

CHE 107 Summer 2017 Exam 3

Question #: 1

What is the pH of a 0.10 M hydrocyanic acid (HCN) solution. $K_a = 4.9 \times 10^{-10}$.

- A. 2.56
B. 3.17
C. 4.04
D. 5.15

Question #: 2

Original Windex has a pH = 11.60 and $[H_3O^+] = \underline{\quad 1 \quad}$ M.
Report your answer with **two** significant figures. Do **NOT** include units in your answer. Use the format 2.2E2 or 2.2E-2 for scientific notation.



1. _____

Question #: 3

A 2.0 M boric acid solution is prepared for use as ant bait. What is the **pH** of the boric acid solution if the percent ionization is 0.0016%?

- A. 1.27
B. 3.96
C. 4.49
D. 6.01



Question #: 4

Given a mixture of 0.10 M HCN, 0.10 M HCl, 0.10 M HNO₃, and 0.10 M HNO₂, which acids must be considered in calculating the pH?

- A. HCN and HNO₃
B. HCN and HNO₂
C. HCl and HNO₃
D. HCl and HNO₂

Question #: 5

Which solution requires the use of the quadratic equation to calculate $[H_3O^+]$?

- A. 0.140 M propanoic acid (HC₃H₅O₂) solution; $K_a(\text{HC}_3\text{H}_5\text{O}_2) = 1.3 \times 10^{-5}$
B. 0.120 M trifluoroacetic acid (HC₂F₃O₂) solution; $K_a(\text{HC}_2\text{F}_3\text{O}_2) = 3.0 \times 10^{-1}$
C. 0.130 M lactic acid (HC₃H₅O₃) solution; $K_a(\text{HC}_3\text{H}_5\text{O}_3) = 1.4 \times 10^{-4}$
D. 0.150 M hypochlorous acid (HClO) solution; $K_a(\text{HClO}) = 2.9 \times 10^{-8}$

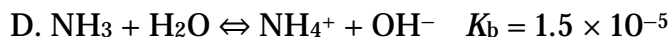
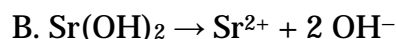
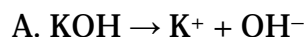
Question #: 6

Given that the K_b of hydroxylamine (HONH_2) is 1.1×10^{-8} , the pK_a of the hydroxylammonium ion (HONH_3^+) is 1. Report your answer with **two decimal** places. Do **NOT** include units in your answer.

1. _____

Question #: 7

In a mixture of four bases in water, which **two** reactions **must** be considered in calculating the pH?



Question #: 8

A solution at 25°C has $[\text{OH}^-] = 6.5 \times 10^{-4} \text{ M}$.

The $p\text{OH} =$ 1, $\text{pH} =$ 2, and the **solution is** 3 [acidic, neutral, basic].

Report your answers with **two decimal** places. Do **NOT** include units in your answer.

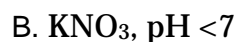
1. _____

2. _____

3. _____

Question #: 9

Which 0.10 M aqueous salt solution has the indicated pH?



Question #: 10

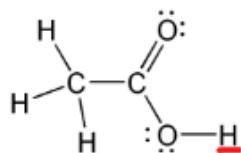
Which **two** 0.010 M polyprotic acid solutions only require you to consider K_{a1} to accurately calculate the pH?

