ACID-BASE PRACTICE TEST Name Key

$HF (aq) + H_2O (l) \leftrightharpoons H_3O^+ (aq) + F^- (aq)$ $K = 7.2 \times 10^{-4}$

1. Which species are considered to be Bronsted-Lowry acids?
   A. Only HF is a Bronsted-Lowry acid because it donates a proton
   B. HF and H_3O^+ are both Bronsted-Lowry acids because they both donate protons
   C. HF and F^- are both Bronsted-Lowry acids because HF gains a proton while F- donates a proton
   D. HF and H_2O are both Bronsted-Lowry acids because HF donates a proton while H_2O gains a proton.

Use the information below for the following two questions.

0.01 M HX	$K_a = 1.0 \times 10^{-4}$
0.01 M HA	$K_a = 1.0 \times 10^{-8}$

2. Which acid solution has a greater pH?
   A. HA because it dissociates less than HX
   B. HA because it dissociates more than HX
   C. HX because it dissociates less than HA
   D. HX because it dissociates more than HA

3. How would diluting HA from 0.15 M to 0.005 M affect the pH of the solution?
   A. The pH would decrease because the [H^+] decreases
   B. The pH would decrease because the [H^+] increases
   C. The pH would increase because the [H^+] decreases
   D. The pH would increase because the [H^+] increases

4. Aqueous solutions of equal molar concentrations of these salts are listed in order of increasing pH

   least basic — most basic

   $NaBr < NaIO_3 < NaF < NaC_2H_3O_2 < Na_2SO_3$

   Which acid is the weakest?

   ↳ conjugate of the strongest base on the list

   A. HBr
   B. HIO_3
   C. HF
   D. $NaHSO_3$

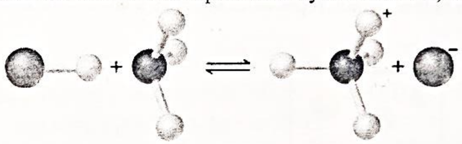
5. Which of the following is the net ionic equation for the addition of 10.0 mL of 0.10 M sulfurous acid to 10.0 mL OF 0.10 M aqueous sodium hydroxide?
   A. $H_2SO_3 + 2OH^- \leftrightharpoons 2 H_2O + SO_3^{2-}$
   B. $H_2SO4 + 2OH^- \leftrightharpoons H_2O + HSO_4^-$
   C. $H_2SO_3 + OH^- \leftrightharpoons H_2O + HSO_3^-$
   D. $H^+ + OH^- \leftrightharpoons H_2O$

6. Which of the following is NOT amphoteric?

   ↳ can donate or accept a proton (act as acid or base)

   A. HSO_3^-
   B. HPO_4^{2-}
   C. NH_4^+
   D. H_2O

The following questions refer to the diagram below, which represents an acid-base reaction. Each chemical is also represented by the letters A, B, C, or D.



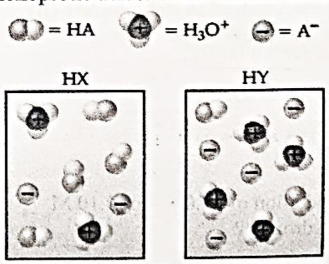
A B C D

7. Identify the conjugate acid-base pairs (acid first/base second)
   A. A/B/ and C/D
   B. A/D and B/C
   C. A/D and C/B
   D. B/C and D/A

8. Which reactant is most likely to be the acid?
   A. HF
   B. HCl
   C. HBr
   D. HI

   } all strong

The following questions refer to the diagram below, which represent aqueous solutions of two monoprotic acids. Water molecules are omitted for clarity.



9. Which of the following statements is true?
   A. HX is the stronger acid and Y^- is the stronger base
   B. HX is the stronger acid and X^- is the stronger base
   C. HY is the stronger acid and Y^- is the stronger base
   D. HY is the stronger acid and X^- is the stronger base.

10.If you mix equal concentrations of HX and Y-, what overall equilibrium reaction will occur?

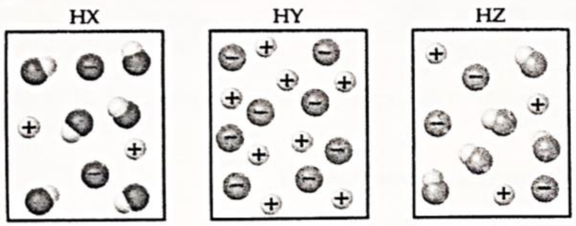
A. $HX + Y^- \rightleftharpoons HY + X^-$

B. $HX \rightleftharpoons H+ + X^-$

C. $Y^- + H_2O \rightleftharpoons HY + OH^-$

D. $HX + H_2O \rightleftharpoons H_3O^+ + X^-$

The following questions refer to the diagram below, which represents aqueous solutions of three acids



11. Identify the weak acid(s)

A. HX, HY, and HZ

B. HX and HZ only

C. HX only

D. HY only

12.Which compound(s) would have a pH greater than 7?

