CHE 107 Spring 2017 Exam 3

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

Question #: 1

What is the pH of a 0.20 M solution of hydrocyanic acid at 25°C?
The K_a of HCN at 25°C is 4.9×10^{-10}.

A. 2.08
B. 5.00
C. 3.89
D. 8.76

Question #: 2

Calculate the percent ionization of a 0.100 M solution of $HC_2H_3O_2$ ($K_a = 1.8 \times 10^{-5}$).
percent ionization = __1__ %
Report your answer with **three** significant figures. Do **NOT** include units or a percent sign in your answer.

1. _____

Question #: 3

What are the **two** products of the ionization of the weak base, CH_3NH_2, in water?
$CH_3NH_2\ (aq) + H_2O\ (l) \Leftrightarrow$ _____ (aq) + _____ (aq)

A. $CH_3NH_3^+$
B. CH_3NH^-
C. OH^-
D. H_3O^+

Question #: 4

What is the value of the equilibrium constant for the reaction shown below? The K_a for acetic acid, $HC_2H_3O_2$, is 1.8×10^{-5}.
$C_2H_3O_2^-(aq) + H_2O(l) \Leftrightarrow HC_2H_3O_2(aq) + OH^-(aq)$

A. 1.8×10^{-5}
B. 1.8×10^{-19}
C. 5.6×10^{4}
D. 5.6×10^{-10}

Question #: 5

What is the correct ordering, from **weakest to strongest**, of the **conjugate bases** of these acids?
$HSeO_4^-$ $K_a = 2.2 \times 10^{-2}$
HIO $K_a = 2.3 \times 10^{-11}$
HClO $K_a = 2.9 \times 10^{-8}$
H_2S $K_a = 8.9 \times 10^{-8}$

A. $SeO_4^{2-} < IO^- < ClO^- < HS^-$
B. $SeO_4^{2-} < HS^- < ClO^- < IO^-$
C. $IO^- < ClO^- < HS^- < SeO_4^{2-}$
D. $HS^- < IO^- < SeO_4^{2-} < ClO^-$

Question #: 6

A 0.100 M solution of NaClO has a pH of 10.27. What is K_b for ClO^-?

A. 3.5×10^{-7}
B. 2.6×10^{-9}
C. 1.4×10^{-5}
D. 9.2×10^{-6}

Question #: 7

Rank the following binary acids from **weakest** to **strongest**.

A. $H_2Te < H_2Se < H_2S < H_2O$
B. $H_2O < H_2S < H_2Se < H_2Te$
C. $H_2S < H_2Se < H_2Te < H_2O$
D. $H_2O < H_2Te < H_2S < H_2Se$

Question #: 8

Rank the following oxyacids in order from **weakest** to **strongest:**

A. H-O-I <H-O-Br <H-O-Cl <H-O-Cl=O
B. H-O-Cl=O <H-O-Cl <H-O-Br <H-O-I
C. H-O-Cl < H-O-Cl=O <H-O-Br <H-O-I
D. H-O-I <H-O-Br <H-O-Cl=O <H-O-Cl

Question #: 9

Identify the **two** Lewis bases.

$6\ Cl^- + Pt^{4+} \longrightarrow [PtCl_6]^{4+}$

$Ag^+ + 2\ NH_3 \rightarrow [Ag(NH_3)_2]^+$

A. Pt^{4+}
B. Cl^-
C. Ag^+
D. NH_3

Question #: 10

Which **two** combinations will **not** act as a buffer?

A. 1.0 M Na_2S and 0.50 M H_2S
B. 0.50 M $C_6H_5NH_2$ and 0.30 M $C_6H_5NH_3Cl$
C. 0.010 M HF and 0.030 M NaF
D. 1.0 M NaCl and 1.5 M HCl

Question #: 11

A 100.0 mL buffer solution contains 0.500 M $HCHO_2$ ($K_a = 1.8 \times 10^{-4}$) and 0.500 M $NaCHO_2$. What is the pH of the solution after the addition of 0.0100 mol of HCl?

A. 4.89
B. 10.63
C. 3.57
D. 2.28

Question #: 12

Human blood contains a buffer system composed of 0.0012 M carbonic acid, H_2CO_3, and 0.024 M HCO_3^-.
If the K_a value for H_2CO_3 at body temperature is 7.9×10^{-7}, what is the pH of human blood?

