Question #: 1

A certain reaction has an enthalpy of $\Delta H = -68$ kJ and an activation energy of $E_a = 108$ kJ. Using the diagram below, fill in the correct value or word for each blank. Do not include units.

Energy

1. $\underline{\text{1 kJ}}$
2. $\underline{\text{activation energy, products, reactants, transition state}}$
3. $\underline{\text{3 kJ}}$
4. $\underline{\text{Activation energy for the reverse reaction = 4 kJ}}$

Item Weight: 1.0

Question #: 2

A reaction has an activation energy of 78.3 kJ/mol. If the rate constant is 12.2 s$^{-1}$ at 150. K, what is the rate constant when the temperature is increased to 175 K?

A. $3.91 \times 10^3$ s$^{-1}$
B. $8.73 \times 10^4$ s$^{-1}$
C. $1.64 \times 10^{-5}$ s$^{-1}$
D. $9.59 \times 10^4$ s$^{-1}$

Item Weight: 1.0

Question #: 3

Given the following reaction and data, what is the rate law for the reaction?

$\text{CH}_3\text{Cl}(g) + 3 \text{Cl}_2(g) \rightarrow \text{CCl}_4(g) + 3 \text{HCl}(g)$

<table>
<thead>
<tr>
<th>[CH$_3$Cl] (M)</th>
<th>[Cl$_2$] (M)</th>
<th>Initial Rate (M/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.050</td>
<td>0.050</td>
<td>0.014</td>
</tr>
<tr>
<td>0.100</td>
<td>0.050</td>
<td>0.029</td>
</tr>
<tr>
<td>0.100</td>
<td>0.100</td>
<td>0.041</td>
</tr>
<tr>
<td>0.200</td>
<td>0.200</td>
<td>0.115</td>
</tr>
</tbody>
</table>

A. rate = $k[\text{CH}_3\text{Cl}][\text{Cl}_2]^{1/2}$
B. rate = $k[\text{CH}_3\text{Cl}][\text{Cl}_2]$
C. rate = $k[\text{Cl}_2]$
D. rate = $k[\text{CH}_3\text{Cl}]^{1/2}[\text{Cl}_2]$

Item Weight: 1.0
Question #: 4

The mechanism below has been proposed for a certain gas phase reaction.

\[
\begin{align*}
\text{Step 1} & \quad \text{NO}_2 + \text{SO}_2 \leftrightharpoons \text{NO} + \text{SO}_3 \\
\text{Step 2} & \quad \text{NO} + \frac{1}{2} \text{O}_2 \leftrightharpoons \text{NO}_2
\end{align*}
\]

In this mechanism:
NO\textsubscript{2} is a ___1___ [catalyst, product, reactant, reaction intermediate] and
NO is a ___2___ [catalyst, product, reactant, reaction intermediate].

1. ____________  
2. ____________  

Item Weight: 1.0

Question #: 5

Use the diagram to fill in the blanks with the correct word or phrase from the word bank: active site, complex, enzyme, induced fit, lock-and-key, products, substrate.

Not all words or phrases will be used.

In the figure below, the ___1___ of the ___2___ is ready to accept the ___3___. Once this catalyzed reaction occurs, the ___4___ are released.

\[
\begin{align*}
\text{1. } & \quad \text{__________} \\
\text{2. } & \quad \text{__________} \\
\text{3. } & \quad \text{__________} \\
\text{4. } & \quad \text{__________}
\end{align*}
\]

Item Weight: 1.0

Question #: 6

Which two statements are true for the reaction \(\text{CO}(g) + \text{Cl}_2(g) \rightleftharpoons \text{COCl}_2(g)\) at equilibrium at 25 °C?

A. The partial pressures of CO, Cl\textsubscript{2}, and CO\textsubscript{Cl\textsubscript{2}} remain relatively constant.
B. At equilibrium, the reactions stop.
C. The rate of the reverse reaction [CO\textsubscript{Cl\textsubscript{2}}(g) \rightleftharpoons \text{CO}(g) + \text{Cl}_2(g)] is twice the rate of the forward reaction.
D. \(K_p\) for the reaction does not change when the pressure of CO\textsubscript{Cl\textsubscript{2}}(g) is reduced by half.

