

$$\frac{9}{15} \rightarrow \left(\frac{15}{25} \right)$$

Analytical Chemistry
Second Exam

د. عماري

Name: Date: 12/12/2012

Reg. No.: Seat no:

Section: 1 2 3 4 5 6

$$\begin{array}{r} 15 \\ 15 \\ \hline 50 \\ 45 \end{array}$$

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

4/4

5/2

GOOD LUCK

ask :: recieve and believe

1. What volume of 0.200 M HCl must be added to 250.0 mL of 0.300 M sodium mandelate (NaA) to produce a buffer solution with pH of 3.37. K_a of mandelic acid (HA) is: 4.0×10^{-4}

- a) 97 mL (b) 40 mL c) 0.4 mL d) 1601 mL e) 194 mL

2. Calculate the ionic strength of a solution that is 0.10 M in FeCl_3 and 0.20 M in FeCl_2 .

- a) 2.4 M b) 0.8 M (c) 1.2 M d) 1.6 M e) 0.5 M

3. Using activities, calculate the solubility of BaSO_4 in 0.0333 M solution of $\text{Mg}(\text{ClO}_4)_2$. The thermodynamic solubility product constant 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) 2.0×10^{-5} M e) 2.8×10^{-5} M

4. Neglecting any effect caused by volume changes upon addition of sodium hydroxide to a dilute solution of acetic acid, would you expect the ionic strength of the acetic acid solution to:

- a) increase
b) decrease
c) remains constant
d) we cannot predict what will happen to the ionic strength
e) none of the above statements is correct.

5. The correct mass-balance equation for an aqueous solution saturated with $\text{Fe}(\text{OH})_3$ is:

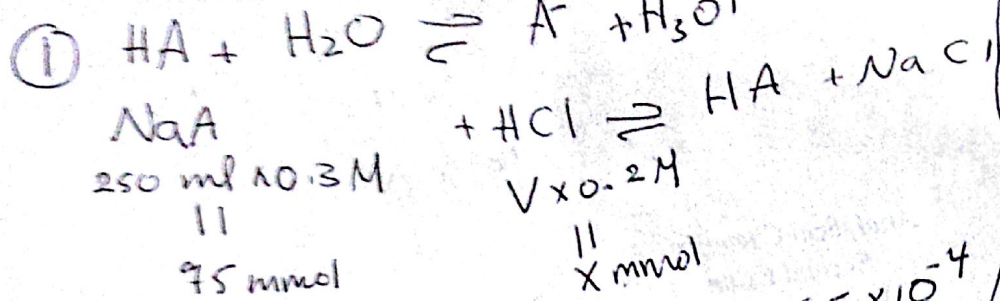
- a) $[\text{Fe}^{3+}] = 3[\text{OH}^-]$
(b) $3[\text{Fe}^{3+}] + [\text{H}_3\text{O}^+] = [\text{OH}^-]$
c) $[\text{Fe}^{3+}] + [\text{H}_3\text{O}^+] = [\text{OH}^-]$
d) $[\text{Fe}^{3+}] + [\text{OH}^-] = [\text{H}_3\text{O}^+]$
e) none of the above

6. The molar solubility for BaSO_4 is lowest when dissolved in a solution that has $[\text{H}_3\text{O}^+]$ of:

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

7. Which is the correct charge-balance equation of solution containing 0.2 M H_3AsO_4

- a) $3[\text{AsO}_4^{3-}] + [\text{H}_3\text{O}^+] = [\text{OH}^-] \times$
b) $3[\text{AsO}_4^{3-}] + [\text{OH}^-] = [\text{H}_3\text{O}^+] \times$
c) $3[\text{H}_2\text{AsO}_4^-] + [\text{H}_3\text{O}^+] = [\text{OH}^-] \times$
d) $[\text{AsO}_4^{3-}] + [\text{H}_3\text{O}^+] = [\text{OH}^-] \times$
(e) $3[\text{AsO}_4^{3-}] + [\text{H}_2\text{AsO}_4^-] + 2[\text{HAsO}_4^{2-}] + [\text{OH}^-] = [\text{H}_3\text{O}^+]$



