Keis for Mini Quiz

Acid dissociation constants, Ka

Acetic acid (CH_3CO_2H)	1.8×10^{-5}		
Ammonium ion (NH_4^+)	5.6×10^{-10}	Nitrous acid (HNO_2)	4.5×10^{-4}
Benzoic acid	6.5×10^{-5}	Phosphoric acid (H_3PO_4)	
Carbonic Acid (H_2CO_3)		$K_a(1)$	7.5×10^{-3}
$K_a(1)$	4.2×10^{-7}	$K_a(2)$	6.2×10^{-8}
$K_a(2)$	4.8×10^{-11}	$K_a(3)$	4.8×10^{-13}
Formic acid (HCO_2H)	1.7×10^{-4}	Sulfuric acid (H_2SO_4)	
Hydrocyanic acid (HCN)	4.9×10^{-10}	$K_a(1)$	very large
Hydrofluoric acid(HF)	7.2×10^{-4}	$K_a(2)$	1.3×10^{-2}
Hydronium ion (H_3O^+)	1.0	Water	$1. \times 10^{-14}$

1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIII	10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 Noble Gases
1 H 1.008																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.21	76 Os 190.2	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)

$$K_b = \frac{K_w}{K_a}$$ Ion product of water (K_w) = 1.0×10^{-14}

$pK_a = -\log K_a$

Henderson-Hasselbalch equation: $pH = pK_a + \log \frac{[base]}{[acid]}$

Mini Quiz Acid Base / Solubility

$CO_3^{2-} + H_2O \rightleftharpoons HCO_3^- + OH^-$

1. _____ Which one of the following gives a basic solution when dissolved in water?

A. $AlCl_3$ B. HOCl C. K_2CO_3 D. $NaClO_4$ E. NH_4NO_3

2. _____ Which one of the phrases best completes the statement?

An aqueous solution of $KHSO_4$ is:

A. acidic because K_a of HSO_4^- is greater than K_b. of HSO_4^-

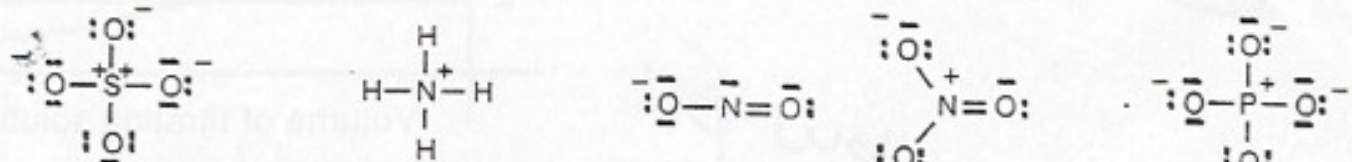
B. acidic because K^+ reacts with water to give $KOH(aq) + H^+(aq)$.

C. neutral because neither K^+ nor HSO_4^- reacts with water.

D. basic because HSO_4^- reacts with water to give $H_2SO_4\,(aq) + HO^-(aq)$.

E. basic because K_a of HSO_4^- is less than K_w.

3. _____ Which one of the following is the strongest base?



A. B. C. D. E.

4. _____ Which of the following has the lowest pH? Non metal oxide

A saturated aqueous solution of:

A. ammonia (NH_3)

B. diethyl ether ($CH_3CH_2OCH_2CH_3$)

C. potassium nitrate (KNO_3)

D. carbon dioxide (CO_2)

E. lithium oxide (Li_2O)

$CO_2 + H_2O \rightleftharpoons H_2CO_3$

5. _____ Which one of the following produces a buffer solution?

