107 2016 Spring Exam 3

Your Name: _____ **Your ID:** _____

Question #: 1

What is the pH of a solution that is 0.052 M in HBr and 0.020 M in HNO_3?

A. 1.70
B. 1.28
C. 1.14
D. 2.98

Question #: 2

For a solution with pH = 4.26, $[H_3O^+]$ = __1__ M.
Report your answer with **two** significant digits, in the form 2.2E2 or 2.2E-2 if you use scientific notation.

1. _____

Question #: 3

A 0.35 M solution of benzoic acid ($HC_7H_5O_2$, a weak acid), has a pH of 2.32.
The percent ionization of 0.35 M benzoic acid = __1__%.
Report your answer with **two** significant figures.

1. _____

Question #: 4

Which of the following solutions has the same pH as a solution containing 0.010 M HNO_3 and 0.020 M HClO ($K_a = 2.9 \times 10^{-8}$).

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

Question #: 5

An aqueous solution of HF (K_a = 6.8 ×10⁻⁴) has a concentration of 0.0010 M. At equilibrium, [HF] = _____ M.

A. 1.8×10^{-4}

B. $0.0010 - \left[\frac{-6.8\times10^{-4} \pm \sqrt{(6.8\times10^{-4})^2 + 4(6.8\times10^{-7})}}{2}\right]$

C. 8.2×10^{-4}

D. $\frac{-6.8\times10^{-4} \pm \sqrt{(6.8\times10^{-4})^2 + 4(6.8\times10^{-7})}}{2}$

Question #: 6

Given that the K_a of propanoic acid ($HC_3H_5O_2$) is 1.3×10^{-5}, the pK_b of the propanoate ion ($C_3H_5O_2^-$) is __1__.

Report your answer with **three** digits.

1. _____

Question #: 7

Which is the most **basic** solution?

A. pOH = 8.0
B. pOH = 3.0
C. pH = 2.0
D. pH = 9.0

Question #: 8

Calculate the pH of a 0.22 M CH_3NH_3Br solution.

$K_b(CH_3NH_2) = 4.4 \times 10^{-4}$

A. 5.65
B. 2.09
C. 11.82
D. 10.64

Question #: 9

Which of the following compounds has more than one ionizable proton in aqueous solution?

A. CH_4
B. H_3PO_4
C. $HC_2H_3O_2$
D. NH_3

Question #: 10

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

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

Question #: 11

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

A. $HBrO$ B. $HBrO_2$ C. $HBrO_3$

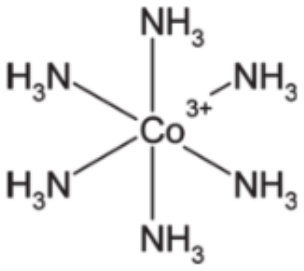
Question #: 12

Select **all** of the Lewis **acids**.

A. BCl_3
B. Cu^{2+}
C. CO
D. CN^-

Question #: 13

Choose the statements that describe Lewis acid-base behavior in the hexaamminecobalt(III) ion.



A. Cobalt(III) is the Lewis acid and donates electrons.
Ammonia is the Lewis base and accepts electrons.
B. Cobalt(III) is the Lewis acid and accepts electrons.
Ammonia is the Lewis base and donates electrons.
C. Cobalt(III) is the Lewis base and donates electrons.
Ammonia is the Lewis acid and accepts electrons.
D. Cobalt(III) is the Lewis base and accepts electrons.
Ammonia is the Lewis acid and donates electrons.

Question #: 14

Select **all** of the **true** statements about buffers.

A. A buffer is an aqueous solution composed of a strong acid and a strong base.
B. A buffer can absorb unlimited amounts of acid or base.
C. A buffer may contain a weak base and its conjugate acid.
D. A solution that contains 0.50 M $HC_2H_3O_2$ (acetic acid) and 0.50 M $NaC_2H_3O_2$ (sodium acetate) is an effective buffer.

