CP Study Guide: Acids and Bases

1) List at least three characteristic properties of acids and three of bases.

ACID:
- 
- 
- 

BASE:
- 
- 
- 

2) Identify the acid, base, conjugate acid, and conjugate base in the following reactions:

a) \( \text{HNO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+ + \text{NO}_3^- \)
   
   acid   base   c.acid   c.base

b) \( \text{H}_2\text{C}_2\text{O}_4 + \text{CH}_3\text{NH}_2 \rightarrow \text{HC}_2\text{O}_4^- + \text{CH}_3\text{NH}_3^+ \)
   
   acid   base   c.base   c.acid

c) \( \text{NH}_4^+ + \text{H}_2\text{O} \rightarrow \text{NH}_3 + \text{H}_3\text{O}^+ \)
   
   acid   base   c.base   c.acid

3) Complete and balance the following neutralization / acid-base reactions:

a) \( 2 \text{NaOH} + \text{H}_2\text{CO}_3 \rightarrow 2\text{H}_2\text{O} + \text{Na}_2\text{CO}_3 \)

b) \( \text{H}_2\text{SO}_4 + \text{Ba(OH)}_2 \rightarrow 2\text{H}_2\text{O} + \text{BaSO}_4 \)

c) \( \text{H}_2\text{S} + 2\text{KOH} \rightarrow 2\text{H}_2\text{O} + \text{K}_2\text{S} \)

d) \( \text{Al(OH)}_3 + 3\text{HBr} \rightarrow 3\text{H}_2\text{O} + \text{AlBr}_3 \)

4) Given a salt, predict an acid-base pair which would produce the salt:

(example: \( \text{MgCl}_2 \), acid = HCl & base = Mg(OH)_2)

a) \( \text{Al}_2(\text{SO}_4)_3 \)
   
   acid = \( \text{H}_3\text{SO}_4 \)
   
   base = \( \text{Al(OH)}_3 \)

c) \( \text{CaCl}_2 \)
   
   acid = HCl
   
   base = Ca(OH)_2

b) \( \text{NH}_4\text{F} \)
   
   acid = HF
   
   base = NH_4OH

d) \( \text{KBr} \)
   
   acid = HBr
   
   base = KOH

5) A 55.6 mL sample of HCl is titrated with 79.9 mL of a 1.25 M solution of NaOH. What is the molarity of the HCl?
<table>
<thead>
<tr>
<th>Acid (HCl) +ox = +1</th>
<th>Base (NaOH) +ox = +1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Va = 55.6 mL</td>
<td>Vb = 79.9 mL</td>
</tr>
<tr>
<td>Ma = ??</td>
<td>Mb = 1.25 M</td>
</tr>
<tr>
<td>Na = ??</td>
<td>Nb = Mb(+ox) = 1.25</td>
</tr>
<tr>
<td></td>
<td>(1) = 1.25 N</td>
</tr>
</tbody>
</table>

NaVa = NbVb
Na(55.6mL) = (1.25)(79.9mL)
Na = 1.80 N

Na = Ma (+ox)
1.80 = M (1)
Ma = 1.80 M

6) Perform the following molarity/normality problems:

a) What is the normality of a 5.0 M phosphoric acid (H₃PO₄) solution?

N = M(+ox) = 5.0M (+3) = 15 N

b) Find the normality of 5.6 g HBr in 450.0 mL of solution.

SKIP, HARDER THAN WILL BE ON THE TEST

c) If 45.0 mL of 0.30 N H₂SO₄ are neutralized by 75.0 mL of NaOH, find the normality of the NaOH.

<table>
<thead>
<tr>
<th>Acid (H₂SO₄) +ox = +2</th>
<th>Base (NaOH) +ox = +1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Va = 45.0 mL</td>
<td>Vb = 75.0 mL</td>
</tr>
<tr>
<td>Ma = ??</td>
<td>Mb = ??</td>
</tr>
<tr>
<td>Na = 0.30 N</td>
<td>Nb = ?</td>
</tr>
</tbody>
</table>

NaVa = NbVb
(0.30N)(45.0mL) = Nb(75.0mL)
Nb = 0.18 N

d) A 43.7 mL sample of Ba(OH)₂ is neutralized by 33.5 mL of 0.86 M HCl. What is the normality and molarity of the Ba(OH)₂ solution?