A. NaX, NaY, and NaZ

B. NaX and NaZ only

C. KX only

D. KZ only

X^- and Z^- are CB of weak acids

13.Equal molar concentrations of which compounds would form a buffer?

A. HX and HZ

B. HX and NaX

C. HX and HY

D. HY and NaY

$\downarrow$
weak acid
w/ its conjugate
base

The following questions refer to the system described below:

A total of 30.0 mL of a 0.10 M solution of a monoprotic acid ($K_a = 1.0 \times 10^{-5}$) is titrated with 0.20 M sodium hydroxide solution.

14.Before the titration begins, the pH of the solution is about

A. 2

B. 3

C. 7

D. 9

$1\times10^{-5} = \frac{x^2}{.1-\cancel{x}}$

$1\times10^{-6} = x^2$

$\rightarrow x = 1\times10^{-3} = [H^+]$

pH = 3

15.At the equivalence point, the pH of the solution is about

A. 2

B. 5

C. 7

D. 9

$\rightarrow$ pH must be > 7
since we have a WA w/ SB

16.What amount of NaOH is required to reach the equivalence point?

A. 15.0 mL

B. 30.0 mL

C. 45.0 mL

D. 60.0 mL

mol acid = 0.03 L × .1 M = 0.003 mol

$.20\,M\ NaOH = \frac{.003\,mol}{x\,L}$

17. The approximate pH of the solution when the weak acid is half neutralized is

A. 2

B. 5

C. 7

D. 9

$pH = pKa = -\log(1\times10^{-5})$

18.Which indicator is the most appropriate for signaling the endpoint of the titration? The approximate pH range for the color change of each indicator is given

A. Bromphenyl blue	pH = 3-4.5
B. Phenolphthalein	pH = 8-10
C. Thymol blue	pH = 1.5-2.5
D. Alizarin yellow R	pH = 11-12

19.In a research project, a scientist adds 0.1 mole of HCN, 0.1 mole of H_3O^+, and 0.1 mol of CN^- to water to make a total volume of 1 L. will this reaction proceed to a great extent in the forward direction or the reverse direction?

$HCN + H_2O \rightleftharpoons H_3O^+ + CN^-$ K_a=6.2 x 10^{-10}

A. Forward; acids always dissociate in water

B. Forward; the Q value is less than K

C. Reverse; the Q value is greater than K

D. Reverse; water cannot be a reactant.

$\frac{.1 \times .1}{.1} > 6.2\times10^{-10}$

Use the information in the chart to answering the following questions. The chart shows three acids and their Ka values.

Acid	K_{a1}	K_{a2}	K_{a3}
HNO_2	4.0×10^{-4}		
$H_2C_2O_4$	6.5×10^{-2}	6.1×10^{-5}	
H_3AsO_4	5.5×10^{-3}	1.7×10^{-7}	5.1×10^{-12}

20. Aqueous solutions of the three acids shown above are tested for their electrical conductivity. Which of the following is the correct ranking of the degree with which they conduct electricity?

A. $HNO_2 > H_2C_2O_4 > H_3AsO_4$
B. ~~$H_3AsO_4 > H_2C_2O_4 > HNO_2$~~
C. $H_2C_2O_4 > H_3AsO_4 > HNO_2$
D. None of these acids will conduct electricity because they are all weak acids

larger K = more dissociation into ions = more conductivity

21. What is the K value for the following reaction:
$H_3AsO_4 \rightleftharpoons 3\ H^+ + AsO_4^{3-}$

A. 1.2×10^{-2}
B. 5.5×10^{-3}
C. ~~1.0×10^{-14}~~
D. 4.8×10^{-21}

$K_{a1} \times K_{a2} \times K_{a3}$

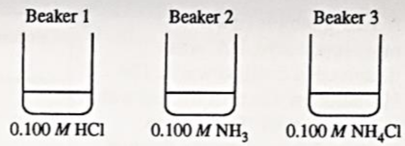
$(5.5\times10^{-3})(1.7\times10^{-7})(5.1\times10^{-12})$

22. A 0.10 M solution of which of the following salts would have the highest pH?

A. KH_2AsO_4
B. $K_2C_2O_4$
C. $NaNO_2$
D. ~~$NaNO_3$~~

look for conjugate of weakest acid tested.

