Analytical Chemistry
Second Exam

Name: .... Date: 19/12/2011

Reg. No.: .....0101041......Seat no.:.....................

Section: (1) 2 (3) 4 أسئلة كتابة

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1. ✗ b̶ c d e   9. ✗ b c d e

2. a b ⓒ d ✗   10. ✗ b c d e

3. a̶ b c d ✗   11. a b ✗ d̶ e

4. a ✗ c d̶ e   [12.] ✗ b c d e

5. a b ✗ d e   13. a b c ✗ e

[6.] a b̶ c ✗ e   14. ⓐ ✗ c d̶ e

7. a ✗ c d e   15. a b c d ✗

8. a ✗ c d e

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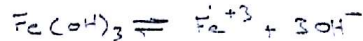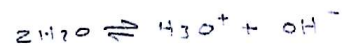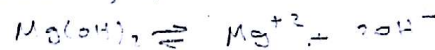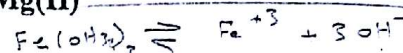
1. Calculate the molar solubility of $Fe(OH)_3$ ($Ksp = 5\times10^{-39}$) in water

a) 2.0×10^{-18} M   b) 5.0×10^{-18} M   c) 6.5×10^{-18} M   d) 9.0×10^{-18} M
e) 8.0×10^{-18} M

2. Calculate the pH of a solution that is 0.1 M of each Fe(III) and Mg(II), in which Fe(III) is needed to be separated quantitatively from the Mg(II) as hydroxide. Given that
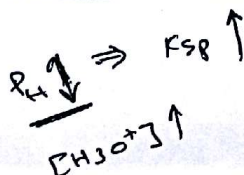K_{sp} for $Fe(OH)_3 = 5\times10^{-39}$
K_{sp} for $Mg(OH)_2 = 7.1\times10^{-12}$
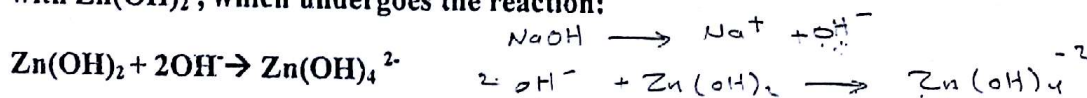Using 1×10^{-6} M as criterion for quantitative removal of ions

a) 5.07,   b) 8.92   c) 3.23   d) 10.77   e) 2.47

3. The molar solubility for $SrSO_4$ is highest when dissolved in a solution that has $[H_3O^+]$ of :

a) 2.50M
b) 1.50 M
c) 0.10 M
d) 0.20 M
e) 0.06 M

4. Which is the mass-balanced equation for a a solution that is 0.10 M in NaOH and saturated with $Zn(OH)_2$, which undergoes the reaction:

$$Zn(OH)_2 + 2OH^- \rightarrow Zn(OH)_4^{2-}$$

a) $0.10 = [Na^+] = [OH^-] + [Zn(OH)_4^{2-}]$
b) $0.10 = [Na^+] = [OH^-] - 2[Zn(OH)_4^{2-}]$
c) $0.10 = [Na^+] = [OH^-] - [Zn(OH)_4^{2-}]$
d) $0.10 = [Na^+] = [OH^-] + 2[Zn(OH)_4^{2-}]$
e) None of the above

5. Which is the correct charge – balance equation of solution containing 1M $Al_2(SO_4)_3$

a) $[Al^{3+}] + [H_3O^+] = 2[SO_4^{2-}] + [OH^-]$
b) $3[Al^{3+}] + [H_3O^+] = [SO_4^{2-}] + [OH^-]$
c) $3[Al^{3+}] + [H_3O^+] = 2[SO_4^{2-}] + [OH^-]$
d) $[Al^{3+}] + [H_3O^+] = [SO_4^{2-}] + [OH^-]$
e) None of the above
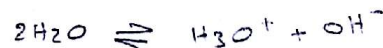
6. Calculate the molar solubility of CuS in a solution in which the $[H_3O^+]$ is held constant at 2.0×10^{-1} M. K_{sp} for CuS is 8×10^{-37}, and for H_2S $K_1 = 9.6 \times 10^{-8}$ and $K_2 = 1.3 \times 10^{-14}$

a) 3.5×10^{-12} M   b) 5.1×10^{-9} M   c) 3.2×10^{-8} M

d) 3.4×10^{-23} M   e) 4×10^{-4} M

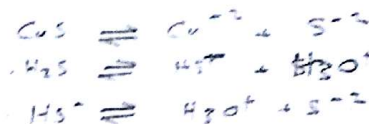**7. Generation of hydroxide ion as a precipitating agent from urea for the purpose of precipitating Fe^{3+} as $Fe(OH)_3$ is called:**

a) peptization
b) precipitation from homogeneous solution
c) coagulation
d) digestion of the precipitate
e) coprecipitation

8. An aqueous solution contains $NaNO_3$ and KBr. The bromide ion was separated as AgBr by addition of excess precipitating agent $AgNO_3$. The charge on the surface of the coagulated colloidal precipitate is:

a) Positive charge due to the adsorption of potassium ions
b) Negative charge due to the adsorption of nitrate ions
c) Positive charge due to the adsorption of silver ions
d) Neutral since primary adsorption layer will neutralize the counter ions
e) Negative charge due to the adsorption of bromide ions.

9. Which of the following statements is correct:
a) disperion of colloidal precipitates occurs when washed with distilled water.
b) inclusion means capturing of foreign ions into the space lattices of the crystal.
c) occlusion means entrapment of a solution droplet into the crystal during precipitation.
d) In gravimetric analysis positive error occurs if the crucible containing the precipitate is dried to constant weight.
e) the particle size decreases by decreasing the relative supersaturation ratio.

10. Treatment of a 0.2500 g of impure potassium chloride with an excess of $AgNO_3$ resulted in the formation of a 0.2912 g of AgCl (molar mass = 143.36 g/mol). Calculate the percentage of KCl (molar mass = 74.59 g/ mol) in the sample.

a) 60.6%   b) 121.2 %   c) 30.3 %   d) 52.0 %   e) 26.0 %

11. In Volhard method for the determination of I^- in an aqueous sample 20.00 mL of 0.10M $AgNO_3$ is added to 10.00 mL of an unkown I^- solution. The unreacted $AgNO_3$ is back titrated with 5.00 mL of 0.10 M KSCN using Fe^{3+} as indicator. Calculate the concentration of I^- in the unkown sample given that the atomic mass of I^- is 127.0 g/mol.

a) 25.40 g/L   b) 0.15 g/L   c) 6.35g/L   d) 19.05 g/L   e) 38.10 g/L

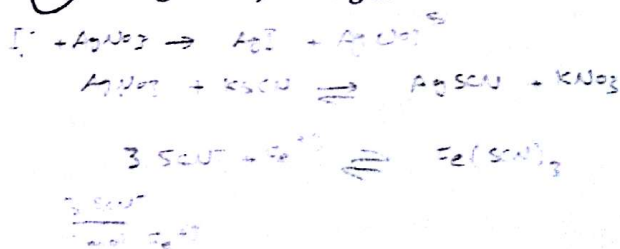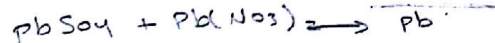$Pb(NO_3)_2$ $0.2/M$.
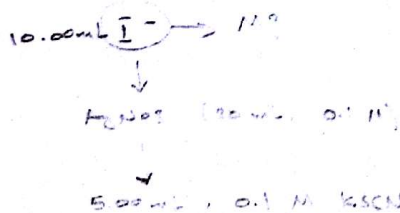
$Na_2SO_4 + Pb(NO_3)_2 \longrightarrow PbSO_4$
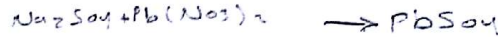
$PbSO_4 + Pb(NO_3)_2 \longrightarrow Pb$

12. In the titration of 35.00 ml of 0.40 M of Na_2SO_4 with 0.20 M $Pb(NO_3)_2$, $PbSO_4$ precipitates down. Calculate the P function of Pb^{2+} (pPb) after adding 50.00 ml of $Pb(NO_3)_2$. K_{sp} for $PbSO_4$ is: 1.6×10^{-8}

a) 6.5   b) 7.11   c) 5.08   d) 3.89   e)2.72

13. A solution of $HClO_4$ was standardized by dissolving 0.4125 g of primary standard grade HgO (molar mass = 216.59 g/mol) in a solution of KBr:

216.59 / $0.4125g$ $\longrightarrow 46.51 mL$ $HClO_4$.

$HgO(s) + 4 Br^- + H_2O \longrightarrow HgBr_4^{2-} + 2 OH^-$
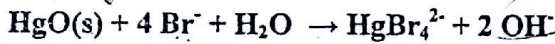
The liberated OH^- consumed 46.51 ml of the $HClO_4$ solution. The molarity of the $HClO_4$ is:

H

a) 0.042 M
b) 0.021 M
c) 0.063 M
d) 0.082 M
e) 0.100 M

14.In the argentometric determination of bromide ion in an aqueous sample using Mohr's-method for the endpoint detection, the effect of carrying out accidently this titration at pH= 3 will have

a. positive error
b. negative error
c. There will be no effect on the reults of the titration.
d. Higher precipitate amount of Ag_2CrO_4 is formed.
e. Endpoint could not be detected

15. In titration of 50.00 mL of 0.050 M KI with 0.10 M $AgNO_3$, calculate pAg after addition of 25.00 mL of the $AgNO_3$ solution. Ksp for AgI is 1.7×10^{-17}.

a) 3.70   b) 16.77   c) 1.30   d) 6.58   e) 8.38

$p_{Ag} = pI = \dfrac{p_{Ksp}}{2}$.

