Unit 4 - Chapter 4 End of Chapter Practice Problems - KEY

1. A) $49.73\text{g } H_2SO_4 \left| \frac{1\text{ mol } H_2SO_4}{98\text{g } H_2SO_4} \right. = \frac{0.5\text{ mol } H_2SO_4}{0.500\text{ L soln}} = \boxed{1.01\text{ M } H_2SO_4}$

$2H \times 1 = 2$
$1S \times 32 = 32$
$40 \times 16 = 64$
98

B) $5.035\text{g } FeCl_3 \left| \frac{1\text{ mol } FeCl_3}{162.5\text{g } FeCl_3} \right. = \frac{0.031\text{ mol } FeCl_3}{0.250\text{ L}} = \boxed{0.12\text{M}}$

$1Fe \times 56 = 56$
$3Cl \times 35.5 = 106.5$
162.5

2. A) $21.18\text{g } Fe(NO_3)_3 \left| \frac{1\text{ mol } Fe(NO_3)_3}{242\text{g } Fe(NO_3)_3} \right. = \frac{0.088\text{ mol } Fe(NO_3)_3}{1\text{ L soln}} = \boxed{0.088\text{M } Fe(NO_3)_3}$

$1Fe \times 56 = 56$
$3N \times 14 = 42$
$90 \times 16 = 144$
242

B) $72.06\text{g } BaCl_2 \left| \frac{1\text{ mol } BaCl_2}{208\text{g } BaCl_2} \right. = \frac{0.346\text{ mol } BaCl_2}{0.5\text{ L soln}} = \boxed{0.69\text{M } BaCl_2}$

$1Ba \times 137 = 137$
$2Cl \times 35.5 = 71$
208

3. A) $0.25\text{ M } Na_3PO_4 = \frac{0.25\text{ mol } Na_3PO_4}{1\text{ L soln}} \left| \frac{3\text{ mol } Na^+}{1\text{ mol } Na_3PO_4} \right. = \boxed{0.75\text{ mol } Na^+}$

$\frac{0.25\text{ mol } Na_3PO_4}{1\text{ L soln}} \left| \frac{1\text{ mol } PO_4^{-3}}{1\text{ mol } Na_3PO_4} \right. = \boxed{0.25\text{ mol } PO_4^{-3}}$

B) $0.87\text{M } Na_2CO_3 = \frac{0.87\text{ mol } Na_2CO_3}{1\text{ L soln}} \left| \frac{2\text{ mol } Na^+}{1\text{ mol } Na_2CO_3} \right. = \boxed{1.74\text{ mol } Na^+}$

$\frac{0.87\text{ mol } Na_2CO_3}{1\text{ L soln}} \left| \frac{1\text{ mol } CO_3^{-2}}{1\text{ mol } Na_2CO_3} \right. = \boxed{0.87\text{ mol } CO_3^{-2}}$

4. A) $1.5\text{M } KMnO_4 = \frac{1.5\text{ mol } KMnO_4}{1\text{ L soln}} \left| \frac{1\text{ L soln used}}{} \right. = 1.5\text{ mol } KMnO_4 \left| \frac{158\text{g } KMnO_4}{1\text{ mol } KMnO_4} \right. = \boxed{\begin{array}{l}237\text{g } KMnO_4 \\ +\text{ADD } H_2O \text{ TO} \\ 1\text{ L MARK}\end{array}}$

$1K \times 39 = 39$
$1Mn \times 55 = 55$
$40 \times 16 = 64$
158

B) $0.2\text{M } AgNO_3 = \frac{0.2\text{ mol } AgNO_3}{1\text{ L soln}} \left| \frac{0.25\text{ L}}{} \right. = 0.05\text{ mol } AgNO_3 \left| \frac{170\text{g } AgNO_3}{1\text{ mol } AgNO_3} \right. = \boxed{\begin{array}{l}8.5\text{g } AgNO_3 \\ +\text{ADD } H_2O \text{ TO} \\ 250\text{mL MARK}\end{array}}$

$1Ag \times 108 = 108$
$1N \times 14 = 14$
$30 \times 16 = 48$
170

5. A) $(500\text{mL})(1.0\text{M}) = \underbrace{(X\text{ mL})(17.8\text{M})}_{\text{STOCK SOL'N}}$ $\boxed{X = 28\text{mL STOCK SOL'N} + \text{ADD IT TO } 472\text{mL } H_2O}$