Item Weight: 1.0
Question #: 7

Which of the following is the correct equilibrium constant expression, $K_c$, for the reaction below?

$U(s) + 3 \text{F}_2(g) \rightleftharpoons \text{UF}_6(g)$

A. $K_c = \frac{[\text{UF}_6]}{[\text{F}_2]^3}$

B. $K_c = \frac{[\text{UF}_6]}{[\text{F}_2]}$

C. $K_c = \frac{[\text{UF}_6]}{[\text{U}][\text{F}_2]^3}$

D. $K_c = \frac{[\text{UF}_6]}{[\text{U}] + [\text{F}_2]^3}$

Item Weight: 1.0

Question #: 8

Given

$\text{HF}(aq) \rightleftharpoons \text{H}^+(aq) + \text{F}^-(aq)$

$K_c = 6.8 \times 10^{-4}$

$\text{H}_2\text{C}_2\text{O}_4(aq) \rightleftharpoons 2 \text{H}^+(aq) + \text{C}_2\text{O}_4^{2-}(aq)$

$K_c = 3.8 \times 10^{-6}$

calculate the equilibrium constant for

$2 \text{HF}(aq) + \text{C}_2\text{O}_4^{2-}(aq) \rightleftharpoons 2 \text{F}^-(aq) + \text{H}_2\text{C}_2\text{O}_4(aq)$

$K = \underline{1}$

Report your answer with two significant figures. Do NOT include units in your answer. Use the format format 2.2E2 or 2.2E-2 for numbers in scientific notation.

1. ____________

Item Weight: 1.0

Question #: 9

At 700 K, the reaction $2 \text{SO}_2(g) + \text{O}_2(g) \rightleftharpoons 2 \text{SO}_3(g)$

$K_c = 4.3 \times 10^6$

has $P_{\text{SO}_2} = P_{\text{SO}_3} = 2.20 \text{ atm}$ and $P_{\text{O}_2} = 1.25 \times 10^{-4} \text{ atm}$. Is the reaction at equilibrium?

A. The reaction is at equilibrium because $Q_p = 7.5 \times 10^4$.

B. The reaction is not at equilibrium because $Q_p = 7.5 \times 10^4$.

C. The reaction is at equilibrium because $Q_p = 8.0 \times 10^3$.

D. The reaction is not at equilibrium because $Q_p = 8.0 \times 10^3$.

Item Weight: 1.0
Question #: 10

What **two** changes occur when the temperature is **reduced**?

\[ \text{CH}_4(g) + \text{CO}_2(g) \rightleftharpoons 2 \text{CO}(g) + 2 \text{H}_2(g) \quad \Delta H_{\text{rxn}} = 248 \text{ kJ} \]

A. \( K \) increases slightly.  
B. \( K \) decreases slightly.  
C. The reaction shifts to products.  
D. The reaction shifts to reactants.  

**Item Weight: 1.0**

---

Question #: 11

Initially, only \( \text{H}_2\text{S}(g) \) is present in a reaction vessel. Once the reaction

\[ 8 \text{H}_2\text{S}(g) \rightleftharpoons 8 \text{H}_2(g) + \text{S}_8(g) \quad K_c = 57.4 \]

achieves equilibrium, the concentration of \( \text{H}_2\text{S}(g) \) has decreased to 0.125 M and the concentration of \( \text{H}_2(g) \) has increased to 0.270 M. What is the concentration of \( \text{S}_8(g) \) at equilibrium?