Analytical Chemistry
Second Exam

Name: .... Date: 30/4/2012

Reg. No.: .....ة١٥٤٣٧٥........Seat no.:.....................

Section: 1 2 3 4 ٩-١٠ ٢٣٢

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1. a b c (d) e   9. a b c d (e)

2. a b c ~~d~~ (e)   10. (a) b c d e

3. a b c (d) ~~e~~   11. a b c (d) e

4. a b c d (e)   12. a b (c) d e

5. a b (c) d e   13. a b c (d) e

6. a b c (d) e   14. a b (c) d e
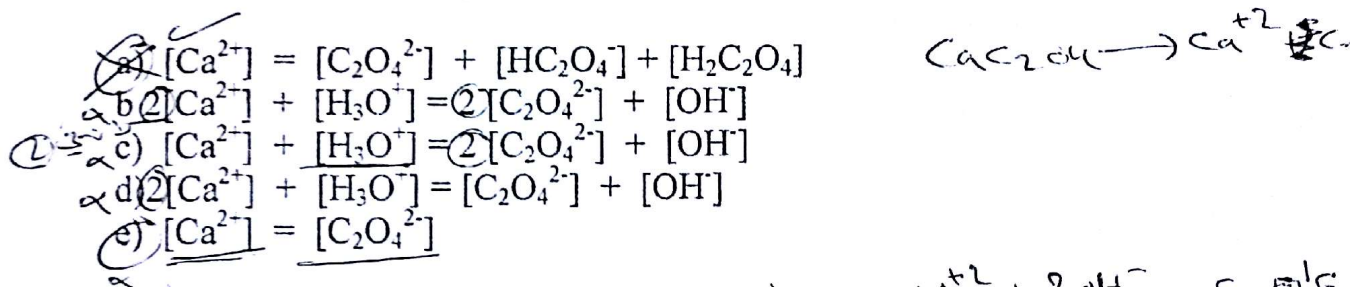
7. a (b) c d e   15. a b c d (e)

8. a (b) c d e

GOOD LUCK

1

$cu\ cl \rightarrow cu^{+2} + cl^-$

$ksp \approx (0.48) \times 0.21 \cdot ksp'$

$6 = 0.81$

6.37

$KNO_3 \rightarrow K^+ + NO_3^-$

$KNO_3\ 0.05\ M$
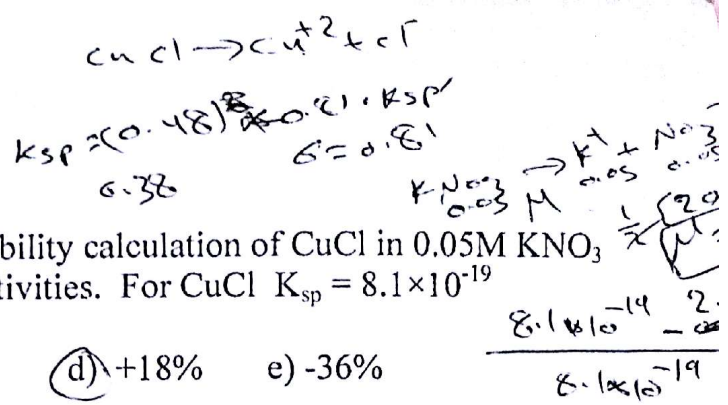
1. Calculate the % relative error in solubility calculation of CuCl in 0.05M KNO₃ when using molarities instead of activities. For CuCl $K_{sp} = 8.1 \times 10^{-19}$

a) -46%   b) +36%   c) -18%   (d) +18%   e) -36%

$\dfrac{8.1 \times 10^{-14} - 2}{8.1 \times 10^{-19}}$

2. A correct mass-balance equation for a solution saturated with CaC₂O₄ is:-

a) $[Ca^{2+}] = [C_2O_4^{2-}] + [HC_2O_4^-] + [H_2C_2O_4]$

b) $2[Ca^{2+}] + [H_3O^+] = 2[C_2O_4^{2-}] + [OH^-]$

c) $[Ca^{2+}] + [H_3O^+] = 2[C_2O_4^{2-}] + [OH^-]$

d) $2[Ca^{2+}] + [H_3O^+] = [C_2O_4^{2-}] + [OH^-]$

e) $[Ca^{2+}] = [C_2O_4^{2-}]$

$CaC_2O_4 \rightarrow Ca^{2+} + C_2O_4^{2-}$

$Mg(OH)_2 \rightarrow Mg^{2+} + 2OH^- = [Mg]S[E]$

3. Calculate the molar solubility of Mg(OH)₂ (Ksp = 7.1 x 10⁻¹²) in water.

a) 7.1×10^{-12} M   b) 2.4×10^{-14} M   c) 4.1×10^{-11} M   (d) 1.2×10^{-4} M

e) 8.0×10^{-18} M

$= 4 \times^3$

3.55

1.2

4. Generation of hydroxide ion as a precipitating agent from urea for the purpose of precipitating Fe³⁻ as Fe(OH)₃ is called:

a) peptization
b) coagulation
c) precipitation from homogeneous solution.
d) digestion of the precipitate
e) coprecipitation

5. An aqueous solution contains NaNO₃ and KBr. The bromide ion was separated as AgBr by addition of excess precipitating agent AgNO₃. The charge on the surface of the primary adsorption layer of the colloidal precipitate is   +ve

a) Positive charge due to the adsorption of potassium ions
b) Negative charge due to the adsorption of nitrate ions
c) Positive charge due to the adsorption of silver ions
d) Negative charge due to the adsorption of bromide ions .
e) Neutral since primary adsorption layer will neutralize the counter ions

2

6. Which of the following statements is correct:

a) Peptization is heating the precipitate in solution to coagulate the precipitate.
b) Inclusion or mixed crystal formation occurs in case of colloidal precipitates.
c) Coprecipitaion is bringing down with the precipitate substance which are normally soluble.
d) Colloidal precipitates are best washed with distilled water.
e) Occlusion is replacing some ions in the crystal by foreign ions.

7. A sample of pure sodium oxalate, $Na_2C_2O_4$, weighing 0.2856 g (molar mass 134 g/mol) is dissolved in water, sulfuric acid is added, and the solution is titrated at $70^\circ C$, requiring 45.12 mL of a $KMnO_4$ solution. The end point is overrun and back-titration is carried out with 1.78 mL of 0.0516 M solution of oxalic acid. Calculate the molarity of the $KMnO_4$ solution.

Equation is:

$$2MnO_4^- + 5C_2O_4^{2-} + 16 H^+ \rightarrow Mn^{2+} + 10CO_2 + 8H_2O$$

a) 0.048 M   b) 0.0197 M   c) 0.0394M   d) 0.009 M   e) 0.018 M

8. In the titration 50.0 mL 0.1 M NaCl with 0.1 M $AgNO_3$, calculate pCl after, addition of 50.0 mL $AgNO_3$

K_{sp} for $AgCl = 1 \times 10^{-10}$

no. ~d $AgNO_3$ = $50 \times 10^{-3} \times 0.1$ =
no mol NaCl = $50 \times 10^{-3} \times 0.1$ =

a) 6.00   b) 5.00   c) 7.5   d) 7.00   e) 9.00 $[Ag^+] = \overline{}$
                                                                            100

$P - log(0) = 0$

9. Chloride ions are to be determined by titration in a solution of pH 1.5. Which method would give the best results:-

$Z < 0$ acid

a) Mohr's method using K_2CrO_4 indicator.
b) Fajan's method using dichloroflourescein indicator.
c) Titration with EDTA.
d) Titration with HCl.
e) Back titration using Volhard's method in which Fe^{3+} indicator is used.

3

10. Iodide ions are to be separated from chloride ions as silver salts in a solution containing 0.10 M of each ion. Given that K_{sp} for $AgCl = 1.8 \times 10^{-10}$, K_{sp} for AgI is 7.3×10^{-17} and using 1×10^{-5} M as a criterion for quantitative precipitation, which of the following statements is correct:-

   a) separation is not feasible.
   b) I^- can be separated if $[Ag^+]$ is less than 7.3×10^{-12} M.
   c) I^- can be separated from Cl^- if $[Ag^+]$ is held between 7.3×10^{-12}-1.8×10^{-9} M.
   d) $AgCl$ will precipitate if $[Ag^+] = 7.3 \times 10^{-10}$ M.
   e) Both Cl^- and I^- will precipitate at $[Ag^+]$ 7.3×10^{-12} - 1.8×10^{-9} M.