Question #: 15

A solution that contains 0.43 M formic acid ($HCHO_2$, $K_a = 1.8 \times 10^{-4}$) and 0.21 M potassium formate ($KCHO_2$) has pH = _____.

A. 3.43
B. 1.04
C. 3.73
D. 12.96

Question #: 16

The pH of 25 mL of an aqueous solution that is 0.10 M NH_3 ($K_b = 1.8 \times 10^{-5}$) and 0.10 M NH_4Cl is __1__ (<, =, >) 7.

The addition of a few drops of HCl will __2__ [**slightly**, **greatly**] __3__ [**increase**, **decrease**] the pH.

1. _____ 2. _____ 3. _____

Question #: 17

Which conjugate acid-base pair is the most appropriate for preparing a buffer with pH = 8.70?

A. 0.100 M $HC_2H_3O_2$,
0.100 M $LiC_2H_3O_2$,
pK_a($HC_2H_3O_2$) = 4.74

B. 0.100 M HCN,
0.100 M NaCN,
pK_a(HCN) = 9.31

C. 0.100 M $C_5H_5NH^+$,
0.100 M C_5H_5N,
pK_a($C_5H_5NH^+$) = 5.23

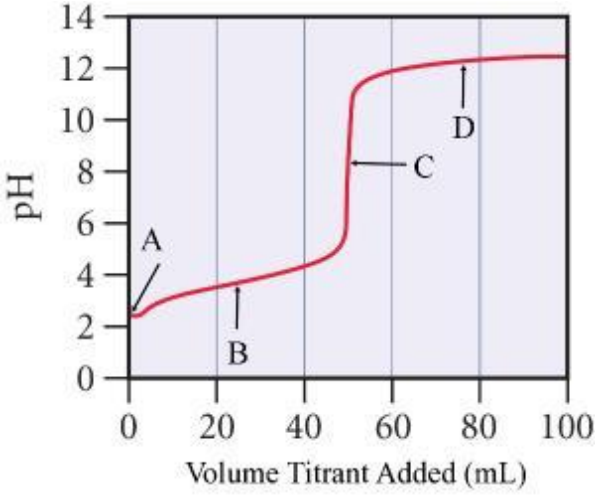
D. 0.100 M HClO,
0.100 M KClO,
pK_a(HClO) = 7.54

Question #: 18

The pH vs. volume curve below shows the titration of a 0.10 M solution of a __1__ [**strong base**, **strong acid**, **weak base**, **weak acid**] (in the flask) with a 0.10 M solution of a __2__ [**strong base**, **strong acid**, **weak base**, **weak acid**] (titrant, in the buret).

At point __3__ [**A**, **B**, **C**, **D**], the pH of the solution equals the pK_a of the solute.

Point __4__ [**A**, **B**, **C**, **D**] is the equivalence point of the titration.



1. _____ 2. _____ 3. _____ 4. _____

Question #: 19

Calculate the pH when 15.0 mL of 0.20 M benzoic acid ($HC_7H_5O_2$, $K_a = 6.5 \times 10^{-5}$) is titrated with 20.0 mL of 0.15 M sodium hydroxide (NaOH).

A. 8.56
B. 7.95
C. 5.33
D. 6.25

Question #: 20

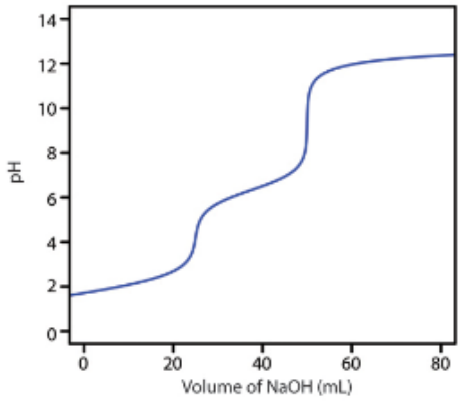
What is the pH when 25.0 mL of 0.200 M piperidine ($C_5H_{11}N$, $K_b = 1.33 \times 10^{-3}$) has been titrated with 11.0 mL of 0.500 M HI?