- A.
 $\text{H}_2\text{SO}_4 + \text{H}_2\text{O} \rightarrow \text{HSO}_4^- + \text{H}_3\text{O}^+ \quad K_{a1} = \text{strong}$
 $\text{HSO}_4^- + \text{H}_2\text{O} \rightleftharpoons \text{SO}_4^{2-} + \text{H}_3\text{O}^+ \quad K_{a2} = 1.2 \times 10^{-2}$
- B.
 $\text{H}_2\text{C}_2\text{O}_4 + \text{H}_2\text{O} \rightleftharpoons \text{HC}_2\text{O}_4^- + \text{H}_3\text{O}^+ \quad K_{a1} = 6.0 \times 10^{-2}$
 $\text{HC}_2\text{O}_4^- + \text{H}_2\text{O} \rightleftharpoons \text{C}_2\text{O}_4^{2-} + \text{H}_3\text{O}^+ \quad K_{a2} = 6.1 \times 10^{-5}$
- C.
 $\text{H}_3\text{C}_6\text{H}_5\text{O}_7 + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{C}_6\text{H}_5\text{O}_7^- + \text{H}_3\text{O}^+ \quad K_{a1} = 7.4 \times 10^{-4}$
 $\text{H}_2\text{C}_6\text{H}_5\text{O}_7^- + \text{H}_2\text{O} \rightleftharpoons \text{HC}_6\text{H}_5\text{O}_7^{2-} + \text{H}_3\text{O}^+ \quad K_{a2} = 1.7 \times 10^{-5}$
 $\text{HC}_6\text{H}_5\text{O}_7^{2-} + \text{H}_2\text{O} \rightleftharpoons \text{C}_6\text{H}_5\text{O}_7^{3-} + \text{H}_3\text{O}^+ \quad K_{a3} = 4.0 \times 10^{-7}$
- D.
 $\text{H}_3\text{PO}_4 + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{PO}_4^- + \text{H}_3\text{O}^+ \quad K_{a1} = 7.5 \times 10^{-3}$
 $\text{H}_2\text{PO}_4^- + \text{H}_2\text{O} \rightleftharpoons \text{HPO}_4^{2-} + \text{H}_3\text{O}^+ \quad K_{a2} = 6.2 \times 10^{-8}$
 $\text{HPO}_4^{2-} + \text{H}_2\text{O} \rightleftharpoons \text{PO}_4^{3-} + \text{H}_3\text{O}^+ \quad K_{a3} = 4.2 \times 10^{-13}$

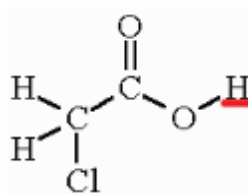
Question #: 11

Which hydrogen, underlined in red, is the **most acidic** in the acetic acid analogues listed below?

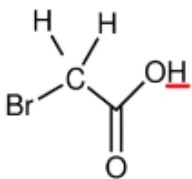
A.



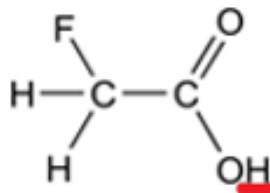
C.



B.

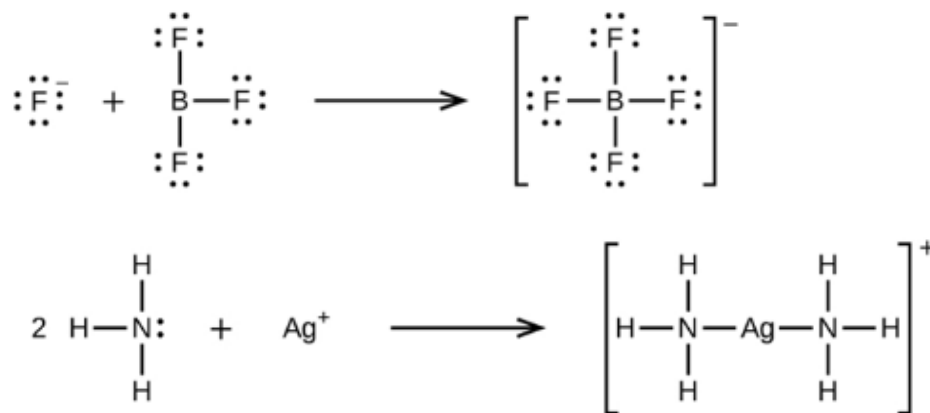


D.



Question #: 12

Which **two** substances function as **Lewis bases**?



- A. NH₃
B. F⁻

- C. Ag⁺
D. BF₃
-

Question #: 13

Which **two** combinations will act as buffers?

- A. 1.0 M NaHSeO₃ and 0.75 M H₂SeO₃
B. 0.90 M CH₃NH₂ and 1.0 M CH₃NH₃Cl

- C. 0.80 M H₃PO₄ and 0.60 M Na₃PO₄
D. 1.5 M Ca(OH)₂ and 1.0 M H₂SO₄
-

Question #: 14

What is the pH of a 0.500 L buffer solution that is 0.400 M HNO₂ (pK_a = 3.34) and 0.300 M NaNO₂ after the addition of 0.010 mol of NaOH? Ignore any volume change from the addition of NaOH. Report pH to **two decimal** places. Do **NOT** include units in your answer.

pH = 1

1. _____

Question #: 15

Calculate the base-to-acid ratio needed to prepare a pH 3.00 pyruvic acid, sodium pyruvate buffer. The pK_a of pyruvic acid is 2.39.

