

Student Name: _____

Recitation Section Number: _____

Recitation Instructor: _____

The exam has 25 questions for credit and an additional one to check the color of your exam booklet. Please answer all 26 questions **on the OpScan sheet**. There is no penalty for guessing. At the end of the 80-minute exam period, please hand in only *this* top sheet and your OpScan form. If you finish early, please do not disturb your fellow students. A proctor will check your picture-ID, OpScan form and signature *during* the exam. Exam scores and an exam curve will be posted as soon as possible.

ON THE OpScan FORM: (Use a Number 2 Pencil or Darker)

- (1) SIGN your name across the TOP of the form.
- (2) code only the following information: **[blacken circles]**
 - (a) Your Name . . . LAST NAME FIRST
[blank space between last and first names]
 - (b) Your SOCIAL SECURITY NUMBER
[Start under Box A and continue to Box I]
 - (c) Your RECITATION SECTION NUMBER (Boxes **K & L**)
[Sections R1=51, R2=52, R3=53, R4 = 54]
 - (d) Your EXAM FORM NUMBER (Box **P**)

Your EXAM FORM is: ①

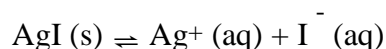
See last pages of exam for physical constants, periodic table, and other information.

1. In the titration of 20.0 mL of 0.200 M HOBr with 0.100 NaOH, what is the pH at the equivalence point? ($K_a \text{ HOBr} = 2.5 \times 10^{-9}$)
- A) 7.00
B) 3.29
C) 10.71
D) 4.40
E) 10.86
2. The solubility of silver carbonate is 0.032 M at 20°C. Calculate the K_{sp} of silver carbonate, Ag_2CO_3 .
- A) 3.3×10^{-5}
B) 1.0×10^{-3}
C) 5.0×10^{-4}
D) 1.3×10^{-4}
E) 6.5×10^{-5}
3. In the solution above a precipitate of CrF_3 , the concentration of Cr^{3+} is 0.015 M. What is the concentration of F^- in the solution? ($K_{sp} = 6.6 \times 10^{-11}$)
- A) 0.015 M
B) 0.045 M
C) 4.4×10^{-9} M
D) 1.6×10^{-3} M
E) 1.9×10^{-17} M
4. Two salts, AX and BX_2 , have identical K_{sp} values at a given temperature. One can say
- A) the salts are more soluble in 0.1 M NaX than in water.
B) the molar solubility of AX is identical to BX_2 .
C) addition of NaX will not affect the solubilities of the salts.
D) the molar solubility of AX is greater than that of BX_2 .
E) the molar solubility of BX_2 is greater than that of AX .

5. The metal center in a complex ion is

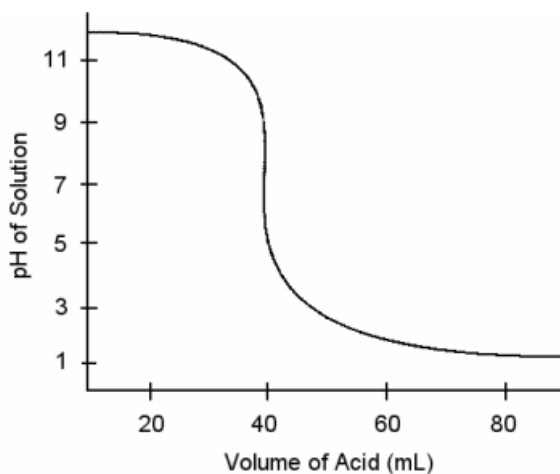
- A) a Lewis base.
- B) a Lewis acid.
- C) a ligand.
- D) insoluble in the solvent.
- E) a Bronsted-Lowry base.

6. If some powdered silver iodide is added to a saturated solution of silver iodide, which of the following observations would you expect to take place?



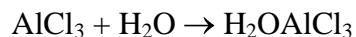
- A) The concentration of dissolved silver ions will increase.
- B) The concentration of dissolved iodide ions will increase.
- C) The concentration of both dissolved silver and dissolved iodide will increase.
- D) The concentration of the solid silver iodide will increase.
- E) Nothing will happen.

