
CHE 107 Fall 2016 Exam 3

Your Name: _____

Your ID: _____

Question #: 1

$[\text{H}_3\text{O}^+]$ in a typical solution of hand soap is 3.2×10^{-10} M. The pH of this solution is 1. Report your answer with **two** decimal places. Do **NOT** include units in your answer.

1. _____

Question #: 2

The pH of Coca-Cola is 2.50. What is $[\text{H}_3\text{O}^+]$ in this drink?

- A. 1.3×10^{-2} M
 - B. 2.9×10^{-4} M
 - C. 1.0×10^{-1} M
 - D. 3.2×10^{-3} M
-

Question #: 3

The percent ionization of a 0.20 M solution of chloroacetic acid ($\text{HC}_2\text{H}_2\text{ClO}_2$) is 1 %.

$K_a(\text{HC}_2\text{H}_2\text{ClO}_2) = 1.4 \times 10^{-3}$

Report your answer with **two** significant figures. Do **NOT** include units or the percent sign in your answer.

1. _____

Question #: 4

Which of the following solutions has the same pH as a solution containing 0.010 M HBr and 0.020 M HBrO ($K_a = 2.8 \times 10^{-9}$)?

- A. 0.010 M HNO₃
 - B. 0.030 M HCl
 - C. 0.030 M HCN ($K_a = 4.9 \times 10^{-10}$)
 - D. 0.010 M H₂SO₄ ($K_{a2} = 1.2 \times 10^{-2}$)
-

Question #: 5

Calculating the exact pH of a 0.010 M solution of fluoroacetic acid (HC₂H₂FO₂) requires the use of the quadratic equation. Estimate the pH without performing the calculation.

$K_a(\text{HC}_2\text{H}_2\text{FO}_2) = 2.6 \times 10^{-3}$

- A. between 1.00 and 2.00
 - B. between 2.00 and 3.00
 - C. between 6.00 and 7.00
 - D. between 12.00 and 13.00
-

Question #: 6

The pK_b of pyridine (C₅H₅N) is 8.77.

K_a of the pyridinium ion (C₅H₅NH⁺) is 1 .

Report your answer with **two** significant figures. Use the format 2.2E2 or 2.2E-2 for scientific notation.

1. _____

Question #: 7

Which choice describes a **slightly basic** solution?

- A. pH = 2.00
 - B. pH = 6.00
 - C. pOH = 6.00
 - D. pOH = 2.00
-

Question #: 8

Select **two** salts that dissolve in water to give a solution with pH < 7.

- A. CaF₂
 - B. CH₃NH₃Cl
 - C. CrCl₃
 - D. Sr(ClO₄)₂
 - E. NaNO₂
 - F. KNO₃
-

Question #: 9

Select **two true** statements about a dilute solution of a typical diprotic acid, H₂X.

K_{a1} = first acid ionization constant

K_{a2} = second acid ionization constant

- A. $X^{2-} \approx K_{a2}$
 - B. $K_{a1} < K_{a2}$
 - C. $HX^- \approx K_{a2}$
 - D. $K_{a1} > K_{a2}$
-

Question #: 10

HCl is a strong acid, while HF is a weak acid. Select the reason for this difference from the list below.

- A. Chlorine is more electronegative than fluorine.
 - B. The H–Cl and H–F bond polarities are the same.
 - C. The H–Cl bond is weaker than the H–F bond.
 - D. Chlorine has a smaller atomic radius than fluorine.
-

Question #: 11

Which is the **weakest** of these oxyacids?

- A. HClO₄
 - B. H₂SO₄
 - C. H₃PO₄
 - D. H₄SiO₄
-

Question #: 12

Which **two** of the substances below function as **Lewis acids**?

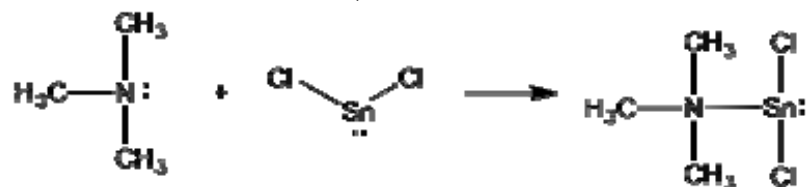


- A. Cu²⁺
 - B. NH₃
 - C. BF₃
 - D. F⁻
-

Question #: 13

In the reaction below, 1 is the Lewis base, 2 is the Lewis acid and 3 is the Lewis adduct.