- A. 0.122
B. 0.812

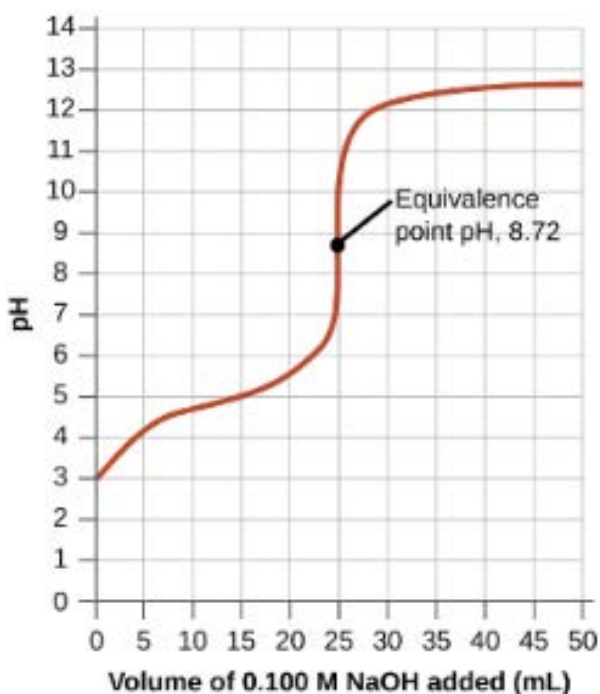
- C. 2.64
D. 4.07

Question #: 16

Which combination is best for preparing a pH 8.70 buffer?

- A. methylammonium iodide ($pK_a = 10.64$) and methylamine
- B. ammonium chloride ($pK_a = 9.25$) and ammonia
- C. ethylammonium bromide ($pK_a = 10.75$) and ethylamine
- D. hypochlorous acid ($pK_a = 7.54$) and potassium hypochlorite

Question #: 17



A 25.0 mL sample of which 0.100 M solution was used to generate the titration curve below?

- A. HClO_4
- B. $\text{HC}_2\text{H}_3\text{O}_2$
- C. H_3PO_4
- D. HNO_3

Question #: 18

A 25.0 mL portion of 0.200 M HF ($pK_a = 3.17$) is titrated with 0.250 M KOH. What is the pH after 4.00 mL of KOH has been added? pH = 1 Report your answer with **two decimal** places. Do **NOT** include units in your answer.

1. _____

Question #: 19

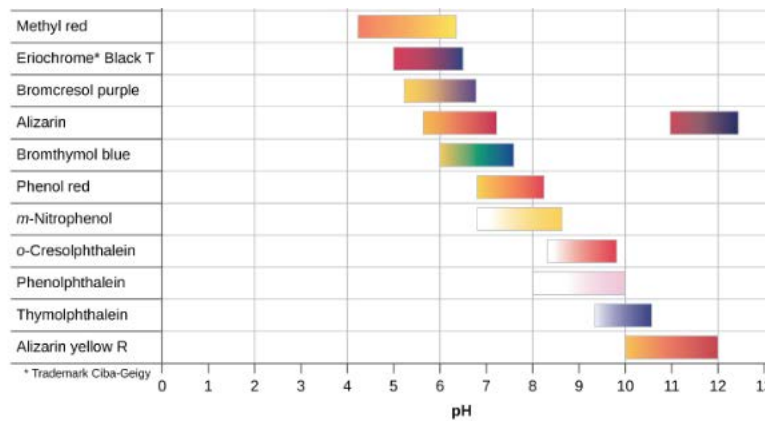
What is the pH of the solution formed after 20.0 mL of 0.20 M ketamine, $\text{C}_{13}\text{H}_{16}\text{ClNO}$, is titrated with 5.0 mL of 1.0 M HI? $K_b = 3.0 \times 10^{-7}$ for $\text{C}_{13}\text{H}_{16}\text{ClNO}$

- A. 4.60
- B. 7.00
- C. 1.40
- D. 2.20

Question #: 20

Which indicator would be appropriate for the titration of a **weak acid** with a **strong base**? Be sure to scroll down to see the pH scale at the bottom of the figure.

- A. methyl red
- B. bromthymol blue
- C. *o*-cresolphthalein
- D. alizarin yellow R



Question #: 21

What is the molar solubility of $\text{BaF}_2(\text{s})$ in 0.40 M NaF ? The K_{sp} of BaF_2 is 2.5×10^{-5} .

