# CHE107 Summer 2016 EX3

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

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**Question #:** 1

A cup of orange juice has $[H_3O^+] = 2.1 \times 10^{-4}$ M. What is the pH of the orange juice?
pH = __1__
Report your answer to **two** decimal places.

1. _____

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**Question #:** 2

The pH of freshly-squeezed lemon juice is 1.89. What is the concentration of $H_3O^+$ in the juice?

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

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**Question #:** 3

What is the **pH** of a 0.300 M solution hydrofluoric acid solution with a percent ionization of 3.42%?

A. 0.300
B. 1.989
C. 3.138
D. 4.086

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**Question #:** 4

What is the **pH** of a solution that is 0.100 M in HClO ($K_a = 2.9 \times 10^{-8}$) and 0.100 M in HCl? Report your answer to **two** decimal places.
**pH** = __1__

1. _____

---

**Question #:** 5

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

A. 0.150 M benzoic acid ($HC_7H_5O_2$) solution; $K_a(HC_7H_5O_2) = 6.5 \times 10^{-5}$
B. 0.120 M pyruvic acid ($HC_3H_3O_3$) solution; $K_a(HC_3H_3O_3) = 4.1 \times 10^{-3}$
C. 0.110 M nitrous acid ($HNO_2$) solution; $K_a(HNO_2) = 1.8 \times 10^{-4}$
D. 0.050 M hydrocyanic acid (HCN) solution; $K_a(HCN) = 4.9 \times 10^{-10}$

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**Question #:** 6

Given that the $K_a$ of nitrous acid ($HNO_2$) at 25°C is $4.0 \times 10^{-4}$, the **p$K_b$** of the nitrite ion ($NO_2^-$) is __1__. Report your answer to **two** decimal places.

1. _____

---

**Question #:** 7

In a mixture of three bases (KOH, $CH_3NH_2$, and $NH_3$) of equal concentration, which choice below list(s) the reaction(s) that **must** be considered in calculating the pH? Choose the **single** best answer.

A.

$$KOH \rightarrow K^+ + OH^-$$

B.

$$CH_3NH_2 + H_2O \rightleftharpoons CH_3NH_3^+ + OH^- \quad K_b = 4.4 \times 10^{-4}$$

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^- \quad K_b = 1.8 \times 10^{-5}$$

C.

$$KOH \rightarrow K^+ + OH^-$$

$$CH_3NH_2 + H_2O \rightleftharpoons CH_3NH_3^+ + OH^- \quad K_b = 4.4 \times 10^{-4}$$

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^- \quad K_b = 1.8 \times 10^{-5}$$

D.

$$KOH \rightarrow K^+ + OH^-$$

$$CH_3NH_2 + H_2O \rightleftharpoons CH_3NH_3^+ + OH^- \quad K_b = 4.4 \times 10^{-4}$$

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^- \quad K_b = 1.8 \times 10^{-5}$$

$$2\,H_2O \rightleftharpoons H_3O^+ + OH^- \quad K_w = 1.0 \times 10^{-14}$$

**Question #:** 8

Which is the **least basic** solution?

A. pH = 10
B. pH = 13
C. pOH = 2
D. pOH = 5

---

**Question #:** 9

Select the **two** salts that have a pH <7 when dissolved in water.

A. $Ca(C_2H_3O_2)_2$
B. $CH_3NH_3Br$
C. $CrCl_4$
D. $LiClO_4$
E. $NaNO_2$
F. KI

---

**Question #:** 10

For which **two** 0.010 M polyprotic acid solutions **must** you consider more than just $K_{a1}$ to accurately calculate the pH?

A.

$H_2SO_4 + H_2O \rightarrow HSO_4^- + H_3O^+ \quad K_{a1} = \text{strong}$

$HSO_4^- + H_2O \rightleftharpoons SO_4^{2-} + H_3O^+ \quad K_{a2} = 1.2 \times 10^{-2}$

B.

$H_2C_2O_4 + H_2O \rightleftharpoons HC_2O_4^- + H_3O^+ \quad K_{a1} = 6.0 \times 10^{-2}$

$HC_2O_4^- + H_2O \rightleftharpoons C_2O_4^{2-} + H_3O^+ \quad K_{a2} = 6.1 \times 10^{-5}$

C.