11. Calculate the pH of a solution that is 0.1 M of each Fe(III) and Mg(II), in which Fe(III) is needed to be separated quantitatively from the Mg(II) as hydroxide. Given that
K_{sp} for $Fe(OH)_3 = 5 \times 10^{-39}$ = $Fe^{+3} + 3OH^{-1} \Rightarrow [Fe^{+3}][3OH^{-1}]^3$ 2.5
K_{sp} for $Mg(OH)_2 = 7.1 \times 10^{-12}$ $\sqrt{\frac{5\times10^{-37}}{0.3}} = \sqrt{\frac{0.1 \times 3 \times^3}{0.3}}$
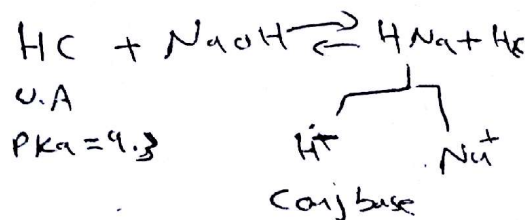Using 1×10^{-6} M as criterion for quantitative removal of ions   ① 0.397

a) 3.23   b) 8.92   c) 5.07   d) 10.77   e) 2.47 3.28×10^{-4}
                                                            3.048×10^{-11}

12. 0.10M solution of an acid HC (pKa = 4.30) is titrated with 0.10 M NaOH, which is the most suitable indicator for this titration:

Indicator	pK$_{in}$
I (acid)	8 ↑
II (base)	5
III (acid)	10 ↑

$HC + NaOH \rightleftharpoons NaC + H_2O$
$w.A$
$pKa = 4.3$
                            H^+ Na^+
                           Conj base

a) I   b) II   c) III   d) I or II   e) II or III

$conj\,base \Leftarrow solution\,$ قلوية سوف تكون
$\Leftarrow$ acid النوع

$[OH^-] = \sqrt{\frac{kw}{ka} \cdot [c^-]}$
                                             H^-

$indicator \Rightarrow 7-8$

4

$3 \partial \times 10$

13. 40.00 mL of 0.0900 M HCl is titrated with 0.1 M NaOH. Calculate the pH after addition of 30.00 mL of NaOH 3×10^{-3} — 0.6 8.5×10^{-3}

   a) 1.82   b) 2.34   c) 1.51   (d) 2.07   e) 0.09

14. In the titration of 40.00 mL of 0.110 M NaOCL (K_a for HOCl $= 6.25 \times 10^{-10}$) with 0.100 M HCl. Calculate the pH after addition of 44.00 mL HCl.

   a) 6.38   b) 5.24   c) 4.00   d) 3.21   e) 8.76

   $[cl^-] = 2.5 \times 10^{-5}$
   $= [H_3O^+]$

15. Which of the following acids would show the sharpst end point when 50.00 mL of 0.10M of the acid is titrated with 0.10 M NaOH:

   a) Acid I with $Ka = 1 \times 10^{-2}$
   b) Acid II with $Ka = 1 \times 10^{-4}$
   c) Acid III with $Ka = 1 \times 10^{-6}$
   d) Acid IV with $Ka = 1 \times 10^{-8}$
   e) Acid V: very strong acid

5

Department of Chemistry
Analytical Chemistry
Second Exam

Date: Dec. 20, 2005

Name: ....

Section: ....12:30 – 2:00

Reg. No.: ......0046199....

اسم المدرس: ....

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1. a   b   c   (d)   e   9.   a   (b)   c   d   e

2. a   b   (c)   d   e   10. (a)   b   c   d   e

3. (a)   b   c   d   e   11. a   b   c   (d)   e

4. a   b   (c)   d   e   12. (a)   b   c   d   e

5. a   b   (c)   d   e   13. a   b   c   (d)   e

6. a   b   c   d   (e)   14. a   b   (c)   d   e

7. a   b   c   (d)   e   15. a   b   c   d   (e)

8. a   (b)   c   d   e

GOOD LUCK

$\dfrac{0.1\times10^{-3}\,g}{107.9\,g}\bigg|\,0.5$

$Ksp = 1\times10^{-10} = [Ag^+][Cl^-]$
1.85×10^{-6}

1. The Ag^+ (atomic mass 107.9 g/mol) in a solution is precipitated by the addition of Cl^- ion. The final volume of the solution is 500 mL. What should be the concentration of Cl^- if no more than 0.10 mg Ag^+ remains unprecipitated? K_{sp} for $AgCl = 1.0\times10^{-10}$

a) 2.68×10^{-4} M b) 1.0×10^{-5} M c) 5.00×10^{-7} M
d) 5.39×10^{-5} M e) 3.1×10^{-8} M

0.0616 moles

$NH_3 + HCl$

$NH_4^+ \rightleftharpoons NH_3 + H_3O^+$

$(500 - V_{Ag})$

$\dfrac{0.1}{V_{Ag}} = \dfrac{V_{Ag}}{V_{Ag}} = \dfrac{n\,\text{el}}{(0.5 - V_{Ag})0.0617\,mol}$

V_{Ag^+}

$0.05 - \dfrac{V_{Ag}}{10} = n\,V_{Ag}$

2. What is the pH of a solution prepared by dissolving 3.30 g of NH_4Cl (molar mass 53.5 g/mol) in water, adding 125.0 mL of 0.0111 M NaOH and diluting to 500 mL. K_b for NH_3 is 1.75×10^{-5}.

1.388×10^{-3} mol.

n mols NaOH = 1.387×10^{-3}
n moles HCl = 0.0617 mol

a) 10.11   b) 7.56   c) 6.44   d) 7.00   e) 8.77

HCl left pH = 0.0602
$= H_3O^+$
No. of moles HCl = 0.0617
$NH_4Cl \rightarrow Cl^- + 4OH^-$
$+ 0.01$
$H_4Cl^+ \rightleftharpoons + H_3O^+$

3. Which of the following acids would give the sharpest end point when 23.00 mL of 0.10 M of the acid is titrated with 0.10 M NaOH.

a) acid D with $K_a = 10^{-2}$
b) acid E with $K_a = 10^{-4}$
c) acid A with $K_a = 10^{-5}$
d) acid B with $K_a = 10^{-10}$
e) acid C with $K_a = 10^{-8}$

NH_3 NH_4^+ OH^-

NH_4^+ NH_3 $H^+ = \dfrac{[x][0.06]}{2.7\times10^{-3}}$

3.39 x x

$\left(0.062 - 2.78\times10^{-3}\right)$

$(3.6 - 3.596)\times10^{-3}$ C_{H^+}

135.95

4. 100 mL 0.036 M HCl solution is titrated with 0.100 M NaOH. Calculate the pH after addition of 35.95 mL of the titrant.
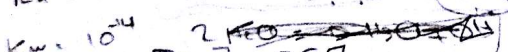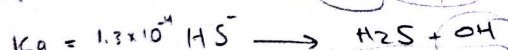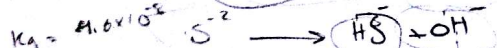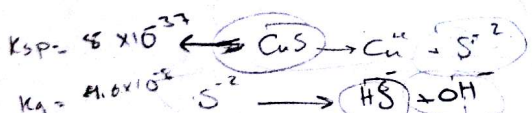
a) 3.01   b) 7.00   c) 4.43   d) 9.11   e) 8.11

moles HCl = 3.6×10^{-3}
moles NaOH = 3.595×10^{-3}

$\dfrac{5\times10^{-6}}{0.13595} =$

5. Calculate the molar solubility of CuS in a solution in which $[H_3O^+]$ concentration is held constant at 1.0×10^{-1} M. Given that K_{sp} for $CuS = 8\times10^{-37}$
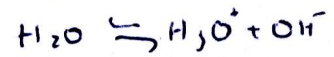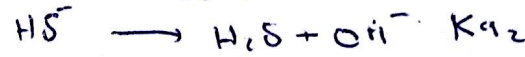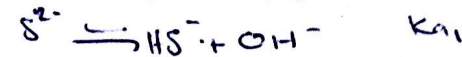For H_2S $K_{a1} = 9.6\times10^{-8}$
$K_{a2} = 1.3\times10^{-14}$

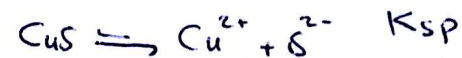$CuS \rightleftharpoons Cu^{2+} + S^{2-}$ Ksp
$S^{2-} \rightleftharpoons HS^- + OH^-$ K_{a1}
$HS^- \rightarrow H_2S + OH^-$ K_{a2}
$H_2O \rightleftharpoons H_3O^+ + OH^-$

a) 5×10^{-2} M   b) 7×10^{-35} M   c) 2.5×10^{-9} M   d) 4×10^{-7} M   e) 3×10^{-3} M

$Ksp = 8\times10^{-37}$ $CuS \rightarrow Cu^{2+} + S^{2-}$
$Ka = 4.0\times10^{-2}$ $S^{2-} \rightarrow HS^- + OH^-$ $Ksp = [Cu^+][S^{2-}]$
$Ka = 1.3\times10^{-4}$ $HS^- \rightarrow H_2S + OH^-$
$Kw = 10^{-14}$ $Ksp = [Cu^+]\,Ka_1\,Ka_2\,(1\times10^{-1})^2$
$[H_3O^+] = 1\times10^{-1}$

$[OH^-] = [HS^-] + [H_2S] + [H_3O^+]$

5.71×10^{-10}

Cu $+ HS^- = [OH^-] +$

٢

6. Coprecipitation in case of colloidal precipitates occurs by:

   a) mechanical entrapment   b) inclusion   c) inclusion
   d) surface adsorption
   e) all of the above processes occur

7. A sample of a weak base B is titrated with 0.100 M HCl. 40.0 mL of titrant is required to reach the equivalence point. When 24.0 mL of titrant had been added, the pH was 5.84. Calculate pK$_b$ of the weak base.

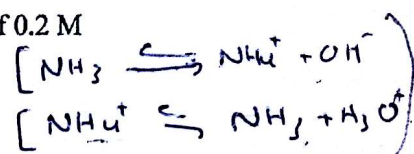   a) 5.84   b) 7.98   c) 8.11   d) 9.31   e) 5.67

8. Calculate the buffer capacity as moles of NaOH for a buffer consisting of 0.2 M NH$_3$ and 0.3 M NH$_4$Cl (K$_b$ for NH$_3$ = 1.75x10^{-5})

   a) 3.11x10^{-2} mol   b) 6.5x10^{-2} mol   c) 0.23 mol
   d) 6.5x10^{-4} mol   e) 1.1x10^{-3} mol

9. The type of mechanism by which crystalline precipitates form is:

   a) nucleation mechanism.
   b) coprecipitation.
   c) coagulation.
   d) particle growth mechanism.
   e) none of the above.