A. 4.62
B. 7.00
C. 7.40
D. 8.43

Question #: 13

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

A. 0.50 M nitrous acid (HNO_2) and 0.50 M sodium nitrite ($NaNO_2$)
B. 0.50 M nitrous acid (HNO_2) and 0.005 M sodium nitrite ($NaNO_2$)
C. 0.05 M nitrous acid (HNO_2) and 0.05 M sodium nitrite ($NaNO_2$)
D. 2.0 M hydrochloric acid (HCl) and 2.0 M sodium hydroxide (NaOH)

Question #: 14

What is the pH of the solution formed when 40.0 mL of 0.125 M $HC_2H_3O_2$ is titrated with 16.0 mL of 0.500 M KOH? The K_a for acetic acid is 1.8×10^{-5}.
Report your answer with **two decimal places**. Do **NOT** include units in your answer.
pH = 1

1. _____

Question #: 15

What is the pH of the solution formed after 25.0 mL of 0.500 M C_5H_5N is titrated with 5.0 mL of 0.500 M HBr?
$K_b = 1.7 \times 10^{-9}$ for C_5H_5N

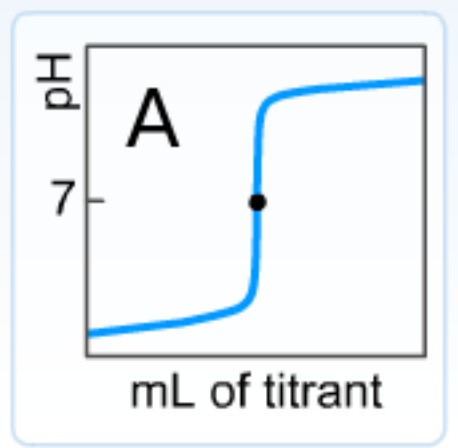
A. 5.83
B. 8.16
C. 4.63
D. 9.37

Question #: 16

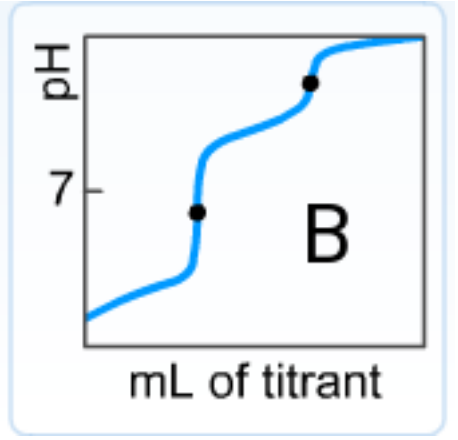
Fill in the blanks with A, B, C, **or** D to match the titration description with the appropriate titration curve.

__1__ Titration of a weak acid with a strong base.
__2__ Titration of a strong acid with a strong base.
__3__ Titration of a polyprotic acid with a strong base.
__4__ Titration of a weak base with a strong acid.

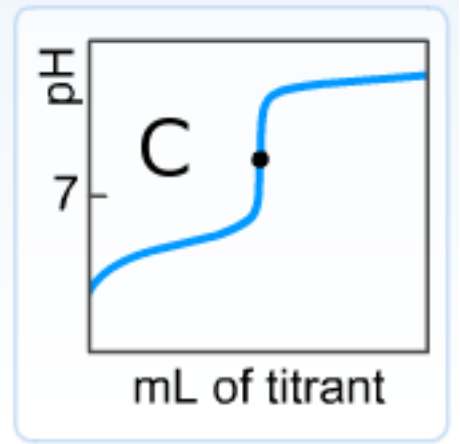
A.



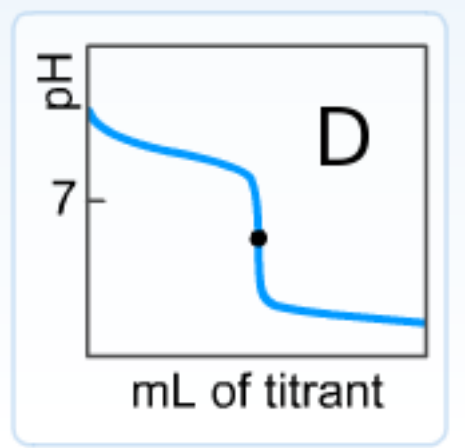
B.



C.