$500 - 28 = 472\text{mL } H_2O$

B) $(1.5\text{ L})(0.25\text{M}) = \underbrace{(X\text{ L})(1.0\text{M})}_{\text{STOCK SOL'N}}$ $\boxed{X = 0.375\text{ L STOCK SOL'N} + \text{ADD IT TO } 1.125\text{ L } H_2O}$

(375mL) $1.5\text{ L} - .375\text{ L} = 1.125\text{ L } H_2O$

C) $M = \frac{\text{mol SOLUTE}}{\text{L SOL'N}}$ $0.15\text{M} = \frac{X\text{ mol } KBrO_3}{1.0\text{ L SOL'N}}$ $X = 0.15\text{ mol } KBrO_3 \left| \frac{167\text{g } KBrO_3}{1\text{ mol } KBrO_3} \right. = \boxed{\begin{array}{l}25\text{g } KBrO_3 \\ +\text{ADD } H_2O \\ \text{TO 1.0L} \\ \text{MARK}\end{array}}$

$1K \times 39 = 39$
$1Br \times 80 = 80$
$30 \times 16 = 48$
167

6. $3.697\text{g KHP} \left| \frac{1\text{ mol KHP}}{204\text{g KHP}} \right. = \frac{0.018\text{mol KHP}}{0.1000\text{L Sol'N}} = \boxed{0.18\text{M KHP}}$

$8\text{C} \times 12 = 96$
$5\text{H} \times 1 = 5$
$4\text{O} \times 16 = 64$
$1\text{K} \times 39 = 39$
204

7. $120.0\text{g NaOH} \left| \frac{1\text{ mol NaOH}}{40\text{g NaOH}} \right. = \frac{3\text{ mol NaOH}}{0.500\text{L Sol'N}} = \boxed{6.00\text{M}}$

$1\text{Na} \times 23 = 23$
$1\text{O} \times 16 = 16$
$1\text{H} \times 1 = 1$
40

8. $2\,HCl + Ca(OH)_2 \rightarrow CaCl_2 + 2H_2O$

0.12M, 30mL — 0.50M, ?mL

$0.12\text{M HCl} = \frac{0.12\text{mol HCl}}{1\text{L Sol'N}} \left| 0.030\text{L} \right. = 0.036\text{mol HCl} \left| \frac{1\text{mol Ca(OH)}_2}{2\text{mol HCl}} \right. = 0.0018\text{mol Ca(OH)}_2$

$\frac{0.5\text{M Ca(OH)}_2}{} = \frac{0.0018\text{mol Ca(OH)}_2}{X\text{ L}}$

$X = 0.0036\text{L} = \boxed{3.6\text{mL Ca(OH)}_2}$

9. A) $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

B) $Mg_3N_2 + 3H_2O \rightarrow 3MgO + 2NH_3$

10. A) $2NaCl_{(aq)} + Hg_2(NO_3)_{2(aq)} \rightarrow 2NaNO_{3(aq)} + Hg_2Cl_{2(s)}$

B) $Ca(OH)_{2(aq)} + Na_2CO_{3(aq)} \rightarrow CaCO_{3(s)} + 2NaOH_{(aq)}$

11. A) $Na_2S_{(aq)} + Cu(NO_3)_{2(aq)} \rightarrow NaNO_{3(aq)} + CuS_{(s)}$

$Na^+_{(aq)} + S^{-2}_{(aq)} + Cu^{+2}_{(aq)} + NO_3^{-1}_{(aq)} \rightarrow Na^{+1}_{(aq)} + NO_3^{-1}_{(aq)} + CuS_{(s)}$

$S^{-2}_{(aq)} + Cu^{2+}_{(aq)} \rightarrow CuS_{(s)}$

B) $HF_{(aq)} + KOH_{(aq)} \rightarrow H_2O_{(l)} + KF_{(aq)}$

$H^+_{(aq)} + F^-_{(aq)} + K^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)} + K^+_{(aq)} + F^-_{(aq)}$

$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$

12. $Na_2CO_3 + CaF_2 \rightarrow CaCO_3 + 2\,NaF$

1.5 mol — 0.75 mol — ? g

$1.5\text{mol Na}_2\text{CO}_3 \left| \frac{1\text{mol CaCO}_3}{1\text{mol Na}_2\text{CO}_3} \right| \frac{100\text{g CaCO}_3}{1\text{mol CaCO}_3} = 1500\text{g CaCO}_3$