A. 8.11
B. 7.00
C. 2.53
D. 1.86

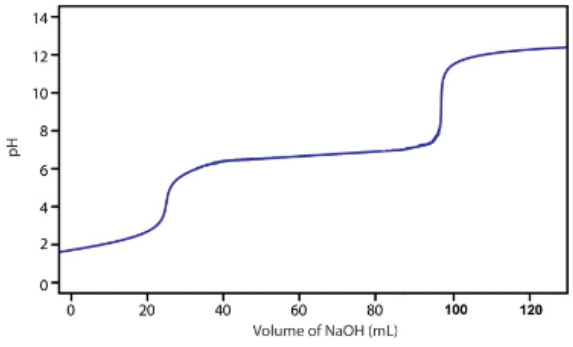
Question #: 21

Which plot shows the titration of a diprotic acid with NaOH?

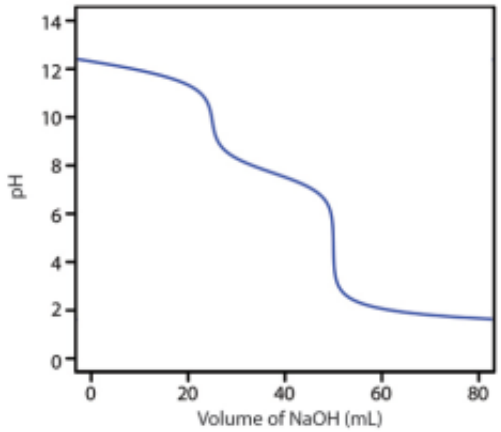
A.



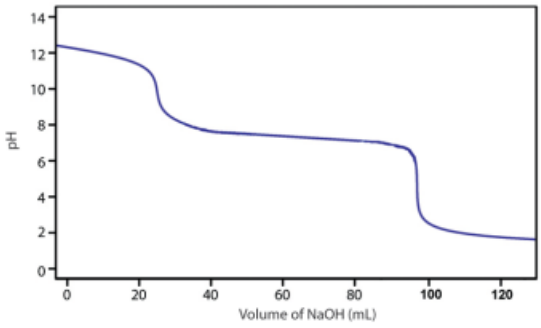
B.



C.



D.



Question #: 22

The pH range over which an indicator is expected to change color during an acid-base titration is given by the equation _____.

A. $pH = pK_a \pm 10$
B. $pH = pK_a \pm 1$
C. $pH = pK_a \pm 0.1$
D. $pH = K_a \pm 10$

Question #: 23

For which pair of compounds can you **directly** compare K_{sp} values as a measure of relative solubility?

A. $Al(OH)_3$ and $CdCO_3$
B. MgF_2 and Ag_2CrO_4
C. BaC_2O_4 and $Mn(OH)_2$
D. $Pb_3(PO_4)_2$ and $La(IO_3)_3$

Question #: 24

The molar solubility of lead(II) sulfate in pure water is __1__ M.
$K_{sp}(PbSO_4) = 1.8 \times 10^{-8}$
Report your answer with **two** significant figures, using the format 2.2E2 or 2.2E-2 if you use scientific notation.

1. _____

Question #: 25

What is the molar solubility of AgBr in a 0.030 M $AgNO_3$ solution?
The K_{sp} of AgBr is 5.0×10^{-13}.

A. 1.7×10^{-11} M
B. 7.1×10^{-7} M
C. 5.0×10^{-13} M
D. 4.1×10^{-6} M

Question #: 26

Fill in each blank with the symbol <, = or >to describe the solubility of the salt in pure water compared to its solubility in an acidic aqueous solution.
The solubility of $PbCl_2$ in water __1__ the solubility of $PbCl_2$ in an acidic solution.
The solubility of BaF_2 in water __2__ the solubility of BaF_2 in an acidic solution.
The solubility of $Ca(OH)_2$ in water __3__ the solubility of $Ca(OH)_2$ in an acidic solution.

