# ACID/BASE I REVIEW

KEY

| ① | [H⁺] | pH | pOH | [OH⁻] | A/B/N? |
|---|---|---|---|---|---|
| a) | $3.0\times10^{-2}$ M | 1.523 | 12.48 | $3.3\times10^{-13}$ M | A |
| b) | $4.6\times10^{-8}$ M | 7.34 | 6.66 | $2.2\times10^{-7}$ M | B |
| c) | $1.9\times10^{-12}$ M | 11.72 | 2.28 | $5.2\times10^{-3}$ M | B |
| d) | $5.9\times10^{-9}$ M | 8.23 | 5.77 | $1.7\times10^{-6}$ M | B |
| e) | $8.0\times10^{-5}$ M | 4.10 | 9.90 | $1.3\times10^{-10}$ M | A |
| f) | $1.0\times10^{-7}$ M | 7.00 | 7.00 | $1.0\times10^{-7}$ M | N |
| g) | $1.0\times10^{-3}$ M | 3.00 | 11.00 | $1.0\times10^{-11}$ M | A |
| h) | 10 M | −1.0 | 15.0 | $1\times10^{-15}$ M | A |
| i) | $1.1\times10^{-12}$ M | 11.96 | 2.06 | $8.7\times10^{-3}$ M | B |
| j) | $2.6\times10^{-6}$ M | 5.58 | 8.42 | $3.8\times10^{-9}$ M | A. |

②

$[H^+] = 3.7\times10^{-8}$ M $[OH^-] = 2.7\times10^{-7}$ M

③ a) pH = −0.30 pOH = 14.30 b) pH = 10.54, pOH = 3.46 c) 0.70, pOH = 13.30.
d) pH = 8.398 pOH = 5.602

④ $H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$

mol $H_2SO_4$ = (0.500M)(0.02500L) = 0.0125 / $H_2SO_4$ is diprotic
mol $H^+$ = 2 × 0.0125 = 0.0250
mol $OH^-$ = 0.0250
mol NaOH = 0.0250 mass NaOH = $\frac{0.0250\text{ mol}}{1}\left|\frac{40.0\text{ g}}{1\text{ mol}}\right.$ = 1.00 g NaOH

⑤ $M_iV_i = M_fV_f$
$\therefore M_f = \frac{M_iV_i}{V_f}$ $M_f = \frac{(0.15M)(0.02500L)}{0.1000L}$ = 0.0375 M
$[H_3O^+]_f$ = 0.0375M ∴ pH = 1.43

⑥ a) $H_2Te$ b) $HTe^-$

⑦ $HCO_3^- + HIO_3 \rightleftharpoons H_2CO_3 + IO_3^-$
B A A B

⑧ a) Conjugate base: The base produced when an acid reacts with water. A conj base has one less proton than its corresponding acid.

b) $\underset{A}{HCN}$, $\underset{B}{CN^-}$

⑨ $HNO_3 + KOH \longrightarrow KNO_2 + H_2O$.

mol $HNO_3$ = (0.35M)(0.25L) = 0.0875
mol $H^+$ = 0.0875
mol $OH^-$ = 0.0875
mol KOH = 0.0875
Volume KOH = $\frac{\text{mol}}{M} = \frac{0.0875\text{ mol}}{0.050M}$ = 1.75 or 1.8 L

⑩ $[H_3O^+] = 6.3\times10^{-5}$ M $[OH^-] = 1.6\times10^{-10}$ M

⑪ $HCl + KOH \longrightarrow KCl + H_2O$

mol $H^+$ = (0.150M)(0.0600L) = 0.00900
mol $OH^-$ = (0.100M)(0.1400L) = 0.01400
mol $OH^-$ in excess = 0.01400 − 0.00900 = 0.00500
$[OH^-] = \frac{0.00500\text{ mol}}{0.200\text{ L}}$ = 0.0250M ∴ pOH = 1.602 ∴ pH = 12.398

⑫ a) a substance that can act as an acid or a base
b) $H_2PO_4^-$

⑬ a) $H_2C_2O_4 + 2NaOH \longrightarrow Na_2C_2O_4 + 2H_2O$

b) $\frac{1.00\text{ g}}{90\text{ g}}\left|\frac{1\text{ mol}}{}\right.$ = 0.01111 mol / $H_2C_2O_4$ is diprotic

mol $H^+$ = 2 × 0.01111 = 0.02222 mol
mol $OH^-$ = 0.02222 mol
mol NaOH = 0.02222 mol
[NaOH] = $\frac{0.02222\text{ mol}}{0.06000\text{ L}}$ = 0.370M

⑭ $9.6\times10^{-14}$

6.51 × 2 = 13.02 = pKw
invlog(−13.02) = $9.55\times10^{-14}$

⑮ Volume NaOH = $\frac{\text{Trial 1} + \text{Trial 3}}{2} = \frac{11.33 + 11.31}{2}$ = 11.32 mL ⊗ Throw out Trial 2