10. AgCl is precipitated by adding NaCl to an aqueous solution of AgNO$_3$. The ion most strongly absorbed to the surface of the colloidal precipitate before the equivalence point is:-

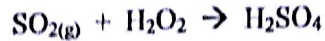   a) OH$^-$ b) Na$^+$ c) Cl$^-$ d) Ag$^+$ e) H$_3$O$^+$

11. The best wash solvent for Fe(OH)$_3$ gelatinous precipitate is:-

   a) dilute ammonia solution   b) pure water
   c) acetone   d) dilute HNO$_3$ solution
   e) ethanol

Scanned by CamScanner

12. A 4.476 g sample of a petroleum product was burned in a tube furnace, and the SO_2 (molar mass 64 g/mol) produced was collected in 3% H_2O_2. Reaction is:-

$$SO_{2(g)} + H_2O_2 \rightarrow H_2SO_4$$

A 25.00 mL portion of 0.00923 M NaOH was introduced into the solution of H_2SO_4. Reaction is: 1.6363×10^{-4}

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

following which the excess base was back titrated with 13.33 mL of 0.01007 M HCl. Calculate the parts per million of sulfur (atomic mass 32 g/mol) in the sample.

   a) 345.0 ppm   b) 0.345 ppm   c) 300.0 ppm

   d) 175.0 ppm   e) 115.0 ppm

$\sqrt{K_a\,M}$

13. Which of the following indications is most suitable for the titration of 50.00 mL of 0.10 M acetic acid ($K_a = 1.75 \times 10^{-5}$) with 0.10 M NaOH.

	Transition range
a) Alizarin yellow	10.0 – 12.0
b) Thymol blue	1.2 – 2.8
c) phenol red	6.2 – 2.8
d) cresol purple	7.6 – 9.2
e) Thymol phthalein	9.3 – 10.5

1.75×10^{-5} $\dfrac{5 \times 10^{-3}}{100}$ = 6

0.1

0.1 – 0.1   Y   X

$\boxed{5 \times 10^{-6}}$ Kb

$\dfrac{}{100}$

14. 0.7500 g sample containing only NaCl (molar mass 58.34 g/mol) and NaBr (molar mass 102.89 g/mol) was treated with excess $AgNO_3$. The mixture AgCl (molar mass 143.34 g/mole) and AgBr (molar mass 187.78 g/mol) is filtered, washed, dried and found to weigh 1.5220 g. Calculate the percentage of NaCl in the sample?

   a) 68.11%   b) 16.76%   c) 32.34%   d) 64.64%   e) 4.01%

4.60×10^{-3} mol $\dfrac{1\,mol.}{1\,mol}$

15. The process of dispersing an insoluble material into a liquid as a colloid is called:

   a) peptization   b) occlusion   c) inclusion

   d) coagulation   e) nucleation

$1.522\,g = x + y$

$.750 = x + y$

$\frac{a}{3}$ 10.38

6

7/184

Analytical Chemistry
Second Exam

Name: .... Date: 24-4-2013

Reg. No.: ....Seat no.:..................... Time : 60 min.

Section: 1   ②   3   4   5   6

****

1. (a)~~a~~ b c d e   9. ~~a~~ b c d ~~e~~

2. a ~~b~~ c d e   10. a b ~~c~~ d e

3. a b c d ~~e~~   11. ~~a~~ b c ~~d~~ e

4. a ~~b~~ c ~~d~~ e   12. a ~~b~~ c d ~~e~~

5. ~~a~~ b c d e   13. ~~a~~ b c d e

6. a ~~b~~ c d e   14. a b c d ~~e~~

7. a b c d ~~e~~   15. ~~a~~ ~~b~~ c d e
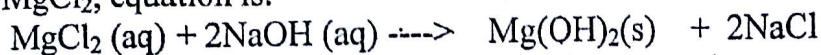
8. a b ~~c~~ ~~d~~ e

GOOD LUCK

$$\frac{1}{2}\left[0.1\,(2)^2 + 0.2(1)^2\right] + 0.2(3\int + 0\cdot2\ldots 6$$
$$2-2 \to 6$$

$$1:2 \to 3$$

1. Calculate the ionic strength of a solution that is 0.10M in $FeCl_2$ and 0.20M in $FeCl_3$. $1:3 \to$
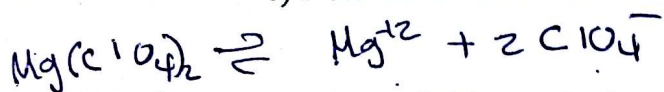
   (a) 1.5   b) 1.6 M   c) 2.4 M   d) 1.4 M   e) 0.8M

2. Neglecting any effect caused by volume changes upon addition of sodium hydroxide to a dilute solution of magnesium chloride $MgCl_2$, equation is:
$$MgCl_2\,(aq) + 2NaOH\,(aq) \dashrightarrow Mg(OH)_2(s) + 2NaCl$$
would you expect the ionic strength of the magnesium chloride solution to:

   a) Remain constant   (b) Increase   c) Decrease
   d) We cannot predict what will happen to the ionic strength
   e) None of the above statements is correct.

$$Mg(ClO_4)_2 \rightleftharpoons Mg^{+2} + 2ClO_4^-$$
$$\mu = 0.0501$$

$$\gamma_{Ba^{+2}} = 0.46$$
$$\gamma_{SO_4^{2-}} = 0.44$$
$$\mu \to 06$$

$$S \quad \gamma_{Ba^{+2}}\,\gamma_{SO_4^{-2}}$$

$$K_{sp} = [Ba^{+2}][SO_4^{=}] = 1.1\times10^{-10}$$
$$S^2 = 1.1$$
$$\sqrt{5.435\times10^{-10}}$$
$$= 2.33\times10^{-5}$$

3. Using activities, calculate the solubility of $BaSO_4$ in 0.0167M of $Mg(ClO_4)_2$. The thermodynamic solubility product for $BaSO_4$ is 1.1×10^{-10}.

   a) 1.0×10^{-5} M b) 1.1×10^{-10} M c) 0.10 M d) 1.2×10^{-5} M (e) 2.33×10^{-5} M

4. Concerning the activity coefficient, which of the following statements is **incorrect**:

   a) In very dilute solutions, the activity coefficient of any ion is unity. ✓
   (b) In solutions that are not too concentrated, the activity coefficient for a given species is independent of the nature of the electrolyte and dependent only on the ionic strength.
   c) The activity coefficient of an uncharged molecule is approximately unity, regardless of ionic strength.
   d) As the ionic strength decreases, the activity coefficient approaches zero. ✓
   e) At any given ionic strength, the activity coefficients of ions of the same charge and radius are approximately equal. ✓

$$= \frac{0.51\,3\sqrt{\mu}}{1+3.3\sqrt{\mu}}$$

5. Using the systematic approach for complex systems, calculate the molar solubility of $Al(OH)_3$ ($K_{sp} = 3\times10^{-34}$) in water. $K_w = 1\times10^{-14}$

$$1.825\times10^{-9}$$

   (a) 3×10^{-13} M
   b) 3.2×10^{-9} M
   c) 5.0×10^{-13} M
   d) 4.2×10^{-12} M
   e) 8.0×10^{-13} M
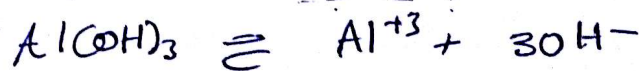
$$Al(OH)_3 \rightleftharpoons Al^{+3} + 3OH^-$$
$$2H_2O \rightleftharpoons 2H_3O^+ + OH^-$$
$$[OH^-] = 3[Al^{+3}] + [H_3O^+] - ①$$
$$K_w = [H_3O^+][OH^-] = 1\times10^{-14}$$
$$K_{sp} = 3\times10^{-34} = [Al^{+3}][OH^-]^3$$
$$[H_3O^+] \gg 3[Al^{+3}]$$

$$[Al^{+3}] = \frac{3\times10^{-34}}{(10^{-7})^3} = 3\times10^{-13}$$

$$3\times10^{-9}$$

6. Calculate the minimum pH of a solution that is 0.1 M of each Fe(III) and Mg(II), in which

    Fe(III) is needed to be separated quantitatively from the Mg(II) as hydroxide.
given that:
Ksp for Fe(OH)$_3$ = 5×10^{-39} → ppt first → $K_{sp} = [Fe^{+3}][OH^-]^3 = 5 \times 10^{-29}$
Ksp for Mg(OH)$_2$= 7.1×10^{-12}
Using 1×10^{-5} M as criterion for quantitative removal of ions.
$10^{-5} \times S^3 =$;
$S = 7.94 \times 10^{-12}$

a) 3.23
b) 2.90 *(circled)*
c) 5.07
d) 10.77
e) 8.93 *(circled)*

$7.1 \times 10^{-k} = [Mg][OH^-]^2$ poH = 11.1

$[OH^-] = 8.426 \times 10^{-6}$ $\boxed{pH = 2.89}$

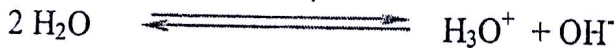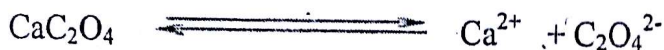$pOH = 5:07$
$pH = 8.925$