7. Examine the titration curve shown below. Which of the following titrations could it represent?



- A) HCl by NaOH
- B) HCl by NH_3
- C) H_2SO_4 by NaOH
- D) Ca(OH)_2 by HCl
- E) NH_3 by HCl

8. Identify the Lewis Acid in the following equation.



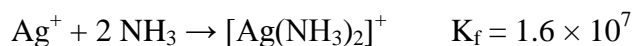
- A) H_2O
B) H_2OAlCl_3
C) AlCl_3
D) H^+
E) Cl^-
9. In the titration of 30.0 mL of 0.400 M HCl, what is the pH of the solution after 16.0 mL of 0.200 M NaOH has been added?
- A) 0.718
B) 0.944
C) 2.06
D) 1.65
E) 0.319
10. For iron (III) hydroxide, what is the relationship between K_{sp} and s , the molar solubility?
- A) $K_{\text{sp}} = s^2$
B) $K_{\text{sp}} = 3s^4$
C) $K_{\text{sp}} = 4s^3$
D) $K_{\text{sp}} = 27s^4$
E) $K_{\text{sp}} = 3s^2$
11. Calculate the molar solubility of $\text{Al}(\text{OH})_3$, in 0.10 M NaOH. ($K_{\text{sp}} = 1.3 \times 10^{-33}$)
- A) 1.3×10^{-33} M
B) 0.10 M
C) 1.3×10^{-30} M
D) 4.8×10^{-32} M
E) 2.6×10^{-9} M

12. What is the concentration of Ca^{2+} that remains dissolved after addition of 0.15 mol of Ca^{2+} and 0.16 mol $\text{C}_2\text{O}_4^{2-}$ to make a 1.0 L aqueous solution? (K_{sp} for $\text{CaC}_2\text{O}_4 = 2.7 \times 10^{-9}$)
- A) 0.01 M
B) 2.7×10^{-9} M
C) 2.7×10^{-10} M
D) 2.7×10^{-7} M
E) There are no calcium ions in the solution.
13. What is the charge on vanadium in the compound $\text{K}_4 [\text{V}(\text{CN})_6]$?
- A) -4
B) 0
C) +2
D) +3
E) +4
14. Name the following coordination compound: $\text{K}_3[\text{CoCl}_6]$:
- A) tripotassiumcobalt chloride
B) potassium chlorocobalt (VI)
C) potassium hexachlorocobalt (VI)
D) potassium hexachlorocobaltate (III)
E) tripotassium hexachlorocobalt (III)
15. Calculate the solubility of Ag_2CrO_4 in 0.10 M AgNO_3 . ($K_{\text{sp}} = 2.4 \times 10^{-12}$)
- A) 8.4×10^{-5} M
B) 2.4×10^{-10} M
C) 1.3×10^{-4} M
D) 6.2×10^{-4} M
E) 4.8×10^{-3} M

16. Which of the following could not be a ligand?

- A) Br^-
- B) NH_3
- C) H_2O
- D) NH_4^+
- E) CN^-

17. Calculate the free $[\text{Ag}^+]$ in a solution that contains 0.620 M AgNO_3 and 1.20 M NH_3 ?



- A) $2.0 \times 10^{-2} \text{ M}$
- B) $1.15 \times 10^{-7} \text{ M}$
- C) $9.69 \times 10^{-7} \text{ M}$
- D) $4.84 \times 10^{-5} \text{ M}$
- E) $5.80 \times 10^{-1} \text{ M}$

18. What is the correct formula for bis (ethylenediammine) dinitrito-N-cobalt (III) nitrate?

- A) $[\text{CoN}_2(\text{en})_2](\text{NO}_3)_3$
- B) $[\text{Co}(\text{NO}_2)_2(\text{en})_2]\text{NO}_3$
- C) $[\text{Co}(\text{NO}_3)_2(\text{en})_2]_3\text{NO}_3$
- D) $[\text{Co}(\text{NO}_2)_2(\text{en})_2]_3\text{NO}_3$
- E) $[\text{Co}(\text{NO}_2)_2(\text{en})_2]_3(\text{NO}_3)_3$