1. _____ 2. _____ 3. _____

Question #: 27

A solution contains 0.00250 M $CaCl_2(aq)$ and 0.00250 M $Fe(NO_3)_2(aq)$. $KOH(s)$ is added to precipitate out both $Ca(OH)_2(s)$ and $Fe(OH)_2(s)$. Determine which compound precipitates first and the minimum $[OH^-]$ needed for this compound to be precipitated.
$K_{sp}[Ca(OH)_2] = 4.68 \times 10^{-6}$
$K_{sp}[Fe(OH)_2] = 4.87 \times 10^{-17}$

A. $Ca(OH)_2$ precipitates first; $[OH^-] = 4.33 \times 10^{-2}$ M
B. $Fe(OH)_2$ precipitates first; $[OH^-] = 4.33 \times 10^{-2}$ M
C. $Ca(OH)_2$ precipitates first; $[OH^-] = 1.40 \times 10^{-7}$ M
D. $Fe(OH)_2$ precipitates first; $[OH^-] = 1.40 \times 10^{-7}$ M

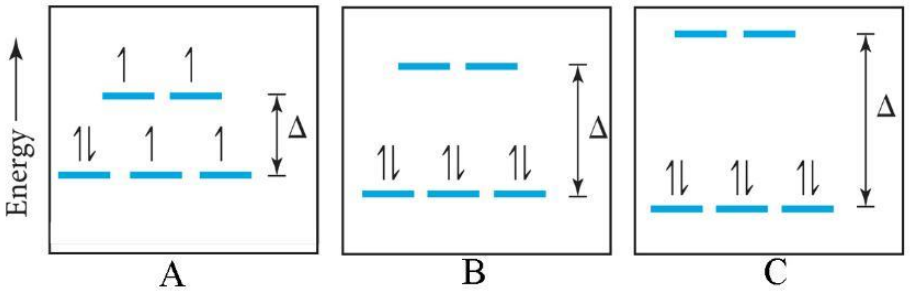
Question #: 28

For the coordination compound $[Fe(H_2O)_4(NH_3)(OH)]Cl$,
the coordination number of Fe is __1__ and the oxidation state of Fe is __2__.
Include a + or –sign in your answer to **2**.

1. _____ 2. _____

Question #: 29

Three ligands from the spectrochemical series can be ordered from strong-field to weak-field in the order CN^- >NH_3 > F^-. Crystal-field diagrams of three octahedral cobalt(III) complex ions formed with these ligands are shown.



$[CoF_6]^{3-}$ matches diagram __1__.
$[Co(CN)_6]^{3-}$matches diagram __2__.
$[Co(NH_3)_6]^{3+}$ 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 0.015 M $Fe(NO_3)_3$ and 0.100 M NaCN. What concentration of $Fe^{3+}(aq)$ remains when iron(III) and cyanide ions react to form the hexacyanoferrate(III) complex according to this equilibrium equation?

$Fe^{3+}(aq) + 6\ CN^-(aq) \rightleftharpoons [Fe(CN)_6]^{3-}(aq) \quad K_f = 2.0 \times 10^{43}$

A. 9.0×10^{-27} M
B. 6.2×10^{-44} M
C. 2.3×10^{-10} M
D. 7.5×10^{-34} M

107 2016 Spring Exam 3

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For a solution with pH = 4.26, $[H_3O^+]$ = __1__ M.
Report your answer with **two** significant digits, in the form 2.2E2 or 2.2E-2 if you use scientific notation.

1. 5.5x10-5|5.5e-5|5.5 x 10-5|5.5 e -5|5.5E-5|5.5 E-5|5.5 E -5|

Question #: 3
A 0.35 M solution of benzoic acid ($HC_7H_5O_2$, a weak acid), has a pH of 2.32.
The percent ionization of 0.35 M benzoic acid = __1__ %.
Report your answer with **two** significant figures.