7. In an aqueous solution, where calcium oxalate was precipitated at pH = 4,
the following equilibria were established

$$CaC_2O_4 \rightleftharpoons Ca^{2+} + C_2O_4^{2-}$$ $[Ca^{2+}] = 2[C_2O_4^{-2} + HC_2O_4 +$

$$H_2C_2O_4 + H_2O \rightleftharpoons H_3O^+ + HC_2O_4^-$$

$$HC_2O_4^- + H_2O \rightleftharpoons H_3O^+ + C_2O_4^{2-}$$

$$2 H_2O \rightleftharpoons H_3O^+ + OH^-$$

$\boxed{2[Ca^{+2}] + [H_3O^+] = [HC_2O_4^-]}$
$2[C_2O_4]$
$+ [OH^-]$

One of the following **charge-balance** equations, **is correct**

a) $[Ca^{2+}] = [C_2O_4^{2-}] + [HC_2O_4^-] + [H_2C_2O_4]$ ×
b) $2[Ca^{2+}] = 2[C_2O_4^{2-}] + [HC_2O_4^-] + [H_2C_2O_4]$ ×
c) $[Ca^{2+}] = [C_2O_4^{2-}] - [HC_2O_4^-] - [H_2C_2O_4]$ ×
d) $[Ca^{2+}] + [H_3O^+] = 2[C_2O_4^{2-}] + [HC_2O_4^-] + [OH^-]$
e) $2[Ca^{2+}] + [H_3O^+] = 2[C_2O_4^{2-}] + 2[HC_2O_4^-] + [OH^-]$

S^{-2}

8. Which is the correct mass balance equation for an aqueous solution
of 0.20 M in H$_3$AsO$_4$, Given that

$$0.2$$
$$H_3AsO_4 + H_2O \rightleftharpoons$$ 0.2   0.2 $[H_3O^+] = [H_2AsO_4^-] + [HAsO_4^{2-}$
$$H_2AsO_4^- + H_2O \rightleftharpoons H_3O^+ + H_2AsO_4^-$$ $+ [AsO_4^{3-}] + [OH^-]$
$$HAsO_4^{2-} + H_2O \rightleftharpoons HAsO_4^{2-} + H_3O^+$$ $+ [H_3AsO_4]$
$$\phantom{HAsO_4^{2-} + H_2O \rightleftharpoons} AsO_4^{3-} + H_3O^+$$
$$2 H_2O \rightleftharpoons H_3O^+ + OH^-$$

$[H_3AsO_4] = [H_2AsO_4^-]$
$0.2 \quad =$
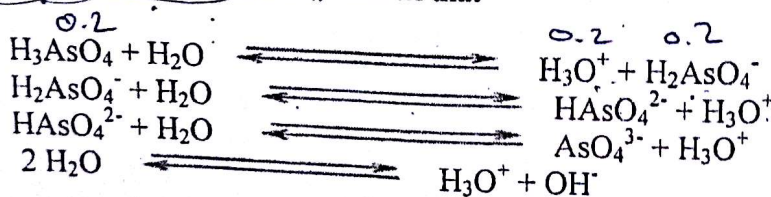
a) C$_{H3AsO4}$ =0.2 M = $[H_2AsO_4^-] + 2[HAsO_4^{2-}] + 3[AsO_4^{3-}]$
b) $[H_3O^+]$ = $[OH^-] + [H_2AsO_4^-] + 2[HAsO_4^{2-}] + 3[AsO_4^{3-}]$
c) C$_{H3AsO4}$ =0.2 M = $[H_3AsO_4] + [H_2AsO_4^-] + [HAsO_4^{2-}] + [AsO_4^{3-}]$
d) C$_{H3AsO4}$ =0.2 M = $[H_3AsO_4] + [H_2AsO_4^-] + [HAsO_4^{2-}] + [AsO_4^{3-}]$
e) C$_{H3AsO4}$ =0.2 M = $[H_3AsO_4] + [H_2AsO_4^-] + [HAsO_4^{2-}] + [AsO_4^{3-}] - [OH^-]$
$[H_3AsO_4] + [H_2AsO_4^-] + [HAsO_4^{2-}] + 3[AsO_4^{3-}]$

9. Encircle the correct statement:

a) Precipitates always have some ions adsorbed on their surfaces. Either anions or cations will be adsorbed during precipitation, depending on which is in excess.

b) The primary adsorbed ions are held by a chemical bond, whereas the secondary adsorbed ions are held by electrostatic attraction

c) It is preferable that the precipitate in gravimetric analysis must have a low Ksp value to reduce negative determinate errors

d) The rate of precipitation increases as the relative supersaturation increases. This applies to both colloidal and crystalline precipitates.

e) All of the above statements are correct

10. Which of the following statements is **correct**:

a) the particle size decreases by decreasing the relative supersaturation ratio.

b) inclusion means capturing of foreign ions into the space lattices of the crystal.

c) dispersion of colloidal precipitates occurs when washed with distilled water.

d) In gravimetric analysis positive error occurs if the crucible containing the precipitate is dried to constant weight.

e) occlusion means entrapment of a solution droplet into the crystal during precipitation.

11. Encircle the **correct** statement:

a) Precipitation from a heterogeneous solution involves slowly generating the precipitating ion by a homogeneous chemical reaction

b) Coprecipitation, especially surface adsorption, can be avoided by heating only)

c) Peptization means that part of the precipitate coagulates

d) Precipitation from a homogeneous solution keeps Q-S/S low at all times; hence a pure, dense precipitate forms.

e) The choice of the drying temperature of the precipitate depends on the nature of the precipitating agent

12. In the titration of a NaBr solution with silver nitrate solution, $AgNO_3$, what ion is mostly adsorbed in the primary adsorption layer after the end point:

a) Br^-
b) Na^+
c) NO_3^-
d) H_3O^+
e) Ag^+

handwritten top right: $n_{SiO_2} = 2 \times n = 0.01170$ ....

$m = 0.705\,g$
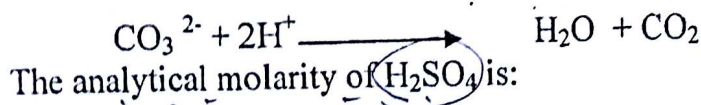
13. Calculate the mass of SiO_2 (60.1 gmol^{-1}) precipitate that would be obtained from a 1.0g sample of pure $NaAl(SiO_2)_2$ (170gmol^{-1}).

   (a) 0.71g   b) 0.38g   c) 1.1g   d) 0.12g   c) 0.12g   d) 0.91g

handwritten right:
$50 \times 40 = 0.2 \times V$
$U = 100\,m\ell$
$120\,m\ell \to$ after
or $n_{Pb} > n_{x-}$
$[Pb] = \dfrac{Ksp}{n-n}$ ...
$= 6.8 \times$
6.167
$\boxed{\dfrac{n-n}{U}}$

14. In the titration of 50.00 ml of 0.40 M of Na_2SO_4 with 0.20 M $Pb(NO_3)_2$, $PbSO_4$ precipitates down. Calculate the P function of Pb^{2+} (pPb) after adding 120.00 ml of $Pb(NO_3)_2$. K_{sp} for $PbSO_4$ is: 1.6×10^{-8}.

(handwritten "24" left margin)

   a) 0.69   b) 3.90   c) 3.33   d) 7.80   (e) 6.66

15. A 0.4512 g of primary –standard grade Na_2CO_3 (106g/mol) required 36.44 mL of an H_2SO_4 solution to reach the end point in the reaction:
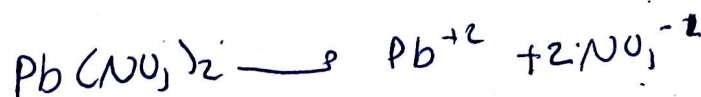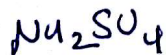
$$CO_3^{2-} + 2H^+ \longrightarrow H_2O + CO_2$$

The analytical molarity of H_2SO_4 is:

   a) 0.117 M   (b) 0.234 M   c) 0.00851 M   d) 0.0234 M   e) 0.0177M

handwritten left margin: 3.89

handwritten bottom workings:

$[Cl^-] = $ $n_1 = 2\,n_{H^+}$

$\longrightarrow 2.336 \times 10^{-4} \times 10^3$

$= 0.234\,M$

Na_2SO_4

$Pb(NO_3)_2 \longrightarrow Pb^{+2} + 2NO_3^{-1}$

$[\quad]_{excess} = \dfrac{n-n}{V_{tot}}$ $k_{sp} = [Pb][SO_4]$

$[\quad] = \dfrac{V \times k_{sp}}{n-n}$

Values of t for Various Levels of Probability

Degrees of Freedom	80%	90%	95%	99%	99.9%
1	3.08	6.31	12.7	63.7	637
2	1.89	2.92	4.30	9.92	31.6
3	1.64	2.35	3.18	5.84	12.9
4	1.53	2.13	2.78	4.60	8.61
5	1.48	2.02	2.57	4.03	6.87
6	1.44	1.94	2.45	3.71	5.96
7	1.42	1.90	2.36	3.50	5.41
8	1.40	1.86	2.31	3.36	5.04
9	1.38	1.83	2.26	3.25	4.78
10	1.37	1.81	2.23	3.17	4.59
15	1.34	1.75	2.13	2.95	4.07
20	1.32	1.73	2.09	2.84	3.85
40	1.30	1.68	2.02	2.70	3.55
60	1.30	1.67	2.00	2.62	3.46
∞	1.28	1.64	1.96	2.58	3.29

