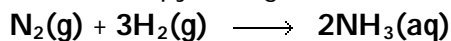


Name:

Question 1
(9 points)

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



Was determined to be $-93 \text{ kJ}\cdot\text{mol}^{-1}$. Knowing that the ΔH_f° of for the elements in their standard state is 0 and $\Delta H_f^\circ \text{NH}_3(\text{aq}) = -80 \text{ kJ}\cdot\text{mol}^{-1}$. Using heats of formation data, determine the enthalpy change for the reaction.

$$\begin{aligned}\Delta H_{\text{rxn}}^\circ &= \Sigma \Delta H_f^\circ(\text{Products}) - \Sigma \Delta H_f^\circ(\text{Reactants}) \\ &= 2 \Delta H_f^\circ \text{NH}_3(\text{aq}) - [\Delta H_f^\circ \text{N}_2(\text{g}) + 3 \Delta H_f^\circ \text{H}_2(\text{g})] \\ &= 2(-80.0) - [0 + 3(0)] \\ &= -160 \text{ kJ}\cdot\text{mol}^{-1}\end{aligned}$$

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 Classify each of the following molecules as **Polar** or **Non Polar**.
(8 points)

- A. CH_2O Polar
- B. ONCl Polar
- C. NF_3 Polar
- D. CS_2 Non Polar

Question 4 Circle the intermolecular forces that are applicable to the following:
(10 Points)

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 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

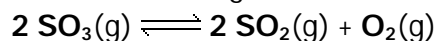
D. The type(s) of intermolecular forces expected between **CH_3NH_3** molecules:

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

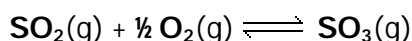
Circle the molecule that is expected to have the higher boiling point.

CH_4 CH_3OH CH_3CH_3 $\text{CH}_3\text{CH}_2\text{OH}$ $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$

Question 5 The equilibrium constant, K_c , for the following reaction is 1.67×10^{-2} at 1180 K:
(5 Points)



Calculate K_c at this temperature for:

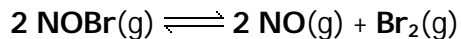


$$K_c = \{ 1/1.67 \times 10^{-2} \}^{1/2}$$
$$= 7.74$$

Name:

Question 6
(5 Points)

Consider the following reaction:



If **0.580** moles of **NOBr(g)**, **0.567** moles of **NO**, and **0.446** moles of **Br₂** are at equilibrium in a **10.8 L** container at **452K**, the value of the equilibrium constant

$$K = [\text{NO}]^2[\text{Br}_2]/[\text{NOBr}]^2$$

$$[\text{NO}] = 0.567/10.8 = 0.0525$$

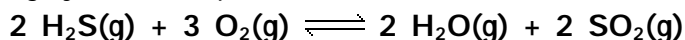
$$[\text{Br}_2] = 0.446/10.8 = 0.0413$$

$$[\text{NOBr}] = 0.580/10.8 = 0.0537$$

$$K = (0.0525)^2(0.0413)/(0.0537)^2 = \mathbf{0.0395 (3.95 \times 10^{-2})}$$

Question 7
(5 Points)

Consider the following system at equilibrium:



The production of **SO₂** by this reaction would be favored by:

(Circle those that apply)

- A. removing H₂S
- B. removing H₂O**
- C. adding H₂O
- D. adding H₂S**
- E. adding O₂**

Question 8
(8 Points)

- A. The formula for the **conjugate acid** of **CO₃²⁻** is. **HCO₃⁻**
- B. The formula for the **conjugate base** of **HPO₄²⁻** is. **PO₄³⁻**
- C. The formula for the **conjugate base** of **H₃PO₄** is **H₂PO₄⁻**
- D. The formula for the **conjugate acid** of **NH₃** is **NH₄⁺**

Question 9
(8 points)

The **[H₃O⁺]** in an aqueous solution is **5.58x10⁻³ M**.

The **[OH⁻]** in the solution is **1.78x10⁻¹² 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?

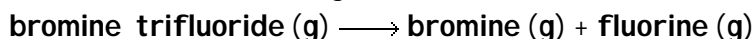
$$M = \text{moles KBr} / V(L)$$

$$\text{moles KBr} = M \times V(L)$$

$$\text{Moles KBr} = 0.160 \times 0.500 = \mathbf{0.080}$$

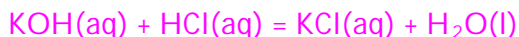
$$0.080 \text{ moles KBr} \times (119.0 \text{g KBr} / 1 \text{ mole KBr}) = \mathbf{9.52 \text{g KBr}}$$

Question 11 (6 Points) According to the following reaction, how many moles of **bromine trifluoride** are necessary to form **0.387 moles fluorine gas**?



$$0.387 \text{ moles F}_2 \times (2 \text{ BrF}_3 / 3 \text{ F}_2) = \mathbf{0.258 \text{ moles BrF}_3}$$

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.



$$\text{Moles of HCl} = M \times V(L) = 0.652 \times 0.0211 = \mathbf{1.38 \times 10^{-2}}$$

$$1.38 \times 10^{-2} \text{ moles HCl} \times (1 \text{ KOH} / 1 \text{ HCl}) = \mathbf{1.38 \times 10^{-2} \text{ moles KOH}}$$

$$1.38 \times 10^{-2} \text{ moles KOH} \times (56.11 \text{g KOH} / 1 \text{ mole KOH}) = \mathbf{0.772 \text{g KOH}}$$

<u>Score:</u> Do Not Write Here	<u>Note:</u> Do Not Write Here
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