Chemistry 112-2013, Exam #3, May 3 NAME: _____

Questions 1-12 = 3 points each

1. What is the conjugate base of $HC_2O_4^-$?

(a) $H_2C_2O_4$ (b) $C_2O_4^{2-}$ (c) 2 CO_2 (d) $H_3C_2O_4^+$

2. What are $[H_3O^+]$ and $[OH^-]$ for a solution that has a pH of 9.0?

(a) $[H_3O^+] = 9$ M and $[OH^-] = 5$ M

(b) $[H_3O^+] = 5$ M and $[OH^-] = 9$ M

(c) $[H_3O^+] = 1 \times 10^{-9}$ M and $[OH^-] = 1 \times 10^{-5}$ M

(d) $[H_3O^+] = 1 \times 10^{-5}$ M and $[OH^-] = 1 \times 10^{-9}$ M

(e) $[H_3O^+] = 1 \times 10^{9}$ M and $[OH^-] = 1 \times 10^{5}$ M

3. What is the pH of a 0.000483 M solution of NaOH?

(a) 4.83×10^{-4} (b) 2.07×10^{-11} (c) 10.68 (d) 3.31 (e) 7.00

4. Will $Cu_3(PO_4)_2$ be more soluble in pure water, or in water in which Na_3PO_4 has been dissolved?

$$Cu_3(PO_4)_2(s) \Leftrightarrow 3\ Cu^{2+}(aq) + 2\ PO_4^{3-}(aq)$$

Circle answer: pure water or Na_3PO_4 solution

5. Which acid base pair would be best to use for creating a buffer of pH = 3. Circle one.

a. HF/F^- b. $CH_3CO_2H/CH_3CO_2^-$

c. NH_4^+/NH_3 d. HCO_3^-/CO_3^{2-}

6. Which of the following mixtures will form a buffer solution (in 1 L water). Circle all correct choices.

0.10 mol CH_3CO_2H + 0.030 mol $NaCH_3CO_2$

0.10 mol CH_3CO_2H + 0.10 mol $NaCH_3CO_2$

0.10 mol NaCl + 0.10 mol CH_3CO_2H

7. Indicate the pH range of a solution of **each** of the following: Circle one on each line.

a) NH_4NO_3	acidic	neutral	basic
b) KNO_3	acidic	neutral	basic
c) KCN	acidic	neutral	basic

8. What types of chemical systems do K_{sp} constants describe? Choose one.

a) weak acids b) weak bases c) buffer solutions

d) soluble salts e) insoluble salts

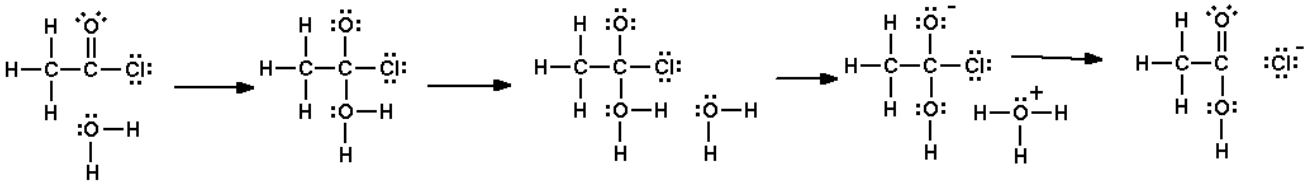
9. What is the solubility of AgBr, *in grams per liter*? Molar mass = 187.8 g/mol.

a) 1.38×10^{-4} g/L b) 1.01×10^{-10} g/L c) 5.07×10^{-11} g/L

d) 7.35×10^{-7} g/L e) 1.38×10^{-4} g/L

10. Consider the following set of reaction steps. Add the following labels to the species they represent. Point to the species and add the label. You label four things in total. If something is both Lewis and Bronsted, label it Bronsted. For example, find something that is acting as a Lewis Acid and draw and arrow to it labeled with "LA."

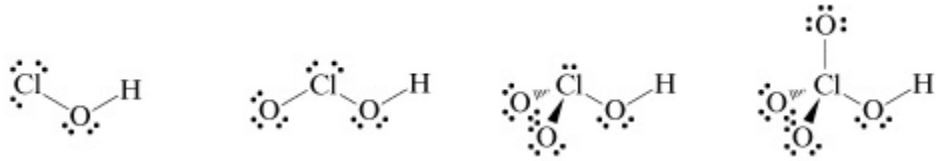
BA = Bronsted Acid	LA = Lewis Acid
BB = Bronsted Base	LB = Lewis Base



11. For each of the following, circle the one that will have the higher pH (or circle they are the same):

a. 0.1 M CH_3CO_2H	or	0.1 M $NaCH_3CO_2$	or	same
b. 0.1 M HCl	or	0.1 NaOH	or	same
c. 0.1 M HCl	or	0.1 M HNO_3	or	same