Add 100 mL of 0.1 *M* NaOH to

A. 50 mL of 0.1 *M* NaF

B. 150 mL of 0.1 *M* NaF

C. 50 mL of 0.1 *M* HF

D. 150 mL of 0.1 *M* HF

E. 100 mL of a solution that is 0.1 *M* in NaF and 0.1 *M* in HF

10 mmol OH^-

$HF + OH^- \rightarrow H_2O + F^-$

15 mmol 10 mmol

6. Which one of the following produces a buffer solution?

Add 100 mL of 0.1 *M* HCl to

A. 50 mL of 0.1 *M* NH_3

B. 150 mL of 0.1 *M* NH_3

C. 50 mL of 0.1 *M* NH_4Cl

D. 150 mL of 0.1 *M* NH_4Cl

E. 100 mL of a solution that is 0.1 *M* in NH_3 and 0.1 *M* in NH_4Cl

HCl + NH3 →
10mmol 15mmol
NH4+

7. The titration curve shown at the right is most consistent with the addition of:

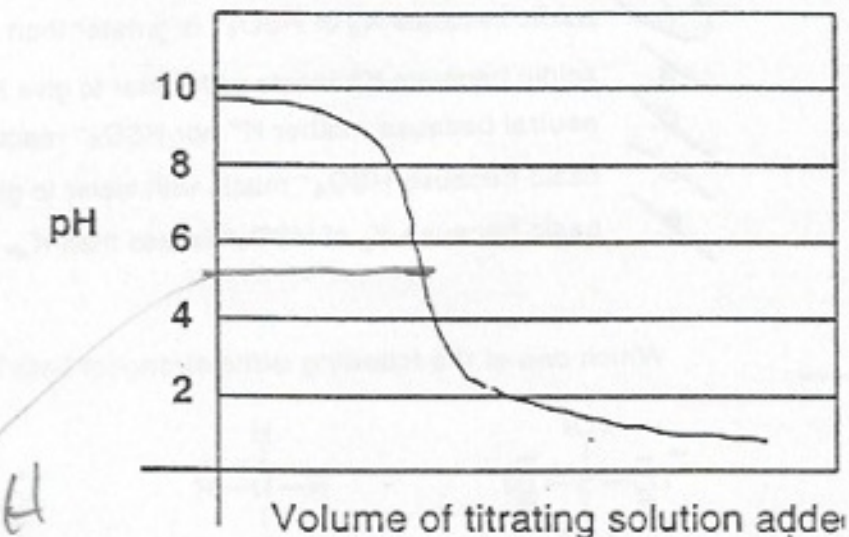
A. a strong base to a strong acid

B. a weak base to a strong acid

C. a strong base to a weak acid

D. a strong acid to a strong base

E. a strong acid to a weak base



low pH at the equivalence pt Due to

8. In the reaction shown at the right, hydroxide ion acts as:

1. Base

A. a Brønsted acid

B. a Brønsted base

C. a Lewis acid

D. a Lewis base

E. an oxidizing agent

c. Acid

electron pair donor

9. In the reaction shown, ammonia acts as:

A. a Brønsted acid

B. a Brønsted base

C. a Lewis acid

D. a Lewis base

E. an oxidizing agent

proton acceptor — electron pair donor

10. For which one of the following is the percent ionization the greatest? (Hint: You need to think in quantitative terms, but it is possible to answer the question without doing a detailed calculation.)

A. 0.1 *M* $HNO_2(aq)$

B. 0.1 *M* $NH_4^+(aq)$

C. 1.0 *M* $CH_3COOH(aq)$

D. 1.0 *M* $HCOOH(aq)$

E. 1.0 *M* $HCN(aq)$

strongest Acid

4.5 × 10⁻⁴ 1.8 × 10⁻⁵ 1.7 × 10⁻⁴

11. A saturated solution of potassium hydrogen tartrate is sometimes used as a pH reference standard and has a pH of 3.557 at 25°C. What is the hydrogen ion concentration [H^+] in this solution?