$pH = 3.37 \rightarrow [H_3O^+] = 4.265 \times 10^{-4}$

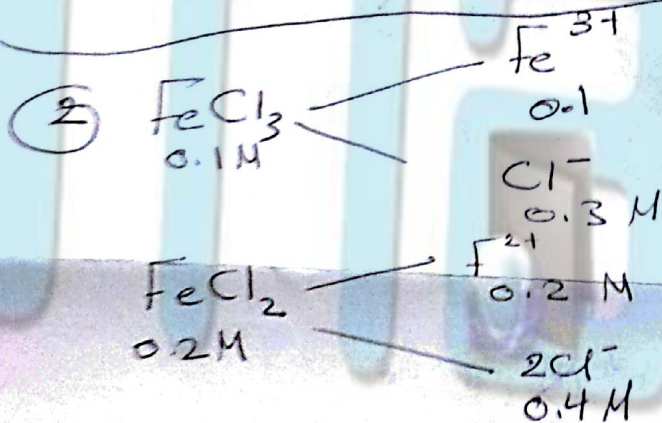
$[H_3O^+] = K_a \frac{[HA]}{[A^-]}$

$4.265 \times 10^{-4} = 4 \times 10^{-4} \times \frac{X}{75 - X}$

$X = 38.7 \text{ mmol}$

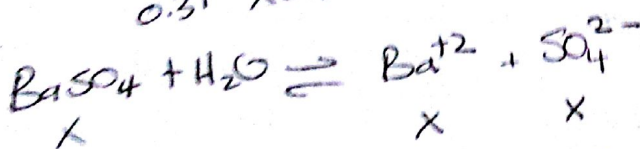
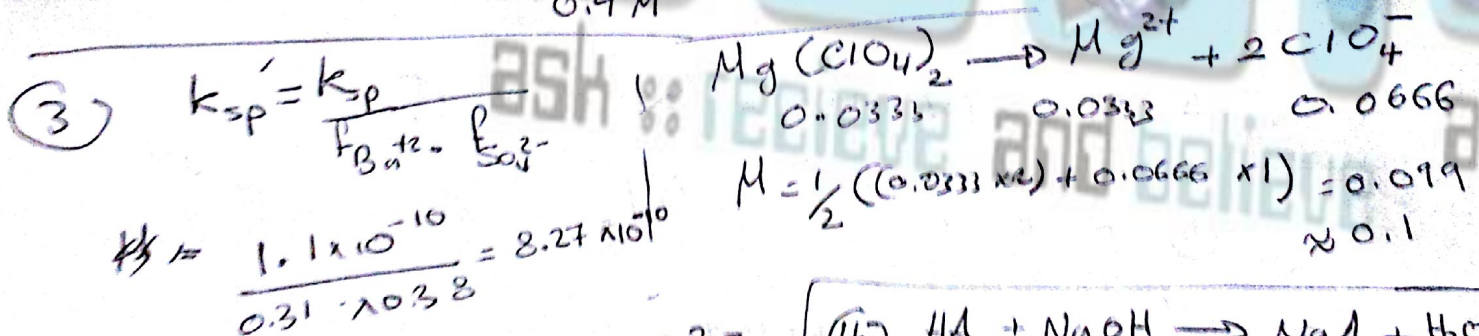
$V \times 0.2 = 38.7$

$V = 193.5 \text{ ml}$



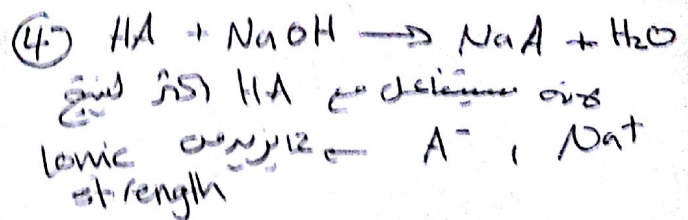
$\mu = \frac{1}{2} (0.1 \times 3^2 + 0.3 \times 1^2 + 0.2 \times 2^2 + 0.4 \times 1^2)$

$= \frac{1}{2} (2.4) = 1.2$



$K_{sp} = X^2 \rightarrow X = \sqrt{K_{sp}}$

$= \sqrt{8.27 \times 10^{-10}} = 2.87 \times 10^{-5}$



8. Calculate the hydrogen ion concentration at which Tl^+ precipitates quantitatively from a solution that is 0.01 M in Tl^+ using saturated solution of H_2S (0.10 M) as a precipitating agent. K_{sp} for Tl_2S = 6×10^{-22} .
Use 1×10^{-4} as a criterion for quantitative precipitation.

For H_2S : $K_1 = 9.6 \times 10^{-8}$ and $K_2 = 1.3 \times 10^{-14}$

- a) $0.55 \times 10^{-3} M$ (b) $1.40 \times 10^{-4} M$ c) $4.56 \times 10^{-5} M$ d) 1.08M e) 3.5

9. A precipitate of $BaSO_4$ is contaminated with $Ba(NO_3)_2$. The best way to remove the impurity is:

- a) filtration b) ignition (c) digestion d) washing e) none of the above

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

- a) coagulation b) nucleation (c) peptization d) occlusion e) inclusion

11. A sample of a pure metal chloride (MCl) weighing 0.58051 g is dissolved in water and the chloride precipitated as $AgCl$. If the precipitate weighs 1.4236 g, calculate the atomic weight of the metal (M), assuming that the atomic weights of chlorine and silver are 35.453 and 107.868, respectively.

