

Name: \_\_\_\_\_

date: \_\_\_\_\_ period: \_\_\_\_\_

Che. 17 &amp; 20 equilibrium &amp; electrochem

test

7075 points

ap chemistry

**Academic Honesty:** The answers on this test are my own and I am using only the allowed set of notes as described in the syllabus. I have not discussed the test questions with anyone before or during the test nor have I seen the test questions prior to the exam. If you violate any of the preceding items or do not sign, your semester grade is a F.

Signature: \_\_\_\_\_

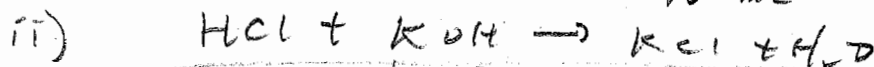
In problems involving any calculation, show your work in an organized manner, include (i) any relevant equation (or formula), (ii) conversion factor(s), (iii) put the proper units in your calculations and answer, and (iv) proper number of significant figures in your answer.

1. 35 mL of 75 mM HCl was titrated by \_\_\_ of 100 mM KOH; what is the pH? [10 points]

a. 23 mL

$$i) n_{\text{HCl}} = [\text{HCl}] V_{\text{HCl}} = \frac{75 \text{ mmol}}{10^3 \text{ mL}} \cdot 35 \text{ mL} = 2.625 \text{ mmol HCl}$$

$$n_{\text{KOH}} = [\text{KOH}] V_{\text{KOH}} = \frac{100 \text{ mmol}}{10^3 \text{ mL}} \cdot 23 \text{ mL} = 2.3 \text{ mmol KOH}$$



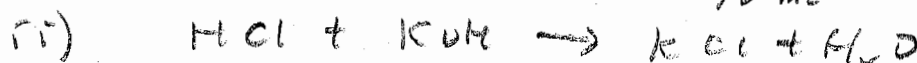
n <sub>i</sub>	2.625	2.3		
n <sub>c</sub>	-2.3	-2.3		
n <sub>e</sub>	0.325	0		

$$iii) [\text{H}^+] = [\text{HCl}] = \frac{n_{\text{HCl}}}{V} = \frac{0.325 \text{ mmol}}{(23 + 35) \text{ mL}} \cdot \frac{10^3 \text{ mL}}{L} \cdot \frac{\text{mol}}{10^3 \text{ mmol}} = 0.0056 \text{ M}$$

$$iv) \text{pH} = -\log [\text{H}^+] = -\log(0.0056) = \underline{2.25}$$

b. 30 mL

$$i) n_{\text{KOH}} = [\text{KOH}] V_{\text{KOH}} = \frac{100 \text{ mmol}}{10^3 \text{ mL}} \cdot 30 \text{ mL} = 3 \text{ mmol KOH}$$



n <sub>i</sub>	2.625	3		
n <sub>c</sub>	-2.625	-2.625		
n <sub>e</sub>	0	0.375		

$$iii) [\text{OH}^-] = [\text{KOH}] = \frac{n_{\text{KOH}}}{V} = \frac{0.375 \text{ mmol}}{(30 + 35) \text{ mL}} \cdot \frac{10^3 \text{ mL}}{L} \cdot \frac{\text{mol}}{10^3 \text{ mmol}} = 0.00577 \text{ M}$$

$$iv) \text{pOH} = -\log [\text{OH}^-] = -\log(0.00577) = 2.239$$

$$v) \text{pH} + \text{pOH} = 14 \rightarrow \text{pH} = 14 - \text{pOH} = 14 - 2.239 = \underline{11.76}$$

2. How many grams of potassium benzoate are needed to prepare 125 mL aqueous solution with 10.0 mM benzoic acid, where it's pH = 5.25? [10 points]