$H_2C_4H_4O_6 + 2NaOH \longrightarrow Na_2C_4H_4O_6 + 2H_2O$

moles NaOH = (0.104M)(0.01132L) = $1.177\times10^{-3}$
moles $H^+$ = $1.177\times10^{-3}$
moles $H_2C_4H_4O_6$ = $1.177\times10^{-3} \div 2 = 5.886\times10^{-4}$

$5.886\times10^{-4}$ mol $\left|\frac{150.0\text{ g}}{1\text{ mol}}\right.$ = $8.829\times10^{-2}$ g

10.00 mL wine sample = 10.00 g sample due to 1.0 g/mL density

% of tartaric acid in wine = $\frac{8.829\times10^{-2}\text{ g}}{10.00\text{ g}}\times100$ = 0.883%

(16) ① Ⅲ 1.0M HBr strong acid / 100% dissoc. into charges
Ⅰ 1.0M $CH_3COOH$ weak acid } $CH_3COOH$ stronger 'weak acid' than HCN
Ⅱ 1.0M HCN weak acid } ∴ $CH_3COOH$ dissociates to a greater extent!
The more charge produced in solution, the greater the conductivity.

(17) a) $NH_4Br + KHCO_3 \longrightarrow KBr + NH_4HCO_3$

b) $NH_4^+ + HCO_3^- \rightleftharpoons NH_3 + H_2CO_3$

c) reactants $H_2CO_3$ is the stronger acid + drives the equil. to the left thereby favouring reactants.

(18) starting pH = 4.50 ∴ $[H_3O^+] = 3.16 \times 10^{-5} M$

$mol\ H_3O^+ = (3.16 \times 10^{-5} M)(140 L) = 0.00443\ mol\ H_3O^+$ in solution

target pH = 7.20 ∴ $[H_3O^+] = 6.31 \times 10^{-8} M$

$mol\ H_3O^+ = (6.31 \times 10^{-8} M)(140 L) = 8.8 \times 10^{-6}\ mol$

mol $OH^-$ needed is difference between starting and target moles of $H_3O^+$

$0.00443 - 8.8 \times 10^{-6}\ mol = 4.42 \times 10^{-3}\ mol\ OH^- \Rightarrow Ca(OH)_2 \rightarrow Ca^{2+} + 2OH^-$

$mol\ Ca(OH)_2 = \frac{4.42 \times 10^{-3}}{2} = 2.21 \times 10^{-3}$ (stoich: $4.42 \times 10^{-3} \div 2$)

$mass\ Ca(OH)_2 = 2.21 \times 10^{-3}\ mol \left| \frac{74.1\ g}{1\ mol} \right. = 1.6 \times 10^{-1}\ g$

(19) $H_3O^+$ is the strongest of any weak acid.
When any strong acid is reacted with water, it reacts 100% to form $H_3O^+$
e.g. $HCl + H_2O \xrightarrow{100\%} H_3O^+ + Cl^-$
∴ no strong acids exist in water!

(20) $pKw = -\log(2.95 \times 10^{-15}) = 1.453 \times 10^{1} = 14.530$

a) pH of pure water $= \frac{14.530}{2} = 7.265$

b) neutral as $[H_3O^+] = [OH^-]$ and/or pH = pOH.

(21) a) $HSO_3^- + IO_3^- \rightleftharpoons SO_3^{2-} + HIO_3$
A B B A

c) reactants. $HIO_3$ is a stronger acid than $HSO_3^-$, thereby driving the equation to the left, favouring reactants.

(22) a) $2H_2O + 57kJ \rightleftharpoons H_3O^+ + OH^-$ b) $Kw = [H_3O^+][OH^-]$

c) $Kw = 1.0 \times 10^{-14}$ $pKw = 14$

d) Kw increases as an increase in temp favours endothermic rxn (fwd rxn) and therefore both $[H_3O^+]$ and $[OH^-]$ increase.

(23) a) 7-8 b) 5-7 c) 10-14 d) 1-3 e) 5

(24) a) Arrhenius acid: any substance that releases $H^+$ in water.
b) Arrhenius base: any substance that releases $OH^-$ in water.
c) Bronsted-Lowry Acid: a substance that donates a proton to another substance.
d) Bronsted-Lowry Base: a substance that accepts a proton from another substance.

(25) $CO_{3\,(aq)}^{2-} + H_2O_{(l)} \rightleftharpoons HCO_{3\,(aq)}^- + OH^-_{(aq)}$

$Al(H_2O)_{6\,(aq)}^{3+} + H_2O_{(l)} \rightleftharpoons Al(H_2O)_5(OH)_{(aq)}^{2+} + H_3O^+_{(aq)}$

(26) a) Conductivity test
The strong acid solution will conduct much better than an equal molar concentration of a weak acid solution

b) pH meter
The strong acid solution will have a lower pH than an equal molar concentration of a weak acid solution.