1. 1.4|1.4%|1.4 %|

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Which of the following solutions has the same pH as a solution containing 0.010 M HNO_3 and 0.020 M HClO ($K_a = 2.9 \times 10^{-8}$).

✓A. 0.010 M HCl
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✓B. $0.0010 - \left[\frac{-6.8\times10^{-4} \pm \sqrt{(6.8\times10^{-4})^2 + 4(6.8\times10^{-7})}}{2}\right]$

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Given that the K_a of propanoic acid ($HC_3H_5O_2$) is 1.3 ×10⁻⁵, the pK_b of the propanoate ion ($C_3H_5O_2^-$) is __1__.

Report your answer with **three** digits.

1. 9.11|9.12|9.10|

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Which is the most **basic** solution?

A. pOH = 8.0
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Which is the **weakest** of these oxyacids?

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Select **all** of the Lewis **acids**.

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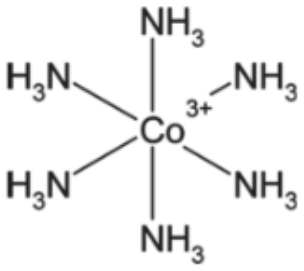
Choose the statements that describe Lewis acid-base behavior in the hexaamminecobalt(III) ion.



A. Cobalt(III) is the Lewis acid and donates electrons.
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The addition of a few drops of HCl will __2__ [**slightly**, **greatly**] __3__ [**increase**, **decrease**] the pH.

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Which conjugate acid-base pair is the most appropriate for preparing a buffer with pH = 8.70?

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pK_a($HC_2H_3O_2$) = 4.74

✓B. 0.100 M HCN,
0.100 M NaCN,
pK_a(HCN) = 9.31

C. 0.100 M $C_5H_5NH^+$,
0.100 M C_5H_5N,
pK_a($C_5H_5NH^+$) = 5.23

D. 0.100 M HClO,
0.100 M KClO,
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The pH vs. volume curve below shows the titration of a 0.10 M solution of a __1__ [**strong base**, **strong acid**, **weak base**, **weak acid**] (in the flask) with a 0.10 M solution of a __2__ [**strong base**, **strong acid**, **weak base**, **weak acid**] (titrant, in the buret).

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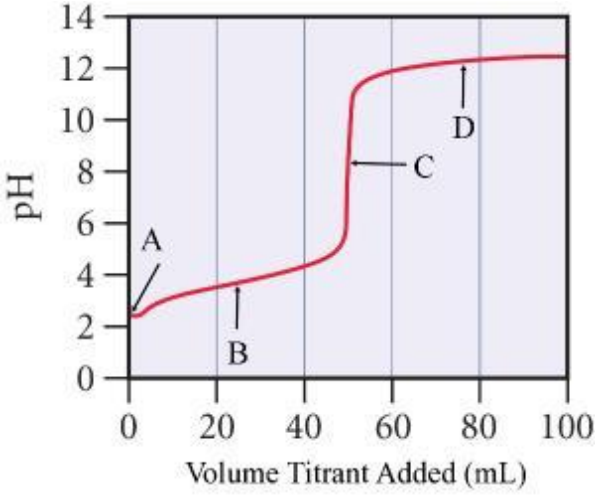
Point __4__ [**A**, **B**, **C**, **D**] is the equivalence point of the titration.



1. weak acid|week acid|WA|W A| 2. strong base 3. B 4. C

Question #: 19

Calculate the pH when 15.0 mL of 0.20 M benzoic acid ($HC_7H_5O_2$, $K_a = 6.5 \times 10^{-5}$) is titrated with 20.0 mL of 0.15 M sodium hydroxide (NaOH).