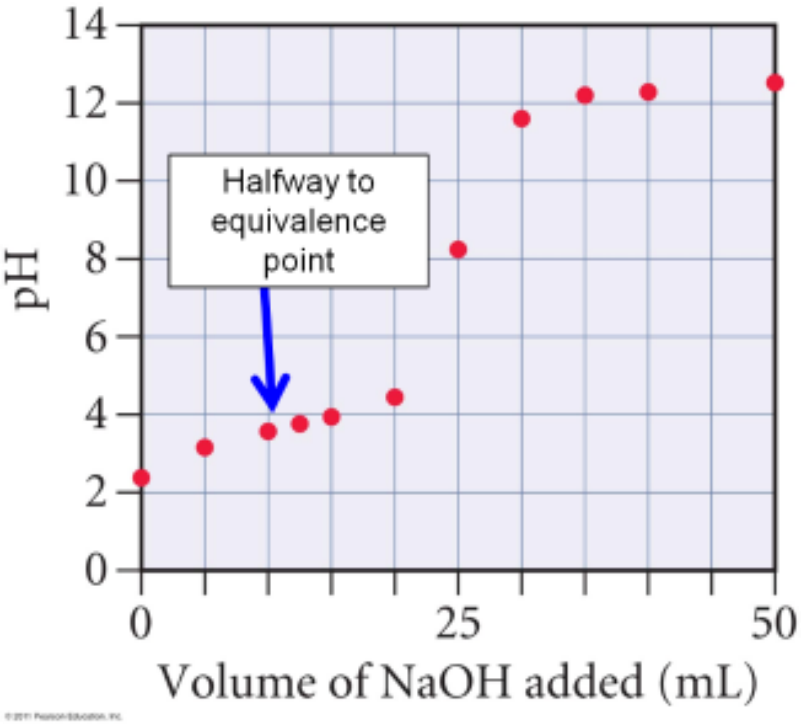
D.



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

Question #: 17

Using the diagram below, describe the significance of the pH halfway to the equivalence point for the titration of a weak acid with a strong base.



A. At halfway to the equivalence point, pH = pK_a.
B. At halfway to the equivalence point, pH = pOH.
C. At halfway to the equivalence point, pH = 7.
D. At halfway to the equivalence point, pH = K_a.

Question #: 18

Methyl red, an indicator with a pK_a of 5.0, is red in its acid form and yellow in its basic form. What color will a solution appear if the $[In^-]/[HIn]$ is 15?

A. red
B. yellow
C. orange
D. green

Question #: 19

Which equation shows the dissolution of the slightly soluble aluminum hydroxide?

A. $Al(OH)_3(s) \Leftrightarrow Al^{3+}(aq) + 3\ OH^-(aq)$
B. $Al(OH)_3(s) + H_2O(l) \rightarrow [Al(OH)_4]^-(aq) + H^+(aq)$
C. $Al^{3+}(aq) + 3\ OH^-(aq) \rightarrow Al(OH)_3(s)$
D. $Al(OH)_3(s) + 3\ H_3O^+(aq) \Leftrightarrow [Al(H_2O)_6]^{3+}(aq)$

Question #: 20

What is the correct relationship between K_{sp} and molar solubilty (S) for scandium fluoride, ScF_3?
K_{sp} =

A. $27S^4$
B. S^2
C. $3S^4$
D. $4S^3$

Question #: 21

Which compound has the **largest** molar solubility?

A. $BaSO_4$ $K_{sp} = 1.07 \times 10^{-10}$
B. CaF_2 $K_{sp} = 1.46 \times 10^{-10}$
C. $PbSO_4$ $K_{sp} = 1.82 \times 10^{-8}$
D. $Mg(OH)_2$ $K_{sp} = 2.06 \times 10^{-13}$

Question #: 22

Describe the solubility of $PbBr_2(s)$ when added to a solution of $NaBr(aq)$ compared to the solubility of $PbBr_2(s)$ in pure water. The dissociation of $PbBr_2$ is shown below.
$PbBr_2(s) \Leftrightarrow Pb^{2+}(aq) + 2\ Br^-(aq)$

A. The solubility of $PbBr_2$ is greater in the solution containing NaBr.
B. The solubility of $PbBr_2$ is lower in the solution containing NaBr.
C. The solubility of $PbBr_2$ is the same in each case.

Question #: 23

The solubility of which salt is **<u>increased</u>** by a decrease in pH?

A. MgF_2
B. AgI
C. NaCl
D. KBr

Question #: 24

A pH-neutral solution containing 0.100 M Cu^{2+} and 0.150 M Ni^{2+} is slowly titrated with a sodium hydroxide solution. Assuming minimal volume changes, which solid precipitates first and what concentration of OH^- was required? The K_{sp} for $Cu(OH)_2$ is 2.2×10^{-20} and for $Ni(OH)_2$ is 5.5×10^{-16}.

