A.P. Chemistry Practice Test: Ch. 14, Acids and Bases

Name___________________________________

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) The conjugate base of HSO_4^- is

A) H_2SO_4 B) SO_4^{2-} C) $H_3SO_4^+$ D) HSO_4^+ E) OH^-

2) The conjugate acid of HSO_4^- is

A) H^+ B) H_2SO_4 C) HSO_4^+ D) SO_4^{2-} E) HSO_3^+

3) The molar concentration of hydronium ion in pure water at 25°C is __________.

A) 7.00 B) 1.0×10^{-7} C) 1.00 D) 1.0×10^{-14} E) 0.00

4) The molar concentration of hydroxide ion in pure water at 25°C is __________.

A) 1.00 B) 1.0×10^{-14} C) 1.0×10^{-7} D) 0.00 E) 7.00

5) What is the pH of an aqueous solution at 25°C in which $[OH^-]$ is 0.0025 M?

A) +2.60 B) –2.60 C) +11.40 D) –11.40 E) –2.25

6) What is the pH of an aqueous solution at 25° that contains 3.98×10^{-9} M hydronium ion?

A) 7.000 B) 9.000 C) 8.400 D) 5.600 E) 3.980

7) What is the concentration (in M) of hydronium ions in a solution at 25°C with pH = 4.282?

A) 4.28 B) 1.92×10^{-10} C) 1.66×10^{4} D) 9.71 E) 5.22×10^{-5}

8) Which solution below has the highest concentration of hydroxide ions?

A) pH = 3.21 B) pH = 9.82 C) pH = 7.93 D) pH = 12.59 E) pH = 7.00

9) What is the pH of a 0.015–M aqueous solution of barium hydroxide?

A) 12.18 B) 1.52 C) 12.48 D) 1.82 E) 10.35

10) Sodium hydroxide is a strong base. This means that __________.

A) aqueous solutions of NaOH contain equal concentrations of H^+ (aq) and OH^- (aq)

B) NaOH does not dissociate at all when it is dissolved in water

C) NaOH dissociates completely to Na^+(aq) and OH^-(aq) when it dissolves in water

D) NaOH cannot be neutralized by a weak acid

E) NaOH cannot be neutralized by ordinary means

11) Of the following acids, __________ is not a strong acid.

A) HNO_3 B) HCl C) HNO_2 D) $HClO_4$ E) H_2SO_4

12) Of the following, __________ is a weak acid.

A) HBr B) HF C) $HClO_4$ D) HCl E) HNO_3

13) Which one of the following is the weakest acid?

A) HF ($K_a = 6.8 \times 10^{-4}$)

B) Acetic acid ($K_a = 1.8 \times 10^{-5}$)

C) HNO_2 ($K_a = 4.5 \times 10^{-4}$)

D) HClO ($K_a = 3.0 \times 10^{-8}$)

E) HCN ($K_a = 4.9 \times 10^{-10}$)

14) HZ is a weak acid. An aqueous solution of HZ is prepared by dissolving 0.020 mol of HZ in sufficient water to yield 1.00 L of solution. The pH of the solution was 4.93 at 25°C. The K_a of HZ is __________.

A) 6.9×10^{-9} B) 1.4×10^{-10} C) 1.2×10^{-5} D) 2.8×10^{-12} E) 9.9×10^{-2}

15) The K_a of hypochlorous acid (HClO) is 3.0×10^{-8} at 25°C. What is the % ionization of hypochlorous acid in a 0.015–M aqueous solution of HClO at 25°C?

A) 1.4×10^{-3} B) 14 C) 2.1×10^{-5} D) 4.5×10^{-8} E) 0.14

16) The pH of a 0.55–M aqueous solution of hypobromous acid, HBrO, at 25°C is 4.48. What is the value of K_a for HBrO?

A) 3.3×10^{-5} B) 2.0×10^{-9} C) 6.0×10^{-5} D) 1.1×10^{-9} E) 3.0×10^{4}

17) The K_a of hypochlorous acid (HClO) is 3.0×10^{-8}. What is the pH at 25°C of an aqueous solution that is 0.020 M in HClO?