A. 0.121 M  
B. 0.0612 M  
C. 0.00214 M  
D. 1.27 M  

**Item Weight: 1.0**

---

Question #: 12

What is the equilibrium pressure of \( \text{PCl}_5 \) if 950 torr of \( \text{PCl}_3 \) and 570 torr of \( \text{Cl}_2 \) are added to a reaction vessel at 298 K and allowed to reach equilibrium?

\[ \text{PCl}_3(g) + \text{Cl}_2(g) \rightleftharpoons \text{PCl}_5(g) \quad K_P = 6.4 \times 10^{-3} \text{ at 298 K} \]

A. 610 torr  
B. 0.17 torr  
C. 22 torr  
D. 4.6 torr  

**Item Weight: 1.0**
Question #: 13

Given

\[ \text{SO}_2\text{Cl}_2(g) \rightleftharpoons \text{SO}_2(g) + \text{Cl}_2(g) \] and \( K_c = 0.0780 \) at 273 K,

what method must be used to solve for the equilibrium concentrations if the initial concentrations are \([\text{SO}_2\text{Cl}_2] = 0.440 \text{ M}, [\text{SO}_2] = 0.640 \text{ M}, \) and \([\text{Cl}_2] = 0.940 \text{ M}\)?

A. \( K_c = \frac{(0.640 - x)(0.940 - x)}{0.440 + x} \)

B. \( K_c = \frac{(0.640 + x)(0.940 + x)}{0.440 - x} \)

C. \( K_c = \frac{(0.640)(0.940)}{0.440 + x} \)

D. \( \sqrt{K_c} = \sqrt{\frac{(0.640 - x)^2}{(0.440 + x)^2}} \)

Item Weight: 1.0

Question #: 14

Given

\[ 2 \text{NO}(g) \rightleftharpoons \text{N}_2(g) + \text{O}_2(g) \] and \( K_c = 2.44 \times 10^3 \) at 298 K,

what method must be used to solve for the equilibrium concentrations if the initial concentrations are \([\text{NO}] = 0.400 \text{ M}, [\text{N}_2] = 0.020 \text{ M}, \) and \([\text{O}_2] = 0.020 \text{ M}\)?

A. \( K_c = \frac{(0.020 - x)^2}{(0.400 + 2x)^2} \)

B. \( K_c = \frac{(0.020 + x)^2}{(0.400 - 2x)^2} \)

C. \( K_c = \frac{(0.020 + x)}{(0.400 - 2x)^2} \)

D. \( \sqrt{K_c} = \sqrt{\frac{(0.020 + x)^2}{(0.400 - 2x)^2}} \)

Item Weight: 1.0
Question #: 15

Which choice identifies a Brønsted-Lowry conjugate acid-base pair and the function of each substance in the reaction?

\[
\text{CH}_3\text{COOH}(aq) + \text{HS}^-(aq) \rightleftharpoons \text{CH}_3\text{COO}^-(aq) + \text{H}_2\text{S}(aq)
\]

A. \text{CH}_3\text{COOH}, base; \text{CH}_3\text{COO}^-, conjugate acid  
B. \text{HS}^-, base; \text{H}_2\text{S} \text{ conjugate acid}  
C. \text{CH}_3\text{COOH}, acid; \text{H}_2\text{S}, conjugate base  
D. \text{HS}^-, acid; \text{CH}_3\text{COO}^-, conjugate base

Item Weight: 1.0

Question #: 16

Which of the following are true given \(K_w = 5.48 \times 10^{-14}\) for pure water at 50 °C?

A. \([\text{H}^+] = [\text{OH}^-] = 1.0 \times 10^{-7} \text{ M}\)  
B. \([\text{H}^+] = 1.3 \times 10^{-6} \text{ M}\)  
C. pH = 6.63  
D. pOH = 7.84

Item Weight: 1.0

Question #: 17

\([\text{H}^+] = \underline{\phantom{1}} \text{ M}\) when pOH = 10.37 at 25 °C.

Answer to two significant figures. Use the format 2.2E2 or 2.2E-2 for numbers in scientific notation.