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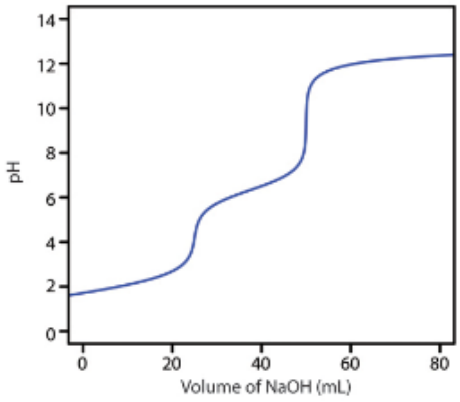
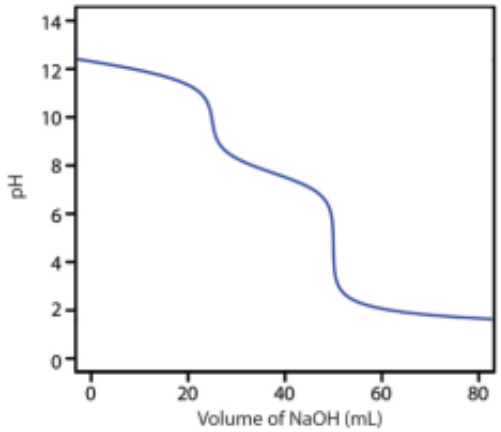
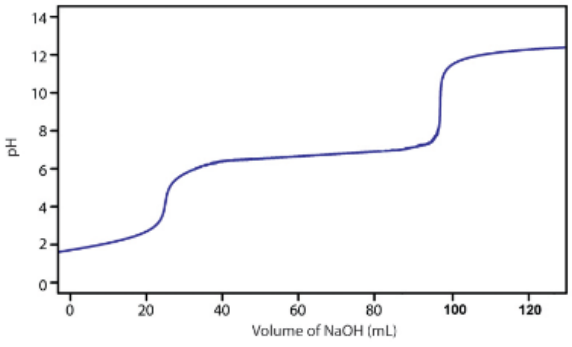
✓A.



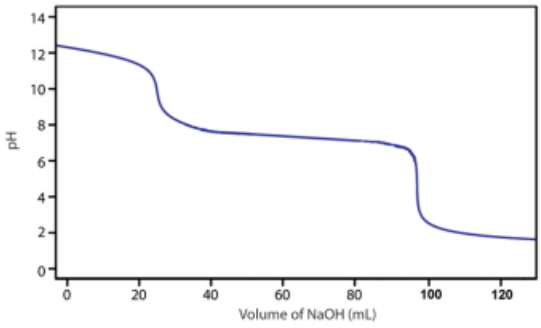
C.



B.



D.



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The pH range over which an indicator is expected to change color during an acid-base titration is given by the equation _____.

A. $pH = pK_a \pm 10$
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Question #: 23

For which pair of compounds can you **directly** compare K_{sp} values as a measure of relative solubility?

A. $Al(OH)_3$ and $CdCO_3$
✓B. MgF_2 and Ag_2CrO_4
C. BaC_2O_4 and $Mn(OH)_2$
D. $Pb_3(PO_4)_2$ and $La(IO_3)_3$

Question #: 24

The molar solubility of lead(II) sulfate in pure water is __1__ M.
$K_{sp}(PbSO_4) = 1.8 \times 10^{-8}$
Report your answer with **two** significant figures, using the format 2.2E2 or 2.2E-2 if you use scientific notation.

1. 1.3E-4|1.3 E-4|1.35E-4|1.34E-4|1.33E-4|1.35 E-4|1.34 E-4|1.33 E-4|1.35 E-4|1.34 E-4|1.33 E-4|

Question #: 25

What is the molar solubility of AgBr in a 0.030 M $AgNO_3$ solution?
The K_{sp} of AgBr is 5.0×10^{-13}.