A) +2.45 B) –2.45 C) –9.22 D) +9.22 E) +4.61

18) The acid–dissociation constants of phosphoric acid (H_3PO_4) are $K_{a1} = 7.5 \times 10^{-3}$, $K_{a2} = 6.2 \times 10^{-8}$, and $K_{a3} = 4.2 \times 10^{-13}$ at 25°C. What is the pH of a 2.5–M aqueous solution of phosphoric acid?

A) 0.13 B) 1.8 C) 2.5 D) 0.40 E) 0.87

19) B is a weak base. Which equilibrium corresponds to the equilibrium constant K_a for HB^+?

A) $HB^+ (aq) + H_3O^+ (aq) \rightleftharpoons H_2B^{2+} (aq) + H_2O (l)$

B) $B (aq) + H_2O(l) \rightleftharpoons HB^+ (aq) + OH^- (aq)$

C) $HB^+ (aq) + OH^- (aq) \rightleftharpoons B (aq) + H_2O (l)$

D) $B (aq) + H_3O^+ (aq) \rightleftharpoons HB^+ (aq) + H_2O (l)$

E) $HB^+ (aq) + H_2O (l) \rightleftharpoons B (aq) + H_3O^+ (aq)$

20) The acid–dissociation constant for chlorous acid, $HClO_2$, at 25°C is 1.0×10^{-2}. Calculate the concentration of H^+ if the initial concentration of acid is 0.100 M..

A) 1.0×10^{-3} B) 1.0×10^{-2} C) 2.7×10^{-2} D) 3.7×10^{-2} E) 3.2×10^{-2}

21) Ammonia is a __________.

A) weak base B) strong acid C) salt D) strong base E) weak acid

22) The pH of a 0.10–M solution of a weak base is 9.82. What is the K_b for this base?

A) 4.3×10^{-8} B) 2.0×10^{-5} C) 6.6×10^{-4} D) 2.1×10^{-4} E) 8.8×10^{-8}

23) Using the data in the table, which of the conjugate bases below is the strongest base?

Acid	K_a
HOAc	1.8×10^{-5}
$HCHO_2$	1.8×10^{-4}
HClO	3.0×10^{-8}
HF	6.8×10^{-4}

A) F^-
B) ClO^-
C) CHO_2^-
D) OAc^-
E) OAc^- and CHO_2^-

24) The base-dissociation constant, K_b, for pyridine, C_5H_5N, is 1.4×10^{-9}. THe acid-dissociation constant, K_a, for the pyridinium ion, $C_5H_5NH^+$, is __________.

A) 7.1×10^{-6} B) 1.4×10^{-5} C) 1.0×10^{-7} D) 1.4×10^{-23} E) 7.1×10^{-4}

25) Which of the following ions will act as a weak base in water?

A) ClO^-
B) Cl^-
C) NO_3^-
D) OH^-
E) None of the above will act as a weak base in water.

26) Determine the pH of a 0.15-M aqueous solution of KF. For hydrofluoric acid, $K_a = 7.0 \times 10^{-4}$.

A) 5.83 B) 6.59 C) 8.16 D) 2.33 E) 12.01

27) A 0.0035-M aqueous solution of a particular compound has pH = 2.46. The compound is __________ .

A) a strong base B) a weak acid C) a weak base D) a strong acid E) a salt

28) The K_a for formic acid ($HCHO_2$) is 1.8×10^{-4}. What is the pH of a 0.35-M aqueous solution of sodium formate ($NaCHO_2$)?

A) 5.36 B) 8.64 C) 10.71 D) 4.20 E) 3.29

29) A 0.1–M aqueous solution of __________ will have a pH of 7.0 at 25.0°C.