Fill in each blank with **A**, **B** or **C**.



A	$(\text{CH}_3)_3\text{N}$
B	SnCl_2
C	$(\text{CH}_3)_3\text{NSnCl}_2$

1. _____
 2. _____
 3. _____
-

Question #: 14

Which **three** of the following pairs can act as a buffer in aqueous solution? Concentrations of all substances are about 0.25 M.

- A. HCl and NaOH
 - B. HBr and KBr
 - C. HCN and LiCN
 - D. HF and H₂O
 - E. HNO₂ and NaNO₂
 - F. NaHSO₄ and Na₂SO₄
-

Question #: 15

A solution that contains 0.25 M formic acid (HCHO_2 , $K_a = 1.8 \times 10^{-4}$) and 0.75 M potassium formate (KCHO_2) has $\text{pH} = \underline{\hspace{2cm}}$.

- A. 4.22
 - B. 9.84
 - C. 4.75
 - D. 3.36
-

Question #: 16

How does the addition of a few drops of 0.100 M HCl change the pH of 25.0 mL of a solution containing 0.80 M propanoic acid ($\text{HC}_3\text{H}_5\text{O}_2$, $\text{p}K_a = 4.87$) and 0.80 M sodium propanoate ($\text{NaC}_3\text{H}_5\text{O}_2$)?

- A. The pH will drop several pH units below 4.87.
 - B. The pH will drop less than one pH unit below 4.87.
 - C. The pH will rise several pH units above 4.87.
 - D. The pH will rise less than one pH unit above 4.87.
-

Question #: 17

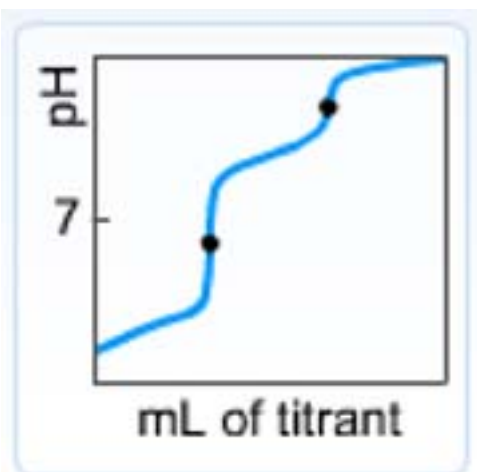
Which solution is the **most effective** buffer?

- A. 0.030 M nitrous acid (HNO_2) and 0.030 M sodium nitrite (NaNO_2)
 - B. 0.300 M benzoic acid ($\text{HC}_7\text{H}_4\text{O}_2$) and 0.300 M sodium benzoate ($\text{NaC}_7\text{H}_4\text{O}_2$)
 - C. 0.300 M nitric acid (HNO_3) and 0.300 M sodium nitrate (NaNO_3)
 - D. 0.300 M acetic acid ($\text{HC}_2\text{H}_3\text{O}_2$) and 0.300 M sodium benzoate ($\text{NaC}_7\text{H}_4\text{O}_2$)
-

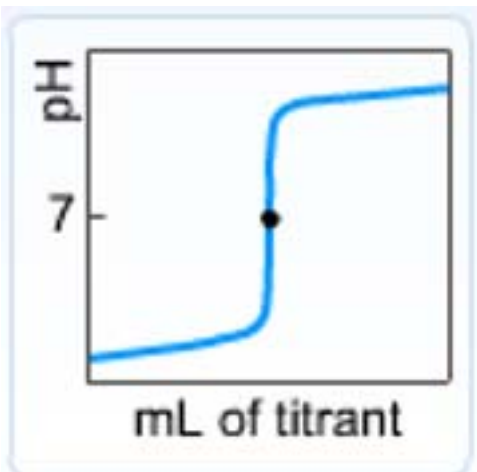
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Which one of the following pH curves shows the titration of a strong, monoprotic acid with a strong base?

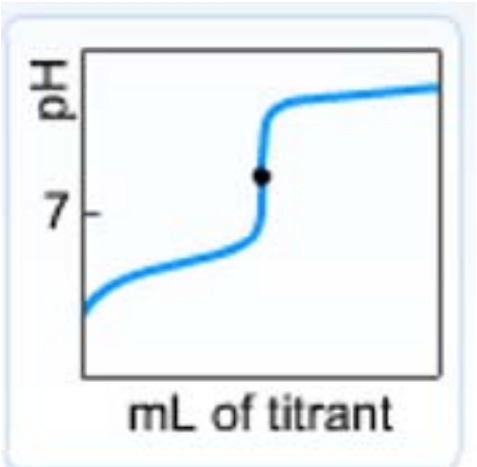
A.