$H_2C_6H_6O_6 + H_2O \rightleftharpoons HC_6H_6O_6^- + H_3O^+ \quad K_{a1} = 8.0 \times 10^{-5}$

$HC_6H_6O_6^- + H_2O \rightleftharpoons C_6H_6O_6^- + H_3O^+ \quad K_{a2} = 1.6 \times 10^{-12}$

D.

$H_3C_6H_5O_7 + H_2O \rightleftharpoons H_2C_6H_5O_7^- + H_3O^+ \quad K_{a1} = 7.4 \times 10^{-4}$

$H_2C_6H_5O_7^- + H_2O \rightleftharpoons HC_6H_5O_7^{2-} + H_3O^+ \quad K_{a2} = 1.7 \times 10^{-5}$

$HC_6H_5O_7^{2-} + H_2O \rightleftharpoons C_6H_5O_7^{3-} + H_3O^+ \quad K_{a3} = 4.0 \times 10^{-7}$

E.

$H_3PO_4 + H_2O \rightleftharpoons H_2PO_4^- + H_3O^+ \quad K_{a1} = 7.5 \times 10^{-3}$

$H_2PO_4^- + H_2O \rightleftharpoons HPO_4^{2-} + H_3O^+ \quad K_{a2} = 6.2 \times 10^{-8}$

$HPO_4^{2-} + H_2O \rightleftharpoons PO_4^{3-} + H_3O^+ \quad K_{a3} = 4.2 \times 10^{-13}$

---

**Question #:** 11

Which is the **strongest** acid?

A. $H_3PO_4$
B. $H_3PO_3$
C. $H_3AsO_4$
D. $H_3AsO_3$

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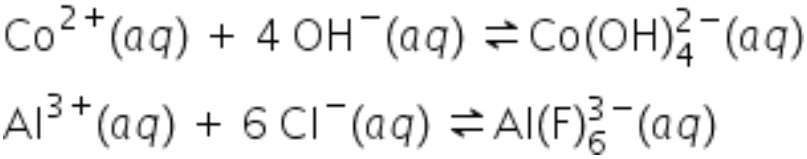
**Question #:** 12

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



A. $Co^{2+}$
B. $OH^-$
C. $Al^{3+}$
D. $Cl^-$

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**Question #:** 13

What is the pH of a 1.0 L buffer solution that is 0.300 M $CH_3COOH$ ($pK_a$ = 4.76) and 0.300 M $CH_3COONa$ after the addition of 0.050 mol of NaOH?
Ignore any volume change from the addition of NaOH. Report pH to **two** decimal places.
pH = 1

1. _____

---

**Question #:** 14

Which of the following solutions results in a **buffer**?

A. 10.0 mL of 0.100 M NaOH + 5.0 mL of 0.100 M HCl
B. 10.0 mL of 0.100 M NaOH + 20.0 mL of 0.100 M $HCHO_2$
C. 20.0 mL of 0.100 M NaOH + 10.0 mL of 0.200 M $HClO_2$
D. 10.0 mL of 0.100 M $NH_3$ + 10.0 mL of 0.100 M HCl

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**Question #:** 15

Calculate the base-to-acid ratio needed to prepare a pH 4.00 propanoic acid, potassium propanoate buffer.
$K_a$(propanoic acid) = $1.3 \times 10^{-5}$

A. 0.13
B. 0.067
C. 5.8
D. 8.7

---

**Question #:** 16

Which choice should be the **most effective** buffer against added acid or base?

A. 0.010 M nitrous acid and 0.010 M sodium nitrite
B. 0.100 M formic acid and 0.010 M sodium formate
C. 0.100 M hypochlorous acid and 0.100 M sodium hypochlorite
D. 0.010 M benzoic acid and 0.100 M sodium benzoate