$NaOCl$ KCl NH_4Cl $Ca(OAc)_2$

A) $NaOCl$
B) KCl
C) NH_4Cl
D) $Ca(OAc)_2$
E) KCl and NH_4Cl

30) An aqueous solution of __________ will produce a basic solution.
A) $NaCl$
B) $NaHSO_4$
C) KBr
D) NH_4ClO_4
E) Na_2SO_4

31) Of the following, the acid strength of __________ is the greatest.
A) Cl_3CCOOH
B) CH_3COOH
C) $BrCH_2COOH$
D) $ClCH_2COOH$
E) $Cl_2CHCOOH$

32) A 0.10–M solution of the sodium salt of which of the following anions will have the highest pH?
A) ClO_2^-
B) IO_3^-
C) IO^-
D) ClO^-
E) IO_2^-

33) Which one of the following cannot act as a Lewis base?
A) NH_3
B) BF_3
C) Cl^-
D) CN^-
E) H_2O

34) Metal oxides are typically __________ while nonmetal oxides are typically __________.
A) acidic, basic
B) basic, amphoteric
C) basic, acidic
D) amphoteric, basic
E) amphoteric, acidic

35) Which equation correctly represents the reaction between carbon dioxide and water?
A) $CO_2 (aq) + H_2O (l) \rightarrow H_2CO (aq) + O_2 (g)$
B) $CO_2 (aq) + H_2O (l) \rightarrow H_2 (g) + CO (g) + O_2 (g)$
C) $CO_2 (aq) + H_2O (l) \rightarrow H_2O_2 (aq) + CO (g)$
D) $CO_2 (aq) + 2H_2O (l) \rightarrow CH_4 (g) + 2O_2 (aq)$
E) $CO_2 (aq) + H_2O (l) \rightarrow H_2CO_3 (aq)$

36) Which of the following substances will dissolve in water to produce an acidic solution?
A) NH_3
B) Na_2O
C) $NaC_2H_3O_2$
D) $C_6H_{12}O_6$
E) $FeCl_3$

Answer Key
Testname: CH_14_PRAC_TEST_ACIDS_BASES.TST

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) B
ID: chem9b 16.1-6

2) B
ID: chem9b 16.1-7

3) B
ID: chem9b 16.1-9

4) C
ID: chem9b 16.1-10

5) C
ID: chem9b 16.1-15

6) C
ID: chem9b 16.1-16

7) E
ID: chem9b 16.1-18

8) D
ID: chem9b 16.1-22

9) C
ID: chem9b 16.1-25

10) C
ID: chem9b 16.1-28

11) C
ID: chem9b 16.1-31

12) B
ID: chem9b 16.1-32

13) E
ID: chem9b 16.1-33

14) A
ID: chem9b 16.1-34

15) E
ID: chem9b 16.1-36

16) B
ID: chem9b 16.1-37

17) E
ID: chem9b 16.1-40

18) E
ID: chem9b 16.1-47

19) E
ID: chem9b 16.1-49

20) C
ID: chem9b 16.1-52

21) A
ID: chem9b 16.1-53

22) A
ID: chem9b 16.1-54

23) B
ID: chem9b 16.1-60

24) A
ID: chem9b 16.1-62

25) A
ID: chem9b 16.1-65

26) C
ID: chem9b 16.1-68

27) D
ID: chem9b 16.1-69

28) B
ID: chem9b 16.1-72

29) B
ID: chem9b 16.1-74

30) E
ID: chem9b 16.1-77

31) A
ID: chem9b 16.1-82

32) C
ID: chem9b 16.1-85

33) B
ID: chem9b 16.1-90

34) C
ID: chem9b 22.1-70

35) E
ID: chem9b 22.1-127

36) E
ID: chem9b 16.2-11

Advanced Placement Chemistry: 1997 Free Response (and Answers)

- Question 1 is question 4 in previous years, question 2 is question 1 in previous years and questions 3&4 are questions 2&3 in previous years.
- students are now allowed 10 minutes to answer question 1, after which they must seal that portion of the test.
- [square root] applies to the numbers enclosed in parenthesis immediately following
- All simplifying assumptions are justified within 5%.
- One point deduction for a significant figure or math error, applied only once per problem.
- No credit earned for numerical answer without justification.