- A. $1.6 \times 10^{-4} \text{ M}$
- B. $4.7 \times 10^{-5} \text{ M}$
- C. $2.9 \times 10^{-6} \text{ M}$
- D. $3.1 \times 10^{-2} \text{ M}$

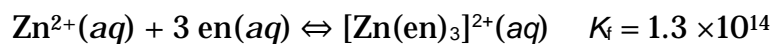
Question #: 22

A pH-neutral solution containing 0.50 M Pb^{2+} and 0.050 M Sn^{2+} is titrated with a concentrated sodium hydroxide solution. Assuming minimal volume changes, which solid precipitates first and what concentration of OH^- is required? The K_{sp} for $\text{Pb}(\text{OH})_2$ is 1.4×10^{-20} and for $\text{Sn}(\text{OH})_2$ is 5.5×10^{-27} .

- A. $\text{Pb}(\text{OH})_2$, $1.7 \times 10^{-10} \text{ M}$
- B. $\text{Pb}(\text{OH})_2$, $3.3 \times 10^{-13} \text{ M}$
- C. $\text{Sn}(\text{OH})_2$, $1.7 \times 10^{-10} \text{ M}$
- D. $\text{Sn}(\text{OH})_2$, $3.3 \times 10^{-13} \text{ M}$

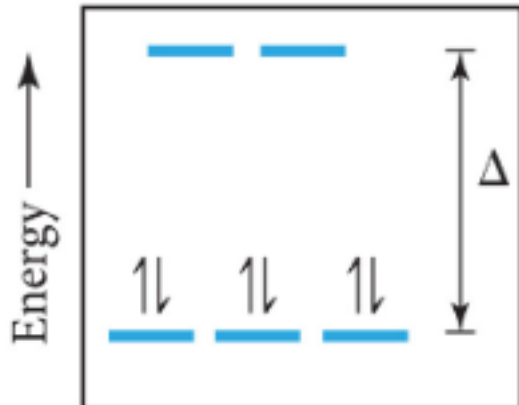
Question #: 23

A solution is prepared such that it contains $0.020 \text{ M Zn}(\text{NO}_3)_2$ and $0.100 \text{ M ethylenediamine}$. What concentration of $\text{Zn}^{2+}(\text{aq})$ remains once the reaction reaches equilibrium according to the equation below?



- A. $9.0 \times 10^{-8} \text{ M}$
- B. $6.2 \times 10^{-20} \text{ M}$
- C. $4.7 \times 10^{-16} \text{ M}$
- D. $2.4 \times 10^{-12} \text{ M}$

Question #: 24

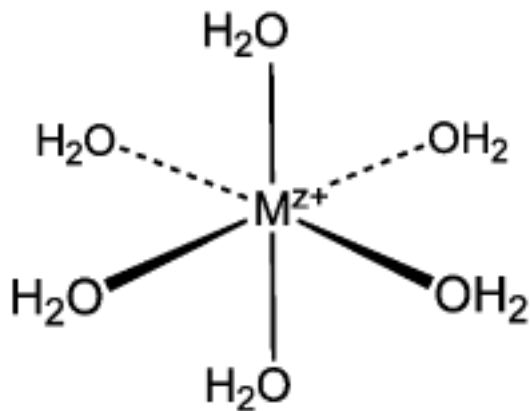


Given the crystal-field diagram for $[\text{Fe}(\text{CN})_6]^{4-}$, CN^- is a 1-field [strong, weak] ligand, the complex ion is 2 [diamagnetic, paramagnetic], and will be slightly 3 [attracted to, repelled by] a magnetic field.

1. _____
2. _____
3. _____

Question #: 25

If $\text{M}^{Z+} = \text{Co}^{3+}$ in the figure below, Co^{3+} can be characterized as a _____ according to the _____ acid-base theory since Co^{3+} is a small, highly charged metal cation. However, we have to use the _____ acid-base theory to describe the coordination of H_2O with Co^{3+} to form the complex shown.