$0.75\text{mol CaF}_2 \left| \frac{1\text{mol CaCO}_3}{1\text{mol CaF}_2} \right| \frac{100\text{g CaCO}_3}{1\text{mol CaCO}_3} = \boxed{75\text{g CaCO}_3}$

$1\text{Ca} \times 40 = 40$
$1\text{C} \times 12 = 12$
$3\text{O} \times 16 = 48$
100

13. $HCl + NaOH \rightarrow NaCl + H_2O$

0.1379M, ? mL — 0.2789M, 10.0mL

$0.2789\text{M NaOH} = \frac{0.2789\text{mol}}{1\text{L Sol'N}} \left| 0.010\text{L} \right. = 0.002789\text{mol NaOH} \left| \frac{1\text{mol HCl}}{1\text{mol NaOH}} \right. = 0.002789\text{mol HCl}$

$0.1379\text{M HCl} = \frac{0.002789\text{mol HCl}}{X\text{ L}}$

$X = 0.0202\text{L} = \boxed{20.2\text{mL HCl}}$

14. $2\,NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

1.50M 0.5M

?mL 275mL

$0.5\,M\ H_2SO_4 = \frac{0.5\,mol\,H_2SO_4}{1\,L\,Sol'N} \left| \frac{0.275\,L}{} \right. = 0.1375\,mol\,H_2SO_4 \left| \frac{2\,mol\,NaOH}{1\,mol\,H_2SO_4} \right. = 0.275\,mol\,NaOH$

$1.50M\ NaOH = \frac{0.275\,mol\,NaOH}{X\ L} \qquad X = 0.183L = \boxed{183mL\ NaOH}$

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15. a) $2H_3PO_4 + 3Mg(OH)_2 \rightarrow Mg_3(PO_4)_2 + 6H_2O$

b) $2HC_2H_3O_2 + Ba(OH)_2 \rightarrow Ba(C_2H_3O_2)_2 + 2H_2O$

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16. $(X\,mL)(1OH^-)(.2M) = (50mL)(2H^+)(0.1M)$ $\boxed{X = 50mL}$

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17. *MONOPROTIC BASE = $1\,OH^-$*

$(30.0mL)(1OH^-)(X\,M) = (12.0mL)(1H^+)(0.15M)$ $\boxed{X = 0.06M}$

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18. a) $Sn^{2+} + Cu^{2+} \rightarrow Sn^{4+} + Cu^{+}$

STEP 1 (½ RXNS)

RED: $Cu^{2+} \rightarrow Cu^{+1}$

OXID: $Sn^{2+} \rightarrow Sn^{+4}$

STEP 2 (BALANCE CHARGES)

$1e^- + Cu^{2+} \rightarrow Cu^{+1}$

$Sn^{2+} \rightarrow Sn^{+4} + 2e^-$

STEP 3 (BALANCE e^- BETWEEN EQUATIONS)

$2(1e^- + Cu^{2+} \rightarrow Cu^{+1})$

$Sn^{2+} \rightarrow Sn^{+4} + 2e^-$

STEP 4 (ADD EQUATIONS)

$2e^- + 2Cu^{2+} + Sn^{2+} \rightarrow 2Cu^{+1} + Sn^{+4} + 2e^-$

STEP 5 (CANCEL e^-)

$\boxed{2Cu^{2+} + Sn^{2+} \rightarrow 2Cu^{+1} + Sn^{+4}}$

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b) $Br_2^{0} + S^{+4}O_2^{-2} + H_2^{+1}O^{-2} \rightarrow H^{+1} + Br^{-1} + H_2^{+6}S^{-2}O_4^{-2}$