A. 6.60×10^{-3} *M*
B. 8.19×10^{-3} *M*
C. 2.77×10^{-4} *M*
D. 5.05×10^{-4} *M*
E. 7.14×10^{-4} *M*

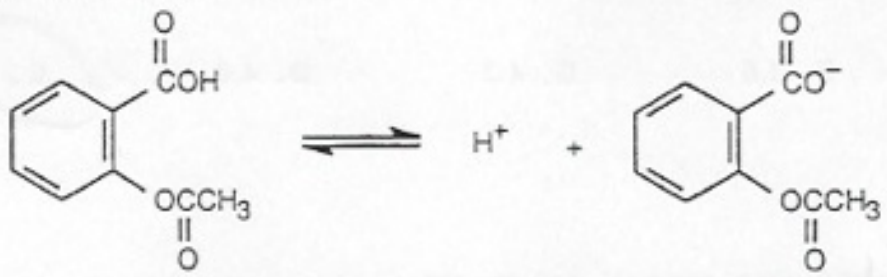
$[H^+] = 10^{-3.557}$

12. Chloroacetic acid has a K_a of 1.4×10^{-3}. What is the pH of a 0.05 *M* solution of sodium chloroacetate?

2.77×10^{-4}

A. 2.9 B. 4.7 C. 5.5 D. 7.8 E. 8.6

13. Consider aspirin, which has a K_a of 3.0×10^{-4}:



aspirin acetylsalicylate ion

What is the ratio $\frac{[\text{acetylsalicylate ion}]}{[\text{aspirin}]}$ at the pH of blood (7.40)?

A. 0.057 B. 1.68 C. 312 D. 1,425 E. 7,413

14. You are titrating 30.0 mL of a solution of 0.20 *M* acetic acid. Which one of the following best represents the contents of the acetic acid solution after 10.0 mL of 0.10 *M* KOH have been added?

	A.	B.	C.	D.	E.
mmol CH_3COOH	4.0	5.0	5.0	5.5	6.0
$[CH_3COO^-]$, mol/L	0.050	0.033	0.025	0.020	0
$[H^+]$, mol/L	3.0×10^{-5}	6.0×10^{-5}	9.0×10^{-5}	7.0×10^{-4}	4.0×10^{-3}
pH	4.33	4.13	4.04	3.52	2.70

15. In a 5.0 *M* solution of phosphoric acid, $[H^+] = 0.19$ *M*. What is $[PO_4^{3-}]$?

A. 5.3×10^{-20} *M*
B. 1.6×10^{-19} *M*
C. 6.2×10^{-8} *M*
D. 0.19 *M*
E. 0.063 *M*

16. How much KOH would you dissolve in water in order to prepare 1.00 L of a solution having a pH of 12.00?

A. 0.40 g B. 0.56 g C. 0.80 g D. 1.44 g E. 5.1 g

17. What is the pH of a solution prepared by dissolving 0.60 g of hydrogen bromide in sufficient water to give a final volume of 250 mL?

A. 1.0 B. 1.5 C. 2.0 D. 2.5 E. 3.0

18. What is the pH of a solution prepared by dissolving 0.60 g of hydrogen cyanide (HCN) in sufficient water to give a final volume of 250 mL?

A. 3.1 B. 3.6 C. 4.1 D. 4.6 E. 5.1.

19. A saturated solution of $Ca(OH)_2$ has a pH of 13.42. What is the molar solubility of $Ca(OH)_2$ in water?

A. 0.06 M B. 0.13 M C. 0.19 M D. 0.26 M E. 0.33 M

20. From among the compounds shown, which one is the **most soluble** in water? (Define solubility in this problem as molarity of a saturated solution calculated on the basis of K_{sp}.)

A.	$CaCO_3$	$K_{sp} = 2.8 \times 10^{-9}$
B.	$BaCO_3$	$K_{sp} = 5.1 \times 10^{-9}$
C.	$CuCO_3$	$K_{sp} = 1.4 \times 10^{-10}$
D.	Ag_2CO_3	$K_{sp} = 8.1 \times 10^{-12}$
E.	Hg_2CO_3	$K_{sp} = 8.9 \times 10^{-17}$

