Solve each of the following problems. Show your work in the space provided. Write your final answer on the blank line.

**Part A**

1. Write an equilibrium expression for the following reaction:

   \[ \text{A}_\text{(g)} + \text{B}_\text{(g)} \leftrightharpoons \text{AB}_\text{(g)} \]

   Then calculate the value of \( K_{eq} \) given that \([\text{A}] = 1.1 \times 10^{-3}\text{M}, [\text{B}] = 4.4\text{M}, \) and \([\text{AB}] = 1.5 \times 10^{-8}\text{M}. \) Finally, tell whether reactants or products are favored, and why.

   \[
   K_{eq} = \frac{[\text{AB}]}{[\text{A}][\text{B}]} = \frac{(1.5 \times 10^{-8})}{(1.1 \times 10^{-3})(4.4)} = 3.1 \times 10^{-6}
   \]

   Reactants are favored because \( K_{eq} \) is less than 1

2. Write an equilibrium expression for the following reaction:

   \[ \text{A}_2\text{(g)} + \text{B}_\text{(g)} \leftrightharpoons \text{A}_2\text{B}_\text{(g)} \]

   Then calculate the value of \( K_{eq} \) given that \([\text{A}_2] = 1.9 \times 10^{-3}\text{M}, \) and \([\text{A}_2\text{B}] = 1.4 \times 10^{-5}\text{M}. \) Finally, tell whether reactants or products are favored, and why.

   \[
   K_{eq} = \frac{[\text{A}_2\text{B}]}{[\text{A}_2]} = \frac{1.4 \times 10^{-5}}{1.9 \times 10^{-3}} = 7.4 \times 10^{-3}
   \]

   Reactants are favored because \( K_{eq} \) is less than 1

3. Write an equilibrium expression for the following reaction:

   \[ 2\text{A}_\text{(g)} + \text{B}_\text{(g)} \leftrightharpoons \text{A}_2\text{B}_\text{(g)} \]

   Then calculate the value of \( K_{eq} \) given that \([\text{A}] = 1.0 \times 10^{-6}\text{M}, [\text{B}] = 2.2 \times 10^{-4}\text{M}, \) and \([\text{A}_2\text{B}] = 6.5 \times 10^{-1}\text{M}. \) Finally, tell whether reactants or products are favored, and why.

   \[
   K_{eq} = \frac{[\text{A}_2\text{B}]}{[\text{A}]^2[\text{B}]} = \frac{6.5 \times 10^{-1}}{(1.0 \times 10^{-6})(2.2 \times 10^{-4})} = 3.0 \times 10^{15}
   \]

   Products are favored because \( K_{eq} \) is greater than 1.
Write an equilibrium expression for the following reaction:

\[ A(g) + B_2(g) \rightleftharpoons AB(g) + B(g) \]

Then calculate the value of \( K_{eq} \) given that \([B_2] = 5.5 \times 10^{-4} \text{M}\), and \([B] = 3.9 \times 10^{-7} \text{M}\). Finally, tell whether reactants or products are favored, and why.

\[ K_{eq} = \frac{[AB][B]}{[A][B_2]} = \frac{3.9 \times 10^{-7}}{5.5 \times 10^{-4}} = 7.1 \times 10^{-4} \]

Reactants are favored because \( K_{eq} \) is less than 1.

5. Write an equilibrium expression for the following reaction:

\[ 2A(g) + 3B(g) \rightleftharpoons A_2B_3(g) \]

Then calculate the value of \( K_{eq} \) given that \([A] = 4.6 \times 10^{-3} \text{M}\), and \([B] = 1.5 \times 10^{-5} \text{M}\). Finally, tell whether reactants or products are favored, and why.

\[ K_{eq} = \frac{1}{[A]^2[B]^3} = \frac{1}{(4.6 \times 10^{-3})^2(1.5 \times 10^{-5})^3} = 1.4 \times 10^{19} \]

Products are favored because \( K_{eq} \) is greater than 1.

Part B

6. Write an equilibrium expression for the following reaction:

\[ AB_2(g) + \text{energy} \rightleftharpoons A(g) + B_2(g) \]

Then calculate the value of \( K_{eq} \) given that \([B_2] = 1.3 \times 10^{-9} \text{M}\). Finally, predict the effect of increased temperature on the value of \( K_{eq} \) and explain your answer.

\[ K_{eq} = [B_2] = 1.3 \times 10^{-9} \]

Increasing temperature will shift the eqm to the products, increasing \([B_2] \) and increasing \( K_{eq} \) because this reaction is endothermic.
7. Write an equilibrium expression for the following reaction:

\[ 2A(g) + B(g) + \text{energy} \rightleftharpoons A_2B(g) \]

Then calculate the value of \( K_{eq} \) given that \([A] = 1.6 \times 10^{-2}\text{M}, [B] = 1.4 \times 10^{-4}\text{M}, \) and \([A_2B] = 3.6 \times 10^{-1}\text{M}. \) Finally, predict the effect of decreased temperature on the value of \( K_{eq} \) and explain your answer.

\[
K_{eq} = \frac{[A_2B]}{[A]^2[B]} = \frac{3.6 \times 10^{-1}}{(1.6 \times 10^{-2})^2(1.4 \times 10^{-4})} = 1.0 \times 10^7
\]

This is an endothermic reaction, decreasing the temperature shifts the equilibrium towards the reactants and decreases \( K_{eq}. \)

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**Part C**

8. Write an equilibrium expression for the following reaction:

\[ A_2(g) + B(s) \rightleftharpoons A(g) + AB(s) \]

Then calculate the concentration of \([A] \) given that \( K_{eq} = 1.5 \times 10^{-3}\text{M}, \) and \([A_2] = 2.5 \times 10^{-4}\text{M}. \) Finally, predict the effect of adding some \( A_2(g) \) on the values for \([A], \) and explain your answer.

\[
K_{eq} = \frac{[A]}{[A_2]} = 1.5 \times 10^{-3} = \frac{[A]}{2.5 \times 10^{-4}} \quad [A] = 3.8 \times 10^{-7}\text{M}
\]

Adding some \( A_2(g) \) will increase the value for \([A] \) but will not change the value of \( K_{eq}. \)

9. Write an equilibrium expression for the following reaction:

\[ 2A(g) + B_2(g) \rightleftharpoons A_2B + B(g) \]

Then calculate the concentration of \( A_2B, \) given that \( K_{eq} = 7.1 \times 10^{-4}\text{M}, [A] = 1.9 \times 10^{-2}\text{M}, \) \([B_2] = 4.1 \times 10^{-3}\text{M}, \) and \([B] = 8.4 \times 10^{-3}\text{M}. \) Finally, predict the effect of adding some \( A(g) \) on the values for \([B_2], [A_2B], \) and \([B], \) and explain your answer.

\[
K_{eq} = \frac{[A_2B][B_2]}{[A]^2[B]} = 7.1 \times 10^{-4} = \frac{[A_2B]}{(1.9 \times 10^{-2})^2(4.1 \times 10^{-3})} \quad [A_2B] = 1.2 \times 10^{-1} \sim 1.3 \times 10^{-1}
\]

Adding \( A(g), \) will shift the equilibrium to the product; \([B_2] \) will decrease, \([A_2B] \) and \([B] \) will increase. \( K_{eq} \) will not change.