A. $Cu(OH)_2$, 4.7×10^{-10} M
B. $Cu(OH)_2$, 6.1×10^{-8} M
C. $Ni(OH)_2$, 4.7×10^{-10} M
D. $Ni(OH)_2$, 6.1×10^{-8}M

Question #: 25

Solid Na_2CO_3 is slowly added to a solution that is 0.0100 M in Pb^{2+} and 0.0100 M in Ag^{+}. What is the remaining concentration of Pb^{2+} when Ag^{+} begins to precipitate?
Ag_2CO_3 K_{sp}= 8.46×10^{-12}
$PbCO_3$ K_{sp} =7.40×10^{-14}

A. 8.75×10^{-7} M
B. 8.46×10^{-12} M
C. 7.40×10^{-14} M
D. 7.95×10^{-5} M

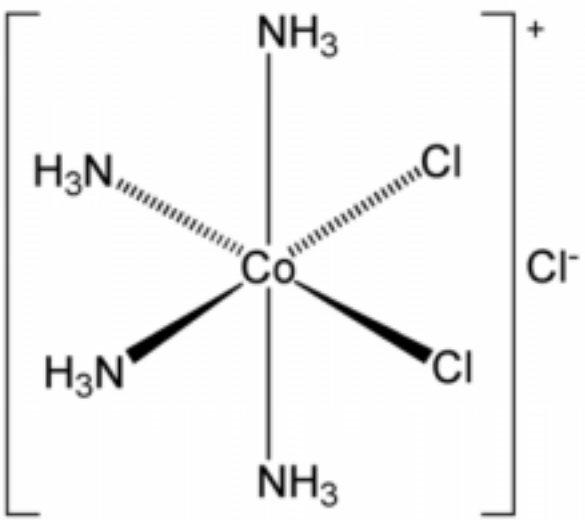
Question #: 26

Use the terms **coordination compound**, **ligand**, or **complex ion** to complete the following sentence.
Referring to the chemical formula, $K_4[Fe(CN)_6]$,
CN^- is a __1__, $Fe(CN)_6^{4-}$ is a __2__, and $K_4[Fe(CN)_6]$ is a __3__.

1. _____
2. _____
3. _____

Question #: 27

Determine the charge of Co in the coordination compound below.

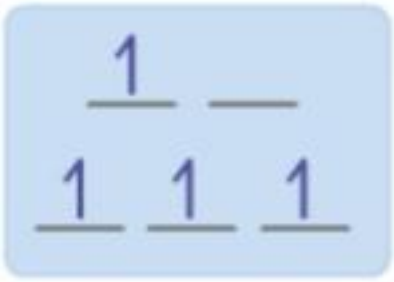


A. 0
B. +1
C. +2
D. +3

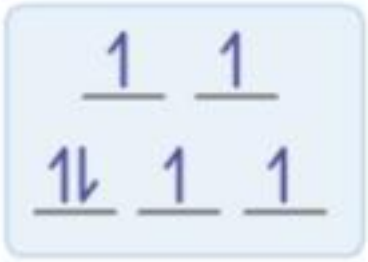
Question #: 28

Which diagram represents the *d* orbital electrons for Cr^{2+} in an octahedral high-spin (weak-field) complex?

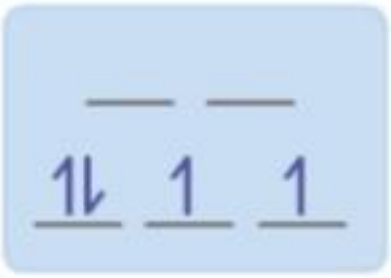
A.



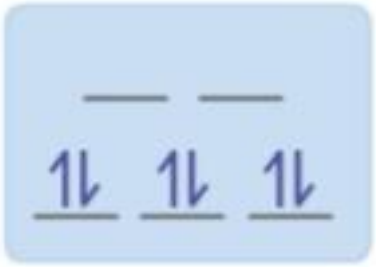
B.



C.



D.



Question #: 29

A solution initially contains 0.020 M $Cr(NO_3)_3$ and 0.180 M NaOH. What concentration of $Cr^{3+}(aq)$ remains when chromium(III) and hydroxide ions react to form the complex ion according to the equilibrium below?

$Cr^{3+}(aq) + 4\ OH^-(aq) \Leftrightarrow [Cr(OH)_4]^-(aq) \quad K_f = 8.0 \times 10^{29}$

A. 6.1×10^{-30} M
B. 4.2×10^{-42} M
C. 2.5×10^{-28} M
D. 8.0×10^{-38} M

Question #: 30

What is the equilibrium constant, K, for
$AgCl(s) + 2\ NH_3(aq) \Leftrightarrow Ag(NH_3)_2^+(aq) + Cl^-(aq)$
given $K_{sp} = 1.8 \times 10^{-10}$ for AgCl
$K_f = 1.7 \times 10^7$ for $Ag(NH_3)_2^+$
$K =$ 1