[. . .]

(2) The overall dissociation of oxalic acid, $H_2C_2O_4$ is represented below. The overall dissociation constant is also indicated.

$$H_2C_2O_4 <===> 2\ H^+ + C_2O_4^{2-} \quad K = 3.78 \times 10^{-6}$$

a) What volume of 0.400-molar NaOH is required to neutralize completely a 5.00×10^{-3}-mole sample of pure oxalic acid?

b) Give the equations representing the first and second dissociations of oxalic acid. Calculate the value of the first dissociation constant, K_1, for oxalic acid if the value of the second dissociation constant, K_2, is 6.40×10^{-5}

c) To a 0.015-molar solution of oxalic acid, a strong acid is added until the pH is 0.5. Calculate the $[C_2O_4^{2-}]$ in the resulting solution. (Assume the change in volume is negligible.)

d) Calculate the value of the equilibrium constant, K_b, for the reaction that occurs when solid $Na_2C_2O_4$ is dissolved in water.

(2)
(a) 5.00×10^{-3} mol $H_2C_2O_4$ = 1.00×10^{-2} mol H^+ = 1.00×10^{-2} mol OH^-
1.00×10^{-2} mol OH^- / 0.400 M = 0.0250L (25.0 mL).
Calculation from moles to volume; use of incorrect moles still earns point.
(b) There are two successive dissociations:
$H_2C_2O_4 <===> H^+ + HC_2O_4^-$ (equilibrium constant = K_1)
$HC_2O_4^- <===> H^+ + C_2O_4^{2-}$ (equilibrium constant = K_2)
Acceptable alternatives are the use of H_2O as reactant and H_3O^+ as product or writing of correct equilibrium constant expressions. Consistent errors (such as missing atoms or charges) are only penalized once.
$K_{12} = K_1$ times K_2, thus
$K_1 = K_{12} / K_2 = 3.78 \times 10^{-4} / 6.40 \times 10^{-5} = 5.91 \times 10^{-2}$; one point
c)
pH = 0.5 therefore H^+ = 0.32M (pH controls 1 sig. fig. in answer)
(This point also earned if conversion of K to pK is correct.)
K small therefore amount of dissociation small therefore assume $[H_2C_2O_4] = 0.015$
$K_{12}= ([H^+]^2 [C_2O_4^{2-}]) / [H_2C_2O_4]$,
then $[C_2O_4^{2-}] = [(3.78 \times 10^{-6}) (0.015)] / (0.32)^2 = 6 \times 10^{-7}$.
(Here 1, 2 , or 3 sig. fig.'s accepted) Two points for correct set-up with substitution and final calculation (-1 point for each error).
Alternative methods, included proper use of Henderson-Hasselbalch equation, can earn credit.
(d)
$C_2O_4^{2-} + H_2O <===> HC_2O_4^- + OH^-$ is the only significant reaction,
so $K_b= K_w / K_2 = 1.00 \times 10^{-14} / 6.40 \times 10^{-5} = 1.56 \times 10^{-10}$
No credit earned if K_1 or K_{12} used; 1, 2 , or 3 sig. fig.'s accepted since number of significant figures for value of K_w not indicated in table on examination.

AP Chemistry, Ch. 14, Acids & Bases
Practice Test

PAGE ONE

(1) This question implies that HSO_4^- is an acid.
HSO_4^- is a proton donor, therefore SO_4^{2-} is the conj. base.
Or, react it with a base to see what is produced.

$$HSO_4^- + HOH \rightleftharpoons SO_4^{2-} + H_3O^+$$

HSO_4^-: acid, proton donor
HSO_4^- / SO_4^{2-}: conjugate A-B pair
SO_4^{2-}: base, proton acceptor

(B)

(2) HSO_4^- is a base here. Let's find its conjugate acid.

$$HSO_4^- + HOH \overset{(?)}{\rightleftharpoons} H_2SO_4 + OH^-$$

note: (not likely to occur in water!)