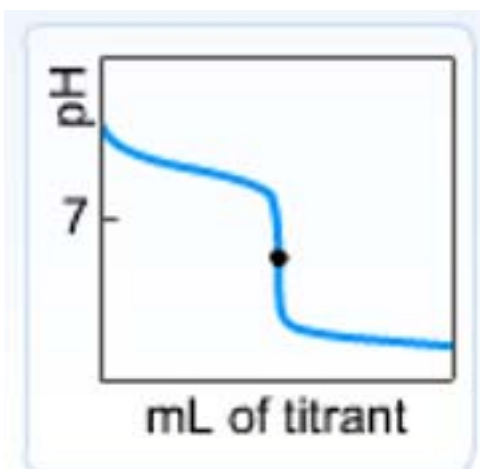
B.



C.



D.



Question #: 19

Titration of 38 mL of a 0.30 M piperidine ($C_5H_{11}N$, $K_b = 1.3 \times 10^{-3}$) solution with 12 mL of 0.50 M HCl results in a solution with $[OH^-] = \underline{\quad 1 \quad}$ M.

Report your answer with **two** significant digits in the format 2.2E2 or 2.2E-2 if you use scientific notation. Do **NOT** include units in your answer.

1. _____

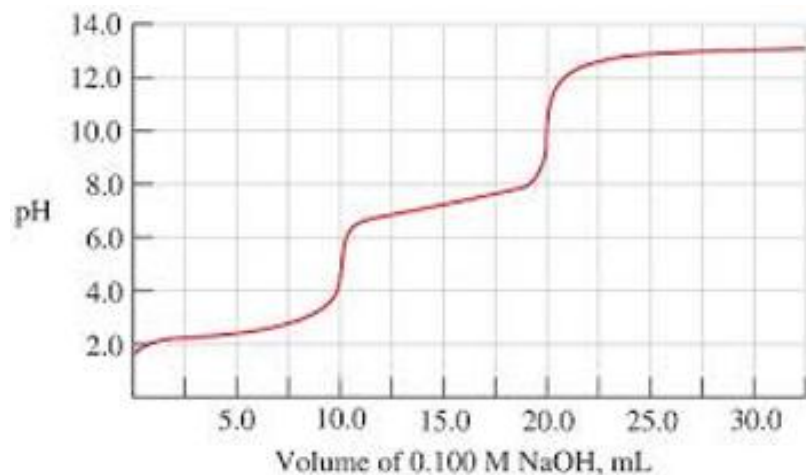
Question #: 20

A 20.0 mL portion of 0.250 M CH_3NH_2 ($K_b = 4.4 \times 10^{-4}$) is titrated with 1.00 M HCl. What is the pH at the equivalence point?

- A. 3.64
 - B. 5.67
 - C. 6.82
 - D. 8.10
-

Question #: 21

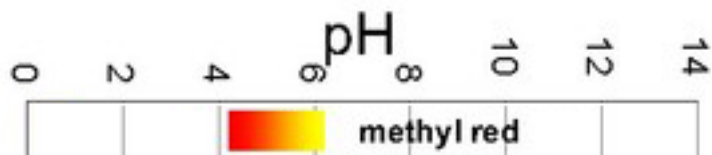
5.00 mL of a solution of a diprotic acid, H_2X , is titrated with 0.100 M NaOH, resulting in the titration curve below. What was the initial concentration of the H_2X solution?



- A. 0.200 M
 - B. 0.100 M
 - C. 0.400 M
 - D. 0.0400 M
-

Question #: 22

Methyl red is a good choice as an indicator for the titration of which acid with 0.10 M KOH?



- A. propanoic acid, $pK_a = 4.87$
 - B. chloroacetic acid, $pK_a = 2.85$
 - C. phenol, $pK_a = 9.80$
 - D. nitric acid
-

Question #: 23

$\text{Ba}(\text{BrO}_3)_2$ and TlCl both have $K_{\text{sp}} = 2 \times 10^{-4}$. Which salt has the **higher molar** solubility?