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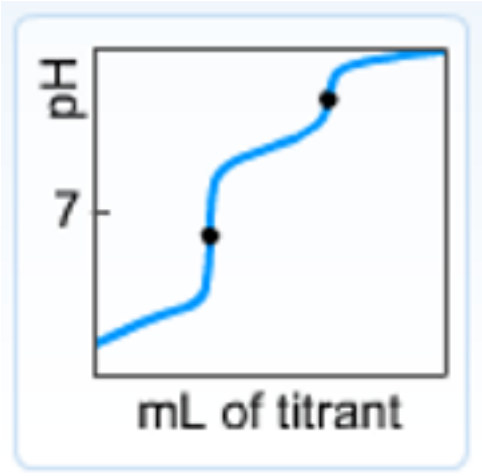
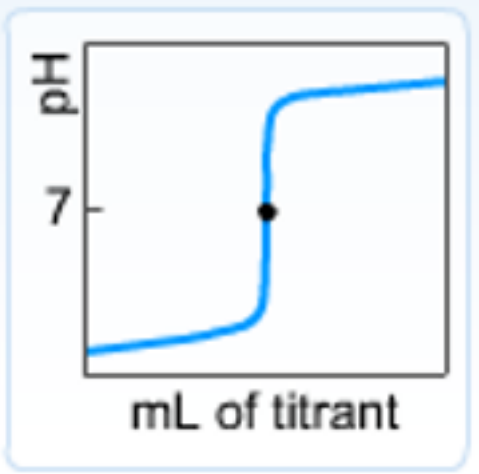
**Question #:** 17

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

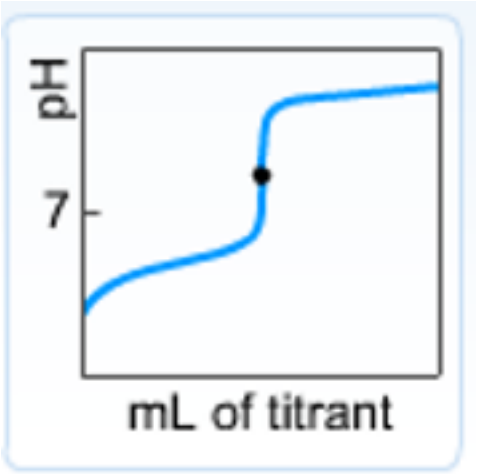
A.



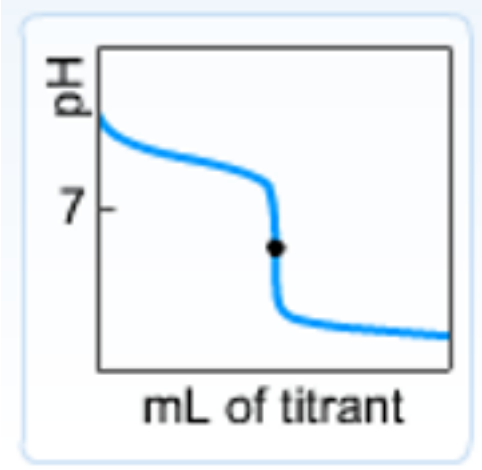
B.




C.




D.



**Question #:** 18

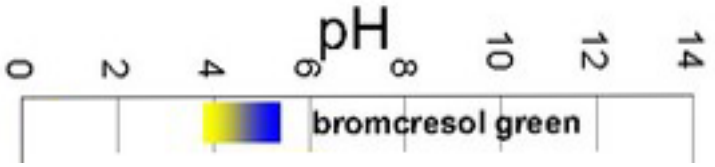
What is the pH after 5.0 mL of 0.500 M LiOH is added to 100.0 mL of 0.200 M hydrofluoric acid (HF, p$K_a$ = 3.46)?

A. 2.61
B. 3.23
C. 2.07
D. 4.58

---

**Question #:** 19

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




A. hydrazoic acid, p$K$a = 4.60
B. nitrous acid, p$K$a = 3.34
C. boric acid, p$K$a = 9.27
D. hydroiodic acid, p$K$a <0

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**Question #:** 20

A 20.0 mL portion of 0.100 M $C_5H_5N$ ($K_b = 1.7 \times 10^{-9}$) is titrated with 0.400 M HCl. What is the pH at the equivalence point?

A. 2.21
B. 3.16
C. 7.00
D. 8.19

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**Question #:** 21

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

A. $Al(OH)_3$ and ZnS
B. $CaF_2$ and $Ag_2CrO_4$
C. $MnC_2O_4$ and $Mn(OH)_2$
D. AgCl and $BaCl_2$

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**Question #:** 22

What happens when two solutions are mixed together such that the concentration of $Ba^{2+}$ is $5.00 \times 10^{-3}$ M and the concentration of $C_2O_4^{2-}$ is $1.00 \times 10^{-3}$ M in the resulting solution?
$K_{sp}(BaC_2O_4) = 1.6 \times 10^{-6}$

A. $Q_{sp} < K_{sp}$ and the solution remains unsaturated.
B. $Q_{sp} = K_{sp}$ and the solution is saturated, resulting in the precipitation of $BaC_2O_4(s)$.
C. $Q_{sp} > K_{sp}$, resulting in precipitation of $BaC_2O_4(s)$, leaving behind an unsaturated solution.
D. $Q_{sp} > K_{sp}$, resulting in precipitation of $BaC_2O_4(s)$, leaving behind a saturated solution.