HSO_4^-: proton acceptor, base
H_2SO_4: proton donor, acid
conjugate acid-base pair

(B)

(3) memorize this, or solve for $[H_3O^+]$:

(B) $K_w = [H_3O^+][OH^-] = 1.00 \times 10^{-14}$ where $[H_3O^+] = [OH^-]$

(4) same as #3

(C)

(5) $pOH = -\log[OH^-] = -\log[0.0025] = 2.60$ $pH = 14 - 2.60 = 11.40$

(C)

(6) $pH = -\log[H_3O^+] = -\log[3.98 \times 10^{-9}] = 8.400$ (C)

(7) $pH = -\log[H_3O^+]$

$4.282 = -\log_{10}[H_3O^+]$

$-4.282 = \log_{10}[H_3O^+]$

$10^{-4.282} = [H_3O^+] = 5.22 \times 10^{-5}$ (E)

(8) most basic = highest pH (D)

(9) $Ba(OH)_{2\,(aq)} \longrightarrow Ba^{2+}_{(aq)} + 2OH^-_{(aq)}$ (strong base)

	$Ba(OH)_{2\,(aq)}$	$Ba^{2+}_{(aq)}$	$2OH^-_{(aq)}$
I	0.015	0	0
C	−0.015	+0.015	+0.030
E	0	0.015	0.030

$pH = 14 - pOH$

$pOH = -\log[0.030] = 1.523$

$\rightarrow pH = 14 - 1.523 = 12.48$ (C)

(10) C

(11) C

(12) B

(13) smallest K_a = weakest acid (E) HCN

(14) $HZ_{(aq)} \rightleftharpoons H^+ + Z^-$

$M = \frac{0.020\,mol}{1.00\,L} = 0.020\,M$

	$HZ_{(aq)}$	H^+	Z^-
I	0.020 M	0	0
C	−x	+x	+x
E	0.020−x	x	x

$pH = 4.93 = -\log[H^+]$

$[H^+] = 10^{-4.93} = 1.175 \times 10^{-5}\,M = x$

$K_a = \frac{[H^+][Z^-]}{[HZ]} = \frac{(1.175\times10^{-5})^2}{0.02-(1.175\times10^{-5})} = 6.9 \times 10^{-9}$ (A)

(15) $HClO \rightleftharpoons H^+ + ClO^-$

	$HClO$	H^+	ClO^-
I	0.015	0	0
C	−x	+x	+x
E	.015−x	x	x

$3.0\times10^{-8} = K_a = \frac{[H^+][ClO^-]}{[HClO]}$

$3.0\times10^{-8} = \frac{x^2}{0.015-x} \approx \frac{x^2}{0.015}$

$4.5\times10^{-10} = x^2$

$2.12\times10^{-5} = x$

$100 \times \frac{2.12\times10^{-5}}{0.015} = \frac{[H^+]_{eq}}{[HClO]_0} \times 100$

✓ check: $\frac{2.12\times10^{-5}}{.015} \times 100 = 0.14\%$ Assumption OK

0.14% = % ionization (E)

(16) $HBrO \rightleftharpoons H^+ + BrO^-$

	$HBrO$	H^+	BrO^-
I	0.55	0	0
C	$-x$	$+x$	$+x$
E	$0.55-x$	x	x

$pH = 4.48 = -\log[H^+]$

$-4.48 = \log_{10}[H^+]$

$10^{-4.48} = [H^+]$

$3.31\times10^{-5} = [H^+]$

$$K_a = \frac{[H^+][BrO^-]}{[HBrO]} = \frac{x^2}{0.55-x}$$

$$= \frac{(3.31\times10^{-5})^2}{(0.55-3.31\times10^{-5})} = 2.0\times10^{-9}$$

(B)