- A. weak acid; Brønsted-Lowry; Lewis
- B. weak acid; Lewis; Brønsted-Lowry
- C. weak base; Brønsted-Lowry; Lewis
- D. weak base; Lewis; Brønsted-Lowry

CHE 107 Summer 2017 Exam 3 - Confidential

Your Name: _____

Your ID: _____

Periodic Table of the Elements

Period	1 IA																	18 VIIIA
1	H 1.008																	He 4.003
2	Li 6.941	Be 9.012											B 10.81	C 12.01	N 14.01	O 16.00	F 19.00	Ne 20.18
3	Na 22.99	Mg 24.31	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIIIB	9 VIIIB	10 VIIIB	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	Ar 39.95
4	K 39.10	Ca 40.08	Sc 44.96	Ti 47.87	V 50.94	Cr 52.00	Mn 54.94	Fe 55.85	Co 58.93	Ni 58.69	Cu 63.55	Zn 65.41	Ga 69.72	Ge 72.64	As 74.92	Se 78.96	Br 79.90	Kr 83.80
5	Rb 85.47	Sr 87.62	Y 88.91	Zr 91.22	Nb 92.91	Mo 95.94	Tc 98	Ru 101.1	Rh 102.9	Pd 106.4	Ag 107.9	Cd 112.4	In 114.8	Sn 118.7	Sb 121.8	Te 127.6	I 126.9	Xe 131.3
6	Cs 132.9	Ba 137.3	La 175.0	Hf 178.5	Ta 180.9	W 183.8	Re 186.2	Os 190.2	Ir 192.2	Pt 195.1	Au 197.0	Hg 200.6	Tl 204.4	Pb 207.2	Bi 209.0	Po 209	At 210	Rn 222
7	Fr 223	Ra 226	Ac 227	Rf 261	Db 262	Sg 266	Bh 264	Hs 277	Mt 288	Ds 291	Rg 292	Cn 285	Uut 284	Fl 289	Uup 289	Lv 292	Uus 293	Uuo 294
lanthanides (see inside)		57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm 145	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0			
actinides		89 Ac 227	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237	94 Pu 239	95 Am 243	96 Cm 247	97 Bk 247	98 Cf 251	99 Es 252	100 Fm 257	101 Md 258	102 No 259			

Molar volume of ideal gas at STP = 22.4 L	Ideal gas constant:	Speed of light, $c = 3.00 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Faraday constant, $F = 9.6485 \times 10^4 \text{ C}\cdot\text{mol}^{-1}$	$R = 8.314 \text{ J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	Rydberg constant, $R_H = 2.18 \times 10^{-18} \text{ J}$
Avogadro's number, $N = 6.022 \times 10^{23} \text{ mol}^{-1}$	$R = 1.987 \text{ cal}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	Electron charge, $e = 1.602 \times 10^{-19} \text{ C}$
Planck's constant, $h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}$	$R = 8.206 \times 10^{-2} \text{ L}\cdot\text{atm}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	Atomic mass unit, $u = 1.6605 \times 10^{-24} \text{ g}$

attachment_for_pubExamUID_Inxp115005998318041827XX_205.jpg

Question #: 1

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1. 2.5E-12|2.5 e-12|

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 - B. HCN and HNO₂
 - ✓C. HCl and HNO₃
 - D. HCl and HNO₂
-

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Question #: 6

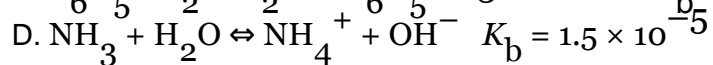
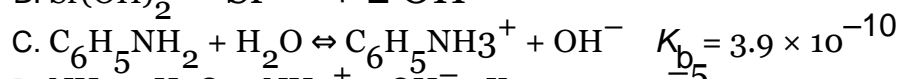
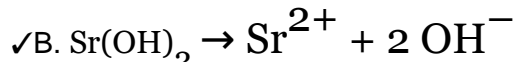
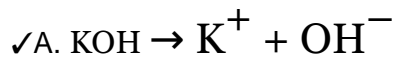
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Report your answer with two decimal places. Do NOT include units in your answer.

1. 6.04

Question #: 7

In a mixture of four bases in water, which two reactions must be considered in calculating the pH?



Question #: 8

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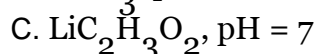
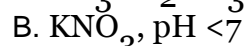
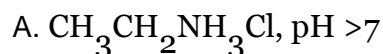
1. 3.19