Critical Values for the Rejection Quotient, Q^*

Q_{crit} (Reject if $Q > Q_{crit}$)

Number of Observations	90% Confidence	95% Confidence	99% Confidence
3	0.941	0.970	0.994
4	0.765	0.829	0.926
5	0.642	0.710	0.821
6	0.560	0.625	0.740
7	0.507	0.568	0.680
8	0.468	0.526	0.634
9	0.437	0.493	0.598
10	0.412	0.466	0.568

Confidence Levels for Various Values of z

Confidence Level, %	z
50	0.67
68	1.00
80	1.28
90	1.64
95	1.96
95.4	2.00
99	2.58
99.7	3.00
99.9	3.29

Activity Coefficients for Ions at 25 °C

Ion	α_X, nm	Activity Coefficient at Indicated Ionic Strength				
		0.001	0.005	0.01	0.05	0.1
H_3O^+	0.9	0.967	0.934	0.913	0.85	0.83
$Li^+, C_6H_5COO^-$	0.6	0.966	0.930	0.907	0.83	0.80
$Na^+, IO_3^-, HSO_3^-, HCO_3^-, H_2PO_4^-, H_2AsO_4^-, OAc^-$	0.4–0.45	0.965	0.927	0.902	0.82	0.77
$OH^-, F^-, SCN^-, HS^-, ClO_3^-, ClO_4^-, BrO_3^-, IO_4^-, MnO_4^-$	0.35	0.965	0.926	0.900	0.81	0.76
$K^+, Cl^-, Br^-, I^-, CN^-, NO_2^-, NO_3^-, HCOO^-$	0.3	0.965	0.925	0.899	0.81	0.75
$Rb^+, Cs^+, Tl^+, Ag^+, NH_4^+$	0.25	0.965	0.925	0.897	0.80	0.75
Mg^{2+}, Be^{2+}	0.8	0.872	0.756	0.690	0.52	0.44
$Ca^{2+}, Cu^{2+}, Zn^{2+}, Sn^{2+}, Mn^{2+}, Fe^{2+}, Ni^{2+}, Co^{2+}, Phthalate^{2-}$	0.6	0.870	0.748	0.676	0.48	0.40
$Sr^{2+}, Ba^{2+}, Cd^{2+}, Hg^{2+}, S^{2-}$	0.5	0.869	0.743	0.668	0.46	0.38
$Pb^{2+}, CO_3^{2-}, SO_3^{2-}, C_2O_4^{2-}$	0.45	0.868	0.741	0.665	0.45	0.36
$Hg_2^{2+}, SO_4^{2-}, S_2O_3^{2-}, CrO_4^{2-}, HPO_4^{2-}$	0.40	0.867	0.738	0.661	0.44	0.35
$Al^{3+}, Fe^{3+}, Cr^{3+}, La^{3+}, Ce^{3+}$	0.9	0.737	0.540	0.443	0.24	0.18
$PO_4^{3-}, Fe(CN)_6^{3-}$	0.4	0.726	0.505	0.394	0.16	0.095
$Th^{4+}, Zr^{4+}, Ce^{4+}, Sn^{4+}$	1.1	0.587	0.348	0.252	0.10	0.063
$Fe(CN)_6^{4-}$	0.5	0.569	0.305	0.200	0.047	0.020

Second Semester 2010/2011
Analytical Chemistry
Second Exam

Name: .... ~~........~~ Date: April,28,2011

Reg. No.: ~~..........~~ ......

Section: ....~~A......A~~

****

1. a b ⊗ d e   9. a ~~b~~ c d ✗

2. a b ✗ d ~~e~~   10. a b c d ⊗

3. a b ⊗ d e   11. a b ~~c~~ ✗ e

4. a ~~b~~ ✗ d e   12. a b ⊗ d e

5. a b ~~c~~ d ✗   13. a ⊗ c d e

6. a b c d ⊗   14. a ⊗ c d e

7. ⊗ b c d e   15. a b c d ⊗

8. a b ⊗ d e

$\frac{5}{3}$ $\frac{5}{2}$

GOOD LUCK

$Na_2SO_4 \rightarrow 2Na^{+1} + SO_4^{-2}$ $\frac{1}{2}[0.04 + 4 \times 0.08] = 0.06$

K   NO3

0.04

$\frac{K^+}{0.04}$ $\frac{NO_3^-}{0.04}$ ... = 0.1

#1 What is the ionic strength of a solution that is 0.04 M in KNO₃ and 0.02 M in Na₂SO₄?

$Na_2SO_4 \rightarrow 2Na^+ + SO_4^-$ 0.04K^+ 0.04NO_3^-

0.02   0.04   0.02

a) 0.15   b) 0.2   c) 0.1   d) 0.05   e) 0.25 Na^+ SO_4^-

0.04   0.02

$\frac{1}{2}[$

2. Which of the following sentences is **not correct**?

a) As a solution approaches infinite dilution, the activity coefficient approaches 1.

b) Activity coefficient of an uncharged molecule is approximately unity regardless of ionic strength.

c) In a solution that is not too concentrated, the activity coefficient of a given ion is independent of the nature of the electrolyte and dependent only on the ionic strength.

d) At any given ionic strength, the activity coefficient of ions of the same charge are approximately equal.

e) For a given ionic strength, the activity coefficient of an ion becomes closer to unity as the charge carried by the ion increases.

$NaCl \rightarrow Na^+ + Cl^-$

0.05   0.05

3. Use activity coefficient to calculate the pH of a 0.120 M HNO₂ (K_a=7.13x10⁻⁴) that is also 0.050 M in NaCl? $HNO_3 \rightarrow H^+ + NO_3^-$

a) 4.5   b) 3.9   c) 1.95   d) 1.55   e) 0.95

$M = \frac{0.5 + 0.05}{2} = 0.05$

4. Which is the mass-balanced equation for a saturated solution of CaF₂? $= 0.05$

Useful equations:

$CaF_2 \rightarrow Ca^{2+} + 2F^-$

$F^- + H_2O \rightarrow HF + OH^-$
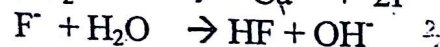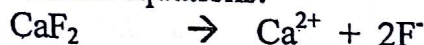
a) $[Ca^{2+}] = \frac{1}{2}\{[F^-] - [HF]\}$

b) $[Ca^{2+}] = \frac{1}{2}\{[F^-] + [HF]\}$

c) $[Ca^{2+}] = 2[F^-] + [HF]$

d) $[Ca^{2+}] = 2[F^-] - [HF]$

e) All of the above

$Ka = \frac{1}{x} \times Y \cdot Ka'$

$\{M NaCl\}$

$Ka' = 1$

$Ka^{\circ} = [H^+] K[NO_2^-]$

$7.13 \times 10^{-4} [H^+]^2$ (0.12) ÷ 0.120 = 0.85

$Ka = a_H^+ \cdot a_{NO_2}^-$

$HNO_2 \rightarrow H^+ + NO_2^-$

$NaCl \rightarrow Na^+ + Cl^-$
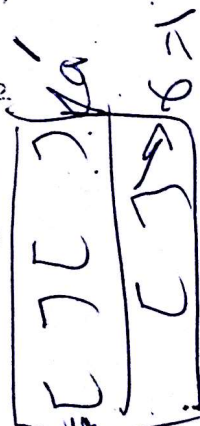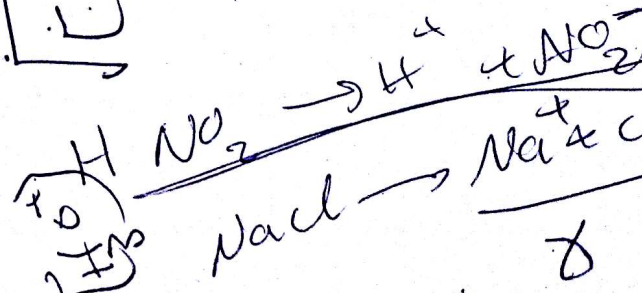
$$0.1 \times 9.6 \times 10^{-8} = [H_3O]^+[HS^-] \quad K_1 = \frac{[H_3O^+][HS^-]}{[H_2S]}$$
$$9.6 \times 10^{-9}$$