1. \underline{\phantom{1}}

Item Weight: 1.0

Question #: 18

Given the following information, classify each solution as acidic, basic, or neutral at 25 °C.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Acidic, Basic or Neutral?</th>
</tr>
</thead>
<tbody>
<tr>
<td>pOH = 4.2</td>
<td>1</td>
</tr>
<tr>
<td>([\text{OH}^-] = 1.0 \times 10^{-8} \text{ M})</td>
<td>2</td>
</tr>
<tr>
<td>([\text{H}_3\text{O}^+] = 1.0 \times 10^{-4} \text{ M})</td>
<td>3</td>
</tr>
</tbody>
</table>

Item Weight: 1.0

Question #: 19

A 0.085 M Sr(OH)\(_2\) solution has pOH = \underline{\phantom{1}}.

Answer to two DECIMAL places.

1. \underline{\phantom{1}}

Item Weight: 1.0
Question #: 20
Which two reactions must be considered in calculating the pH in this mixture of acids?

A. HCl + H₂O → Cl⁻ + H₃O⁺
B. HClO₄ + H₂O → ClO₄⁻ + H₃O⁺
C. HClO₂ + H₂O ⇄ ClO₂⁻ + H₃O⁺
D. HClO + H₂O ⇄ ClO⁻ + H₃O⁺
E. 2 H₂O ⇄ OH⁻ + H₃O⁺  
Item Weight: 1.0

Question #: 21
Which pair has the stronger acid listed first?

A. H₂O, HF  
B. H₂S, H₂Se  
C. H₂Te, H₂S  
D. H₂Te, HI  
Item Weight: 1.0

Question #: 22
Which comparison of acidities is false?

A. H₂SO₄ is a stronger acid than H₂SO₃.  
B. HClO₄ is a stronger acid than HClO₃.  
C. HBrO₃ is a stronger acid than HIO₃.  
D. HIO is a stronger acid than HClO.  
Item Weight: 1.0

Question #: 23
Which pH is correct?

A. NaNO₂, pH = 7  
B. SrClO₄, pH >7  
C. C₅H₅NHBr, pH <7  
D. Li₂CO₃, pH <7  
Item Weight: 1.0

Question #: 24
What is $K_b$ for sodium formate at 25 °C given $K_a$ of formic acid is $1.8 \times 10^{-4}$ at this temperature?

$K_b = \text{ }$ 

Report your answer to two significant figures. Use the format 2.2E2 or 2.2E-2 for numbers in scientific notation.

1. $\text{ }$  
Item Weight: 1.0
Question #: 25

What is the pH of a 0.150 M lithium pyruvate solution (LiC$_3$H$_3$O$_3$), given $K_a$ of pyruvic acid, H$_3$C$_3$H$_3$O$_3$, is $4.1 \times 10^{-3}$?

pH = __1__

Report your answer with two DECIMAL places.

1. ___________  

Item Weight: 1.0
A certain reaction has an enthalpy of $\Delta H = -68 \text{ kJ}$ and an activation energy of $E_a = 108 \text{ kJ}$. Using the diagram below, fill in the correct value or word for each blank. Do not include units.

1. $\text{kJ}$
2. [activation energy, products, reactants, transition state]
3. $\text{kJ}$

Activation energy for the reverse reaction = $\text{4} \text{ kJ}$
A reaction has an activation energy of 78.3 kJ/mol. If the rate constant is 12.2 s\(^{-1}\) at 150 K, what is the rate constant when the temperature is increased to 175 K?

A. \(3.91 \times 10^3\) s\(^{-1}\)
B. \(8.73 \times 10^4\) s\(^{-1}\)
C. \(1.64 \times 10^{-5}\) s\(^{-1}\)
D. \(9.59 \times 10^4\) s\(^{-1}\)

Given the following reaction and data, what is the rate law for the reaction?

\[ \text{CH}_3\text{Cl}(g) + 3 \text{Cl}_2(g) \rightarrow \text{CCl}_4(g) + 3 \text{HCl}(g) \]

<table>
<thead>
<tr>
<th>[\text{CH}_3\text{Cl}] (M)</th>
<th>[\text{Cl}_2] (M)</th>
<th>Initial Rate (M/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.050</td>
<td>0.050</td>
<td>0.014</td>
</tr>
<tr>
<td>0.100</td>
<td>0.050</td>
<td>0.029</td>
</tr>
</tbody>
</table>
The mechanism below has been proposed for a certain gas phase reaction.