2. 10.81

3. basic

Question #: 9

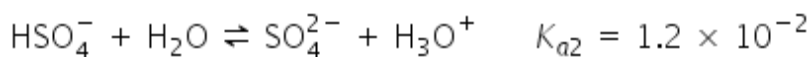
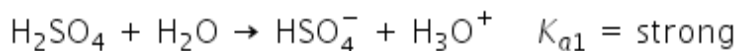
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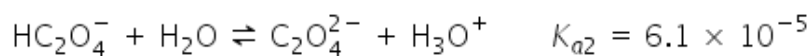
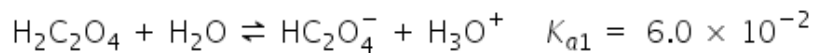
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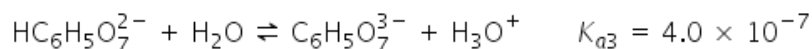
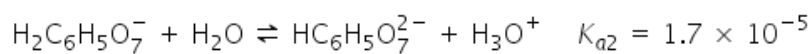
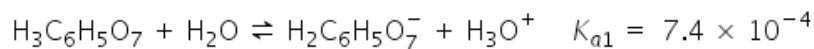
A.



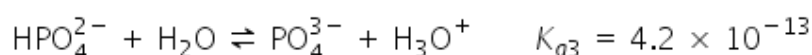
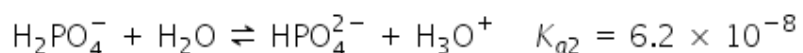
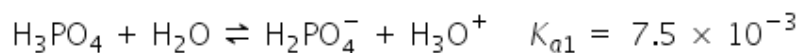
✓B.



C.



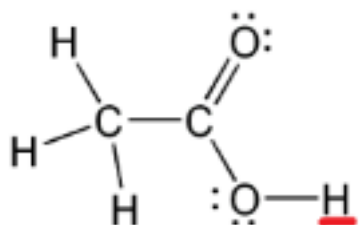
✓D.



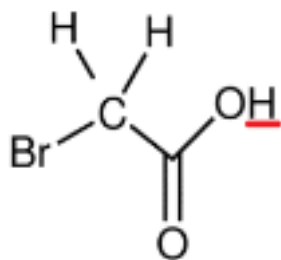
Question #: 11

Which hydrogen, underlined in red, is the **most acidic** in the acetic acid analogues listed below?

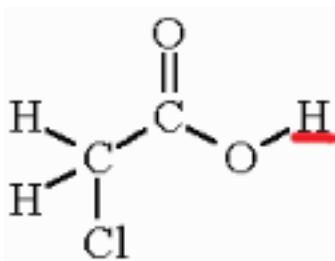
A.



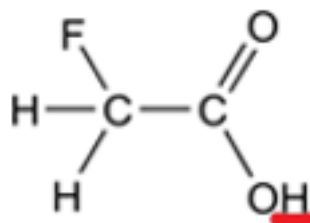
B.



C.

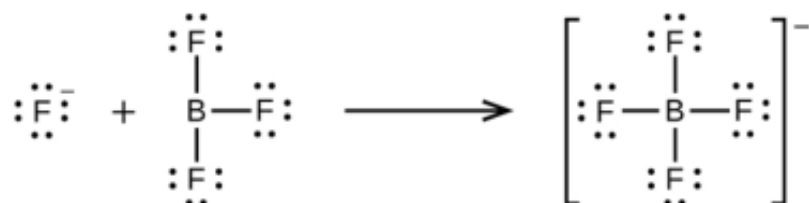


✓D.



Question #: 12

Which two substances function as Lewis bases?



- ✓A. NH_3
- ✓B. F^-
- C. Ag^+
- D. BF_3

Question #: 13

Which **two** combinations will act as buffers?

- ✓A. 1.0 M NaHSeO₃ and 0.75 M H₂SeO₃
- ✓B. 0.90 M CH₃NH₂ and 1.0 M CH₃NH₃Cl
- C. 0.80 M H₃PO₄ and 0.60 M Na₃PO₄
- D. 1.5 M Ca(OH)₂ and 1.0 M H₂SO₄

Question #: 14

What is the pH of a 0.500 L buffer solution that is 0.400 M HNO₂ (pK_a = 3.34) and 0.300 M NaNO₂ after the addition of 0.010 mol of NaOH?

Ignore any volume change from the addition of NaOH. Report pH to **two decimal** places. Do **NOT** include units in your answer.

pH = 1

1. 3.26|3.27|

Question #: 15

Calculate the base-to-acid ratio needed to prepare a pH 3.00 pyruvic acid, sodium pyruvate buffer. The pK_a of pyruvic acid is 2.39.