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**Question #:** 23

What is the final mercury(II) concentration in a solution that is initially 0.010 M $Hg^{2+}$ and 0.400 M $CN^-$?

$$Hg^{2+}(aq) + 4\,CN^-(aq) \rightleftharpoons Hg(CN)_4^{2-}(aq) \quad K_f = 1.8 \times 10^{41}$$

A. $1.8 \times 10^{21}$ M
B. $1.8 \times 10^{-19}$ M
C. $2.8 \times 10^{-51}$ M
D. $3.3 \times 10^{-42}$ M

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**Question #:** 24

For the coordination compound $[Fe(H_2O)_4(NH_3)(OH)]Cl_2$,
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. _____

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**Question #:** 25

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 pH 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; pH = 12.62
B. $Fe(OH)_2$ precipitates first; pH = 7.14
C. $Ca(OH)_2$ precipitates first; pH = 7.14
D. $Fe(OH)_2$ precipitates first; pH = 12.62

**DRAFT**

Do Not Use Until Posted.

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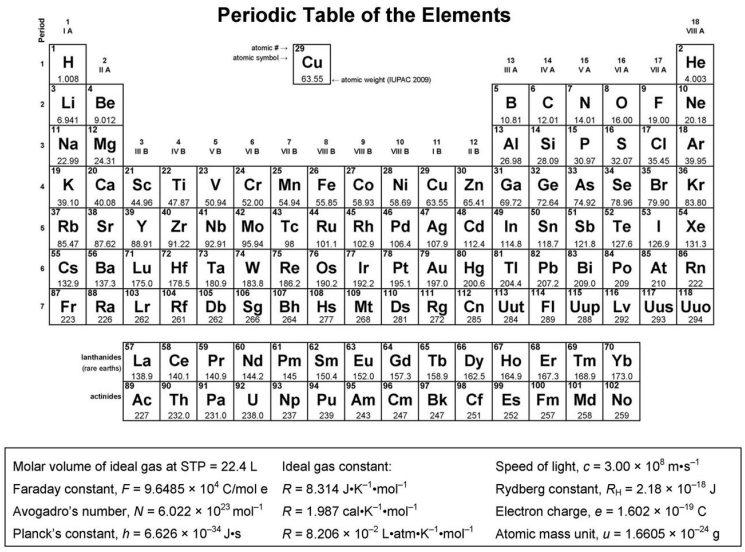
# CHE107 Summer 2016 EX3 - Confidential

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

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**Question #:** 1

A cup of orange juice has $[H_3O^+] = 2.1 \times 10^{-4}$ M. What is the pH of the orange juice?

pH = 1

Report your answer to **two** decimal places.

1. 3.68

---

**Question #:** 2

The pH of freshly-squeezed lemon juice is 1.89. What is the concentration of $H_3O^+$ in the juice?

✓A. $1.3 \times 10^{-2}$ M

B. $2.9 \times 10^{-4}$ M

C. $1.0 \times 10^{-1}$ M
D. $3.2 \times 10^{-3}$ M

---

**Question #:** 3

What is the **pH** of a 0.300 M solution hydrofluoric acid solution with a percent ionization of 3.42%?

A. 0.300
✓B. 1.989
C. 3.138
D. 4.086

---

**Question #:** 4

What is the **pH** of a solution that is 0.100 M in HClO ($K_a = 2.9 \times 10^{-8}$) and 0.100 M in HCl? Report your answer to **two** decimal places.

