1. Know the meanings of and be able to apply the following terms:

| Bronsted-Lowry acid | strong acid | concentrated | chemical indicator |
| :--- | :--- | :--- | :--- |
| Bronsted-Lowry base | strong base | dilute | titration |
| conjugate acid/base pair | weak acid | equivalence point | buffer |
| amphiprotic (amphoteric) | weak base | endpoint | salt |

2. Consider these acids: $\mathrm{HClO}_{2}, \mathrm{HCN}, \mathrm{HF}, \mathrm{HCl}$
a) Arrange these acids from weakest to strongest: $\qquad$
b) Arrange these acids from lowest to highest pH : $\qquad$
c) Arrange these acids from poorest to best electrolytes: $\qquad$
d) Which of these acids will ionize the most in water? $\qquad$
e) Which one of these acids will produce the solution with the highest concentration of $\mathrm{H}_{3} \mathrm{O}^{+}(\mathrm{aq})$ ? $\qquad$
f) Which acid will react most slowly with zinc metal? $\qquad$
g) Write the chemical formula for the conjugate base of each acid: $\qquad$
h) Arrange the conjugate bases from weakest to strongest: $\qquad$
3. Calculate the pH of 0.10 M solutions of HCl and $\mathrm{HClO}_{2}$. ( pH of HCl is $1.00, \mathrm{pH}$ of $\mathrm{HClO}_{2}$ is 1.55 )
4. Write the chemical formula for the conjugate acids of these basic species:
$\mathrm{NH}_{3}$ $\qquad$ $\mathrm{OCl}^{-}$ $\qquad$ $\mathrm{HSO}_{4}^{-}$ $\qquad$ $\mathrm{H}_{2} \mathrm{O}$ $\qquad$ $\mathrm{OH}^{-}$ $\qquad$ $\mathrm{HBO}_{3}{ }^{2-}$ $\qquad$
5. Write chemical formulas showing the following species ionizing (hydrolyzing) in water. Identify all Bronsted-Lowry acids and Bronsted-Lowry bases for each reversible reaction.
a) $\mathrm{N}_{2} \mathrm{H}_{4}(\mathrm{I})+\mathrm{H}_{2} \mathrm{O}(\mathrm{I}) \leftrightarrow$
b) $\mathrm{HCOOH}+\mathrm{H}_{2} \mathrm{O}(\mathrm{I}) \leftrightarrow$
c) $\mathrm{OCN}^{-}(\mathrm{aq})+\mathrm{H}_{2} \mathrm{O}(\mathrm{I}) \leftrightarrow$
d) $\mathrm{HSO}_{4}^{-}$(aq) (as a base) $+\mathrm{H}_{2} \mathrm{O}(\mathrm{I}) \leftrightarrow$
e) $\mathrm{HSO}_{4}^{-}(\mathrm{aq})$ (as an acid) $+\mathrm{H}_{2} \mathrm{O}(\mathrm{I}) \leftrightarrow$
f) $\mathrm{PO}_{4}{ }^{3-}(\mathrm{aq})+\mathrm{H}_{2} \mathrm{O}(\mathrm{I}) \leftrightarrow$
g) $\mathrm{NH}_{4}^{+}(\mathrm{aq})+\mathrm{H}_{2} \mathrm{O}(\mathrm{I}) \leftrightarrow$
6. Write the neutralization reaction that occurs when the following acids and bases are mixed. Identify the salt. Based on the salt, describe the pH of the final solution.
a) $\mathrm{HCN}(\mathrm{aq})+\mathrm{NaOH}(\mathrm{aq}) \rightarrow$
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pH of salt:
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$\qquad$

``` pH of salt:
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``` pH of salt:
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pH of salt:

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``` pH of salt:
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``` pH of salt:
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b) \(\mathrm{HClO}_{3}(\mathrm{aq})+\mathrm{NH}_{4} \mathrm{OH}(\mathrm{aq}) \rightarrow\)
c) \(\mathrm{HF}(\mathrm{aq})+\mathrm{Ca}(\mathrm{OH})_{2}(\mathrm{aq}) \rightarrow\)
d) \(\mathrm{Co}(\mathrm{OH})_{3}(\mathrm{aq})+\mathrm{HI}(\mathrm{aq}) \rightarrow\)
e) \(\mathrm{CH}_{3} \mathrm{COOH}(\mathrm{aq})+\mathrm{KOH}(\mathrm{aq}) \rightarrow\)
f) \(\mathrm{Ba}(\mathrm{OH})_{2}(\mathrm{aq})+\mathrm{HNO}_{3}(\mathrm{aq}) \rightarrow\)
g) \(\mathrm{H}_{2} \mathrm{SO}_{4}(\mathrm{aq})+\mathrm{Be}(\mathrm{OH})_{2}(\mathrm{aq}) \rightarrow\)
7. Calculate the value of Kb for the following conjugate bases:
a) \(\mathrm{HCO}_{3}{ }^{1-}\) \(\qquad\)
b) \(\mathrm{CO}_{3}{ }^{2-}\)
c) \(\mathrm{SO}_{4}{ }^{2-}\)
d) \(\mathrm{H}_{2} \mathrm{PO}_{4}{ }^{1-}\) \(\qquad\)
e) \(\mathrm{PO}_{4}{ }^{3-}\) \(\qquad\)
8. Calculate the \(\left[\mathrm{H}_{3} \mathrm{O}^{+}\right]\)concentration of the final solution, if:
a) 28.0 mL of \(15.0 \mathrm{M} \mathrm{HNO}_{3}\) is diluted to 1.0 L
b) a solution of HF has apH of 2.56
c) the pOH of a solution is 5.15
d) 3.50 g of KOH is dissolved in 500.0 mL of distilled water
9. How much 12.0 M HCl must be diluted to make 1.50 L of 1.00 M HCl solution?
10. Calculate the pH of a 1.25 M solution of acetic acid.
11. If the pH of a 2.00 M solution of cyanic acid \((\mathrm{HOCN})\) is 1.58 , calculate the \(\mathrm{K}_{\mathrm{a}}\) for this acid. \(\left(3.5 \times 10^{-4}\right)\)
12. A 0.0125 M solution of hypobromous acid has a pH of 5.23 at \(25^{\circ} \mathrm{C}\). Calculate the \(\mathrm{K}_{\mathrm{a}}\) for this acid. \(\left(2.8 \times 10^{-9}\right)\)
13. 6.83 mL of a solution of NaOH is standardized against 3.06 g of potassium hydrogen phthlate \(\left(\mathrm{KHC}_{8} \mathrm{O}_{4} \mathrm{H}_{4}\right)\). Calculate the concentration of the base.
14. What volume of \(0.765 \mathrm{M} \mathrm{H}_{3} \mathrm{PO}_{4}\) is required to exactly neutralize 2.000 g of calcium hydroxide? ( \(0.0235 \mathrm{~L}^{2}\) of \(\mathrm{H}_{3} \mathrm{PO}_{4}\) )
15. What is the concentration of a solution of hydroiodic acid if it takes 13.16 mL of 0.508 M KOH solution to exactly titrate 25.00 mL of the hydroiodic acid?
16. 9.88 mL of 1.244 M sodium hydroxide solution is required to exactly titrate 10.00 mL of sulfuric acid. Calculate the concentration of the sulfuric acid solution.
(0.615 M)```