Step 1
\[ \text{NO}_2 + \text{SO}_2 \rightarrow \text{NO} + \text{SO}_3 \]

Step 2
\[ \text{NO} + \frac{1}{2} \text{O}_2 \rightarrow \text{NO}_2 \]

In this mechanism:

\[ \text{NO}_2 \] is a 1 reactant [catalyst, product, reactant, reaction intermediate] and
\[ \text{NO} \] is a 2 reaction intermediate [catalyst, product, reactant, reaction intermediate].

1. catalyst
2. reaction intermediate

Use the diagram to fill in the blanks with the correct word or phrase from the word bank: active site, complex, enzyme, induced fit, lock-and-key, products, substrate.

Not all words or phrases will be used.

In the figure below, the 1 of the 2 is ready to accept the 3. Once this catalyzed reaction occurs, the 4 are released.
Question #: 6

Which **two** statements are **true** for the reaction \( \text{CO}(g) + \text{Cl}_2(g) \Leftrightarrow \text{COCl}_2(g) \) at equilibrium at 25 \(^\circ\)C?

✓ A. The partial pressures of CO, Cl\(_2\), and COCl\(_2\) remain relatively constant.
B. At equilibrium, the reactions stop.
C. The rate of the reverse reaction \([\text{COCl}_2(g) \Leftrightarrow \text{CO}(g) + \text{Cl}_2(g)]\) is twice the rate of the forward reaction.
✓ D. \(K_p\) for the reaction does not change when the pressure of COCl\(_2\) is reduced by half.

Question #: 7

Which of the following is the correct equilibrium constant expression, \(K_c\), for the reaction below?
\( \text{U(s)} + 3 \text{F}_2(g) \Leftrightarrow \text{UF}_6(g) \)

✓ A. 
\[
K_c = \frac{[\text{UF}_6]}{[\text{F}_2]^3}
\]
B. 
\[
K_c = \frac{[\text{UF}_6]}{[\text{F}_2]}
\]
C. 

Given

\[ \text{HF}(aq) \rightarrow \text{H}^+(aq) + \text{F}^-(aq) \quad K_c = 6.8 \times 10^{-4} \]
\[ \text{H}_2\text{C}_2\text{O}_4(aq) \rightarrow 2 \text{H}^+(aq) + \text{C}_2\text{O}_4^{2-}(aq) \quad K_c = 3.8 \times 10^{-6} \]

calculate the equilibrium constant for
\[ 2 \text{HF}(aq) + \text{C}_2\text{O}_4^{2-}(aq) \rightarrow 2 \text{F}^-(aq) + \text{H}_2\text{C}_2\text{O}_4(aq) \quad K = \text{___} \]

Report your answer with \textbf{two} significant figures. Do \textbf{NOT} include units in your answer. Use the format 2.2E2 or 2.2E-2 for numbers in scientific notation.

1. 0.12

---

**Question #9**

At 700. K, the reaction
\[ 2 \text{SO}_2(g) + \text{O}_2(g) \rightarrow 2 \text{SO}_3(g) \quad K_c = 4.3 \times 10^6 \]
has \( P_{\text{SO}_2} = P_{\text{SO}_3} = 2.20 \text{ atm} \) and \( P_{\text{O}_2} = 1.25 \times 10^{-4} \text{ atm} \). Is the reaction at equilibrium?

A. The reaction \textbf{is} at equilibrium because \( Q_p = 7.5 \times 10^4 \).
B. The reaction \textbf{is not} at equilibrium because \( Q_p = 7.5 \times 10^4 \).
C. The reaction \textbf{is} at equilibrium because \( Q_p = 8.0 \times 10^3 \).
D. The reaction \textbf{is not} at equilibrium because \( Q_p = 8.0 \times 10^3 \).