- a) 35.453 b) 45.980 c) 70.906 d) 30.653 (e) 22.990

12. 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 50.00 ml of $Pb(NO_3)_2$. K_{sp} for $PbSO_4$ is: 1.6×10^{-8}

- (a) 6.79 b) 7.11 c) 5.08 (d) 3.89 e) 2.72

13. 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 100.00 ml of $Pb(NO_3)_2$. K_{sp} for $PbSO_4$ is: 1.6×10^{-8}

- a) -6.80 b) 7.11 c) 5.08 (d) 3.89 e) 2.72

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

- a) Mohr's method (potassium chromate indicator) $\rightarrow$ neutral or slightly acidic & basic
b) Fajan's method (adsorption indicators)
(c) Volhard's method (Fe^{3+} indicator) $\rightarrow$ acidic
d) titration with a base using phenolphthalein indicator $\rightarrow$ acid base indicator
e) none of the above.

15. Which of the following anions would give the sharpest end point when titrated with silver ions:

- a) bromide ion (K_{sp} for $AgBr$ is 5.0×10^{-13})
(b) cyanide ion (K_{sp} for $AgCN$ is 2.2×10^{-16})
c) thiocyanate ion (K_{sp} for $AgSCN$ is 1.1×10^{-12})
d) iodate ion (K_{sp} for $AgIO_3$ is 3.1×10^{-8})
e) all ions (Br^- , CN^- , SCN^- , and IO_3^-) would show the same sharpness of end point when titrated with silver nitrate.

$$⑧ [S^{2-}] = \frac{6.48 \times 10^{-14}}{[H_3O^+]^2}$$

$$K_1 \times K_2 = \frac{[H_3O^+][HS^-]}{[H_2S]} \cdot \frac{[H_3O^+][S^{2-}]}{[HS^-]}$$

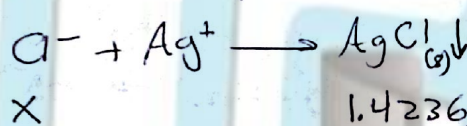
$$9.6 \times 10^{-8} \times 1.3 \times 10^{-14} = \frac{[H_3O^+]^2 \cdot [S^{2-}]}{[H_2S]}$$

$$Ti_2S \rightleftharpoons 2Ti^{+} + S^{2-} \quad [S^{2-}]^{0.1} = \frac{1.25 \times 10^{-23}}{[H_3O^+]^2} \quad \text{--- (V)}$$

$$K_{sp} = [Ti]^2 \cdot [S^{2-}]$$

$$6 \times 10^{-22} = (10^{-4})^2 \times 1.25 \times 10^{-22}$$

$$\Rightarrow [H_3O^+] = 4.56 \times 10^{-5} [H_3O^+]^2$$



$$\begin{array}{r} 35.453 \text{ g} \rightarrow 107.868 \\ 35.453 \\ \hline 143.321 \text{ g} \end{array}$$

$$\begin{array}{r} ? \rightarrow 1.4236 \text{ g} \\ \hline 0.352 \text{ g} \end{array}$$

$$\begin{array}{r} MCl \rightarrow M^{+} + Cl^{-} \\ 0.5805 \quad 0.2285 \text{ g} \quad 0.352 \text{ g} \\ \hline 0.352 \text{ g} \\ 35.453 \end{array}$$

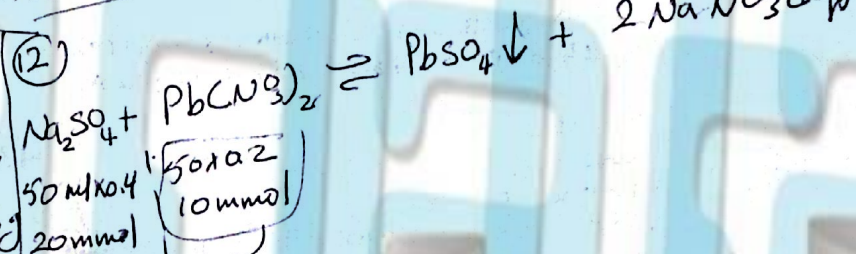
$$\boxed{9.93 \text{ mmol}}$$

$$n_{Cl^{-}} = n_{M^{+}} = 9.93 \text{ mmol}$$

$$M_{w(M^{+})} = \frac{0.2285 \text{ g}}{9.93 \times 10^{-3} \text{ mol}}$$

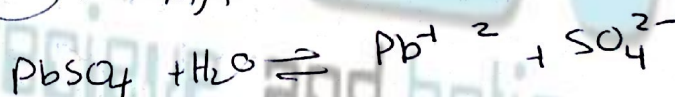
$$= 23 \text{ g/mol}$$

(12)



