

1. (9 points) **SHOW ALL WORK.** At 50 °C, the ion product (K_w) for water is 5.48×10^{-14} . Determine the pH of a 0.0025 M $\text{Ba}(\text{OH})_2$ solution at this temperature. Include a **balanced chemical equation** for the relevant **equilibrium reaction**.

2. (2 points) Among the following, circle the **strongest acid**.



3. (2 points) Among the following, circle the **weakest acid**.

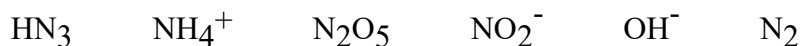


4. (9 points) **SHOW ALL WORK.** At 100 °C, a reaction has an activation energy (E_a) of 165 kJ/mole. When a catalyst is added (at the same temperature), the reaction rate increases by a factor of 10 billion (i.e., 1.00×10^{10} times faster). Determine the activation energy of the catalyzed reaction.

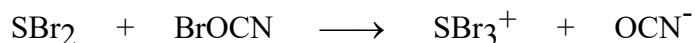
5. (4 points) (a) The conjugate acid of HAsO_4^{2-} is _____.
(b) The conjugate base of HSF_3 is _____.

6. (2 points) A molecule or ion that can function as both an acid and a base is described as being _____. An excellent example of such a species is _____.

7. (4 points) Which one of the following molecules or ions behaves as a **weak base in aqueous solution**? Circle your answer and then write a balanced chemical equation for this process.



8. (10 points) Consider the following reaction in terms of the Lewis Acid-Base concept. Write *complete Lewis electron dot formulas* for all reactants and products. *Clearly indicate which reactant is the Lewis acid and which is the Lewis base.* Use arrows to illustrate the formation and breaking of any bonds as the reaction proceeds from left to right.

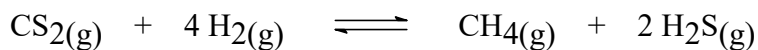


9. (8 points) For two solutions, **A** and **B**, fill in the missing values (at 25 °C) in the table below. *Pay attention to significant figures.*

Solution	pH	[H ₃ O ⁺]	pOH	[OH ⁻]
A	- 1.04			
B			3.275	

10. (10 points) **SHOW ALL WORK.** As the TA for a Gen Chem lab, you are required to prepare 50.0 L of aqueous HBr with a pH of 2.50. In the chemistry storeroom, you find a bottle of stock solution that is 48.0 % HBr by weight and has a density of 1.50 g/mL. Determine the volume (in mL) of stock solution that you will need in order to prepare 50.0 L of HBr solution with pH = 2.50. (molar mass: HBr = 80.9, H₂O = 18.0)

11. Consider the following gas-phase reaction for which $K_c = 8.30 \times 10^5$ at 500°C .



(a) (4 points) How will the equilibrium amount of $\text{CS}_2(\text{g})$ be affected by each of following changes? Indicate your answer by writing the appropriate letter.

[I = increase, D = decrease, N = no change]

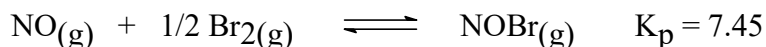
Change	moles $\text{CS}_2(\text{g})$
add some $\text{CH}_4(\text{g})$	
add a catalyst	
increase the pressure	
remove some $\text{H}_2\text{S}(\text{g})$	

(b) (2 points) When the temperature of the above equilibrium system is increased, the value of K_c decreases. This observation indicates that the enthalpy change for the reaction is (circle one):

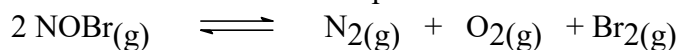
positive zero negative

(c) (10 points) **SHOW ALL WORK.** At 500°C , a 2.00 L container was filled with 0.0200 moles of $\text{CS}_2(\text{g})$ and 0.150 moles of $\text{H}_2(\text{g})$. Calculate the molar concentration of CS_2 in this system after the above equilibrium is established. *Clearly state and justify any assumptions that you may make.* ($K_c = 8.30 \times 10^5$)

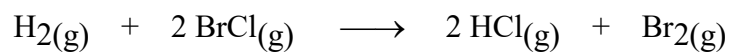
12. (4 points) **SHOW ALL WORK.** Consider the following reactions and their equilibrium constants.



From this information, determine K_p for the reaction below.



13. (10 points) The following gas-phase reaction is found experimentally to be "first order in H_2 and first order in BrCl ." Write the experimental rate law and **propose** a reasonable **two-step mechanism** for this reaction. **Briefly explain** (30 words max) how your mechanism is consistent with the experimental rate law. Clearly indicate which step in your mechanism is the rate-determining step. If your proposed mechanism contains an intermediate, circle it.



14. (10 points) **SHOW ALL WORK.** At 300 K, the following reaction has $K_c = 1.75 \times 10^{-10}$. At this temperature, 0.75 moles of N_2O_5 and 0.50 moles of NO are combined in a 1.00-L container. Determine the molar concentration of O_2 after equilibrium is achieved.