5. Which is the correct charge – balance equation of solution containing 1M $Mg(OH)_2$.

$$Mg(OH)_2 \rightarrow Mg^{+2} + 2OH^-$$
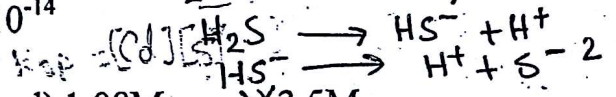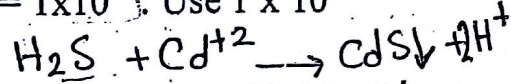$$H_2O \rightarrow H_3O + OH^-$$
$$Mg(OH)_2 \rightarrow mg^+$$
$$H_2O$$
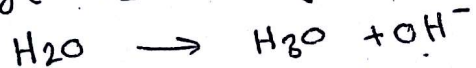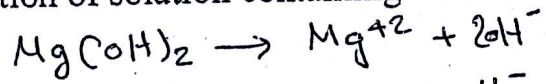
a) $[OH^-] = \frac{1}{2}[Mg^{2+}] + [H_3O^+]$
b) $[OH^-] = [Mg^{2+}] + [H_3O^+]$
✗ $[OH^-] = 2[Mg^{2+}] + [H_3O^+]$
d) $[OH^-] = 3[Mg^{2+}] + 2[H_3O^+]$
✗ None of the above

$$\underline{[H^+]} \qquad 1\times10^{-4}$$
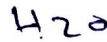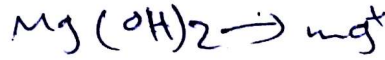
#6. Calculate the hydrogen ion concentration at which CdS precipitates quantitatively from a solution that is 0.01 M in Cd^{2+} using saturated solution of H_2S (0.10 M) as a precipitating agent. K_{sp} for $CdS = 1\times10^{-27}$. Use 1×10^{-4} as a criterion for quantitative precipitation.
For $H_2S : K_1 = 9.6 \times 10^{-8}$ and $K_2 = 1.3 \times 10^{-14}$

$$H_2S + Cd^{+2} \rightarrow CdS\downarrow + 2H^+$$
$$k_{sp} = [Cd][S] \quad H_2S \rightarrow HS^- + H^+$$
$$HS^- \rightarrow H^+ + S^{-2}$$

a) 0.55M   b) 1.40M   c) 0.92 M   d) 1.08M   ✗ 3.5M

$$Cd = [S^{-2}][C_2C_2]C_2$$

7. A cupper ore was analyzed by dissolving 0.8234g sample in concentrated HCl and the Cu II was precipitated as CuSCN ($Ksp = 4.0\times10^{-14}$) by the addition of KSCN. After filtration, the residue was dried to give 0.5394g of pure CuSCN (molar mass = $121.5 gmol^{-1}$). Calculate the percentage of cupper (63.5 $gmol^{-1}$) in the sample.

(a) 34.24%   (b) 21.68%   (c) 46.29%   (d) 18.25%   (e) 39.21%

8. Encircle the correct statement:

(a) Colloidal suspensions show no tendency to settle from solutions but are easily filtered

(b) Crystalline precipitates show no tendency to settle from solutions and are not easily filtered.

(c) The particle size of a freshly formed precipitate is determined by the mechanism of its formation

(d) Particle size of precipitates increases by increasing Q values

(e) The rate of nucleation is believed to decrease with increasing relative supersaturation

3

9. Encircle the correct statement:

   (a) The drying step is a very important step in gravimetric analysis whereby the temperature is controlled so as to cause decomposition
   (b) Washing generally does not remove much of the coprecipitated ions in case of crystalline precipitates.
   (c) Mechanical entrapment results when one of the ions in the crystal lattice is replaced by an ion of another element
   (d) Mechanical entrapment occurs when crystals lie far away from each other during growth
   (e) Coprecipitated impurities always cause positive determinate errors

10. Encircle the correct statement:

   (a) Coagulation can be enhanced by heating, by stirring and by the addition of an electrolyte

   (b) The process by which ions are retained at the surface of the solid is known as adsorption

   (c) The primary and secondary adsorption layers can be positively or negatively charged

   (d) Peptization is a process by which a coagulated colloid goes back to its original dispersed state

   (e) All of the above statements are correct

11. In the Fajan's method for the determination of I^- in an aqueous sample using $AgNO_3$ as titrant and fluorescein as indicator. The indicator functions by coprecipitation of:

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   a) The Fluorescein-NO_3^- complex
   b) Fluorescein- I- complex
   c) Fluresceinate- Ag salt
   d) Fluorescein- AgI
   e) Non of the above

4

12. In which of the following titrations the solution must be acidic:
   a) Mohr's titration
   b) Fajan's titration
   c) Volhard's titration
   d) In both Mohr's and Fajan's titrations
   e) In none of the above.

13. In an argentometric titration ($AgNO_3$ as titrant) to determine the concentration of the
   following anions in aqueous sample: CN^- ($Ksp_{AgCN} = 2.2 \times 10^{-16}$), Cl^- ($Ksp_{AgCl} = 1.8 \times 10^{-10}$), IO_3^- ($Ksp_{AgIO3} = 3.1 \times 10^{-8}$), and BrO_3^- ($Ksp_{AgBrO3} = 5.7 \times 10^{-5}$).

   a) BrO_3^- will precipitate first.
   b) The sharpest end point is obtained in case of titrating CN^-
   c) CN^- will precipitate last
   d) IO_3^- (iodate) and BrO_3^- (bromate) will be precipitated together as single component (one equivalence point)
   e) AgCl will have the sharpest end point.

   [0.1]

14. In the titration of 50.00 ml of 0.0500 M NaCl with 0.1000 M $AgNO_3$ (Ksp = 1.82×10^{-10}). Calculate pAg at the equivalence point.

   a) 8.14   b) 4.87   c) 2.88   d) 5.60   e) 10.24

   $n_{Ag} - .25$
   $n_{Ag} - 2.5 \times 10^{-3}$

15. 4. In the titration of 50.00 ml of 0.0500 M NaCl with 0.1000 M $AgNO_3$ (Ksp = 1.82×10^{-10}). Calculate pAg after addition of 26.00 mL of $AgNO_3$:

   a) 4.87   b) 6.87   c) 8.14   d) 1.78   e) 2.88

   $[Ag^+] = \dfrac{2.6 - 2.5}{}$

5

Date: 19/12/2009
Time: 75 minutes

Student's Name: ~~_____~~

Registration No.: ~~_____~~

Instructor: ☐ Prof Alawi   ☒ Prof Fayyad

Section: ① ② ③ ④ ⑤   12 - 1

Seat No.: _____

ANSWER SHEET

1. a ~~b~~ c d e   9. a ~~b~~ c d e

2. ~~a~~ b c d ~~e~~   10. ~~a~~ b ~~c~~ d e

3. a b c ~~d~~ e   11. a b c d ~~e~~

*4. a b ~~c~~ d ~~e~~   12. a ~~b~~ c d e

5. a ~~b~~ ~~c~~ d e   13. ~~a~~ b c d e

6. ~~a~~ b c d e   14. a b c ~~d~~ e

*7. ~~a~~ b c d e   15. a b ~~c~~ d e

8. a b c d ~~e~~   16. a b c d e

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TABLE 10-2

Activity Coefficients for Ions at 25 °C

Ion	α_X, nm	Activity Coefficient at Indicated Ionic Strength				
		0.001	0.005	0.01	0.05	0.1
H_3O^+	0.9	0.967	0.934	0.913	0.85	0.83
Li^+, $C_6H_5COO^-$	0.6	0.966	0.930	0.907	0.83	0.80
Na^+, IO_3^-, HSO_3^-, HCO_3^-, $H_2PO_4^-$, $H_2AsO_4^-$, OAc^-	0.4–0.45	0.965	0.927	0.902	0.82	0.77
OH^-, F^-, SCN^-, HS^-, ClO_3^-, ClO_4^-, BrO_3^-, IO_3^-, MnO_4^-	0.35	0.965	0.926	0.900	0.81	0.76
K^+, Cl^-, Br^-, I^-, CN^-, NO_2^-, NO_3^-, $HCOO^-$	0.3	0.965	0.925	0.899	0.81	0.75
Rb^+, Cs^+, Tl^+, Ag^+, NH_4^+	0.25	0.965	0.925	0.897	0.80	0.75
Mg^{2+}, Be^{2+}	0.8	0.872	0.756	0.690	0.52	0.44
Ca^{2+}, Cu^{2+}, Zn^{2+}, Sn^{2+}, Mn^{2+}, Fe^{2+}, Ni^{2+}, Co^{2+}, Phthalate^{2-}	0.6	0.870	0.748	0.676	0.48	0.40
Sr^{2+}, Ba^{2+}, Cd^{2+}, Hg^{2+}, S^{2-}	0.5	0.869	0.743	0.668	0.46	0.38
Pb^{2+}, CO_3^{2-}, SO_3^{2-}, $C_2O_4^{2-}$	0.45	0.868	0.741	0.665	0.45	0.36
Hg_2^{2+}, SO_4^{2-}, $S_2O_3^{2-}$, CrO_4^{2-}, HPO_4^{2-}	0.40	0.867	0.738	0.661	0.44	0.35
Al^{3+}, Fe^{3+}, Cr^{3+}, La^{3+}, Ce^{3+}	0.9	0.737	0.540	0.443	0.24	0.18
PO_4^{3-}, $Fe(CN)_6^{3-}$	0.4	0.726	0.505	0.394	0.16	0.095
Th^{4+}, Zr^{4+}, Ce^{4+}, Sn^{4+}	1.1	0.587	0.348	0.252	0.10	0.063
$Fe(CN)_6^{4-}$	0.5	0.569	0.305	0.200	0.047	0.020

0.2   0.2   0.6

$1Fe\,Cl_2 \rightarrow Fe^{+2} + 2Cl^-$
0.1   0.1   0.2

1/ Calculate the ionic strength of a solution that is 0.20 M in $FeCl_3$ and 0.10 M in $FeCl_2$

$\mu = \frac{1}{2}(0.2\,(3)^2 + 0.6\,(-1)^2 + 0.1\,(2)^2 + 0.2\,(-1)^2)$

a) 0.7   ⓑ 1.5   c) 1.2   d) 0.9   e) 1.6

2/ Encircle the correct statement:

ⓐ A colloidal precipitate tends to form when a precipitate has high solubility.
b) Coprecipitation always results in positive error.
c) When (Q-S)/S is large, the precipitate tends to be crystalline.
d) If nucleation predominates, a precipitate containing large particles is produced.
ⓔ None of the above.