**Question #10**
What two changes occur when the temperature is reduced?

\[
\text{CH}_4(g) + \text{CO}_2(g) \rightleftharpoons 2 \text{CO}(g) + 2 \text{H}_2(g) \quad \Delta H_{\text{rxn}} = 248 \text{ kJ}
\]

A. \( K \) increases slightly.

✓ B. \( K \) decreases slightly.

C. The reaction shifts to products.

✓ D. The reaction shifts to reactants.

---

**Question #**: 11

Initially, only \( \text{H}_2\text{S}(g) \) is present in a reaction vessel. Once the reaction

\[
8 \text{H}_2\text{S}(g) \rightleftharpoons 8 \text{H}_2(g) + \text{S}_8(g) \quad K_c = 57.4
\]

achieves equilibrium, the concentration of \( \text{H}_2\text{S}(g) \) has decreased to 0.125 M and the concentration of \( \text{H}_2(g) \) has increased to 0.270 M. What is the concentration of \( \text{S}_8(g) \) at equilibrium?

✓ A. 0.121 M

B. 0.0612 M

C. 0.00214 M

D. 1.27 M

---

**Question #**: 12

What is the equilibrium pressure of \( \text{PCl}_5 \) if 950 torr of \( \text{PCl}_3 \) and 570 torr of \( \text{Cl}_2 \) are added to a reaction vessel at 298 K and allowed to reach equilibrium?

\[
\text{PCl}_3(g) + \text{Cl}_2(g) \rightleftharpoons \text{PCl}_5(g) \quad K_P = 6.4 \times 10^{-3} \text{ at 298 K}
\]

A. 610 torr

B. 0.17 torr

C. 22 torr

✓ D. 4.6 torr
**Question # 13**

Given

\[\text{SO}_2\text{Cl}_2(g) \rightleftharpoons \text{SO}_2(g) + \text{Cl}_2(g)\]

and \(K_c = 0.0780\) at 273 K, what method must be used to solve for the equilibrium concentrations if the initial concentrations are \([\text{SO}_2\text{Cl}_2]\) = 0.440 M, \([\text{SO}_2]\) = 0.640 M, and \([\text{Cl}_2]\) = 0.940 M?

\(\checkmark\) A. \[
K_c = \frac{(0.640 - x)(0.940 - x)}{0.440 + x}
\]

B. \[
K_c = \frac{(0.640 + x)(0.940 + x)}{0.440 - x}
\]

C. \[
K_c = \frac{(0.640)(0.940)}{0.440 + x}
\]

D. \[
\sqrt{K_c} = \sqrt{\frac{(0.640 - x)^2}{(0.440 + x)^2}}
\]

**Question # 14**

Given

\[2\text{ NO}(g) \rightleftharpoons \text{N}_2(g) + \text{O}_2(g)\]

and \(K_c = 2.44 \times 10^3\) at 298 K, what method must be used to solve for the equilibrium concentrations if the initial concentrations are \([\text{NO}]\) = 0.400 M, \([\text{N}_2]\) = 0.020 M, and \([\text{O}_2]\) = 0.020 M?

A. \[
Question #: 15

Which choice identifies a Brønsted-Lowry conjugate acid-base pair and the function of each substance in the reaction?

\[ \text{CH}_3\text{COOH}(aq) + \text{HS}^--(aq) \Leftrightarrow \text{CH}_3\text{COO}^--(aq) + \text{H}_2\text{S}(aq) \]

A. \(\text{CH}_3\text{COOH}, \text{base}; \text{CH}_3\text{COO}^- \text{conjugate acid}\)

B. \(\text{HS}^-, \text{base}; \text{H}_2\text{S} \text{conjugate acid}\) ✓

C. \(\text{CH}_3\text{COOH}, \text{acid}; \text{H}_2\text{S}, \text{conjugate base}\)

D. \(\text{HS}^-, \text{acid}; \text{CH}_3\text{COO}^-, \text{conjugate base}\)

Question #: 16

Which of the following are true given \(K_w = 5.48 \times 10^{-14}\) for pure water at 50 °C?