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

1. _____

DRAFT

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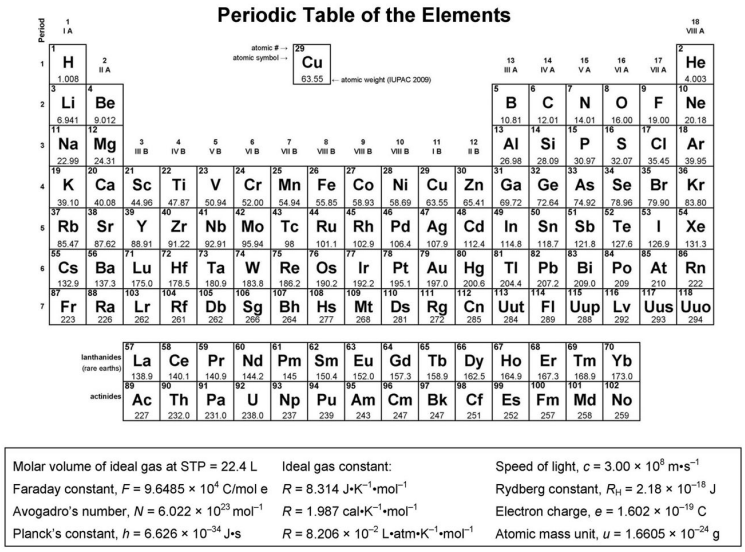

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Question #: 1

What is the pH of a 0.20 M solution of hydrocyanic acid at 25°C?
The K_a of HCN at 25°C is 4.9×10^{-10}.

A. 2.08
✓B. 5.00
C. 3.89
D. 8.76

Question #: 2

Calculate the percent ionization of a 0.100 M solution of $HC_2H_3O_2$ ($K_a = 1.8 \times 10^{-5}$).
percent ionization = 1 %

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

1. 1.34

Question #: 3

What are the **two** products of the ionization of the weak base, CH_3NH_2, in water?

$CH_3NH_2\,(aq) + H_2O\,(l) \Leftrightarrow$ _____ (aq) + _____ (aq)

✓A. $CH_3NH_3^+$
B. CH_3NH^-
✓C. OH^-
D. H_3O^+

Question #: 4

What is the value of the equilibrium constant for the reaction shown below? The K_a for acetic acid, $HC_2H_3O_2$, is 1.8×10^{-5}.

$C_2H_3O_2^-(aq) + H_2O(l) \Leftrightarrow HC_2H_3O_2(aq) + OH^-(aq)$

A. 1.8×10^{-5}
B. 1.8×10^{-19}
C. 5.6×10^{4}
✓D. 5.6×10^{-10}

Question #: 5

What is the correct ordering, from **weakest to strongest**, of the **conjugate bases** of these acids?

$HSeO_4^-$ $K_a = 2.2 \times 10^{-2}$
HIO $K_a = 2.3 \times 10^{-11}$
HClO $K_a = 2.9 \times 10^{-8}$

H_2S $K_a = 8.9 \times 10^{-8}$

A. $SeO_4^{2-} < IO^- < ClO^- < HS^-$
✓B. $SeO_4^{2-} < HS^- < ClO^- < IO^-$
C. $IO^- < ClO^- < HS^- < SeO_4^{2-}$
D. $HS^- < IO^- < SeO_4^{2-} < ClO^-$

Question #: 6

A 0.100 M solution of NaClO has a pH of 10.27. What is K_b for ClO^-?

✓A. 3.5×10^{-7}
B. 2.6×10^{-9}
C. 1.4×10^{-5}
D. 9.2×10^{-6}

Question #: 7

Rank the following binary acids from **weakest** to **strongest**.

A. $H_2Te < H_2Se < H_2S < H_2O$
✓B. $H_2O < H_2S < H_2Se < H_2Te$
C. $H_2S < H_2Se < H_2Te < H_2O$
D. $H_2O < H_2Te < H_2S < H_2Se$

Question #: 8

Rank the following oxyacids in order from **weakest** to **strongest:**

✓A. H-O-I < H-O-Br < H-O-Cl < H-O-Cl=O
B. H-O-Cl=O < H-O-Cl < H-O-Br < H-O-I
C. H-O-Cl < H-O-Cl=O < H-O-Br < H-O-I
D. H-O-I < H-O-Br < H-O-Cl=O < H-O-Cl

Question #: 9

Identify the **two** Lewis bases.

$6\ Cl^- + Pt^{4+} \rightarrow [PtCl_6]^{4+}$

$Ag^+ + 2\ NH_3 \rightarrow [Ag(NH_3)_2]^+$

A. Pt^{4+}
✓B. Cl^-
C. Ag^+
✓D. NH_3

Question #: 10

Which **two** combinations will **not** act as a buffer?

✓A. 1.0 M Na_2S and 0.50 M H_2S
B. 0.50 M $C_6H_5NH_2$ and 0.30 M $C_6H_5NH_3Cl$
C. 0.010 M HF and 0.030 M NaF
✓D. 1.0 M NaCl and 1.5 M HCl

Question #: 11

A 100.0 mL buffer solution contains 0.500 M $HCHO_2$ ($K_a = 1.8 \times 10^{-4}$) and 0.500 M $NaCHO_2$. What is the pH of the solution after the addition of 0.0100 mol of HCl?