$$\begin{array}{l} 50 \text{ mL} \times 0.4 \text{ M} = 20 \text{ mmol} \\ 50 \text{ mL} \times 0.2 \text{ M} = 10 \text{ mmol} \end{array}$$

$$0.1 \text{ M} \rightarrow \text{NaNO}_3$$



$$K_{sp} = [Pb^{2+}] \cdot [SO_4^{2-}]$$

$$[Pb^{2+}] = \frac{1.6 \times 10^{-8}}{0.1} = 1.6 \times 10^{-7}$$

$$P(Pb) = 6.7 \%$$



$$K_{sp} = [Pb^{2+}]^2$$

$$[Pb] = \sqrt{1.6 \times 10^{-8}} = 0.26 \times 10^{-4}$$

$$P(Pb) = 3.89$$

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^*

Number of Observations	Q_{crit} (Reject if $Q > Q_{crit}$)		
	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, %	<i>z</i>
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 ₂ O ⁺	0.9	0.967	0.934	0.913	0.85	0.83
Li ⁺ , C ₆ H ₅ COO ⁻	0.6	0.966	0.930	0.907	0.83	0.80
Na ⁺ , IO ₃ ⁻ , HSO ₃ ⁻ , HCO ₃ ⁻ , H ₂ PO ₄ ⁻ , H ₂ AsO ₄ ⁻ , OAc ⁻	0.4-0.45	0.965	0.927	0.902	0.82	0.77
OH ⁻ , F ⁻ , SCN ⁻ , HS ⁻ , ClO ₃ ⁻ , ClO ₂ ⁻ , 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 ₂ O ₄ ²⁻	0.45	0.868	0.741	0.665	0.45	0.36
Hg ₂ ²⁺ , SO ₄ ²⁻ , S ₂ O ₄ ²⁻ , Cr ₂ 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

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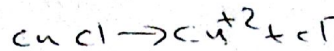
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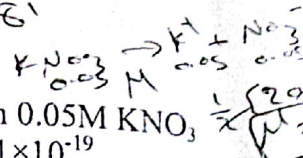
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4. a b c d ☒ e 12. a b ☒ c d e
5. a b ☒ c d e 13. a b c ☒ d e
6. a b ☒ c ☒ d e 14. a b ☒ c d e
7. a ☒ b c d e 15. a b c d ☒ e
8. a ☒ b c d e

GOOD LUCK



$$K_{sp} = (0.48)^2 \times 0.21 \cdot K_{sp}$$

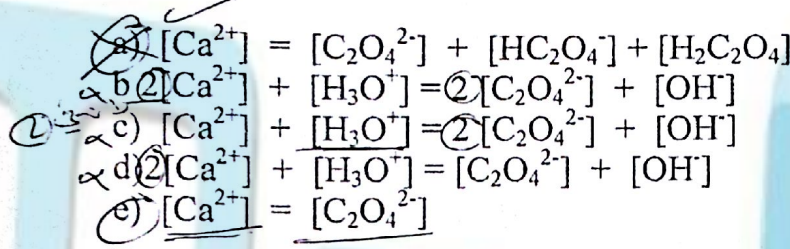
$$6.38 \quad 6 = 0.81$$



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%

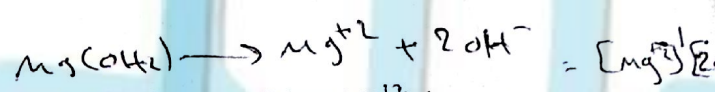
$$\frac{8.1 \times 10^{-19} \cdot 2}{8.1 \times 10^{-19}}$$

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



3. Calculate the molar solubility of Mg(OH)₂ ($K_{sp} = 7.1 \times 10^{-12}$) 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. 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

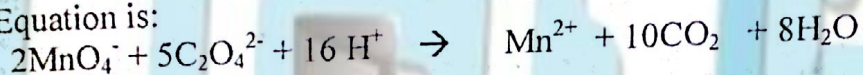
- a) Positive charge due to the adsorption of potassium ions
- b) Negative charge due to the adsorption of nitrate ions
- c) Positive charge due to the adsorption of silver ions
- d) Negative charge due to the adsorption of bromide ions.
- e) Neutral since primary adsorption layer will neutralize the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