**pH** = 1

1. 1.00

---

**Question #:** 5

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

A. 0.150 M benzoic acid ($HC_7H_5O_2$) solution; $K_a(HC_7H_5O_2) = 6.5 \times 10^{-5}$
✓B. 0.120 M pyruvic acid ($HC_3H_3O_3$) solution; $K_a(HC_3H_3O_3) = 4.1 \times 10^{-3}$
C. 0.110 M nitrous acid ($HNO_2$) solution; $K_a(HNO_2) = 1.8 \times 10^{-4}$
D. 0.050 M hydrocyanic acid (HCN) solution; $K_a(HCN) = 4.9 \times 10^{-10}$

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**Question #:** 6

Given that the $K_a$ of nitrous acid ($HNO_2$) at 25°C is $4.0 \times 10^{-4}$, the **p$K_b$** of the nitrite ion ($NO_2^-$) is 1. Report your answer to **two** decimal places.

1. 10.60

---

**Question #:** 7

In a mixture of three bases (KOH, $CH_3NH_2$, and $NH_3$) of equal concentration, which choice below list(s) the reaction(s) that **must** be considered in calculating the pH? Choose the **single** best answer.

✓A.

$$KOH \rightarrow K^+ + OH^-$$

B.

$$CH_3NH_2 + H_2O \rightleftharpoons CH_3NH_3^+ + OH^- \quad K_b = 4.4 \times 10^{-4}$$

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^- \quad K_b = 1.8 \times 10^{-5}$$

C.

$$KOH \rightarrow K^+ + OH^-$$

$$CH_3NH_2 + H_2O \rightleftharpoons CH_3NH_3^+ + OH^- \quad K_b = 4.4 \times 10^{-4}$$

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^- \quad K_b = 1.8 \times 10^{-5}$$

D.

$$KOH \rightarrow K^+ + OH^-$$

$$CH_3NH_2 + H_2O \rightleftharpoons CH_3NH_3^+ + OH^- \quad K_b = 4.4 \times 10^{-4}$$

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^- \quad K_b = 1.8 \times 10^{-5}$$

$$2\,H_2O \rightleftharpoons H_3O^+ + OH^- \quad K_w = 1.0 \times 10^{-14}$$

---

**Question #:** 8

Which is the **least basic** solution?

A. pH = 10
B. pH = 13
C. pOH = 2
✓D. pOH = 5

---

**Question #:** 9

Select the **two** salts that have a pH <7 when dissolved in water.

A. $Ca(C_2H_3O_2)_2$
✓B. $CH_3NH_3Br$
✓C. $CrCl_4$
D. $LiClO_4$
E. $NaNO_2$
F. KI

---

**Question #:** 10

For which **two** 0.010 M polyprotic acid solutions **must** you consider more than just $K_{a1}$ to accurately calculate the pH?

✓A.

$$H_2SO_4 + H_2O \rightarrow HSO_4^- + H_3O^+ \quad K_{a1} = \text{strong}$$
$$HSO_4^- + H_2O \rightleftharpoons SO_4^{2-} + H_3O^+ \quad K_{a2} = 1.2 \times 10^{-2}$$

B.

$$H_2C_2O_4 + H_2O \rightleftharpoons HC_2O_4^- + H_3O^+ \quad K_{a1} = 6.0 \times 10^{-2}$$
$$HC_2O_4^- + H_2O \rightleftharpoons C_2O_4^{2-} + H_3O^+ \quad K_{a2} = 6.1 \times 10^{-5}$$

C.

$$H_2C_6H_6O_6 + H_2O \rightleftharpoons HC_6H_6O_6^- + H_3O^+ \quad K_{a1} = 8.0 \times 10^{-5}$$
$$HC_6H_6O_6^- + H_2O \rightleftharpoons C_6H_6O_6^- + H_3O^+ \quad K_{a2} = 1.6 \times 10^{-12}$$

✓D.

$$H_3C_6H_5O_7 + H_2O \rightleftharpoons H_2C_6H_5O_7^- + H_3O^+ \quad K_{a1} = 7.4 \times 10^{-4}$$
$$H_2C_6H_5O_7^- + H_2O \rightleftharpoons HC_6H_5O_7^{2-} + H_3O^+ \quad K_{a2} = 1.7 \times 10^{-5}$$
$$HC_6H_5O_7^{2-} + H_2O \rightleftharpoons C_6H_5O_7^{3-} + H_3O^+ \quad K_{a3} = 4.0 \times 10^{-7}$$

E.

$$H_3PO_4 + H_2O \rightleftharpoons H_2PO_4^- + H_3O^+ \quad K_{a1} = 7.5 \times 10^{-3}$$
$$H_2PO_4^- + H_2O \rightleftharpoons HPO_4^{2-} + H_3O^+ \quad K_{a2} = 6.2 \times 10^{-8}$$
$$HPO_4^{2-} + H_2O \rightleftharpoons PO_4^{3-} + H_3O^+ \quad K_{a3} = 4.2 \times 10^{-13}$$

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**Question #:** 11

Which is the **strongest** acid?