A. 4.89
B. 10.63
✓C. 3.57
D. 2.28

Question #: 12

Human blood contains a buffer system composed of 0.0012 M carbonic acid, H_2CO_3, and 0.024 M HCO_3^-.
If the K_a value for H_2CO_3 at body temperature is 7.9×10^{-7}, what is the pH of human blood?

A. 4.62
B. 7.00
✓C. 7.40
D. 8.43

Question #: 13

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

✓A. 0.50 M nitrous acid (HNO_2) and 0.50 M sodium nitrite ($NaNO_2$)
B. 0.50 M nitrous acid (HNO_2) and 0.005 M sodium nitrite ($NaNO_2$)
C. 0.05 M nitrous acid (HNO_2) and 0.05 M sodium nitrite ($NaNO_2$)
D. 2.0 M hydrochloric acid (HCl) and 2.0 M sodium hydroxide (NaOH)

Question #: 14

What is the pH of the solution formed when 40.0 mL of 0.125 M $HC_2H_3O_2$ is titrated with 16.0 mL of 0.500 M KOH? The K_a for acetic acid is 1.8×10^{-5}.
Report your answer with **two decimal places**. Do **NOT** include units in your answer.
pH = 1

1. 12.73

Question #: 15

What is the pH of the solution formed after 25.0 mL of 0.500 M C_5H_5N is titrated with 5.0 mL of 0.500 M HBr?
$K_b = 1.7 \times 10^{-9}$ for C_5H_5N

✓A. 5.83
B. 8.16
C. 4.63
D. 9.37

Question #: 16

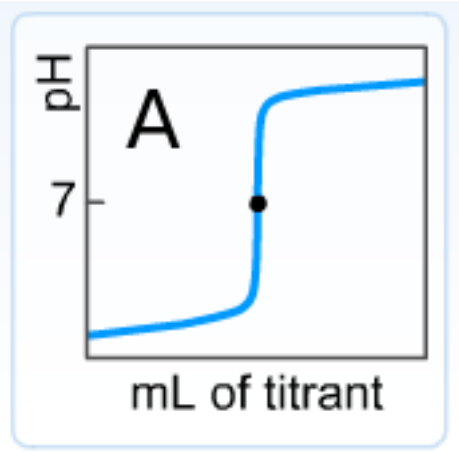
Fill in the blanks with A, B, C, **or** D to match the titration description with the appropriate titration curve.

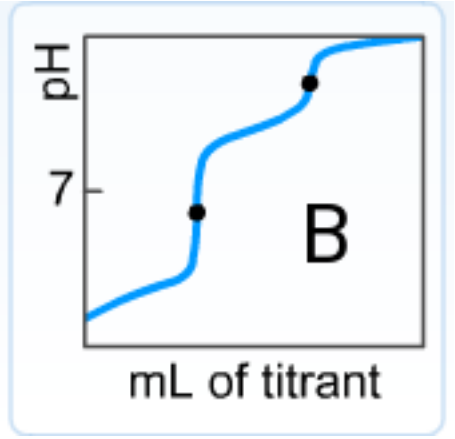
__1__ Titration of a weak acid with a strong base.

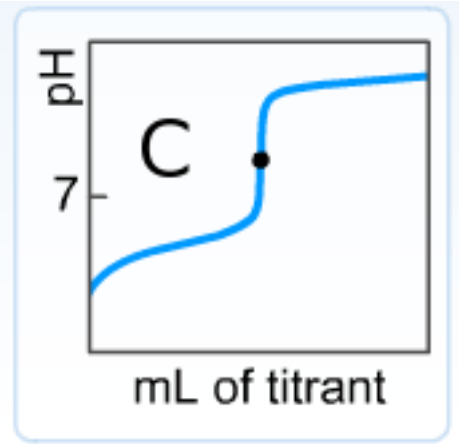
__2__ Titration of a strong acid with a strong base.

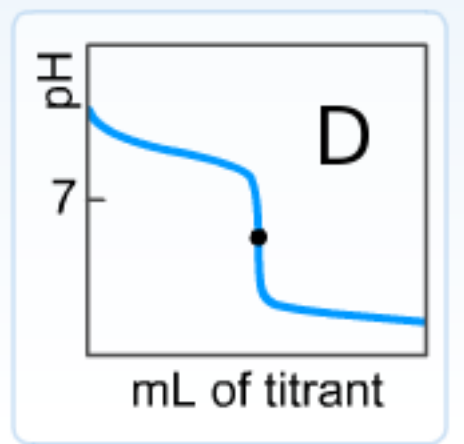
__3__ Titration of a polyprotic acid with a strong base.