- A. TlCl
 - B. $\text{Ba}(\text{BrO}_3)_2$
 - C. TlCl and $\text{Ba}(\text{BrO}_3)_2$ have the same molar solubility.
-

Question #: 24

The solubility of lead(II) sulfate in pure water is 1 M.

$$K_{\text{sp}}(\text{PbSO}_4) = 1.8 \times 10^{-8}$$

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 #: 25

The solubility of AgI in a 0.040 M KI solution is 1 M.

$$\text{The } K_{\text{sp}} \text{ of } \text{AgI} \text{ is } 8.5 \times 10^{-17}.$$

Report your answer with **two** significant figures. Do **NOT** include units in your answer. Use the format 2.2E2 or 2.2E-2 for answers in scientific notation.

1. _____

Question #: 26

The solubility of which **two** of the following compounds is strongly affected by changes in pH?

- A. BaCO_3
 - B. KI
 - C. MgF_2
 - D. AgBr
-

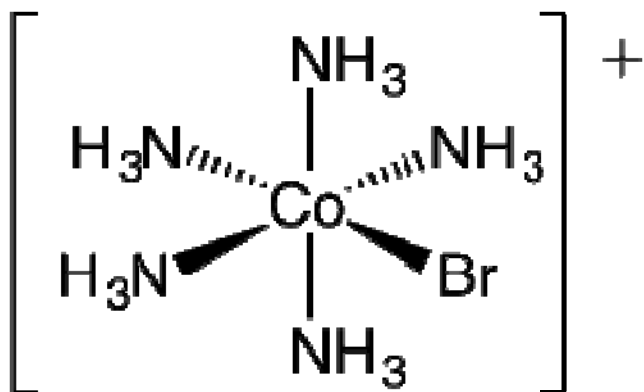
Question #: 27

What happens when 25 mL of 6.0×10^{-3} M $\text{Sr}(\text{NO}_3)_2$ is mixed with 25 mL of 4.0×10^{-3} M KF ?
 $K_{\text{sp}}(\text{SrF}_2) = 4.3 \times 10^{-9}$

- A. $Q_{\text{sp}} < K_{\text{sp}}$
The solution remains unsaturated.
- B. $Q_{\text{sp}} = K_{\text{sp}}$
The solution is saturated but no $\text{SrF}_2(\text{s})$ precipitates.
- C. $Q_{\text{sp}} > K_{\text{sp}}$
 $\text{SrF}_2(\text{s})$ precipitates, leaving behind an unsaturated solution.
- D. $Q_{\text{sp}} > K_{\text{sp}}$
 $\text{SrF}_2(\text{s})$ precipitates, leaving behind a saturated solution.
-

Question #: 28

In the complex below,
oxidation state of Co = 1
coordination number of Co = 2
 d -electron count of Co = d^3



1. _____
2. _____
3. _____
-

Question #: 29

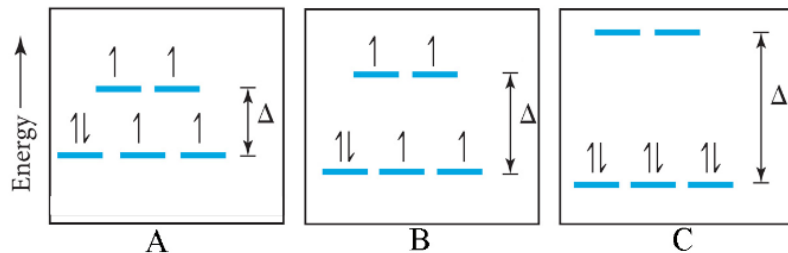
Three ligands from the spectrochemical series can be ordered from strong-field to weak-field in the order $\text{CN}^- > \text{NH}_3 > \text{H}_2\text{O}$. Crystal-field diagrams of three octahedral iron(II) complex ions formed with these ligands are shown below.

$[\text{Fe}(\text{CN})_6]^{4-}$ matches diagram 1.

$[\text{Fe}(\text{NH}_3)_6]^{2+}$ matches diagram 2.

$[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ matches diagram 3.

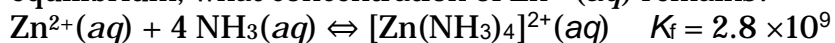
Use the letter of a diagram (A, B or C) for each answer.



1. _____
2. _____
3. _____

Question #: 30

A solution initially contains 0.15 M NH_3 and 0.0011 M $\text{Zn}(\text{NO}_3)_2$. After the solution reaches equilibrium, what concentration of $\text{Zn}^{2+}(\text{aq})$ remains?