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) Coprecipitation 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, $\text{Na}_2\text{C}_2\text{O}_4$, weighing 0.2856 g (molar mass 134 g/mol) is dissolved in water, sulfuric acid is added, and the solution is titrated at 70°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:



- a) 0.048 M b) 0.0197 M c) 0.0394 M 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 $\text{AgCl} = 1 \times 10^{-10}$

a) 6.00

b) 5.00

c) 7.5

d) 7.00

e) 9.00

$$[\text{Ag}^+] = \frac{1}{100}$$

$$p = -\log(0.01) = 2$$

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

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

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 $[Ag^+] 7.3 \times 10^{-12}$ - 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

$$K_{sp} \text{ for } Fe(OH)_3 = 5 \times 10^{-39} = [Fe^{3+}][OH^-]^3 \Rightarrow [Fe^{3+}] = \frac{5 \times 10^{-39}}{[OH^-]^3} \quad 2.5$$

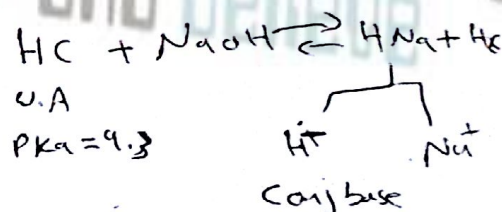
$$K_{sp} \text{ for } Mg(OH)_2 = 7.1 \times 10^{-12} = [Mg^{2+}][OH^-]^2 \Rightarrow [Mg^{2+}] = \frac{7.1 \times 10^{-12}}{[OH^-]^2} \quad 0.3$$

Using 1×10^{-6} M as criterion for quantitative removal of ions

- a) 3.23 b) 8.92 c) 5.07 **d) 10.77** e) 2.47

12. 0.10M solution of an acid HC ($pK_a = 4.30$) 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



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

Conj base < solution acid

$$[OH^-] = \sqrt{\frac{K_w}{K_a} \times [C^-]}$$

indicator $\Rightarrow 7-8$

3×10^{-3}

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 $3 \times 10^{-3} - 0.6 \times 10^{-3}$
- 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 ($K_a \text{ for HOCl} = 6.25 \times 10^{-8}$) 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

$$[\text{Cl}^-] = 2.5 \times 10^{-5} \\ = [\text{H}_3\text{O}^+]$$

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

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

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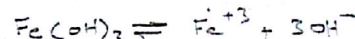
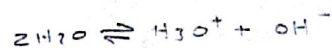
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4

أحمد علاء محيس

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



$$5 \times 10^{-39} = [Fe^{3+}] [OH^-]^3$$

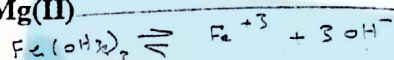


$$3[Fe^{3+}] \ll [OH^-]$$

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

$$[H_3O^+] \ll 3[Fe^{3+}]$$

$$5 \times 10^{-39} = [Fe^{3+}] (3[Fe^{3+}])^3$$



$$5 \times 10^{-39} = 1 \times 10^{-6} [OH^-]^3$$

$$[OH^-] = 5.699 \times 10^{-12}$$

$$pH = 2.76$$

$$1.17 \times 10^{-10} = [Fe^{3+}]$$

$$3.499 \times 10^{-10}$$

$$2.85 \times 10^{-5}$$

$$[H_3O^+] \gg 3[Fe^{3+}]$$

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

$$5 \times 10^{-39} = [Fe^{3+}] (3(1 \times 10^{-7}))^3$$

$$[Fe^{3+}] = 1.85 \times 10^{-19}$$

1. Calculate the molar solubility of $Fe(OH)_3$ ($K_{sp} = 5 \times 10^{-39}$) in water

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

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

$$K_{sp} \text{ for } Fe(OH)_3 = 5 \times 10^{-39}$$

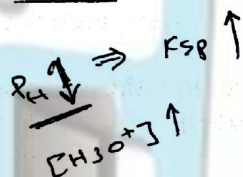
$$K_{sp} \text{ for } Mg(OH)_2 = 7.1 \times 10^{-12}$$

Using $1 \times 10^{-6} M$ as criterion for quantitative removal of ions

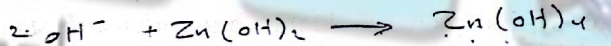
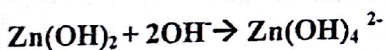
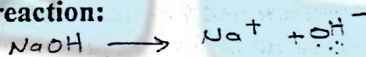
- a) 5.07 b) 8.92 c) 3.23 d) 10.77 e) 2.47