__4__ Titration of a weak base with a strong acid.





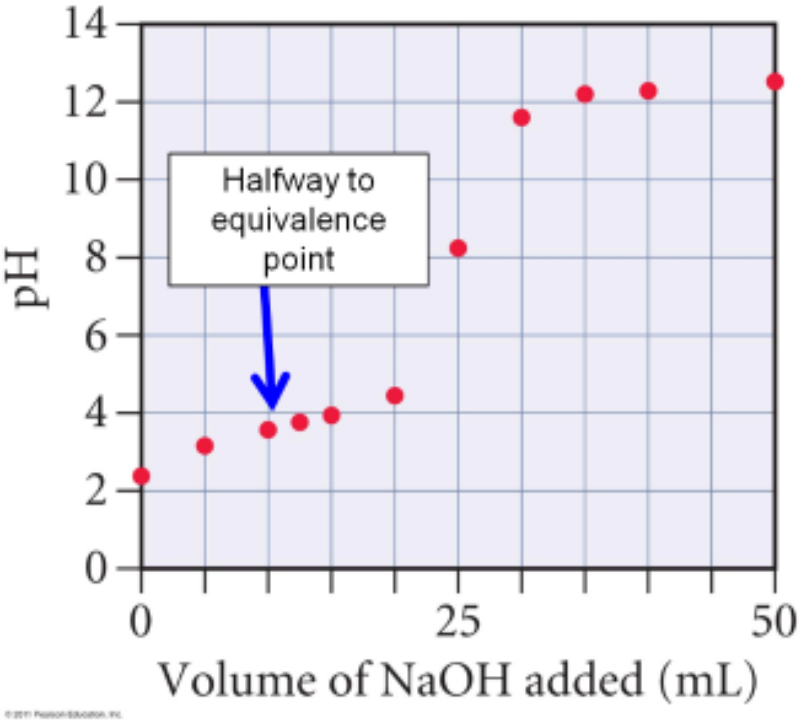




1. C
2. A
3. B
4. D

Question #: 17

Using the diagram below, describe the significance of the pH halfway to the equivalence point for the titration of a weak acid with a strong base.



✓A. At halfway to the equivalence point, pH = pK_a.
B. At halfway to the equivalence point, pH = pOH.
C. At halfway to the equivalence point, pH = 7.
D. At halfway to the equivalence point, pH = K_a.

Question #: 18

Methyl red, an indicator with a pK_a of 5.0, is red in its acid form and yellow in its basic form. What color will a solution appear if the [In^-]/[HIn] is 15?

A. red
✓B. yellow
C. orange
D. green

Question #: 19

Which equation shows the dissolution of the slightly soluble aluminum hydroxide?

✓A. $Al(OH)_3(s) \Leftrightarrow Al^{3+}(aq) + 3\ OH^-(aq)$
B. $Al(OH)_3(s) + H_2O(l) \rightarrow [Al(OH)_4]^-(aq) + H^+(aq)$
C. $Al^{3+}(aq) + 3\ OH^-(aq) \rightarrow Al(OH)_3(s)$
D. $Al(OH)_3(s) + 3\ H_3O^+(aq) \Leftrightarrow [Al(H_2O)_6]^{3+}(aq)$

Question #: 20

What is the correct relationship between K_{sp} and molar solubilty (S) for scandium fluoride, ScF_3 ?

K_{sp} =

✓A. $27S^4$
B. S^2
C. $3S^4$
D. $4S^3$

Question #: 21

Which compound has the **largest** molar solubility?

A. $BaSO_4$ $K_{sp} = 1.07 \times 10^{-10}$
✓B. CaF_2 $K_{sp} = 1.46 \times 10^{-10}$
C. $PbSO_4$ $K_{sp} = 1.82 \times 10^{-8}$
D. $Mg(OH)_2$ $K_{sp} = 2.06 \times 10^{-13}$

Question #: 22

Describe the solubility of $PbBr_2(s)$ when added to a solution of $NaBr(aq)$ compared to the solubility of $PbBr_2(s)$ in pure water. The dissociation of $PbBr_2$ is shown below.
$PbBr_2(s) \Leftrightarrow Pb^{2+}(aq) + 2\ Br^-(aq)$

A. The solubility of $PbBr_2$ is greater in the solution containing NaBr.
✓B. The solubility of $PbBr_2$ is lower in the solution containing NaBr.
C. The solubility of $PbBr_2$ is the same in each case.

Question #: 23

The solubility of which salt is **increased** by a decrease in pH?