- A. $6.5 \times 10^{-5} \text{ M}$
- B. $4.2 \times 10^{-8} \text{ M}$
- C. $8.7 \times 10^{-10} \text{ M}$
- D. $5.8 \times 10^{-14} \text{ M}$

CHE 107 Fall 2016 Exam 3 - Confidential

Your Name: _____

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Periodic Table of the Elements

Period	1 IA	2 IIA											13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA		
1	H 1.008																		He 4.003	
2	Li 6.941	Be 9.012																		Ne 20.18
3	Na 22.99	Mg 24.31																		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	Lr 262	Rf 261	Db 262	Sg 265	Bh 264	Hs 277	Mt 288	Ds 291	Rg 292	Cn 285	Uut 284	Fl 289	Uup 288	Lv 292	Uus 293	Uuo 294		
		lanthanides (see earth)																		
	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: $R = 8.314 \text{ J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	Speed of light, $c = 3.00 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Faraday constant, $F = 9.6485 \times 10^4 \text{ C}\cdot\text{mol}^{-1}$	$R = 1.987 \text{ cal}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	Rydberg constant, $R_H = 2.18 \times 10^{-18} \text{ J}$
Avogadro's number, $N = 6.022 \times 10^{23} \text{ mol}^{-1}$	$R = 8.206 \times 10^{-2} \text{ L}\cdot\text{atm}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	Electron charge, $e = 1.602 \times 10^{-19} \text{ C}$
Planck's constant, $h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}$		Atomic mass unit, $u = 1.6605 \times 10^{-24} \text{ g}$

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Question #: 1

$[\text{H}_3\text{O}^+]$ in a typical solution of hand soap is $3.2 \times 10^{-10} \text{ M}$. The pH of this solution is 1 . Report your answer with **two** decimal places. Do **NOT** include units in your answer.

1. 9.499.489.50

Question #: 2

The pH of Coca-Cola is 2.50. What is $[\text{H}_3\text{O}^+]$ in this drink?

- A. $1.3 \times 10^{-2} \text{ M}$
- B. $2.9 \times 10^{-4} \text{ M}$

- C. 1.0×10^{-1} M
✓D. 3.2×10^{-3} M
-

Question #: 3

The percent ionization of a 0.20 M solution of chloroacetic acid ($\text{HC}_2\text{H}_2\text{ClO}_2$) is 1 %.

$$K_a(\text{HC}_2\text{H}_2\text{ClO}_2) = 1.4 \times 10^{-3}$$

Report your answer with **two** significant figures. Do **NOT** include units or the percent sign in your answer.

1. 8.4|8.5|8.3|

Question #: 4

Which of the following solutions has the same pH as a solution containing 0.010 M HBr and 0.020 M HBrO ($K_a = 2.8 \times 10^{-9}$)?

- ✓A. 0.010 M HNO_3
B. 0.030 M HCl
C. 0.030 M HCN ($K_a = 4.9 \times 10^{-10}$)
D. 0.010 M H_2SO_4 ($K_{a2} = 1.2 \times 10^{-2}$)
-

Question #: 5

Calculating the exact pH of a 0.010 M solution of fluoroacetic acid ($\text{HC}_2\text{H}_2\text{FO}_2$) requires the use of the quadratic equation. Estimate the pH without performing the calculation.

$$K_a(\text{HC}_2\text{H}_2\text{FO}_2) = 2.6 \times 10^{-3}$$

- A. between 1.00 and 2.00
✓B. between 2.00 and 3.00
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Question #: 6

The pK_b of pyridine (C_5H_5N) is 8.77.

K_a of the pyridinium ion ($C_5H_5NH^+$) is 1.

Report your answer with **two** significant figures. Use the format 2.2E2 or 2.2E-2 for scientific notation.

1. 5.9E-6|5.9 E -6|5.9 E-6|5.8E-6|5.8 E -6|5.8 E-6|6.0E-6|6.0 E -6|6.0 E-6|

Question #: 7

Which choice describes a **slightly basic** solution?

- A. pH = 2.00
 - B. pH = 6.00
 - ✓C. pOH = 6.00
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-

Question #: 8

Select **two** salts that dissolve in water to give a solution with pH <7.

- A. CaF_2
 - ✓B. CH_3NH_3Cl
 - ✓C. $CrCl_3$
 - D. $Sr(ClO_4)_2$
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 - F. KNO_3
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Select **two true** statements about a dilute solution of a typical diprotic acid, H_2X .