✓A. $H_3PO_4$
B. $H_3PO_3$
C. $H_3AsO_4$
D. $H_3AsO_3$

---

**Question #:** 12

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

$$Co^{2+}(aq) + 4\,OH^-(aq) \rightleftharpoons Co(OH)_4^{2-}(aq)$$
$$Al^{3+}(aq) + 6\,Cl^-(aq) \rightleftharpoons Al(F)_6^{3-}(aq)$$

✓A. $Co^{2+}$
B. $OH^-$
✓C. $Al^{3+}$
D. $Cl^-$

---

**Question #:** 13

What is the pH of a 1.0 L buffer solution that is 0.300 M $CH_3COOH$ ($pK_a$ = 4.76) and 0.300 M $CH_3COONa$ after the addition of 0.050 mol of NaOH?
Ignore any volume change from the addition of NaOH. Report pH to **two** decimal places.

pH = 1

1. 4.91|4.90|4.92|

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**Question #:** 14

Which of the following solutions results in a **buffer**?

A. 10.0 mL of 0.100 M NaOH + 5.0 mL of 0.100 M HCl
✓B. 10.0 mL of 0.100 M NaOH + 20.0 mL of 0.100 M $HCHO_2$
C. 20.0 mL of 0.100 M NaOH + 10.0 mL of 0.200 M $HClO_2$
D. 10.0 mL of 0.100 M $NH_3$ + 10.0 mL of 0.100 M HCl

---

**Question #:** 15

Calculate the base-to-acid ratio needed to prepare a pH 4.00 propanoic acid, potassium propanoate buffer.
$K_a$(propanoic acid) = $1.3 \times 10^{-5}$

✓A. 0.13
B. 0.067
C. 5.8
D. 8.7

---

**Question #:** 16

Which choice should be the **most effective** buffer against added acid or base?

A. 0.010 M nitrous acid and 0.010 M sodium nitrite
B. 0.100 M formic acid and 0.010 M sodium formate
✓C. 0.100 M hypochlorous acid and 0.100 M sodium hypochlorite
D. 0.010 M benzoic acid and 0.100 M sodium benzoate

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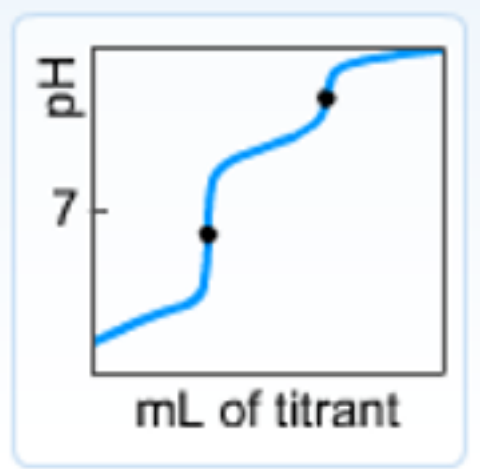
**Question #:** 17

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

A.

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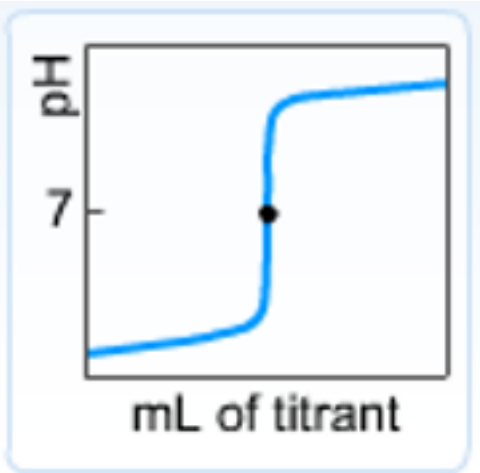