21. K_{sp} for $Ca(OH)_2$ is 5.5×10^{-6}. What is the pH of a saturated solution of $Ca(OH)_2$?

A. 11.90 B. 12.05 C. 12.20 D. 12.35 E. 12.50

5 $100\,ml \times \frac{0.1\,mmol\ OH^-}{ml} = 10\,mmol\ OH^-$

$150\,ml \times \frac{0.1\,mmol\ HF}{ml} = 15\,mmol\ HF$

$HF + OH^- \rightarrow H_2O + F^-$

15 mmol 10 mmol

5 mmol 0 10 mmol

Buffer

6 $NH_3 + H^+ \rightarrow NH_4^+$

15 mmol 10 mmol

5 mmol 0 10 mmol

Buffer

11 $pH = 3.557 = -\log[H^+]$

$[H^+] = 10^{-3.557}$

$= 2.77 \times 10^{-4} M$

12 $ClCH_2COO^- + H_2O \rightleftharpoons ClCH_2COOH + OH^-$

$0.05 - x \qquad\qquad x \qquad x$

$K_b = \frac{1 \times 10^{-14}}{1.4 \times 10^{-3}} = \frac{x^2}{0.05 - x}$

$[OH^-] = x = 5.98 \times 10^{-7}$

$pOH = 6.22$

$pH = 7.78$

13 $Aspirin \rightleftharpoons Acc^- + H^+$

$$pH = pka + \log \frac{[C.Base]}{[Acid]}$$

$$7.4 = -\log(3 \times 10^{-4}) + \log \frac{[Acc^-]}{[Aspirin]}$$

$$7535 = \frac{[Acc^-]}{[Aspirin]}$$

14 $CH_3COOH + OH^- \rightleftharpoons H_2O + CH_3COO^-$

6 mmol 1 mmol

$$\frac{5\ mmol}{40\ mL} = 0.125M$$

$$\frac{1\ mmol}{40\ mL} = 0.025M$$

$$pH = -\log 1.8 \times 10^{-5} + \log \frac{[0.025]}{[0.125]}$$

$$pH = 4.04$$

$$[H^+] = 9.1 \times 10^{-5}$$

15

$$H_3PO_4 \overset{k_1}{\rightleftharpoons} H^+ + H_2PO_4^-$$

$$H_2PO_4 \overset{k_2}{\rightleftharpoons} H^+ + HPO_4^{2-}$$

$$HPO_4^{2-} \overset{k_3}{\rightleftharpoons} H^+ + PO_4^{3-}$$

$$H_3PO_4 \overset{k}{\rightleftharpoons} 3H^+ + PO_4^{3-}$$

$$(7.5\times10^{-3})(6.2\times10^{-8})(4.8\times10^{-13}) = k$$

$$2.23\times10^{-22} = \frac{(0.19)^3(PO_4^{3-})}{5}$$

$$[PO_4^{3-}] = 1.6\times10^{-19}\,M$$

16 $pH = 12$

$[H^+] = 10^{-12}$

$[OH^-] = \frac{10^{-2}\ mol}{L} \times \frac{56\ g}{1\ mol\ KOH}$

$= 0.56\ g\ KOH$

17 $HBr \longrightarrow H^+ + Br^-$

$0.6\ g\ HBr \times \frac{1\ mol\ HBr}{80\ g} \times \frac{1}{0.25\ L} =$

$0.03\ \frac{mol\ H^+}{L}$ $pH = 1.5$

18 $0.6\,g\ HCN \times \frac{1\,mol}{27\,g} \times \frac{1}{0.25\,L}$

$= 0.088\,M\ HCN$

$HCN \rightleftharpoons H^+ + CN^-$

$0.088 - x \qquad x \qquad x$

$6.2 \times 10^{-10} = \frac{x^2}{0.088 - x}$

$[H^+] = x = 7.4 \times 10^{-6}$

$pH = 5.1$

19 $pH = 13.42$

$pOH = 0.58$

$[OH^-] = 0.26\ M$

$$Ca(OH)_{2(s)} \rightleftharpoons Ca^{2+} + 2OH^-$$

$$\tfrac{1}{2}(0.26) \qquad 0.26$$

$$[Ca^{2+}] = 0.13$$

20 $$Ag_2CO_3 \rightleftharpoons 2Ag^+ + CO_3^{2-}$$

$$2x \qquad x$$

$$8.1 \times 10^{-12} = (2x)^2 x$$

$$= 4x^3$$

$$x = 1.26 \times 10^{-4}$$

21 $Ca(OH)_{2(s)} \rightleftharpoons Ca^{2+} + 2OH^-$

$2x \qquad x$

$5.5 \times 10^{-6} = 4x^3$

$[Ca^{2+}] = x = 0.011$

$[OH^-] = 2(0.011) = 0.022$

$pOH = 1.65$

$pH = 12.35$