K_{a1} = first acid ionization constant

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- ✓A. $X^{2-} \approx K_{a2}$
- B. $K_{a1} < K_{a2}$

- C. $HX^- \approx K_{a2}$
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HCl is a strong acid, while HF is a weak acid. Select the reason for this difference from the list below.

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✓C. The H–Cl bond is weaker than the H–F bond.
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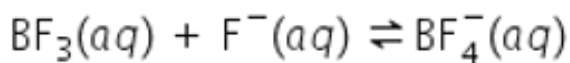
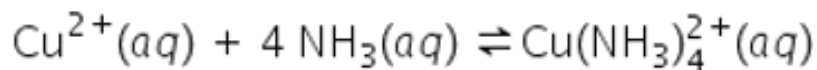
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Which **two** of the substances below function as **Lewis acids**?

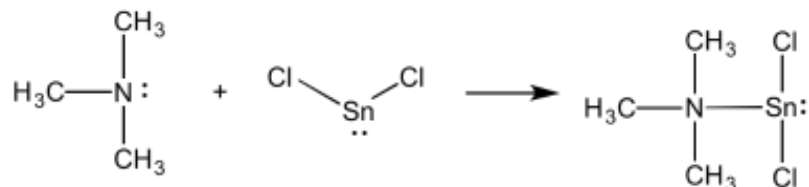


- ✓A. Cu^{2+}
B. NH_3
✓C. BF_3
D. F^-

Question #: 13

In the reaction below, 1 is the Lewis base, 2 is the Lewis acid and 3 is the Lewis adduct.

Fill in each blank with **A**, **B** or **C**.



A	$(\text{CH}_3)_3\text{N}$
B	SnCl_2
C	$(\text{CH}_3)_3\text{NSnCl}_2$

1. A
2. B
3. C

Question #: 14

Which **three** of the following pairs can act as a buffer in aqueous solution? Concentrations of all substances are about 0.25 M.

- A. HCl and NaOH
 - B. HBr and KBr
 - ✓C. HCN and LiCN
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 - ✓E. HNO₂ and NaNO₂
 - ✓F. NaHSO₄ and Na₂SO₄
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A solution that contains 0.25 M formic acid (HCHO_2 , $K_a = 1.8 \times 10^{-4}$) and 0.75 M potassium formate (KCHO_2) has $\text{pH} = \underline{\hspace{2cm}}$.

- ✓A. 4.22
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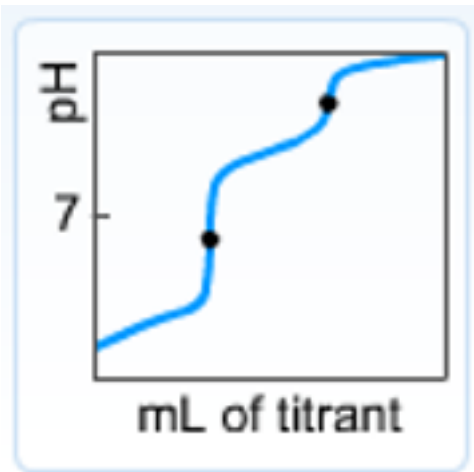
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- C. 0.300 M nitric acid (HNO_3) and 0.300 M sodium nitrate (NaNO_3)
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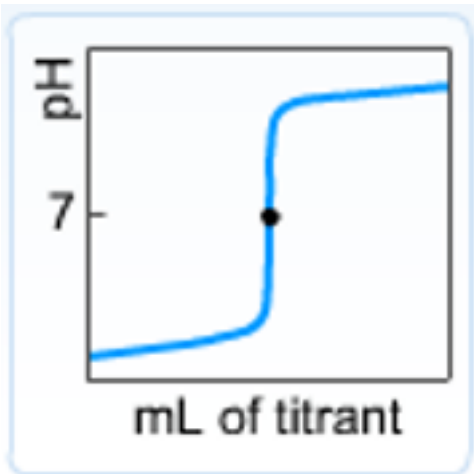
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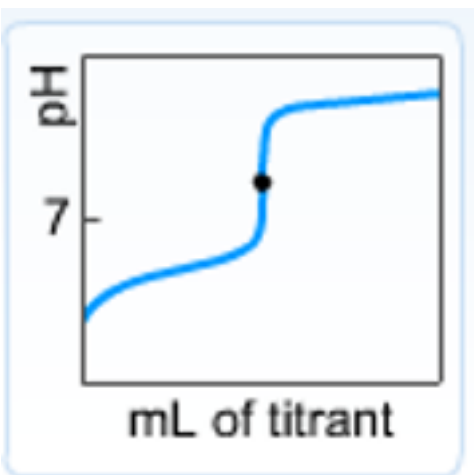
A.