✓A. 1.7×10^{-11} M
B. 7.1×10^{-7} M
C. 5.0×10^{-13} M
D. 4.1×10^{-6} M

Question #: 26

Fill in each blank with the symbol <, = or >to describe the solubility of the salt in pure water compared to its solubility in an acidic aqueous solution.
The solubility of $PbCl_2$ in water __1__ the solubility of $PbCl_2$ in an acidic solution.
The solubility of BaF_2 in water __2__ the solubility of BaF_2 in an acidic solution.
The solubility of $Ca(OH)_2$ in water __3__ the solubility of $Ca(OH)_2$ in an acidic solution.

1. = 2. < 3. <

Question #: 27

A solution contains 0.00250 M $CaCl_2(aq)$ and 0.00250 M $Fe(NO_3)_2(aq)$. KOH(*s*) is added to precipitate out both $Ca(OH)_2(s)$ and $Fe(OH)_2(s)$. Determine which compound precipitates first and the minimum $[OH^-]$ needed for this compound to be precipitated.
$K_{sp}[Ca(OH)_2] = 4.68 \times 10^{-6}$
$K_{sp}[Fe(OH)_2] = 4.87 \times 10^{-17}$

A. $Ca(OH)_2$ precipitates first; $[OH^-] = 4.33 \times 10^{-2}$ M
B. $Fe(OH)_2$ precipitates first; $[OH^-] = 4.33 \times 10^{-2}$ M
C. $Ca(OH)_2$ precipitates first; $[OH^-] = 1.40 \times 10^{-7}$ M
✓D. $Fe(OH)_2$ precipitates first; $[OH^-] = 1.40 \times 10^{-7}$ M

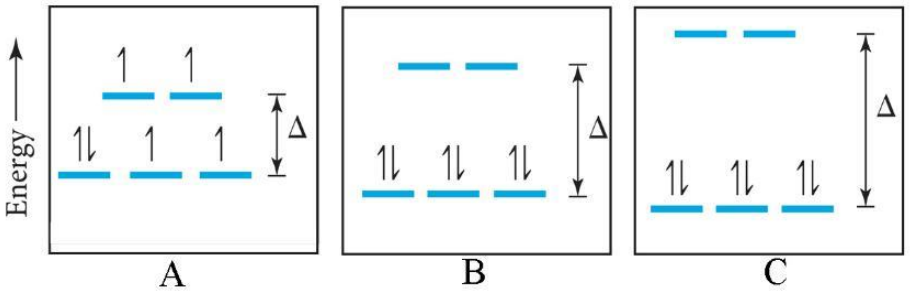
Question #: 28

For the coordination compound $[Fe(H_2O)_4(NH_3)(OH)]Cl$,
the coordination number of Fe is __1__ and the oxidation state of Fe is __2__.
Include a + or –sign in your answer to **2**.

1. 6|six| 2. +2|2+|+two|two+|+ 2|2 +|

Question #: 29

Three ligands from the spectrochemical series can be ordered from strong-field to weak-field in the order $CN^- > NH_3 > F^-$. Crystal-field diagrams of three octahedral cobalt(III) complex ions formed with these ligands are shown.



$[CoF_6]^{3-}$ matches diagram __1__.
$[Co(CN)_6]^{3-}$matches diagram __2__.
$[Co(NH_3)_6]^{3+}$ matches diagram __3__.
Use the letter of a diagram (**A**, **B** or **C**) for each answer.

1. A 2. C 3. B

Question #: 30

A solution initially contains 0.015 M $Fe(NO_3)_3$ and 0.100 M NaCN. What concentration of $Fe^{3+}(aq)$ remains when iron(III) and cyanide ions react to form the hexacyanoferrate(III) complex according to this equilibrium equation?

$Fe^{3+}(aq) + 6\ CN^-(aq) \rightleftharpoons [Fe(CN)_6]^{3-}(aq) \quad K_f = 2.0 \times 10^{43}$

A. 9.0×10^{-27} M
B. 6.2×10^{-44} M
C. 2.3×10^{-10} M
✓D. 7.5×10^{-34} M