STEP 1

RED: $Br_2 \rightarrow Br^{-1}$

OXID: $SO_2 + H_2O \rightarrow SO_4^{-2} + H^+$

STEP 2

$Br_2 \rightarrow 2Br^{-1}$

$SO_2 + H_2O \rightarrow SO_4^{-2} + H^+$

STEP 3

$Br_2 \rightarrow 2Br^{-1}$

$H_2O + SO_2 + H_2O \rightarrow SO_4^{-2} + H^+$

STEP 4

$Br_2 \rightarrow 2Br^{-1}$

$H_2O + SO_2 + H_2O \rightarrow SO_4^{-2} + 4H^+$

STEP 5

$2e^- + Br_2 \rightarrow 2Br^{-1}$

$2H_2O + SO_2 \rightarrow SO_4^{-2} + 4H^+ + 2e^-$

STEP 6

$2e^- + Br_2 + 2H_2O + SO_2 \rightarrow 2Br^{-1} + SO_4^{-2} + 4H^+ + 2e^-$

STEP 7

$\boxed{Br_2 + 2H_2O + SO_2 \rightarrow 2Br^{-1} + SO_4^{-2} + 4H^+}$

19. A) $\overset{+1}{H_3}\overset{+5}{As}\overset{-2}{O_4} + Zn^{\emptyset} \rightarrow \overset{-3}{As}\overset{+1}{H_3} + Zn^{2+}$

STEP 1 - ½ RXNS

RED: $H_3AsO_4 \rightarrow AsH_3$

OXID: $Zn^{\emptyset} \rightarrow Zn^{2+}$

STEP 2 - BALANCE ALL BUT H+O (DONE)

$H_3AsO_4 \rightarrow AsH_3 + 4H_2O$

$Zn^{\emptyset} \rightarrow Zn^{2+}$

STEP 3 - BALANCE O W/ H_2O

STEP 4 - BALANCE H W/ H^+

$8H^+ + H_3AsO_4 \rightarrow AsH_3 + 4H_2O$

$Zn^{\emptyset} \rightarrow Zn^{2+}$

STEP 5 - BALANCE CHARGE W/ e^-

$8e^- + 8H^+ + H_3AsO_4 \rightarrow AsH_3 + 4H_2O$

$Zn^{\emptyset} \rightarrow Zn^{2+} + 2e^-$

STEP 6 - BALANCE e- W/ MULTIPLIER

$8e^- + 8H^+ + H_3AsO_4 \rightarrow AsH_3 + 4H_2O$

$4(Zn^{\emptyset} \rightarrow Zn^{2+} + 2e^-)$

STEP 7 - ADD EQUATIONS

$8e^- + 8H^+ + H_3AsO_4 + 4Zn^{\emptyset} \rightarrow AsH_3 + 4H_2O + 4Zn^{2+} + 8e^-$

STEP 8 - CANCEL e-

$$\boxed{8H^+ + H_3AsO_4 + 4Zn^{\emptyset} \rightarrow AsH_3 + 4H_2O + 4Zn^{2+}}$$

B) $\overset{+6}{Cr_2}\overset{-2}{O_7}^{2-} + Cl^{-} \rightarrow Cr^{3+} + Cl_2^{\emptyset}$

STEP 1

RED: $Cr_2O_7^{2-} \rightarrow Cr^{3+}$

OXID: $Cl^- \rightarrow Cl_2^{\emptyset}$

STEP 2

$Cr_2O_7^{2-} \rightarrow 2Cr^{3+}$

$2Cl^- \rightarrow Cl_2^{\emptyset}$

STEP 3

$Cr_2O_7^{2-} \rightarrow 2Cr^{3+} + 7H_2O$

$2Cl^- \rightarrow Cl_2^{\emptyset}$

STEP 4

$14H^+ + Cr_2O_7^{2-} \rightarrow 2Cr^{3+} + 7H_2O$ (+12 → +6; −2 → ∅)

$2Cl^- \rightarrow Cl_2^{\emptyset}$

STEP 5

$6e^- + 14H^+ + Cr_2O_7^{2-} \rightarrow 2Cr^{3+} + 7H_2O$

$2Cl^- \rightarrow Cl_2^{\emptyset} + 2e^-$

STEP 6

$6e^- + 14H^+ + Cr_2O_7^{2-} \rightarrow 2Cr^{3+} + 7H_2O$

$3(2Cl^- \rightarrow Cl_2^{\emptyset} + 2e^-)$

STEP 7

$6e^- + 14H^+ + Cr_2O_7^{2-} + 6Cl^- \rightarrow 2Cr^{3+} + 7H_2O + 3Cl_2^{\emptyset} + 6e^-$