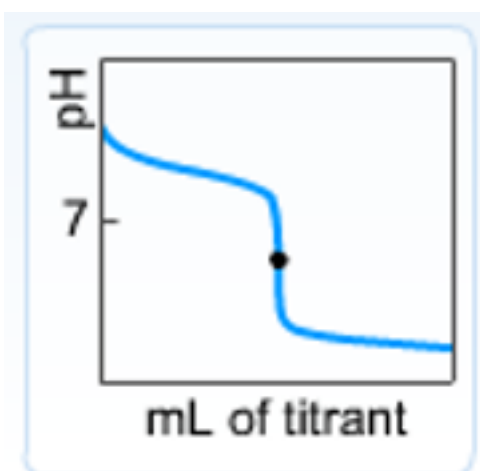
✓B.



C.



D.



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Report your answer with **two** significant digits in the format 2.2E2 or 2.2E-2 if you use scientific notation. Do **NOT** include units in your answer.

1. 1.2E-3|1.2 E -3|1.2 E-3|1.2E -3|1.1E-3|1.1 E -3|1.1 E-3|1.1E -3|0.0012|.0012|0.0011|.0011|

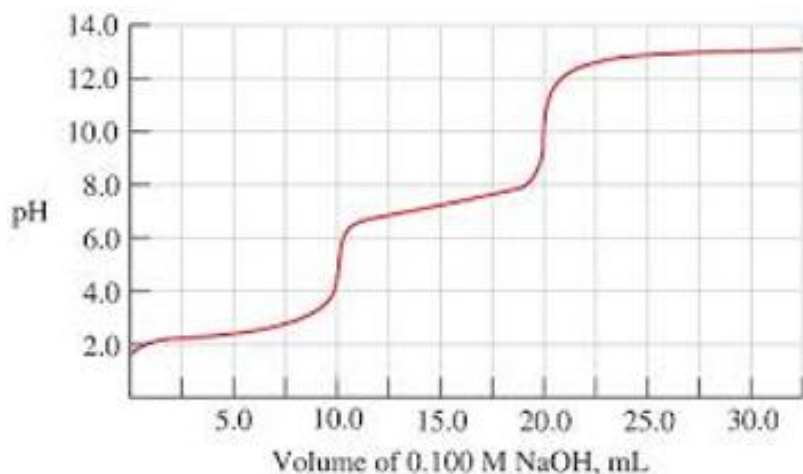
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- ✓B. 5.67
- C. 6.82
- D. 8.10

Question #: 21

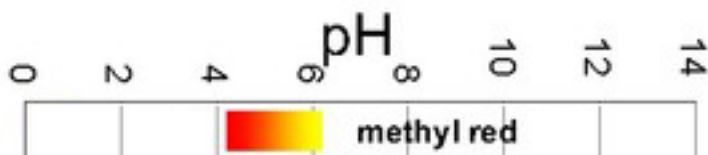
5.00 mL of a solution of a diprotic acid, H_2X , is titrated with 0.100 M NaOH, resulting in the titration curve below. What was the initial concentration of the H_2X solution?



- ✓A. 0.200 M
- B. 0.100 M
- C. 0.400 M
- D. 0.0400 M

Question #: 22

Methyl red is a good choice as an indicator for the titration of which acid with 0.10 M KOH?



- ✓A. propanoic acid, $pK_a = 4.87$
- B. chloroacetic acid, $pK_a = 2.85$
- C. phenol, $pK_a = 9.80$
- D. nitric acid

Question #: 23

$Ba(BrO_3)_2$ and $TlCl$ both have $K_{sp} = 2 \times 10^{-4}$. Which salt has the **higher molar** solubility?

- A. TlCl
 B. $\text{Ba}(\text{BrO}_3)_2$
C. TlCl and $\text{Ba}(\text{BrO}_3)_2$ have the same molar solubility.
-

Question #: 24

The solubility of lead(II) sulfate in pure water is 1 M.

$$K_{\text{sp}}(\text{PbSO}_4) = 1.8 \times 10^{-8}$$

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. 1.3E-4|1.3 E-4|1.3E -4|1.3 E -4|.00013|0.00013|1.4E-4|1.4 E-4|1.4E -4|1.4 E -4|.00014|0.00014|
-

Question #: 25

The solubility of AgI in a 0.040 M KI solution is 1 M.

$$\text{The } K_{\text{sp}} \text{ of } \text{AgI} \text{ is } 8.5 \times 10^{-17}.$$

Report your answer with **two** significant figures. Do **NOT** include units in your answer. Use the format 2.2E2 or 2.2E-2 for answers in scientific notation.