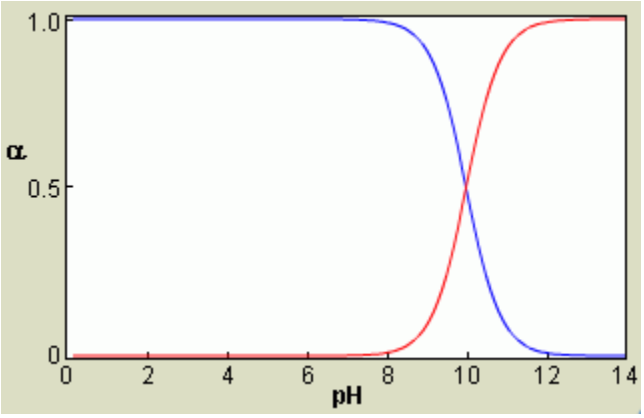
12. Which of the following acids has the largest K_a value? Circle it.



13. Write the net-ionic equation for the acid-base reaction occurring between HClO and KOH.

4 pts

14. Consider the alpha plot below, which is for an acid-base system HA/A^-. *8 pts.*



a. which species is mainly prevalent at pH = 8?

HA or A^- or about the same amount of each

b. What is pK_a of HA? _____

c. What is K_a of HA? _____

d. If this acid-base pair were a pH indicator, would it be suitable for the titration of NH_4^+ with NaOH?

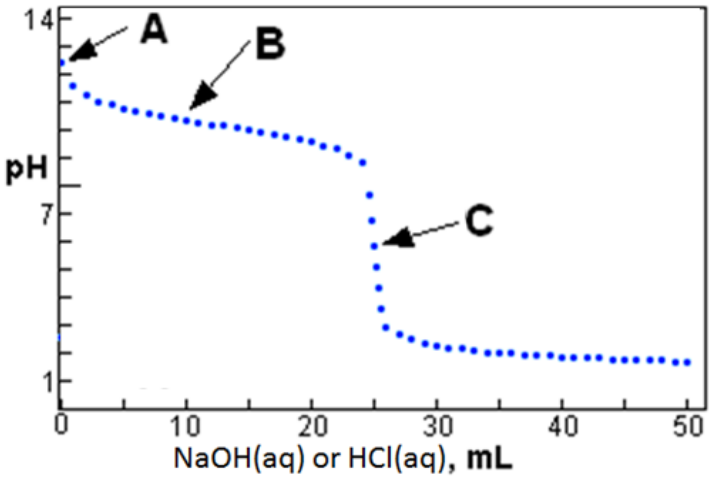
Yes or No

15. What is the pH of a 0.30 M solution of CH_3CO_2H? *12 pts*
Show your work, the ICE method must be used and presented correctly.

pH = _____

16.

Consider the titration curve below involving a weak acid (HA) and a weak base (A^-). *8 pts*



a. Which does this titration represent? Circle it.

weak acid being titrated with NaOH or

weak base being titrated with HCl

b. What is the approximate value of K_a for the acid form of the studied acid-base pair?

K_a = _____

c. What acid-base species is/are mainly in solution at point A? _____

d. What acid-base species is/are mainly in solution at point B? _____

e. What acid-base species is/are mainly in solution at point C? _____

17. A saturated solution of chromium(III) hydroxide, $Cr(OH)_3$, is found to have a pH of 10.63. What is K_{sp} for $Cr(OH)_3$ dissolution? *12 pts*

18. Part a: *10 pts*

What is the pH of a buffer solution made by mixing 100 mL of a 0.14 M $H_2PO_4^-$ and 100 mL of a 0.55 M HPO_4^{2-}?