A. \([\text{H}^+] = [\text{OH}^-] = 1.0 \times 10^{-7}\ M\)
B. \([H^+] = 1.3 \times 10^{-6} \text{ M}\)

✓ C. \(\text{pH} = 6.63\)

D. \(\text{pOH} = 7.84\)

**Question #: 17**

\([H^+] = \_1\_ \text{ M when pOH} = 10.37 \text{ at } 25 \, ^\circ\text{C.}\)

Answer to **two** significant figures. Use the format 2.2E2 or 2.2E-2 for numbers in scientific notation.

1. 2.3E-4|2.3 E-4|

**Question #: 18**

Given the following information, classify each solution as **acidic**, **basic**, or **neutral** at 25 \(^\circ\text{C.}\)

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Acidic, Basic or Neutral?</th>
</tr>
</thead>
<tbody>
<tr>
<td>pOH = 4.2</td>
<td>1</td>
</tr>
<tr>
<td>([\text{OH}^-] = 1.0 \times 10^{-8} \text{ M})</td>
<td>2</td>
</tr>
<tr>
<td>([\text{H}_3\text{O}^+] = 1.0 \times 10^{-4} \text{ M})</td>
<td>3</td>
</tr>
</tbody>
</table>

1. basic
2. acidic
3. acidic

**Question #: 19**

A 0.085 M Sr(OH)_2 solution has pOH = \_1\_.

Answer to **two DECIMAL places**.

1. 0.77|77|

**Question #: 20**
Which two reactions must be considered in calculating the pH in this mixture of acids?

a) HCl + H₂O → Cl⁻ + H₃O⁺
b) HClO₄ + H₂O → ClO₄⁻ + H₃O⁺
c) HClO₂ + H₂O ⇔ ClO₂⁻ + H₃O⁺
d) HClO + H₂O ⇔ ClO⁻ + H₃O⁺
e) 2 H₂O ⇔ OH⁻ + H₃O⁺

A. HCl + H₂O → Cl⁻ + H₃O⁺
B. HClO₄ + H₂O → ClO₄⁻ + H₃O⁺
C. HClO₂ + H₂O ⇔ ClO₂⁻ + H₃O⁺
D. HClO + H₂O ⇔ ClO⁻ + H₃O⁺
E. 2 H₂O ⇔ OH⁻ + H₃O⁺

Question #: 21

Which pair has the stronger acid listed first?

A. H₂O, HF
B. H₂S, H₂Se
C. H₂Te, H₂S
D. H₂Te, HI

C. H₂Te, H₂S

Question #: 22

Which comparison of acidities is false?

A. H₂SO₄ is a stronger acid than H₂SO₃.
B. HClO₄ is a stronger acid than HClO₃.
C. HBrO₃ is a stronger acid than HIO₃.
D. HIO is a stronger acid than HClO.

C. HBrO₃ is a stronger acid than HIO₃.

Question #: 23
Which pH is correct?

A. NaNO₂, pH = 7
B. SrClO₄, pH > 7
✓ C. C₅H₅NHBr, pH < 7
D. Li₂CO₃, pH < 7

---

**Question #: 24**

What is $K_b$ for sodium formate at 25 °C given $K_a$ of formic acid is $1.8 \times 10^{-4}$ at this temperature?

$K_b = \_\_

Report your answer to two significant figures. Use the format 2.2E2 or 2.2E-2 for numbers in scientific notation.

1. 5.6E-11

---

**Question #: 25**

What is the pH of a 0.150 M lithium pyruvate solution (LiC₃H₃O₃), given $K_a$ of pyruvic acid, H₃C₃O₃, is $4.1 \times 10^{-3}$?

pH = \_\_

Report your answer with two DECIMAL places.

1. 7.78