1. 2.1E-15
-

Question #: 26

The solubility of which **two** of the following compounds is strongly affected by changes in pH?

- A. BaCO_3
B. KI
 C. MgF_2
D. AgBr
-

Question #: 27

What happens when 25 mL of 6.0×10^{-3} M $\text{Sr}(\text{NO}_3)_2$ is mixed with 25 mL of 4.0×10^{-3} M KF ?

$$K_{\text{sp}}(\text{SrF}_2) = 4.3 \times 10^{-9}$$

- A. $Q_{sp} < K_{sp}$
The solution remains unsaturated.
- B. $Q_{sp} = K_{sp}$
The solution is saturated but no $\text{SrF}_2(s)$ precipitates.
- C. $Q_{sp} > K_{sp}$
 $\text{SrF}_2(s)$ precipitates, leaving behind an unsaturated solution.
- ✓D. $Q_{sp} > K_{sp}$
 $\text{SrF}_2(s)$ precipitates, leaving behind a saturated solution.

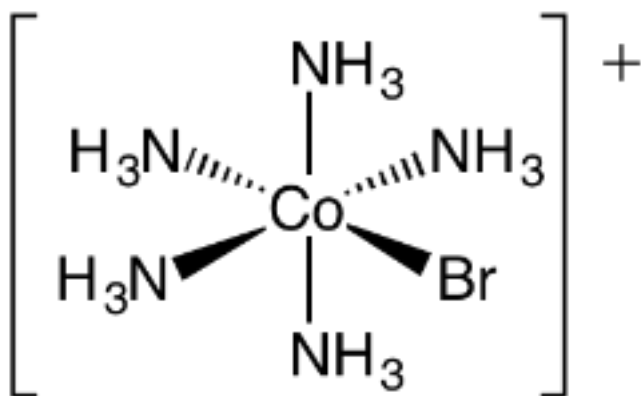
Question #: 28

In the complex below,

oxidation state of Co = 1

coordination number of Co = 2

d-electron count of Co = d 3



1. +2|2+|2|III|(II)|two|positive two|
2. 6|six|
3. 7|seven|

Question #: 29

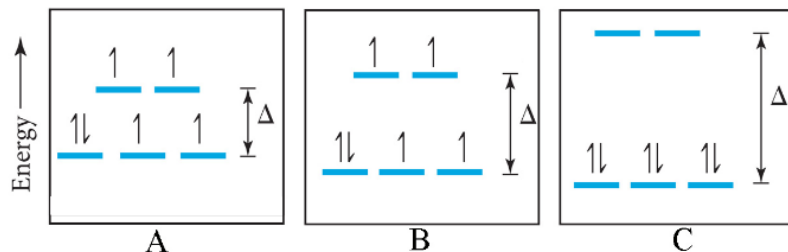
Three ligands from the spectrochemical series can be ordered from strong-field to weak-field in the order $\text{CN}^- > \text{NH}_3 > \text{H}_2\text{O}$. Crystal-field diagrams of three octahedral iron(II) complex ions formed with these ligands are shown below.

$[\text{Fe}(\text{CN})_6]^{4-}$ matches diagram 1.

$[\text{Fe}(\text{NH}_3)_6]^{2+}$ matches diagram 2.

$[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ matches diagram 3.

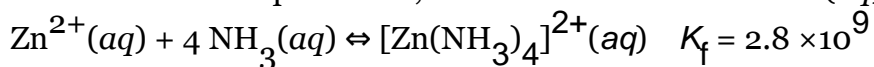
Use the letter of a diagram (**A**, **B** or **C**) for each answer.



1. C
2. B
3. A

Question #: 30

A solution initially contains 0.15 M NH_3 and 0.0011 M $\text{Zn}(\text{NO}_3)_2$. After the solution reaches equilibrium, what concentration of $\text{Zn}^{2+}(\text{aq})$ remains?



- A. 6.5×10^{-5} M
- B. 4.2×10^{-8} M
- ✓ C. 8.7×10^{-10} M
- D. 5.8×10^{-14} M