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

- a) 2.50 M
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 solution that is 0.10 M in NaOH and saturated with $Zn(OH)_2$, which undergoes the reaction:



$$0.10 = [Na^+] = [OH^-] + [Zn(OH)_4^{2-}]$$

$$0.10 = [Na^+] = [OH^-] - 2[Zn(OH)_4^{2-}]$$

$$0.10 = [Na^+] = [OH^-] - [Zn(OH)_4^{2-}]$$

$$0.10 = [Na^+] = [OH^-] + 2[Zn(OH)_4^{2-}]$$

e) None of the above

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

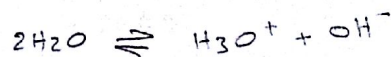
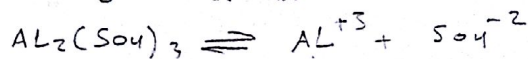
$$a) [Al^{3+}] + [H_3O^+] = 2[SO_4^{2-}] + [OH^-]$$

$$b) 3[Al^{3+}] + [H_3O^+] = [SO_4^{2-}] + [OH^-]$$

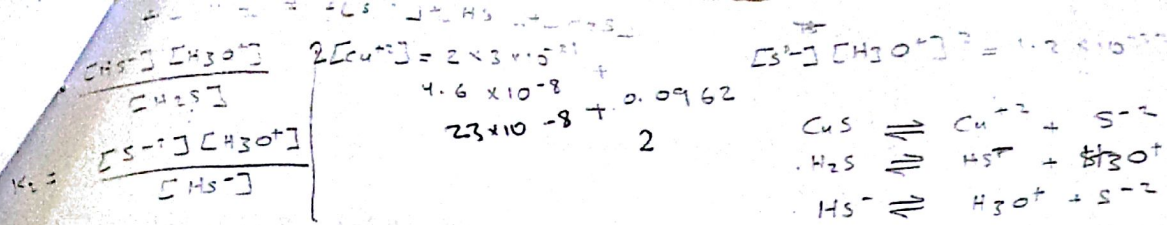
$$c) 3[Al^{3+}] + [H_3O^+] = 2[SO_4^{2-}] + [OH^-]$$

$$d) [Al^{3+}] + [H_3O^+] = [SO_4^{2-}] + [OH^-]$$

e) None of the above

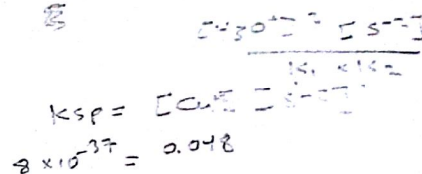


$$3[Al^{3+}] + [H_3O^+] = 2[SO_4^{2-}] + [OH^-]$$



6. Calculate the molar solubility of CuS in a solution in which the $[H_3O^+]$ is held constant at $2.0 \times 10^{-1} M$. 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) $3.5 \times 10^{-12} M$ (b) $5.1 \times 10^{-9} M$ c) $3.2 \times 10^{-8} M$
d) $3.4 \times 10^{-23} M$ e) $4 \times 10^{-4} M$



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:

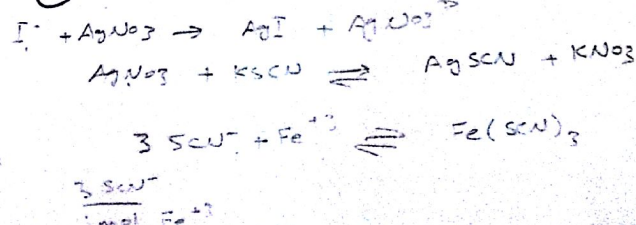
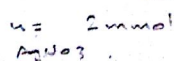
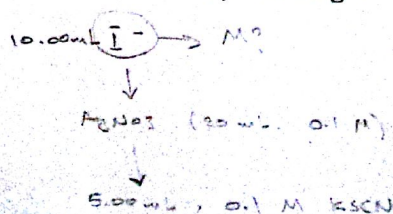
- (a) dispersion of colloidal precipitates occurs when washed with distilled water.
(b) inclusion means capturing of foreign ions into the space lattices of the crystal.
c) occlusion means entrapment of a solution droplet into the crystal during precipitation.
d) In gravimetric analysis positive error 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.