STEP 8

$$\boxed{14H^+ + Cr_2O_7^{2-} + 6Cl^- \rightarrow 2Cr^{3+} + 7H_2O + 3Cl_2}$$

20 A) $\overset{+1\ +5\ -2}{HXeO_4^{-1}} + Pb^{\emptyset} \rightarrow Xe^{\emptyset} + \overset{+1\ +3\ -2}{HPbO_2^{-1}}$

STEP 1 - ½ RXNS

RED: $HXeO_4^{-1} \rightarrow Xe^{\emptyset}$

OXID: $Pb^{\emptyset} \rightarrow HPbO_2^{-1}$

STEP 2 - (DONE) BALANCE ELEMENTS: $HXeO_4^{-1} \rightarrow Xe^{\emptyset} + 4H_2O$

STEP 3 - BALANCE O W/ H_2O: $2H_2O + Pb^{\emptyset} \rightarrow HPbO_2^{-1}$

STEP 4 - BALANCE H W/ H^+: $7H^+ + HXeO_4^{-1} \rightarrow Xe^{\emptyset} + 4H_2O$ (+6 → ∅)

$2H_2O + Pb^{\emptyset} \rightarrow HPbO_2^{-1} + 3H^+$ (∅ → +2)

STEP 5 - BALANCE CHARGE W/ e^-: $6e^- + 7H^+ + HXeO_4^{-1} \rightarrow Xe^{\emptyset} + 4H_2O$

$2H_2O + Pb^{\emptyset} \rightarrow HPbO_2^{-1} + 3H^+ + 2e^-$

STEP 6 - BALANCE e^- BETWEEN EQUATIONS: $6e^- + 7H^+ + HXeO_4^{-1} \rightarrow Xe^{\emptyset} + 4H_2O$

$3(2H_2O + Pb^{\emptyset} \rightarrow HPbO_2^{-1} + 3H^+ + 2e^-)$

STEP 7 - ADD EQUATIONS: $6e^- + 7H^+ + HXeO_4^{-1} + 6H_2O + 3Pb^{\emptyset} \rightarrow Xe^{\emptyset} + 4H_2O + 3HPbO_2^{-1} + 9H^+ + 6e^-$

STEP 8 - CANCEL e^- + H_2O & H^+: $HXeO_4^{-1} + 2H_2O + 3Pb^{\emptyset} \rightarrow Xe^{\emptyset} + 3HPbO_2^{-1} + 2H^+$

STEP 9 - ADD OH^- TO BOTH SIDES TO ELIMINATE H^+, CANCEL H_2O: $\boxed{2OH^- + HXeO_4^{-1} + 3Pb^{\emptyset} \rightarrow Xe^{\emptyset} + 3HPbO_2}$

B) $Co(OH)_3 + Sn^{\emptyset} \rightarrow Co(OH)_2 + HSnO_2^{-1}$

STEP 1: $Sn^{\emptyset} \rightarrow HSnO_2^{-1}$

$Co(OH)_3 \rightarrow Co(OH)_2$

STEP 2 (DONE) + STEP 3: $2H_2O + Sn \rightarrow HSnO_2^{-1}$

$Co(OH)_3 \rightarrow Co(OH)_2 + H_2O$

STEP 4: $2H_2O + Sn \rightarrow HSnO_2^{-1} + 3H^+$ (∅ → +2)

$1H^+ + Co(OH)_3 \rightarrow Co(OH)_2 + H_2O$ (+1 → ∅)

STEP 5: $2H_2O + Sn \rightarrow HSnO_2^{-1} + 3H^+ + 2e^-$

$1e^- + 1H^+ + Co(OH)_3 \rightarrow Co(OH)_2 + H_2O$

STEP 6: $2H_2O + Sn \rightarrow HSnO_2^{-1} + 3H^+ + 2e^-$

$2(1e^- + 1H^+ + Co(OH)_3 \rightarrow Co(OH)_2 + H_2O)$

STEP 7: $2H_2O + Sn + 2e^- + 2H^+ + 2Co(OH)_3 \rightarrow HSnO_2^{-1} + 3H^+ + 2e^- + 2Co(OH)_2 + 2H_2O$

STEP 8: $Sn + 2Co(OH)_3 \rightarrow HSnO_2^{-1} + H^+ + 2Co(OH)_2$

STEP 9: $\boxed{OH^- + Sn + 2Co(OH)_3 \rightarrow HSnO_2^{-1} + H_2O + 2Co(OH)_2}$