<table>
<thead>
<tr>
<th>Acid (HCl) +ox = +1</th>
<th>Base (Ba(OH)₂) +ox = +2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Va = 33.5 mL</td>
<td>Vb = 43.7 mL</td>
</tr>
<tr>
<td>Ma = 0.86</td>
<td>Mb = ??</td>
</tr>
<tr>
<td>Na = Ma(+ox) = 0.86 (1) = 0.86 N</td>
<td>Nb = ??</td>
</tr>
</tbody>
</table>

NaVa = NbVb
(0.86N)(33.5mL) = Nb(43.7mL)
Nb = 0.66 N

Nb = Mb (+ox)
0.66 = M (2)
Ma = 0.33 M
7) Calculate the pH and pOH of the following solutions:

a) \([H^+] = 1 \times 10^{-6} \text{ M} \]
   \[\text{pH} = -\log(1 \times 10^{-6}) = 6\]
   \[\text{pOH} = 14 - \text{pH} = 14 - 6 = 8\]

b) \([H^+] = 7.4 \times 10^{-8} \text{ M} \]
   \[\text{pH} = -\log(7.4 \times 10^{-8}) = 7.1\]
   \[\text{pOH} = 14 - \text{pH} = 14 - 7.1 = 6.9\]

\[\text{c) } [H^+] = 3.22 \times 10^{-3} \text{ M} \]
   \[\text{pH} = -\log(3.22 \times 10^{-3}) = 2.49\]
   \[\text{pOH} = 14 - \text{pH} = 14 - 2.49 = 11.5\]

8) Calculate \([H^+]\) and \([OH^-]\) for the following solutions:

\[\text{pH} = -\log[H^+]\]
\[\text{pOH} = 14 - \text{pH}\]
\[10^{-\text{pH}} = [H^+]\]
\[-pH = \log[H^+]\]

a) a solution with pH = 11
   \[\text{[H}^+] = 10^{-11} \text{ M}\]

b) a solution with pH = 2.45
   \[\text{[H}^+] = 10^{-2.45} = 3.55 \times 10^{-3} \text{ M}\]

c) a solution with pOH = 1.3
   \[\text{[H}^+] = 10^{-1.3} = 5.0 \times 10^{-2} \text{ M (or 0.050 M)}\]

\[\text{[1} \times 10^{-11}\text{]} \text{[OH}^-\text{]} = 1 \times 10^{-14}\]
\[\text{[3.55} \times 10^{-3}\text{]} \text{[OH}^-\text{]} = 1 \times 10^{-14}\]
\[\text{[5.0} \times 10^{-2}\text{]} \text{[OH}^-\text{]} = 1 \times 10^{-14}\]

\[\text{[OH}^-\text{]} = 1 \times 10^{-3} \text{ M}\]
\[\text{[OH}^-\text{]} = 2.82 \times 10^{-12} \text{ M}\]
\[\text{[OH}^-\text{]} = 2 \times 10^{-13} \text{ M}\]

9) Classify each as acidic, basic or neutral.

a. \([H^+] = 6.0 \times 10^{-10} \text{ M}\)
   \[\text{pH} = -\log(6.0 \times 10^{-10}) = 9.2\]
   BASIC (pH > 7)

b. \([H^+] = 2.0 \times 10^{-7} \text{ M}\)
   \[\text{pH} = -\log(2.0 \times 10^{-7}) = 6.7\]
   hardly acidic (pH < 7)

c. \([H^+] = 2.0 \times 10^{-7} \text{ M}\)
   \[\text{pOH} = -\log(2.0 \times 10^{-7}) = 7\]
   BASIC (pH > 7)

d. \([H^+] = 1.0 \times 10^{-7} \text{ M}\)
   \[\text{pOH} = -\log(1.0 \times 10^{-7}) = 7\]
   NEUTRAL (pH = 7)

10) Rank the solutions in #9 from most acidic to most basic

M OST  A C I D I C  D  A  B  M OST  B A S I C