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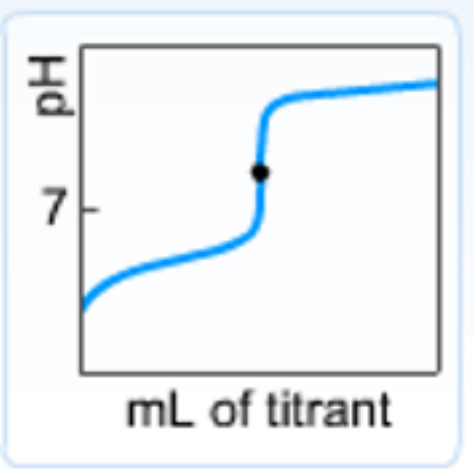
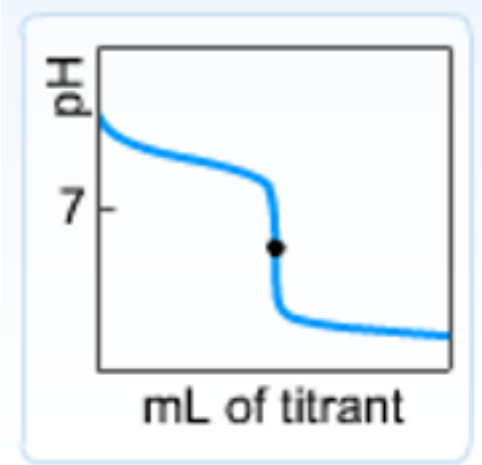



✓D.

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✓A. 2.61
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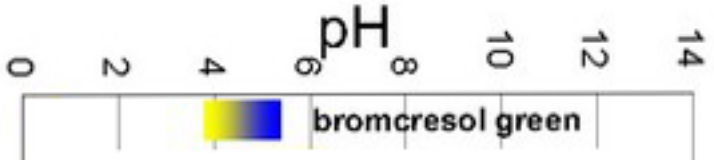


✓A. hydrazoic acid, p*K*a = 4.60
B. nitrous acid, p*K*a = 3.34
C. boric acid, p*K*a = 9.27
D. hydroiodic acid, p*K*a <0

---

**Question #:** 20

A 20.0 mL portion of 0.100 M $C_5H_5N$ ($K_b = 1.7 \times 10^{-9}$) is titrated with 0.400 M HCl. What is the pH at the equivalence point?

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✓B. 3.16
C. 7.00
D. 8.19

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**Question #:** 21

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

A. $Al(OH)_3$ and ZnS
✓B. $CaF_2$ and $Ag_2CrO_4$
C. $MnC_2O_4$ and $Mn(OH)_2$
D. AgCl and $BaCl_2$

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**Question #:** 22

What happens when two solutions are mixed together such that the concentration of $Ba^{2+}$ is $5.00 \times 10^{-3}$ M and the concentration of $C_2O_4^{2-}$ is $1.00 \times 10^{-3}$ M in the resulting solution? $K_{sp}(BaC_2O_4) = 1.6 \times 10^{-6}$

A. $Q_{sp} < K_{sp}$ and the solution remains unsaturated.
B. $Q_{sp} = K_{sp}$ and the solution is saturated, resulting in the precipitation of $BaC_2O_4(s)$.
C. $Q_{sp} > K_{sp}$, resulting in precipitation of $BaC_2O_4(s)$, leaving behind an unsaturated solution.
✓D. $Q_{sp} > K_{sp}$, resulting in precipitation of $BaC_2O_4(s)$, leaving behind a saturated solution.

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**Question #:** 23

What is the final mercury(II) concentration in a solution that is initially 0.010 M $Hg^{2+}$ and 0.400 M $CN^-$?

$$Hg^{2+}(aq) + 4\,CN^{-}(aq) \rightleftharpoons Hg(CN)_4^{2-}(aq) \quad K_f = 1.8 \times 10^{41}$$

A. $1.8 \times 10^{21}$ M
B. $1.8 \times 10^{-19}$ M
C. $2.8 \times 10^{-51}$ M
✓D. $3.3 \times 10^{-42}$ M

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**Question #:** 24

For the coordination compound $[Fe(H_2O)_4(NH_3)(OH)]Cl_2$,
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. +3|3+|+three|three+|+ 3|3 +|

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**Question #:** 25

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 pH 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; pH = 12.62
✓B. $Fe(OH)_2$ precipitates first; pH = 7.14
C. $Ca(OH)_2$ precipitates first; pH = 7.14
D. $Fe(OH)_2$ precipitates first; pH = 12.62