 CH_3OH CH_3CH_3 CH_3CH_2OH $CH_3CH_3CH_2OH$

Question 5 (5 Points)

The equilibrium constant, K_c, for the following reaction is $\mathbf{1.67 \times 10^{-2}}$ at **1180** K:

$$2\,SO_3(g) \rightleftharpoons 2\,SO_2(g) + O_2(g)$$

Calculate K_c at this temperature for:

$$SO_2(g) + \tfrac{1}{2}\,O_2(g) \rightleftharpoons SO_3(g)$$

$K_c = \{ 1/1.67 \times 10^{-2} \}^{1/2}$

= 7.74

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Question 6
(5 Points)

Consider the following reaction:

$$2\ \mathbf{NOBr}(g) \rightleftharpoons 2\ \mathbf{NO}(g) + \mathbf{Br_2}(g)$$

If **0.580** moles of **NOBr(g)**, **0.567** moles of **NO**, and **0.446** moles of **Br_2** are at equilibrium in a **10.8** L container at **452**K, the value of the equilibrium constant

$K = [NO]^2[Br_2]/[NOBr]^2$

[NO]	= 0.567/10.8 = 0.0525
[Br_2]	= 0.446/10.8 = 0.0413
[NOBr]	= 0.580/10.8 = 0.0537

$K = (0.0525)^2(0.0413)/(0.0537)^2 =$ **0.0395 (3.95×10^{-2})**

Question 7
(5 Points)

Consider the following system at equilibrium:

$$2\ H_2S(g) + 3\ O_2(g) \rightleftharpoons 2\ H_2O(g) + 2\ SO_2(g)$$

The production of SO_2 by this reaction would be favored by:
(Circle those that apply)

A. removing H_2S
B. removing H_2O
C. adding H_2O
D. adding H_2S
E. adding O_2

Question 8
(8 Points)

A. The formula for the **conjugate acid** of **CO_3^{2-}** is. HCO_3^-

B. The formula for the **conjugate base** of **HPO_4^{2-}** is. PO_4^{3-}

C. The formula for the **conjugate base** of **H_3PO_4** is $H_2PO_4^-$

D. The formula for the **conjugate acid** of **NH_3** is NH_4^+

Question 9
(8 points)

The $[H_3O^+]$ in an aqueous solution is **5.58×10^{-3}** M.

The $[OH^-]$ in the solution is 1.78×10^{-12} M.

The pH of this solution is 2.25 and the pOH is 11.75.

This solution is Acidic . (Acidic or Basic)

Question 10 (5 points)

You need to make an aqueous solution of **0.160** M **potassium bromide** for an experiment in lab, using a **500** mL volumetric flask. How much solid **potassium bromide** should you add?

M = moles KBr / V(L) moles KBr = M x V(L)

Moles KBr = 0.160 x 0.500 = **0.080**

0.080 moles KBr x (119.0g KBr /1 mole KBr) = **9.52g KBr**

Question 11 (6 Points)

According to the following reaction, how many moles of **bromine trifluoride** are necessary to form **0.387** moles **fluorine gas**?

bromine trifluoride (**g**) $\longrightarrow$ **bromine** (**g**) + **fluorine** (**g**)

$2\ BrF_3(g) = Br_2(g) + 3\ F_2(g)$

0.387 moles F_2 x (2 BrF_3 / 3 F_2) = **0.258 moles BrF_3**

Question 12 (7 points)

How many grams of solid **potassium hydroxide** are needed to exactly neutralize **21.1** mL of a **0.652** M **hydrochloric acid** solution ? Assume that the volume remains constant.

$KOH(aq) + HCl(aq) = KCl(aq) + H_2O(l)$

Moles of HCl = M x V(L) = 0.652 x 0.0211 = **1.38×10^{-2}**

1.38×10^{-2} moles HCl x (1 KOH /1 HCl) = **1.38×10^{-2} moles KOH**

1.38×10^{-2} moles KOH x (56.11g KOH /1 mole KOH) = **0.772g KOH**

Score:	**Note:**
Do Not Write Here	Do Not Write Here