(17) $HOCl \rightleftharpoons H^+ + OCl^-$ $K_a = 3.0\times10^{-8}$

	$HOCl$	H^+	OCl^-
I	0.020	0	0
C	$-x$	$+x$	$+x$
E	$.020-x$	x	x

$$K_a = \frac{[H^+][OCl^-]}{[HOCl]} = \frac{x^2}{0.020-x}$$

$$3.0\times10^{-8} \approx \frac{x^2}{.020}$$

$x^2 = 6\times10^{-10}$

$x = 2.45\times10^{-5}$

Check: $\frac{2.45\times10^{-5}}{0.020}\times100 = 0.12\%$ OK ✓ passes 5% test

$pH = -\log[H^+] = -\log[2.45\times10^{-5}]$

$pH = 4.61$ (E)

(18) Three acids mixed together. The 1st is 100,000 × stronger than the 2nd, which is 100,000 × stronger than the third. Assume that strongest acid dominates pH.

$H_3PO_4 \rightleftharpoons H^+ + H_2PO_4^-$ $K_a = 7.5\times10^{-3}$

	H_3PO_4	H^+	$H_2PO_4^-$
I	2.5	0	0
C	$-x$	$+x$	$+x$
E	$2.5-x$	x	x

↘

(18) (cont'd.)

PAGE FOUR

$$\frac{x^2}{2.5-x} = \frac{[H^+][H_2PO_4^-]}{[H_3PO_4]} \approx \frac{x^2}{2.5} = 7.5\times10^{-3}$$

$$x^2 = (7.5\times10^{-3})(2.5)$$

→ check: $\frac{0.137}{2.5} \times 100 = 5.48\%$

Assumption not OK

$$x = 0.137$$

$$\frac{x^2}{2.5-x} = 7.5\times10^{-3}$$

$$x^2 = (7.5\times10^{-3})(2.5) - (7.5\times10^{-3})(x)$$

$a = 1$
$b = 0.0075$
$c = -0.01875$

$$x^2 + 0.0075x - 0.01875 = 0$$

$$x = \frac{-b \pm \sqrt{b^2-4ac}}{2a} = \frac{-0.0075 \pm \sqrt{(0.0075)^2 - (4)(1)(-0.01875)}}{2}$$

$$= \frac{-0.0075 \pm \sqrt{5.625\times10^{-5} + 0.075}}{2}$$

$$= \frac{-0.0075 + .274}{2}$$

$$x = 0.133 = [H^+]$$

$$pH = -\log[H^+] = -\log[0.133]$$
$$= 0.88 \quad \text{(E)}$$

(19)

$$HB^+ + H_2O \rightleftharpoons B + H_3O^+ \quad \text{(E)}$$

"K_a" stands for the K for dissociation of an acid in H_2O.

(20) →

(20) $HClO_2 \rightleftharpoons H^+ + ClO_2^-$ $K_a = 1.0\times10^{-2}$

	$HClO_2$	H^+	ClO_2^-
I	0.100	0	0
C	$-x$	$+x$	$+x$
E	$.1-x$	x	x

$\frac{x^2}{.1-x} = 1\times10^{-2} \approx \frac{x^2}{.1} \longrightarrow x^2 = 1\times10^{-3}$

$x = 0.0316$

check: $\frac{0.0316}{0.1}\times 100 = 31.6\%$
Assumption not ok.

$\frac{x^2}{.1-x} = 0.01$

$x^2 = (0.01)(.1) - (.01)(x)$

$x^2 = .001 - .01x$

$x^2 + .01x - .001 = 0$

$a = 1$
$b = .01$
$c = -.001$

$x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$

$= \frac{-0.01 \pm \sqrt{(.01)^2-(4)(1)(-0.001)}}{2}$

$= \frac{-0.01 + \sqrt{0.0041}}{2}$

$x = 0.027$

$x = 0.0270 = [H^+]$ (C)

(21) NH_3 is a weak base (A)

(22) $B + H_2O \rightleftharpoons HB^+ + OH^-$

	B	HB^+	OH^-
I	0.1	0	0
C	$-x$	$+x$	$+x$
E	$0.1-x$	x	x

$K_b = ? = \frac{[OH^-][HB^+]}{[B]}$

$= \frac{(6.61\times10^{-5})^2}{0.1-6.61\times10^{-5}}$

$= 4.37\times10^{-8}$

$= 4.4\times10^{-8}$

(A)