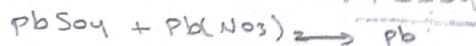
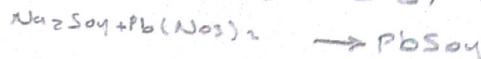
- (a) 60.6% b) 121.2% c) 30.3% d) 52.0% e) 26.0%

11. In Volhard method for the determination of I^- in an aqueous sample $20.00 mL$ of $0.10 M$ $AgNO_3$ is added to $10.00 mL$ of an unknown 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 unknown sample given that the atomic mass of I is $127.0 g/mol$.

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



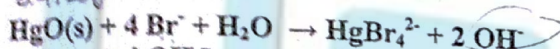
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Na₂SO₄ 0.40 MPb(NO₃)₂ 0.20 M

12. In the titration of 35.00 ml of 0.40 M of Na₂SO₄ with 0.20 M Pb(NO₃)₂, PbSO₄ precipitates down. Calculate the P function of Pb²⁺ (pPb) after adding 50.00 ml of Pb(NO₃)₂. K_{sp} for PbSO₄ is: 1.6 x 10⁻⁸

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

13. A solution of HClO₄ was standardized by dissolving 0.4125 g of primary standard grade HgO (molar mass = 216.59 g/mol) in a solution of KBr:



The liberated OH⁻ consumed 46.51 ml of the HClO₄ solution. The molarity of the HClO₄ is:

- 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 accidentally this titration at pH=3 will have

- a) positive error
b) negative error
c. There will be no effect on the results of the titration.
d. Higher precipitate amount of Ag₂CrO₄ is formed.
e. Endpoint could not be detected

15. In titration of 50.00 mL of 0.050 M KI with 0.10 M AgNO₃, calculate pAg after addition of 25.00 mL of the AgNO₃ solution. K_{sp} for AgI is 1.7 x 10⁻¹⁷.

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

$$p_{\text{Ag}} = pI = \frac{p_{\text{Ksp}}}{2}$$

Department of Chemistry
Analytical Chemistry
Second Exam

Date: Dec. 20, 2005

Name: م.م. نبيل البريني

Section: 12:30 - 2:00

Reg. No.: 0044199

اسم المدرس: د. حنا حنا

- | | |
|--|---|
| 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

$$\frac{0.1 \times 10^{-3} \text{ g/mol}}{107.9 \text{ g/mol}} = 0.5$$

$$K_{sp} = 1 \times 10^{-10} = [Ag^+][Cl^-] = 1.85 \times 10^{-6}$$

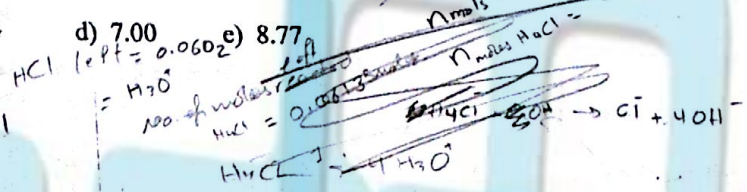
1. The Ag^+ (atomic mass 107.9 g/mol) in a solution is precipitated by the addition of Cl^- ion. The final volume of the solution is 500 mL. What should be the concentration of Cl^- if no more than 0.10 mg Ag^+ remains unprecipitated? K_{sp} for $AgCl = 1.0 \times 10^{-10}$

- a) $2.68 \times 10^{-4} M$ b) $1.0 \times 10^{-5} M$ c) $5.00 \times 10^{-7} M$
☒ d) $5.39 \times 10^{-5} M$ ☐ e) $3.1 \times 10^{-8} M$

$$0.05 - \frac{V_{Ag^+}}{10} = n V_{Ag^+} \quad (500 - V_{Ag^+}) = n V_{Ag^+}$$

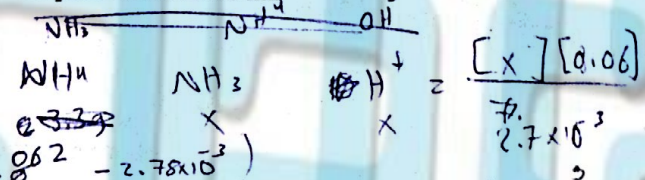
What is the pH of a solution prepared by dissolving 3.30 g of NH_4Cl (molar mass 53.5 g/mol) in water, adding 125.0 mL of 0.0111 M $NaOH$ and diluting to 500 mL. K_b for NH_3 is 1.75×10^{-5} .

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



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 $K_a = 10^{-8}$



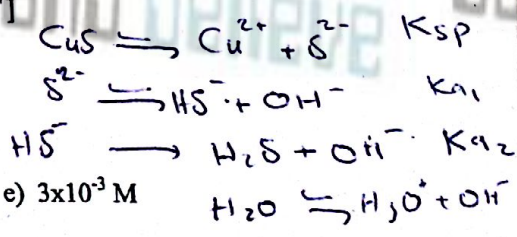
4. 100 mL, 0.036 M HCl solution is titrated with 0.100 M $NaOH$. Calculate the pH after addition of 35.95 mL of the titrant.