1. Each of three beakers contains 25.0 mL of a 0.100 M solution of HCl, NH_3, or NH_4Cl, as shown. Each solution is at 25°C.



(a) Determine the pH of the solution in beaker 1. Justify your answer.

$pH = -\log(.1) = 1$

HCl is a strong acid

(b) In beaker 2, the reaction $NH_3(aq) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$ occurs. The value of Kb for $NH_3(aq)$ is 1.8×10^{-5} at 25°C.

(i) Write the Kb expression for the reaction of $NH_3(aq)$ with $H_2O(l)$.

$$K_b = \frac{[NH_4^+][OH^-]}{[NH_3]}$$

(ii) Calculate the $[OH^-]$ in the solution in beaker 2. $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

$1.8\times10^{-5} = \frac{x^2}{.1-x}$ $\boxed{x = [OH^-] = 0.00134\ M}$

(c) In beaker 3, the reaction $NH_4^+(aq) + H_2O(l) \rightleftharpoons NH_3(aq) + H_3O^+(aq)$ occurs.

(i) Calculate the value of Ka for $NH_4^+(aq)$ at 25°C.

$K_a = \frac{1\times10^{-14}}{K_b} = \frac{1\times10^{-14}}{1.8\times10^{-5}} = \boxed{5.56\times10^{-10}}$

(ii) The contents of beaker 2 are poured into beaker 3 and the resulting solution is stirred. Assume that volumes are additive. Calculate the pH of the resulting solution.

In resulting solution: $[NH_4^+] = [NH_3]$

$\therefore pH = pKa = -\log(5.56\times10^{-10})$ $\boxed{pH = 9.25}$

(d) The contents of beaker 1 are poured into the solution made in part (c)(ii). The resulting solution is stirred. Assume that volumes are additive.

(i) Is the resulting solution an effective buffer? Justify your answer.

No. All the NH_3 will react with the H^+ (from HCl), leaving mostly just $[NH_4^+]$ in the solution.

(ii) Calculate the final $[NH_4^+]$ in the resulting solution at 25°C.

moles in each beaker $= 0.1 \times .025 = 0.0025$ mol

when mixed, H^+ will react with NH_3 to form NH_4^+

total volume = 0.075 L

$\boxed{[NH_4^+]_{final} = \frac{0.005\ mol}{0.075\ L} = 0.0667\ M}$

2. A 1.22 g sample of a pure monoprotic acid, HA, was dissolved in distilled water. The HA solution was then titrated with 0.250 M NaOH. The pH was measured throughout the titration, and the equivalence point was reached when 40.0 mL of the NaOH solution had been added. The data from the titration are recorded in the table below.

Volume of 0.250 *M* NaOH Added (mL)	pH of Titrated Solution
0.00	?
10.0	3.72
20.0	4.20
30.0	?
40.0	8.62
50.0	12.40

(a) Explain how the data in the table above provide evidence that HA is a weak acid rather than a strong acid.

The pH at the equivalence point is above 7.

(b) Write the balanced net-ionic equation for the reaction that occurs when the solution of NaOH is added to the solution of HA.

$HA(aq) + OH^-(aq) \rightarrow A^-(aq) + H_2O(l)$

(c) Calculate the number of moles of HA that were titrated.

mol base $= 0.25\text{M} \times 0.04\,L = 0.01$ mol = mol acid

$\boxed{0.0100 \text{ mol HA}}$

(d) Calculate the molar mass of HA.

$\dfrac{1.22g}{0.01 \text{ mol}} = \boxed{122 \text{ g/mol}}$

(e) Assume that the initial concentration of the HA solution (before any NaOH solution was added) is 0.200 M. Determine the pH of the initial HA solution. The equation for the dissociation reaction of HA in water is: $HA(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + A^-(aq)$

$K_a = 6.3 \times 10^{-5}$

$6.3 \times 10^{-5} = \dfrac{x^2}{.2 - x}$ $\quad x = [H_3O^+] = 0.00355$

$\boxed{pH = 2.45}$

(f) Calculate the value of $[H_3O^+]$ in the solution after 30.0 mL of NaOH solution is added and the total volume of the solution is 80.0 mL.

initial mol HA = 0.01 mol

mol base added $= 0.25M \times 0.03L = 0.0075$ mol base

mol HA left = 0.0025 mol $\rightarrow [HA] = \dfrac{.0025}{.08}$

mol A^- formed = 0.0075 mol $\rightarrow [A^-] = \dfrac{.0075}{.08}$

$pH = pKa + \log \dfrac{[A^-]}{[HA]}$

$pH = 4.68$

$\boxed{\therefore [H_3O^+] = 2.1 \times 10^{-5}}$