19.1

1. $H_2SO_{4(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + HSO_4^-{}_{(aq)}$

acid base c.acid c.base

$H_2SO_4 - HSO_4^-$

$H_2O - H_3O^+$

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2. $H_3PO_{4(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + H_2PO_4^-{}_{(aq)}$

$H_2PO_4^-{}_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + HPO_4^{2-}{}_{(aq)}$

$HPO_4^{2-}{}_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + PO_4^{3-}{}_{(aq)}$

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3. a) $HCOOH$
↳ monoprotic

b) HBr
↳ monoprotic

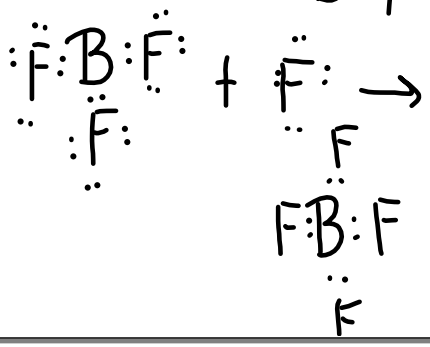
c) H_2SO_3
↳ diprotic

d) H_3ClO_4
↳ triprotic

4. $2Li_{(s)} + 2H_2O_{(l)} \rightarrow H_{2(g)} + 2LiOH_{(aq)}$

5. acid base

$BF_3 + F^- \rightarrow BF_4^-$



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19.2

1. $[H^+] = 1 \times 10^{-6} M$, $pH = 6.0$

2. $[H^+] = 7.2 \times 10^{-9} M$, $pH = 8.14$

3. $[OH^-] = 3.5 \times 10^{-2} M$, $pOH = 1.46$

4. $pH = 3.4$

$14 - 3.4 = 10.6 = pOH$

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5. a) basic
b) acidic
c) acidic
d) neutral
e) acidic

6. a) $[H^+] = 1 \times 10^{-5}\ M$, pH = 5.0

b) $[H^+] = 4.4 \times 10^{-11}\ M$, pH = 10.36

c) $[OH^-] = 2.2 \times 10^{-7}\ M$, pOH = 6.66
pH = 7.34

d) pOH = 1.4, pH = 12.6

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7. a) acidic
b) basic
c) basic
d) basic

8. Logarithms do not recognize negative exponents.

9. pOH = 12.4
pH = 1.6

10. pH = 3.0

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19.3

	HX	H	X
i	0.35	0	0
c	-x	+x	+x
e	0.35-x	4.1×10^{-2}	4.1×10^{-2}

$0.35-4.1 \times 10^{-2}$

$=0.390$

$$Ka = \frac{4.1 \times 10^{-2} \quad 4.1 \times 10^{-2}}{0.309}$$

$=5.4 \times 10^{-3}$

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x

19.3

1. strong base, weak base, weak acid, strong acid

least $[H^+]$ ——————> most $[H^+]$

2. $HF_{(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + F^-_{(aq)}$

$$K_a = \frac{[H_3O^+][F^-]}{HF}$$

3. $N_2H_4 + H_2O \rightleftharpoons N_2H_5^+ + OH^-_{(aq)}$

$$K_b = \frac{[N_2H_5^+][OH^-]}{[N_2H_4]}$$

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4. HCO_3^-, $H_2PO_4^-$, HCOOH, HOOCCOOH

weakest ⟶ strongest

5. a) $H_2S \rightleftharpoons H^+ + HS^-$ $K_a = \frac{[H^+][HS^-]}{[H_2S]}$

b) $NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+$ $K_a = \frac{[NH_3][H_3O^+]}{[NH_4^+]}$

c) $C_6H_5COOH \rightleftharpoons H^+ + C_6H_5COO^-$ $K_a = \frac{[H^+][C_6H_5COO^-]}{C_6H_5COOH}$

6. A 4
B 2
C 1
D 5
E 3
F

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7. $K_b = \frac{[C_6H_5NH_3^+][OH^-]}{[C_6H_5NH_2]}$

8. $K_a = 1.8 \times 10^{-4}$

9. $[H^+] = 3.5 \times 10^{-3} M$

10. $K_a = 4.0 \times 10^{-10}$

May 10-9:20 AM

19.4

1. $C_{NaOH} = 0.55\ mol/L$

2. $C_{Ca(OH)_2} = 4.04 \times 10^{-3}\ mol/L$

3. $C_{H_2SO_4} = 1.60 \times 10^{-2}\ mol/L$

4. $V_{Ba(OH)_2} = 12.7\ mL$

5. $V_{HCl} = 10.6\ mL$

19.5

2. a) neutral
   b) acidic
   c) basic

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$$H_3PO_4 + 3\,KOH \longrightarrow 3H_2O + K_3PO_4$$

Mole ratio of acid to base 1:3

$$1.56\ mol\ H_3PO_4 \times \frac{3\ mol\ KOH}{1\ mol\ H_3PO_4}$$

$$= 4.68\ mol\ KOH$$

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$HNO_3 + NaOH \quad H_2O \quad NaNO_3$

$0.20 \text{ mol } HNO_3$

May 14-9:02 AM

33.

$H_3PO_4 + 3NaOH \longrightarrow 3H_2O + Na_3PO_4$

$$0.0385 \text{ L NaOH} \times \frac{0.150 \text{ mol NaOH}}{1 \text{ L NaOH}} \times \frac{1 \text{ mol } H_3PO_4}{3 \text{ mol NaOH}}$$

M

$$= \frac{0.001925 \text{ mol } H_3PO_4}{0.015 \text{ L } H_3PO_4}$$

$= 0.128 \ M \ H_3PO_4$

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May 10-9:49 AM

May 10-9:51 AM