19. Would a precipitate be observed if equal volumes of a 0.040 M AgNO_3 solution and a 0.030 M NaNO_2 solution are mixed? ($K_{\text{sp}} \text{AgNO}_2 = 6.0 \times 10^{-4}$)

- A) Yes, because $Q_{\text{ip}} < K_{\text{sp}}$.
- B) Yes, because $Q_{\text{ip}} > K_{\text{sp}}$.
- C) No, because $Q_{\text{ip}} < K_{\text{sp}}$.
- D) No, because $Q_{\text{ip}} > K_{\text{sp}}$.
- E) No, because $Q_{\text{ip}} = K_{\text{sp}}$.

20. A saturated solution of $\text{Mg}(\text{OH})_2$ has a pH of 11.03. Determine the K_{sp} for $\text{Mg}(\text{OH})_2$.
- A) 6.2×10^{-12}
 - B) 6.1×10^{-10}
 - C) 1.15×10^{-8}
 - D) 6.1×10^{-8}
 - E) 4.96×10^{-12}
21. In which aqueous solution will the molar solubility of $\text{Ca}(\text{OH})_2$ be smallest?
- A) pure water
 - B) 1 M NH_3
 - C) 1 M NH_3 and 1 M NH_4Cl
 - D) 1 M NH_4Cl
 - E) 1 M HCl
22. Which of the following species can exhibit geometric isomerism?
- A) $[\text{Pt}(\text{NH}_3)(\text{en})\text{Cl}]^+$
 - B) $[\text{Pt}(\text{NH}_3)\text{Cl}_3]^-$
 - C) $[\text{Co}(\text{en})_2\text{Cl}_2]^+$
 - D) $[\text{CrNO}_2(\text{CN})_5]^{2-}$
 - E) $[\text{Pt}(\text{en})_2]^+$
23. If solid Na_2SO_4 is added to a solution that is 0.25 M $\text{Ba}(\text{NO}_3)_2$ what will be the SO_4^{2-} concentration when a precipitate just begins to appear? ($K_{\text{sp}} \text{BaSO}_4 = 1.1 \times 10^{-10}$)
- A) 1.0×10^{-5} M
 - B) 2.1×10^{-5} M
 - C) 4.4×10^{-10} M
 - D) 4.0×10^{-5} M
 - E) 7.0×10^{-9} M
24. Which of the following statements is correct?
- A) Ag_2CO_3 is considered soluble in water. ($K_{\text{sp}} = 8.1 \times 10^{-12}$)
 - B) Ag_2CO_3 is more soluble in AgNO_3 solution than in water.
 - C) Ag_2CO_3 is more soluble in Na_2CO_3 solution than in water.
 - D) Ag_2CO_3 is more soluble in aqueous HCl than in water.
 - E) Ag_2CO_3 is more soluble in CaCO_3 solution than in water.

25. Calcium sulfate is sometimes added to wine both to clarify and to precipitate dissolved lead. Given the following K_{sp} values, what is the $[Pb^{2+}]$ in wine that is saturated with $CaSO_4$? ($K_{sp} CaSO_4 = 9.1 \times 10^{-6}$) ($K_{sp} PbSO_4 = 1.6 \times 10^{-8}$)

- A) $1.8 \times 10^{-2} M$
- B) $1.5 \times 10^{-13} M$
- C) $5.3 \times 10^{-6} M$
- D) $1.3 \times 10^{-4} M$
- E) $3.0 \times 10^{-3} M$

26. What is the color of your exam?

- A. White
- B. Pink

Reference Equations

$$\text{pH} = -\log[\text{H}^+]$$

$$K_w = 1.0 \times 10^{-14}$$

$$\text{pH} = \text{pK}_a - \log \frac{[\text{HA}^-]}{[\text{A}^-]} = \text{pK}_a + \log \frac{[\text{A}^-]}{[\text{HA}^-]}$$

$$\text{pH} + \text{pOH} = 14$$

$$\text{pK}_a + \text{pK}_b = 14$$