Chapter 7 homework answers

A & E see the back of the text.

F] realize that the first equivalence point is from the precipitation of Br-

Volume of titrant for 1^{st} equivalence pt.

0.04000 L (0.05000 mol Br-/L) = 0.002000 mol Br-

0.002000 mol Br-*(L/0.08454 mol $AgNO_3$) = $23.6\underline{6}$ mL

Vol of titrant for 2^{nd} eq. pt.

Same concentration of Cl- therefore vol = 2*$23.6\underline{6}$ mL = $47.3\underline{2}$ mL

See the text for the rest of the answer.

2] The equivalence point is where moles titrant = moles analyte assuming 1:1 stoichiometry. The end point is where the physical property of an indicator indicates the equivalence point.

3] A blank titration measures the amount of titrant required to reach an equivalence point in the absence of an analyte. This is subtracted from the actual titration as a correction factor.

4] A back titration is where an excess of titrant is titrated with a second reagent. This measures the amount of excess titrant.

5] Primary standards are much purer than reagent grade chemicals.

6] Reagent grade acids may introduce contaminants, typically metal ions.

7-11. HCl added to powder = (10.00 mL)(1.396 M) = 13.96 mmol

NaOH required = (39.96 mL)(0.100 4 M) = 4.012 mmol

HCl consumed by carbonate = 13.96 – 4.012 = 9.94_8 mmol

mol $CaCO_3$ = $\frac{1}{2}$ mol HCl consumed = 4.97_4 mmol = 0.497_8 g $CaCO_3$

$$\text{wt\% } CaCO_3 = \frac{0.497_8 \text{ g } CaCO_3}{0.541\,3 \text{ g limestone}} \times 100 = 92.0 \text{ wt\%}$$

7-12. 5.00 mL of 0.033 6 M HCl = 0.168 0 mmol. 6.34 mL of 0.010 0 M NaOH = 0.063 4 mmol. HCl consumed by NH_3 = 0.168 0 – 0.063 4 = 0.104 6 mmol = 1.465 mg of nitrogen. 256 μL of protein solution contains 9.702 mg protein. 1.465 mg of N/9.702 mg protein = 15.1 wt%.

7-14. FM of NaCl = 58.443. FM of KBr = 119.002. 48.40 mL of 0.048 37 M Ag^+ = 2.341 1 mmol. This must equal the mmol of (Cl^-+ Br^-). Let x = mass of NaCl and y = mass of KBr. $x + y = 0.2386$ g.

$$\underbrace{\frac{x}{58.443}}_{\text{moles of Cl}^-} + \underbrace{\frac{y}{119.002}}_{\text{moles of Br}^-} = 2.341\,1 \times 10^{-3} \text{ mol}$$

Substituting $x = 0.238\,6 - y$ gives y = 0.200 0 g of KBr = 1.681 mmol of KBr = 1.681 mmol of Br = 0.134 3 g of Br = 56.28% of the sample.

7-15. Let x = mg of $FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$ and $(54.85 - x)$ = mg of $FeCl_2 \cdot 6H_2O$.
mmol of Ce^{4+} = mmol $FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$ + mmol $FeCl_2 \cdot 6H_2O$.

$$(13.39 \text{ mL})(0.012\,34 \text{ M}) = \frac{x \text{ mg}}{392.13 \text{ mg/mmol}} + \frac{(54.85 - x)}{234.84 \text{ mg/mmol}}$$

$\Rightarrow x = 40.01$ mg $FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$.

mass of $FeCl_2 \cdot 6H_2O$ = 14.84 mg = 0.063 19 mmol = 4.48 mg Cl.

$$\text{wt\% Cl} = \frac{4.48 \text{ mg}}{54.85 \text{ mg}} \times 100 = 8.17\%$$

7-16. 30.10 mL of Ni^{2+} reacted with 39.35 mL of 0.013 07 M EDTA. Therefore, the Ni^{2+} molarity is

$$[Ni^{2+}] = \frac{(39.35 \text{ mL})(0.013\,07 \text{ mol/L})}{30.10 \text{ mL}} = 0.017\,09 \text{ M}.$$

25.00 mL of Ni^{2+} contains 0.427 2 mmol of Ni^{2+}. 10.15 mL of EDTA = 0.132 7 mmol of EDTA. The amount of Ni^{2+} which must have reacted with CN^- was 0.427 2 – 0.132 7 = 0.294 5 mmol. The cyanide which reacted with Ni^{2+} must have been (4)(0.294 5) = 1.178 mmol. $[CN^-]$ = 1.178 mmol/12.73 mL = 0.092 54 M.

7-21. At V_e, moles of Ag^+ = moles of I^-

$(V_e \text{ mL})(0.051\,1 \text{ M}) = (25.0 \text{ mL})(0.082\,3 \text{ M}) \Rightarrow V_e = 40.26$ mL

When V_{Ag^+} = 39.00 mL, $$[I^-] = \frac{40.26 - 39.00}{40.26}(0.082\,30)\left(\frac{25.00}{25.00 + 39.00}\right)$$

$= 1.006 \times 10^{-3}$ M. $[Ag^+] = K_{sp}/[I^-] = 8.3 \times 10^{-14}$ M $\Rightarrow$ $pAg^+ = 13.08$.

When $V_{Ag^+} = V_e$, $[Ag^+][I^-] = x^2 = K_{sp} \Rightarrow x = [Ag^+] = 9.1 \times 10^{-9}$ M

$\Rightarrow pAg^+ = 8.04$.

When V_{Ag^+} = 44.30 mL, there is an excess of (44.30 – 40.26) = 4.04 mL of Ag^+. $$[Ag^+] = \left(\frac{4.04}{25.00 + 44.30}\right)(0.051\,10) = 2.98 \times 10^{-3} \text{ M} \Rightarrow pAg^+ = 2.53.$$

7-23. (a) moles of La^{3+} = $\frac{2}{3}$(moles of $C_2O_4^{2-}$)

$(V_e)(0.025\,7\ M) = \frac{2}{3}(25.00\ mL)(0.031\,1\ M) \Rightarrow V_e = 20.17\ mL$

(b) The fraction of $C_2O_4^{2-}$ remaining when 10.00 mL of La^{3+} have been added is $(20.17 - 10.00)/(20.17) = 0.504\,2$. The concentration of $C_2O_4^{2-}$ is

$[C_2O_4^{2-}] = (0.504\,2)(0.031\,1\ M)\left(\frac{25.00}{35.00}\right) = 0.011\,2\ M$

$[La^{3+}]^2 = K_{sp}/[C_2O_4^{2-}]^3 \Rightarrow [La^{3+}] = 2.7 \times 10^{-10} \Rightarrow pLa^{3+} = 9.57$

(c) $[La^{3+}]^2[C_2O_4^{2-}]^3 = (x)^2(\frac{3}{2}x)^3 = K_{sp} \Rightarrow x = 7.84 \times 10^{-6}\ M$

$pLa^{3+} = 5.11$

(d) $[La^{3+}] = (0.025\,7\ M)\left(\frac{25.00 - 20.17}{50.00}\right) = 0.002\,48\ M$. $pLa^{3+} = 2.61$