$\bar{a}_i = \frac{-y}{\mu_1}$

3/ The ion which has the largest activity coefficient is

a) S^{2-} ⓑ $Fe(CN)_6^{4-}$ c) Mg^{2+} ⓓ Na^+ e) Al^{3+}

$\frac{1}{2}([S^{2-}]\cdot 2^2)$ $\frac{1}{2}([C]\cdot 3^2)$ α $\frac{1}{2}[x]\cdot 3^2$

④ Use activities to calculate the solubility of $PbSO_4$ in a 0.0167 M solution of $Mg(NO_3)_2$. For $PbSO_4$, $K_{sp} = 1.6\times10^{-8}$. The activity coefficients for the ions at indicated ionic strengths

Ion	0.001	0.005	0.01	* 0.05	0.1
Pb^{2+}	0.868	0.742	0.665	0.46	0.37
SO_4^{2-}	0.867	0.740	0.660	0.44	0.36

a) 0.013 mol/L   b) 6.3×10^{-5} mol/L   c) 1.3×10^{-3} mol/L
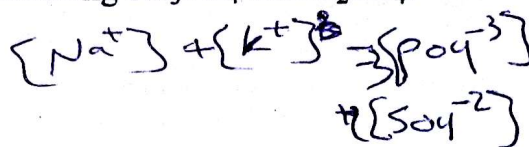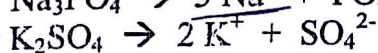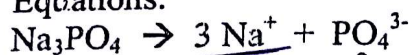d) 5.0×0^{-2} mol/L   e) 2.8×10^{-4} mol/L

5. One of the following statement is **incorrect**:

a) Dilution prior to precipitation decreases the relative supersaturation.
ⓑ Occluded impurities are eliminated by washing.
c) Colloidal particles are electrically charged.
d) Precipitation at low temperature increase the relative supersaturation.
e) Peptization can be prevented by the addition of an electrolyte to the wash solvent.

$T \uparrow$ souf $\alpha \downarrow \Rightarrow$ relative $\downarrow$

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6. Consider an aqueous solution containing Na_3PO_4 and K_2SO_4.

Equations:

$Na_3PO_4 \rightarrow 3\ Na^+ + PO_4^{3-}$

$K_2SO_4 \rightarrow 2\ K^+ + SO_4^{2-}$

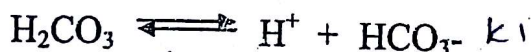$2H_2O \rightarrow H_3O^+ +$

$\{Na^+\} + \{K^+\} \geq 3\{PO_4^{3-}\}$
$+ \{SO_4^{-2}\}$

For simplicity assume that there is no further hydrolysis of ions. Then the charge-balance equation is:

a) $[Na^+] + [K^+] + [H_3O^+] = 3\ [PO_4^{3-}] + 2[SO_4^{2-}] + [OH^-]$

b) $3\ [Na^+] + 2\ [K^+] = [PO_4^{3-}] + [SP_4^{2-}]$

c) $[H_3O^+] = [SO_4^{2-}] + [PO_4^{3-}]$

d) $3\ [Na^+] + 2\ [K^+] + [H_3O^+] = [PO_4^{3-}] + [SP_4^{2-}] + [OH^-]$

e) $[Na^+] + [K^+] = [PO_4^{3-}] + [SO_4^{2-}]$

7. Calculate the molar solubility of Ag_2CO_3 in a solution that has an H_3O^+ concentration of 1.0×10^{-6} M. For Ag_2CO_3, $K_{sp} = 8.1 \times 10^{-12}$ and for H_2CO_3, $K_1 = 4.45 \times 10^{-7}$ and $K_2 = 4.7 \times 10^{-11}$.

Helpful equations:

$$Ag_2CO_{3(s)} \rightleftharpoons 2\ Ag^+ + CO_3^{2-}$$

$H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$ k_1

$HCO_3^- \rightleftharpoons H^+ + CO_3^{2-}$ k_2

a) 5.2×10^{-3} M   b) 7.1×10^{-5} M   c) 0.12 M

d) 3.1×10^{-2} M   e) 6.7×10^{-4} M

8. One of the following mass-balance equations is correct for a solution that is **0.25 M in NaF and saturated with CaF₂**.

Equations:

$NaF \rightarrow Na^+ + F^-$

$CaF_{2(s)} \rightleftharpoons Ca^{2+} + 2\ F^-$

$HF \rightleftharpoons H^+ + F^-$
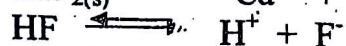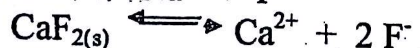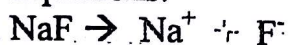
a) $[Na^+] = [Ca^{2+}] + 2[F^-]$

b) $[Na^+] + [Ca^{2+}] = [F^-] - [HF]$

c) $[Na^+] + 2[Ca^{2+}] = [F^-] - [HF]$

d) $[Na^+] + [Ca^{2+}] = [F^-]$

e) $[Na^+] + 2[Ca^{2+}] = [F^-] + [HF]$

$(b.) \leftarrow Sr \quad Ba^{+2}$

9. Given that, for $BaSO_4$, $K_{sp} = 1.1 \times 10^{-10}$ and $SrSO_4$, $K_{sp} = 3.2 \times 10^{-7}$, using 1.0×10^{-6} M as a criterion for quantitative removal, determine whether it is feasible to use SO_4^{2-} to separate Ba^{2+} from Sr^{2+} in a solution that is initially 0.05 M in Sr^{2+} and 0.30 M in Ba^{2+}:

a) The separation is feasible and $[SO_4^{2-}]$ must be held between 1.1×10^{-6} M and 6.4×10^{-4} M.

b) The separation is not feasible.

c) The separation is feasible and $[SO_4^{2-}]$ must be held between 3.2×10^{-7} M and 7.6×10^{-4} M.

d) The separation is feasible and $[SO_4^{2-}]$ must be held between 5.9×10^{-6} M and 1.5×10^{-3} M.

e) The separation is feasible and $[SO_4^{2-}]$ must be held between 6.4×10^{-6} and 1.1×10^{-4} M.

10. An aqueous solution contains $NaNO_3$ and KBr. The bromide ion is precipitated as AgBr by addition of $AgNO_3$. *Before an excess of the precipitating reagent* has been added (i.e., Br^- is still in excess in the solution), the charge on the particle in the primary adsorption layer is:

a) Negative due to adsorption of Br^-.

b) Negative due to adsorption of NO_3^-.

c) Positive due to adsorption of K^+ and Na^+.

d) Positive due to adsorption of Ag^+.

e) Positive due to adsorption of K^+ only.

11. The mercury in a 0.5456-g sample was precipitated with an excess of paraperiodic acid, H_5IO_6:

$$5 \, Hg_2^{2+} + 2 \, H_5IO_6 \rightarrow Hg_5(IO_6)_2 + 10 \, H^+$$

The precipitate was filtered, washed free of precipitating agent, dried and weighed. The weight of the isolated precipitate, $Hg_5(IO_6)_2$ (molar mass=1449 g/mole) was 0.4114 g. The percentage of Hg_2Cl_2 (molar mass= 472) in the sample is:

a) 55.5%   b) 23.6%   c) 41.1%   d) 15.7%   e) 61.4%

$\% \, Hg_2Cl_2 = \dfrac{mass \, Hg_2Cl_2}{mass \, sample} \times 100\%$

$= \dfrac{0.335}{0.5456} \times 100\%$

$n \, Hg_5(IO_6)_2 = \dfrac{0.4114}{1449} = 2.84 \times 10^{-4}$

$n \, Hg_2^{2+} = 1.4 \times 10^{-3}$

12. The average relative supersaturation increases upon:

$\overset{in}{\underset{S}{a}} \nearrow \rightarrow$ decrease

   a) generation of the precipitate in a stirred solution.
   b) generation of the precipitate at low temperature.
   c) using low concentration of the precipitating agent.
   d) using low concentrations of the analyte.
   e) slow addition of reactants.

13. A 50.00 mL of 0.100 M NaCN solution is titrated with 0.200 M HCl standard solution. The pH after addition of 50.00 mL of the HCl standard solution is:

   a) 1.30   b) 4.69   c) 3.72   d) 1.90   e) 5.90

14. Copercipitation in *colloidal precipitates* mainly occurs due to the following mechanism:

   a) Peptization.
   b) Occlusion.
   c) Inclusion of foreign ions.
   d) Surface adsorption.
   e) Mechanical entrapment.

15. A 0.3251 g of a sample containing only $CaCl_2$ (111.0 g mol^{-1}) and NaCl (58.44 g mol^{-1}) yielded 0.8135 g of dried AgCl (143.32 g/mol). The percentage of NaCl in the sample is:

mass sample = mass NaCl + mass $CaCl_2$

no mol Agcl
= no mol Na
+ no mol
$CaCl_2$

   a) 30.9%   b) 60.3%   c) 24.6%   d) 20.9%   e) 11.8%

$$\% \, NaCl = \frac{mass \, NaCl}{mass \, sample} \times 100\%$$

$$= \frac{0.82}{0.3251} \times 100\%$$

$n \, AgCl =$

$$n_{AgCl} = n \, NaCl + 2n \, CaCl_2$$

$$5.67 \times 10^{-3} = \frac{mass}{58.44} + 2\left(\frac{0.3251 - mass}{111}\right)$$

$$5.67 \times 10^{-3} = \frac{mass}{58.44} + \frac{0.6502 - 2\,mass}{111}$$

$$5.67 \times 10^{-3} = \frac{111\,mass}{6486.8} + \frac{37.9 - 116.9\,mass}{6486.8}$$

$$5.67 \times 10^{-3} = \frac{5.22 + 37.9\,mass}{6486.8}$$