- A. 0.122
- B. **0.812**
- C. 2.64
- ✓D. 4.07

Question #: 16

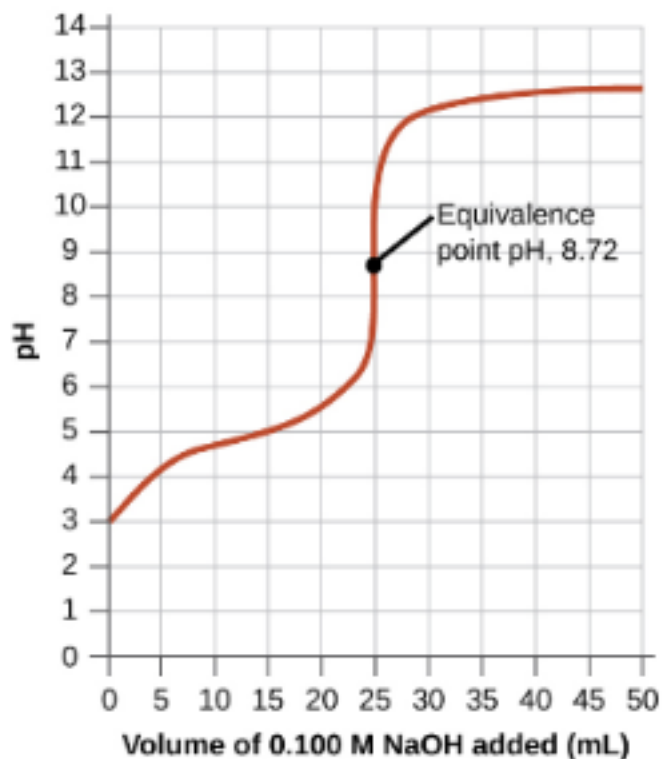
Which combination is best for preparing a pH 8.70 buffer?

- A. methylammonium iodide (pK_a = 10.64) and methylamine
- ✓B. ammonium chloride (pK_a = 9.25) and ammonia
- C. ethylammonium bromide (pK_a = 10.75) and ethylamine

D. hypochlorous acid ($pK_a = 7.54$) and potassium hypochlorite

Question #: 17

A 25.0 mL sample of which 0.100 M solution was used to generate the titration curve below?



- A. HClO_4
- ✓ B. $\text{HC}_2\text{H}_3\text{O}_2$
- C. H_3PO_4
- D. HNO_3

Question #: 18

A 25.0 mL portion of 0.200 M HF ($pK_a = 3.17$) is titrated with 0.250 M KOH. What is the pH after 4.00 mL of KOH has been added?

pH = 1

Report your answer with two decimal places. Do NOT include units in your answer.

1. 2.57

Question #: 19

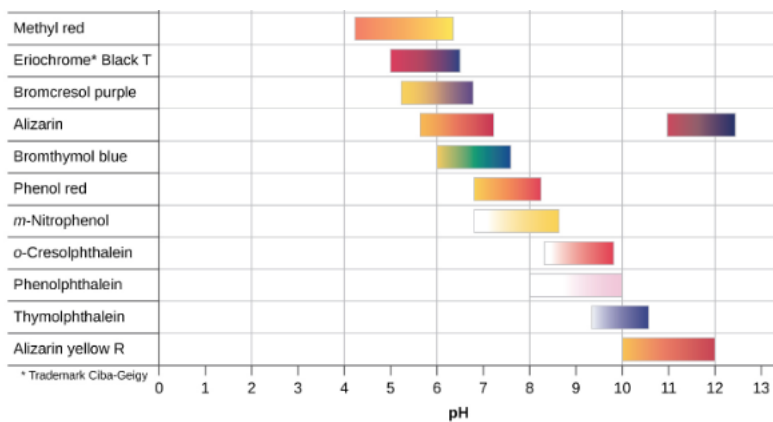
What is the pH of the solution formed after 20.0 mL of 0.20 M ketamine, $C_{13}H_{16}ClNO$, is titrated with 5.0 mL of 1.0 M HI?

$$K_b = 3.0 \times 10^{-7} \text{ for } C_{13}H_{16}ClNO$$

- A. 4.60
- B. 7.00
- ✓C. 1.40
- D. 2.20

Question #: 20

Which indicator would be appropriate for the titration of a **weak acid** with a **strong base**? Be sure to scroll down to see the pH scale at the bottom of the figure.



- A. methyl red
- B. bromthymol blue
- ✓C. o-cresolphthalein
- D. alizarin yellow R

Question #: 21

What is the molar solubility of $\text{BaF}_2(\text{s})$ in 0.40 M NaF ? The K_{sp} of BaF_2 is 2.5×10^{-5} .