$pH = 9.82$

$pOH = 14 - 9.82 = 4.18$

$pOH = -\log[OH^-] = 4.18$

$\log_{10}[OH^-] = -4.18$

$[OH^-] = 10^{-4.18}$

$[OH^-] = 6.607\times10^{-5} = x$

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(23) weakest acid = HCOO
∴ strongest base = COO⁻ { (You can verify this using $K_w = K_a \cdot K_b$) }

(24) $K_w = K_a K_b \quad K_a = \frac{K_w}{K_b} = \frac{1.0 \times 10^{-14}}{1.4 \times 10^{-9}} = 7.1 \times 10^{-6}$ (A)

(25) A = yes / b and C will not accept protons because they are the conjugate bases of strong acids. They will not react

D is a strong base

(26) $KF \xrightarrow{H_2O} K^+ + F^-$

K^+ → will not affect pH
F^- → conj. base of weak acid

$F^- + HOH \rightleftharpoons HF + OH^- \qquad K_b = \frac{K_w}{K_a} = \frac{1 \times 10^{-14}}{7 \times 10^{-4}} = 1.4 \times 10^{-11}$

	F^-	HF	OH^-
I	.15	0	0
C	−x	+x	+x
E	.15−x	x	x

$\frac{1.5 \times 10^{-6}}{.15} \times 100 = .001\%$ 5% assumption OK ✓

$1.4 \times 10^{-11} = \frac{x^2}{.15 - x} \approx \frac{x^2}{.15}$

$x^2 = 2.14 \times 10^{-12}$

$x = 1.5 \times 10^{-6} = [OH^-]$

$pOH = -\log[OH^-] = -\log[1.5 \times 10^{-6}] = 5.83$

$pH = 14 - 5.83 = 8.17$ (C)

(27) pH = 2.46 : This thing is an acid

	$HX \rightarrow$	H^+	$+ X^-$
I	.0035	0	0
C	−.0035	+.0035	+.0035
E	0	.0035	.0035

100% dissociation is implied

$[H_3O^+] = 10^{-2.46} = 3.5 \times 10^{-3} = 0.0035\ M$

because this compound's equilibrium concentration of $[H_3O^+]$ is equal to the compound's nominal (initial) conc, I guess it's a strong acid. I'm iffy on this question. (D)

(28) $NaCHO_2 \rightarrow Na^+ + CHO_2^-$

Na^+ ↓ will not affect pH

CHO_2^- ↓ conjugate base of weak acid

$$CHO_2^- + HOH \rightleftharpoons HCHO_2 + OH^-$$

	CHO_2^-	$HCHO_2$	OH^-
I	0.35	0	0
C	$-x$	$+x$	$+x$
E	$.35-x$	x	x

$K_b = \frac{K_w}{K_a} = \frac{1.0\times10^{-14}}{1.8\times10^{-4}}$

$K_b = 5.56\times10^{-11}$

$K_b = \frac{x^2}{.35-x} = 5.56\times10^{-11} \approx \frac{x^2}{.35}$

Check: $\frac{4.4\times10^{-6}}{.35} \times 100 = .0013\%$ ✓ assumption ok ✓

$x^2 = 1.946\times10^{-11}$

$x = 4.41\times10^{-6} = [OH^-]$

$pOH = -\log[OH^-] = -\log[4.41\times10^{-6}] = 5.36$

$pH = 14 - pOH = 8.64$ (B)

(29) (B), KCl, has neither the conj. base of a weak acid nor the conj. acid of a weak base. Thus it is not a hydrolyzing salt.

(30) (E) SO_4^{2-} is the conjugate base of a weak acid

$$SO_4^{2-} + HOH \rightleftharpoons HSO_4^- + OH^-$$

SO_4^{2-} thus produces hydroxide ions when dissolved in H_2O.