✓A. MgF_2
B. AgI
C. NaCl
D. KBr

Question #: 24

A pH-neutral solution containing 0.100 M Cu^{2+} and 0.150 M Ni^{2+} is slowly titrated with a sodium hydroxide solution. Assuming minimal volume changes, which solid precipitates first and what concentration of OH^- was required? The K_{sp} for $Cu(OH)_2$ is 2.2×10^{-20} and for $Ni(OH)_2$ is 5.5×10^{-16}.

✓A. $Cu(OH)_2$, 4.7×10^{-10} M
B. $Cu(OH)_2$, 6.1×10^{-8} M
C. $Ni(OH)_2$, 4.7×10^{-10} M
D. $Ni(OH)_2$, 6.1×10^{-8}M

Question #: 25

Solid Na_2CO_3 is slowly added to a solution that is 0.0100 M in Pb^{2+} and 0.0100 M in Ag^+. What is the remaining concentration of Pb^{2+} when Ag^+ begins to precipitate?
Ag_2CO_3 $K_{sp} = 8.46 \times 10^{-12}$
$PbCO_3$ $K_{sp} = 7.40 \times 10^{-14}$

✓A. 8.75×10^{-7} M
B. 8.46×10^{-12} M
C. 7.40×10^{-14} M
D. 7.95×10^{-5} M

Question #: 26

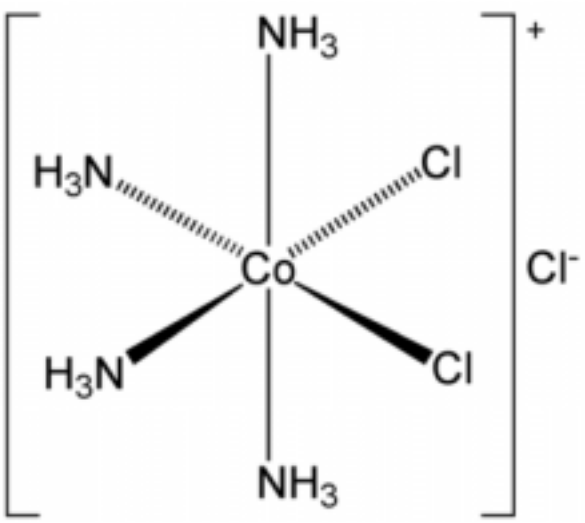
Use the terms **coordination compound**, **ligand**, or **complex ion** to complete the following sentence.

Referring to the chemical formula, $K_4[Fe(CN)_6]$,
CN^- is a __1__, $Fe(CN)_6^{4-}$ is a __2__, and $K_4[Fe(CN)_6]$ is a __3__.

1. ligand
2. complex ion
3. coordination compound

Question #: 27

Determine the charge of Co in the coordination compound below.

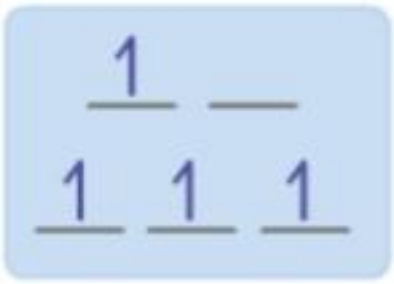


A. 0
B. +1
C. +2
✓D. +3

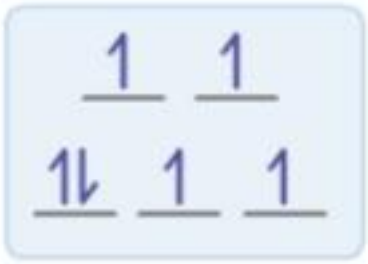
Question #: 28

Which diagram represents the *d* orbital electrons for Cr^{2+} in an octahedral high-spin (weak-field) complex?

✓A.



B.



C.

D.

Question #: 29

A solution initially contains 0.020 M $Cr(NO_3)_3$ and 0.180 M NaOH. What concentration of $Cr^{3+}(aq)$ remains when chromium(III) and hydroxide ions react to form the complex ion according to the equilibrium below?

$Cr^{3+}(aq) + 4\ OH^-(aq) \Leftrightarrow [Cr(OH)_4]^-(aq) \quad K_f = 8.0 \times 10^{29}$

A. 6.1×10^{-30} M
B. 4.2×10^{-42} M
✓C. 2.5×10^{-28} M
D. 8.0×10^{-38} M

Question #: 30

What is the equilibrium constant, K, for

$AgCl(s) + 2\ NH_3(aq) \Leftrightarrow Ag(NH_3)_2^+(aq) + Cl^-(aq)$

given $K_{sp} = 1.8 \times 10^{-10}$ for AgCl

$K_f = 1.7 \times 10^7$ for $Ag(NH_3)_2^+$

$K = \frac{}{1}$

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

1. 3.1E-3|3.1e-3|3.1E-03|3.1e-03|0.0031|.0031|