- ✓A. $1.6 \times 10^{-4} \text{ M}$
- B. $4.7 \times 10^{-5} \text{ M}$
- C. $2.9 \times 10^{-6} \text{ M}$
- D. $3.1 \times 10^{-2} \text{ M}$

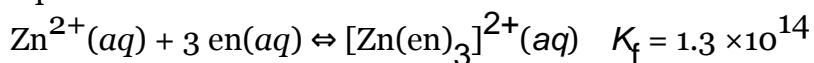
Question #: 22

A pH-neutral solution containing 0.50 M Pb^{2+} and 0.050 M Sn^{2+} is titrated with a concentrated sodium hydroxide solution. Assuming minimal volume changes, which solid precipitates first and what concentration of OH^- is required? The K_{sp} for $\text{Pb}(\text{OH})_2$ is 1.4×10^{-20} and for $\text{Sn}(\text{OH})_2$ is 5.5×10^{-27} .

- A. $\text{Pb}(\text{OH})_2$, $1.7 \times 10^{-10} \text{ M}$
- B. $\text{Pb}(\text{OH})_2$, $3.3 \times 10^{-13} \text{ M}$
- C. $\text{Sn}(\text{OH})_2$, $1.7 \times 10^{-10} \text{ M}$
- ✓D. $\text{Sn}(\text{OH})_2$, $3.3 \times 10^{-13} \text{ M}$

Question #: 23

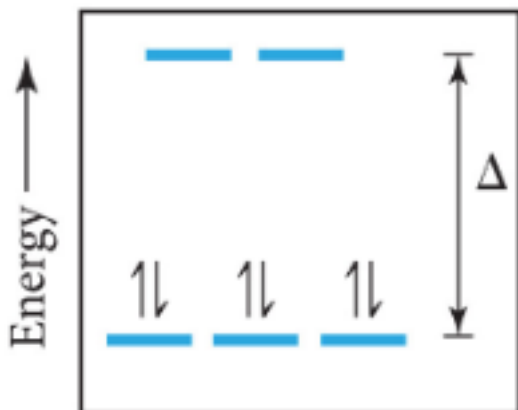
A solution is prepared such that it contains $0.020 \text{ M Zn}(\text{NO}_3)_2$ and 0.100 M ethylenediamine. What concentration of $\text{Zn}^{2+}(\text{aq})$ remains once the reaction reaches equilibrium according to the equation below?



- A. $9.0 \times 10^{-8} \text{ M}$
- B. $6.2 \times 10^{-20} \text{ M}$
- C. $4.7 \times 10^{-16} \text{ M}$
- ✓D. $2.4 \times 10^{-12} \text{ M}$

Question #: 24

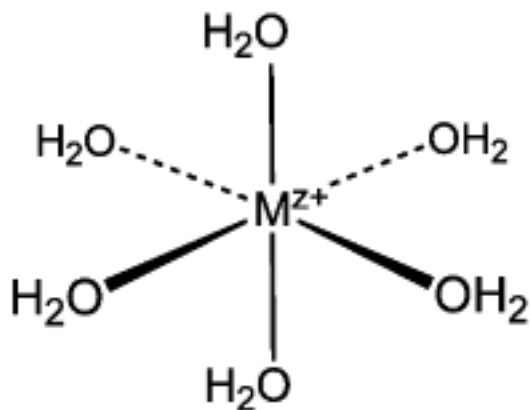
Given the crystal-field diagram for $[\text{Fe}(\text{CN})_6]^{4-}$ below, CN^- is a 1 -field [strong, weak] ligand, the complex ion is 2 [diamagnetic, paramagnetic], and will be slightly 3 [attracted to, repelled by] a magnetic field.



1. strong
2. diamagnetic
3. repelled by

Question #: 25

If $M^{Z+} = \text{Co}^{3+}$ in the figure below, Co^{3+} can be characterized as a _____ according to the _____ acid-base theory since Co^{3+} is a small, highly charged metal cation. However, we have to use the _____ acid-base theory to describe the coordination of H_2O with Co^{3+} to form the complex shown.



- ✓A. weak acid; Brønsted-Lowry; Lewis
 B. weak acid; Lewis; Brønsted-Lowry

C. weak base; Brønsted-Lowry; Lewis

D. weak base; Lewis; Brønsted-Lowry