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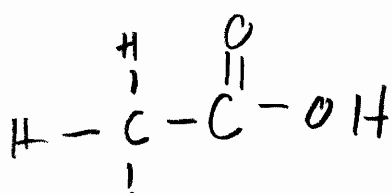
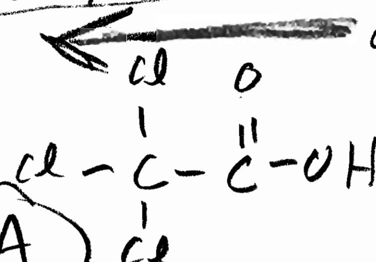
(31)



acetic acid

(A)



trichloroacetic acid

electrons pulled strongly away from O–H bond, weakening the bond, making it easier for H^+ to escape.

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(32) highest pH will come from strongest base.

$K_w = K_a K_b$, so strongest base will come from weakest conjugate acid

~~$HClO_2$~~ > $HClO$

~~HIO_3~~ > ~~HIO_2~~ > HIO

$HClO_2$ HIO
$HClO$ HIO_2
HIO_3

$HClO$ is a stronger acid than HIO because Cl is more electronegative than I

← strong pull

Cl – O – H → weaker O-H bond, H^+ easily removed

I – O – H → stronger O-H bond, H^+ harder to release

←

electrons only weakly pulled toward I

strongest base = IO^- (C)

(33) BF_3

→ great Lewis acid, but can't donate an e- pair so it's a lousy Lewis base.

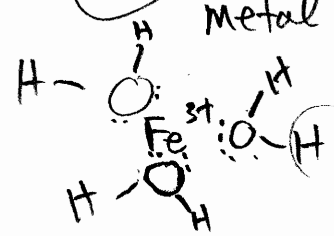
no unshared pairs on B, and B "likes" to accept e- pr to complete its octet.

(B)

(34) C

(35) E

(36) Fe^{3+} = highly charged metal ion = good Lewis acid



→ proton easily removed due to e-'s being pulled toward Fe^{3+}

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$$H_2C_2O_4 \rightleftharpoons 2H^+ + C_2O_4^{2-} \quad K = 3.78 \times 10^{-6}$$

(a) There are a couple of ways to do this. Here is one:

$$2NaOH + H_2C_2O_4 \rightarrow 2HOH + Na_2C_2O_4$$

0.400 M	M	
?	V	
1.00×10^{-2}	n	5.00×10^{-3} moles

$$5.00 \times 10^{-3} \text{ moles } H_2C_2O_4 \times \frac{2 \text{ moles NaOH}}{1 \text{ mol } H_2C_2O_4} = \frac{1.00 \times 10^{-2} \text{ mol NaOH}}{}$$

$$M = \frac{n}{V} \Rightarrow V = \frac{n}{M} = \frac{0.0100 \text{ mole NaOH}}{0.400 \frac{\text{mole}}{L} \text{ NaOH}} = 0.0250 \text{ L} = 25.0 \text{ ml}$$

(b)

$$H_2C_2O_4 \rightleftharpoons H^+ + \cancel{HC_2O_4^-} \quad Ka_1$$

$$\cancel{HC_2O_4^-} \rightleftharpoons H^+ + C_2O_4^{2-} \quad Ka_2$$

$$H_2C_2O_4 \rightleftharpoons 2H^+ + C_2O_4^{2-} \quad K_{overall}$$

$$(Ka_1)(Ka_2) = Ka_{overall}$$

$$(Ka_1)(6.40 \times 10^{-5}) = 3.78 \times 10^{-6}$$

$$Ka_1 = 5.91 \times 10^{-2}$$

(c) ~~You don't know how to do this yet.~~ Sorry. Oops. we haven't worked one like this yet. Stay tuned for buffers,

(d)

$$C_2O_4^{2-} + HOH \rightleftharpoons HC_2O_4^- + OH^- \quad K_b = \frac{K_w}{K_a}$$

$$K_b = \frac{1.0 \times 10^{-14}}{6.40 \times 10^{-5}} = 1.56 \times 10^{-10}$$