pH = _____

Part b: 15 mL of 0.20 M NaOH is added to this buffer *10 pts*

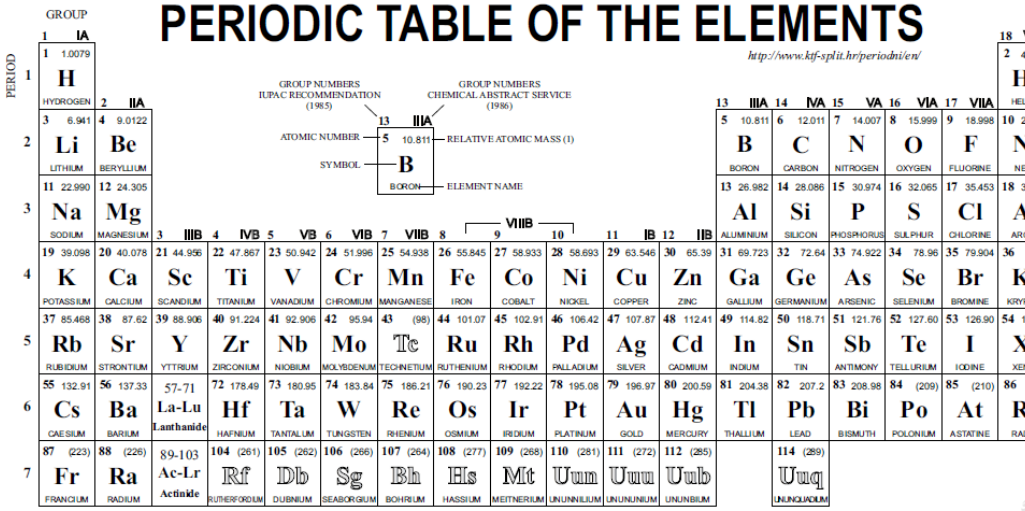
Write the reaction that occurs:

What will be the resulting pH?

K_a and K_b values for Common Weak Acids and Bases

K_a and K_b Values					
Name of Acid	**Acid**	**K_a**	**Name of Base**	**Base**	**K_b**
Hydrogen sulfate ion	HSO_4^-	1.2×10^{-2}	sulfate ion	SO_4^{2-}	8.3×10^{-13}
Phosphoric acid	H_3PO_4	7.5×10^{-3}	dihydrogen phosphate ion	$H_2PO_4^-$	1.3×10^{-12}
Hexaaquairon(III) ion	$Fe(H_2O)_6^{3+}$	6.3×10^{-3}	pentaaquahydroxoiron(III) ion	$Fe(H_2O)_5OH^{2+}$	1.6×10^{-12}
Hydrofluoric acid	HF	7.4×10^{-4}	fluoride ion	F^-	1.4×10^{-11}
Formic acid	HCO_2H	1.8×10^{-4}	formate ion	HCO_2^-	5.6×10^{-11}
Benzoic acid	$C_6H_5CO_2H$	6.3×10^{-5}	benzoate ion	$C_6H_5CO_2^-$	1.6×10^{-10}
Acetic acid	CH_3CO_2H	1.8×10^{-5}	acetate ion	$CH_3CO_2^-$	5.6×10^{-10}
Hexaaquaaluminum ion	$Al(H_2O)_6^{3+}$	7.9×10^{-6}	pentaaquahydroxoaluminum ion	$Al(H_2O)_5OH^{2+}$	1.3×10^{-9}
Carbonic acid	H_2CO_3	4.2×10^{-7}	hydrogen carbonate ion	HCO_3^-	2.4×10^{-8}
Hydrogen sulfide	H_2S	1×10^{-7}	hydrogen sulfide ion	HS^-	1×10^{-7}
Dihydrogen phosphate ion	$H_2PO_4^-$	6.2×10^{-8}	hydrogen phosphate ion	HPO_4^{2-}	1.6×10^{-7}
Hypochlorous acid	HClO	3.5×10^{-8}	hypochlorite ion	ClO^-	2.9×10^{-7}
Ammonium ion	NH_4^+	5.6×10^{-10}	ammonia	NH_3	1.8×10^{-5}
Hydrocyanic acid	HCN	4.0×10^{-10}	cyanide ion	CN^-	2.5×10^{-5}
Hexaaquairon(II) ion	$Fe(H_2O)_6^{2+}$	3.2×10^{-10}	pentaaquahydroxoiron(II) ion	$Fe(H_2O)_5OH^+$	3.1×10^{-5}
Hydrogen carbonate ion	HCO_3^-	4.8×10^{-11}	carbonate ion	CO_3^{2-}	2.1×10^{-4}
Hydrogen phosphate ion	HPO_4^{2-}	3.6×10^{-13}	phosphate ion	PO_4^{3-}	2.8×10^{-2}

K_{sp} Values for Some Insoluble Salts	
Compound	**K_{sp} at 25 °C**
$CaCO_3$	3.4×10^{-9}
$SrCO_3$	5.6×10^{-10}
$BaCO_3$	2.6×10^{-9}
$BaSO_4$	1.1×10^{-10}
CaF_2	5.3×10^{-11}
$FeCO_3$	3.1×10^{-11}
$Fe(OH)_2$	4.9×10^{-17}
AgCl	1.8×10^{-10}
AgBr	5.4×10^{-13}
AgI	8.5×10^{-17}
Ag_2CrO_4	1.1×10^{-12}
$PbCl_2$	1.7×10^{-5}
$PbCrO_4$	2.8×10^{-13}
$PbBr_2$	6.6×10^{-6}
$PbSO_4$	2.5×10^{-8}



$$pH = pK_a + \log \frac{[base]}{[acid]}$$