- a) 3.01 b) 7.00 c) 4.43 d) 9.11 e) 8.11

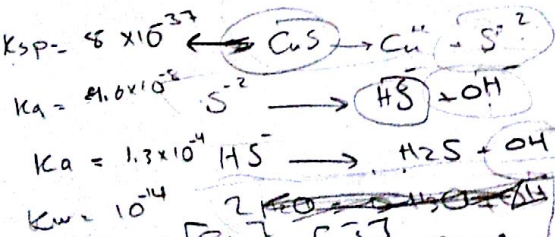
$$\frac{5 \times 10^{-6}}{0.13595} = 3.6 \times 10^{-5}$$

5. Calculate the molar solubility of CuS in a solution in which $[H_3O^+]$ concentration is held constant at $1.0 \times 10^{-1} M$.

Given that K_{sp} for $CuS = 8 \times 10^{-37}$
 For H_2S $K_{a1} = 9.6 \times 10^{-8}$
 $K_{a2} = 1.3 \times 10^{-14}$



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



$$K_{sp} = [Cu^{2+}][S^{2-}]$$

$$K_{sp} = [Cu^{2+}] K_{a1} K_{a2} (1 \times 10^{-1})^2$$

$[Cu^{2+}] = \frac{K_{sp}}{K_{a1} K_{a2} (1 \times 10^{-1})^2}$
 $[OH^-] = \frac{K_w}{[H_3O^+]} = \frac{10^{-14}}{1 \times 10^{-1}} = 10^{-13}$
 $[HS^-] = \frac{K_{a1} [S^{2-}]}{[OH^-]}$
 $[H_2S] = \frac{K_{a2} [HS^-]}{[OH^-]}$

6. Coprecipitation in case of colloidal precipitates occurs by:

- a) mechanical entrapment b) inclusion c) inclusion
 d) surface adsorption
☒ 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

$$\frac{[OH^-]}{M} = K_b$$

$$\frac{1.6 \times 10^{-5}}{6.67 \times 10^{-7}} = 0.166$$

$$K_b = 0.028$$

$$\frac{4 \times 10^{-3}}{0.040 + V}$$

$$[H_3O^+] = 1.45 \times 10^{-6}$$

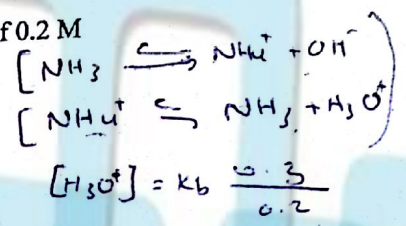
$$[H_3O^+] = \frac{B - 2.4 \times 10^{-3}}{V_{total}}$$

$$[H_3O^+] = K_b$$

$$pK = -\log K$$

8. Calculate the buffer capacity as moles of NaOH for a buffer consisting of 0.2 M NH_3 and 0.3 M NH_4Cl (K_b for $NH_3 = 1.75 \times 10^{-5}$)

- a) 3.11×10^{-2} mol b) 6.5×10^{-2} mol c) 0.23 mol
 d) 6.5×10^{-4} mol e) 1.1×10^{-3} mol



$$pK = [H_3O^+] = 2.625 \times 10^{-5} \quad pH \approx 4.58$$

$$pH \approx 4.155$$

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 adsorbed to the surface of the colloidal precipitate before the equivalence point is:-

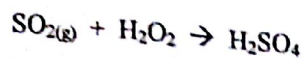
- a) ☒ OH^- b) Na^+ c) Cl^- d) Ag^+ e) H_3O^+

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

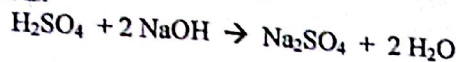
- a) dilute ammonia solution b) pure water
☒ c) acetone d) dilute HNO_3 solution
 e) ethanol

$$pH = pK = 1.63 \text{ salt}$$

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:-



A 25.00 mL portion of 0.00923 M NaOH was introduced into the solution of H_2SO_4 . Reaction is:



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) 175.0 ppm
d) 115.0 ppm
e) 300.0 ppm

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

0.1

0.1 - 0.1

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

$$\frac{5 \times 10^{-6}}{100}$$

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%

$$4.60 \times 10^{-3} \text{ mol}$$

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

$$1.522 \text{ g} = x + y$$

$$0.750 = x + y$$

2/3

10.38