2 pt

$$pH = pK_a + \log \frac{[Bz^-]}{[HBz]}$$

$$5.25 = -\log(6.5 \cdot 10^{-5}) + \log \frac{[Bz^-]}{10 \text{ mM}}$$

$$5.25 = 4.187 + \log \frac{[Bz^-]}{0.01}$$

$$\log \frac{[Bz^-]}{0.01} = 1.063$$

$$\frac{[Bz^-]}{0.01} = 10^{1.063} = 11.5611$$

$$[Bz^-] = 11.6 \cdot 10^{-2} \text{ M} = 0.116 \text{ M}$$

3 pt

$$[KBz] = \frac{n}{V}$$

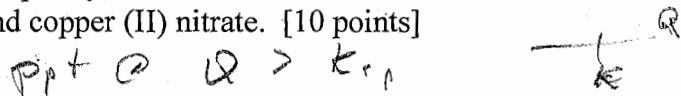
$$0.116 \text{ M} = \frac{n}{125 \text{ mL}} \cdot \frac{10^3 \text{ mL}}{L}$$

$$n = 0.01445 \text{ mol}$$

2 pt

$$0.01445 \text{ mol} \cdot \frac{160 \text{ g}}{\text{mol}} = \boxed{2.31 \text{ g}}$$

3. The addition of sodium carbonate to a 325 mL aqueous solution with 1.0 mM barium nitrate and 0.1 mM copper (II) nitrate forms a precipitate. What is the first precipitate to form? basis / rationale? For simplicity, assume that the addition of sodium carbonate does not change the concentration of barium nitrate and copper (II) nitrate. [10 points]



4 pt

$$i) \text{ Ba ppt @ } [Ba^{2+}][CO_3^{2-}] > 5.1 \cdot 10^{-9}$$

$$10^{-3} \text{ M } [CO_3^{2-}] > 5.1 \cdot 10^{-9}$$

$$[CO_3^{2-}] > 5.1 \cdot 10^{-6} \text{ M}$$

4 pt

$$ii) \text{ Cu ppt @ } [Cu^{2+}][CO_3^{2-}] > 1.4 \cdot 10^{-10}$$

$$10^{-4} [CO_3^{2-}] > 1.4 \cdot 10^{-10}$$

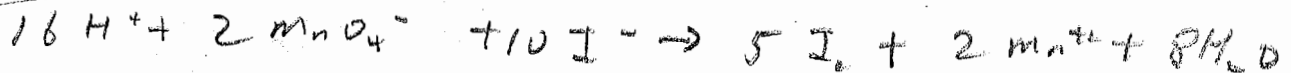
$$[CO_3^{2-}] > 1.4 \cdot 10^{-6} \text{ M}$$

2 pt

iii) ∴ 1<sup>st</sup> ppt = Cu<sup>2+</sup> b/c needs lowest [CO<sub>3</sub><sup>2-</sup>]

4. In regards to the redox reaction in an acid solution:  $MnO_4^- + I^- \rightarrow I_2 + Mn^{2+}$  [20 points] <sup>15</sup>

a. Write the balanced redox reaction



b. What is  $E_{cell}^{\circ}$  at 23 °C



$\frac{E^{\circ}}{1.51V}$

$-0.536V$

$E_{red}^{\circ}$

$E_{oxd}^{\circ}$

$E_{cell}^{\circ} = E_{red}^{\circ} + E_{oxd}^{\circ}$   
 $= 1.51 - 0.536V$   
 $= 0.974V$

c. In a redox titration, 25 mL of 50 mM  $MnO_4^-$  titrated 75 mL of \_\_\_ mM  $I^-$

$10 [MnO_4^-] V_{MnO_4^-} = 2 [I^-] V_{I^-}$

$10 (50mM) 25ml = 2 [I^-] 75ml$

$[I^-] = 83mM$

5. An inert carbon (graphite) electrode is electroplate with 75 mg chromium in 10 minutes; what is the current? [10 points]

$75mg Cr \times \frac{1}{103mg} \times \frac{mol}{52g} \times \frac{3 mol e^-}{1 mol Cr} \times \frac{96,485 C}{mol e^-} = 417.5 C$

$I = \frac{\# Coul}{time} = \frac{417.5 C}{10 min \times 60 sec} = 0.70 A$

207

3 pt

