

This print-out should have 45 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering.

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**001 10.0 points**

Assume that five weak acids, identified only by numbers (1, 2, 3, 4, and 5), have the following ionization constants.

Acid	Ionization Constant $K_a$ value
1	$1.0 \times 10^{-3}$
2	$3.0 \times 10^{-5}$
3	$2.6 \times 10^{-7}$
4	$4.0 \times 10^{-9}$
5	$7.3 \times 10^{-11}$

The anion of which acid is the strongest base?

- 4
- 5
- 2
- 3
- 1

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**002 10.0 points**

The term “ $K_a$  for the ammonium ion” describes the equilibrium constant for which of the following reactions?

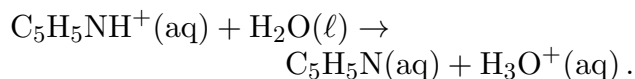
- $\text{NH}_4^+ + \text{H}_2\text{O} \rightleftharpoons \text{NH}_3 + \text{H}_3\text{O}^+$
- $\text{NH}_3 + \text{H}_2\text{O} \rightleftharpoons \text{NH}_4^+ + \text{OH}^-$
- $\text{NH}_3 + \text{H}_3\text{O}^+ \rightleftharpoons \text{NH}_4^+ + \text{H}_2\text{O}$
- $\text{NH}_4^+ + \text{OH}^- \rightleftharpoons \text{NH}_3 + \text{H}_2\text{O}$
- $\text{NH}_4\text{Cl}(\text{solid}) + \text{H}_2\text{O} \rightleftharpoons \text{NH}_4^+ + \text{Cl}^-$
- The term is misleading, because the am-

monium ion is not an acid.

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**003 10.0 points**

If the value of  $K_b$  for pyridine is  $1.8 \times 10^{-9}$ , calculate the equilibrium constant for



- $5.6 \times 10^{-6}$
- $1.8 \times 10^{-9}$
- $1.8 \times 10^{-16}$
- $5.6 \times 10^8$
- $-1.8 \times 10^{-9}$

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**004 10.0 points**

Which of the following is true in pure water at any temperature?

- $K_w$  decreases with increasing temperature.
- $[\text{H}_3\text{O}^+][\text{OH}^-] = 1.0 \times 10^{-14}$
- $[\text{H}_3\text{O}^+] = [\text{OH}^-]$
- pH = 7.0 or greater than 7.0
- pH = 7.0

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**005 10.0 points**

Which is NOT a conjugate acid-base pair?

- $\text{H}_2\text{O} : \text{OH}^-$
- $\text{HCl} : \text{Cl}^-$
- $\text{H}_3\text{SO}_4^+ : \text{H}_2\text{SO}_4$
- $\text{H}_2 : \text{H}^-$
- $\text{H}_2\text{SO}_4 : \text{SO}_4^{2-}$

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**006 10.0 points**

What is the conjugate acid of  $\text{NO}_3^-$ ?

- |                       |                       |
|-----------------------|-----------------------|
| 1. $\text{NO}_2^-$    | 4. $\text{pH} = 1$    |
| 2. $\text{NH}_3$      | 5. $\text{pH} = 3$    |
| 3. $\text{H}^+$       | 6. $\text{pH} = 5000$ |
| 4. $\text{HNO}_3$     | 7. $\text{pH} = 7$    |
| 5. $\text{NO}_3^{2-}$ | 8. $\text{pH} = 4$    |
| 6. $\text{OH}^-$      | 9. $\text{pH} = 6$    |

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**007 10.0 points**What is  $[\text{H}_3\text{O}^+]$  when  $[\text{OH}^-] = 3.3 \times 10^{-9} \text{ M}$ ?

- $1.0 \times 10^{-7} \text{ M}$
- $3.3 \times 10^{-9} \text{ M}$
- $3.3 \times 10^{-5} \text{ M}$
- $3.0 \times 10^{-6} \text{ M}$
- $6.6 \times 10^{-5} \text{ M}$

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**008 10.0 points**What is  $[\text{OH}^-]$  in a 0.0050 M HCl solution?

- $6.6 \times 10^{-5} \text{ M}$
- $5.0 \times 10^{-3} \text{ M}$
- $1.0 \times 10^{-7} \text{ M}$
- $2.0 \times 10^{-12} \text{ M}$
- 1.0 M

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**009 10.0 points**Which pH represents a solution with 1000 times higher  $[\text{OH}^-]$  than a solution with pH of 5?

- $\text{pH} = 2$
- $\text{pH} = 0.005$
- $\text{pH} = 8$

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**010 10.0 points**What is the pH of a 0.12 M  $\text{Ba}(\text{OH})_2$  aqueous solution?

- 1.33802
- 8.7
- 0.619789
- 13.3802
- 10.0352

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**011 10.0 points**Hydroxylamine is a weak molecular base with  $K_b = 6.6 \times 10^{-9}$ . What is the pH of a 0.0500 M solution of hydroxylamine?

- $\text{pH} = 8.93$
- $\text{pH} = 7.12$
- $\text{pH} = 3.63$
- $\text{pH} = 4.74$
- $\text{pH} = 9.26$
- $\text{pH} = 9.48$
- $\text{pH} = 10.37$

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**012 10.0 points**What is the pH of a 0.2 M solution of potassium benzoate ( $\text{KR-COO}^-$ )?  $K_a$  for the generic acid ( $\text{R-COOH}$ ) is  $2.7 \times 10^{-8}$ .

1. 10.285
2. 7.000
3. 10.565
4. 10.195
5. 3.565
6. 7.569
7. 6.431
8. 3.435
9. 10.435
10. 10.805

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**013 10.0 points**

At 25° C, the pH of a water solution of a salt of a WEAK acid and a STRONG base is

1. less than 7.
2. greater than 7.
3. about 7.
4. equal to the hydrogen ion concentration.

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**014 10.0 points**

What is the pH of a 0.16 M solution of anilinium nitrate ( $\text{C}_6\text{H}_5\text{NH}_3\text{NO}_3$ )?  $K_b$  for aniline is  $4.2 \times 10^{-10}$ .

Your answer must be within  $\pm 0.4\%$

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**015 10.0 points**

The pH of lemon juice is approximately 2.4. At this pH, the hydronium ion concentration is closest to which value?

1.  $2.50 \times 10^{-12}$  M
2.  $5.62 \times 10^{-4}$  M
3.  $4.00 \times 10^{-3}$  M

4. 250 M

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**016 10.0 points**

Which solution has the highest pH?

1. 0.1 M of  $\text{KHCOO}$ ,  
 $K_{a\text{HCOOH}} = 1.8 \times 10^{-4}$
2. 0.1 M of  $\text{KCl}$ ,  $K_{a\text{HCl}} = \text{very large}$
3. 0.1 M of  $\text{KCH}_3\text{COO}$ ,  
 $K_{a\text{HC}_2\text{H}_3\text{O}_2} = 1.8 \times 10^{-5}$
4. 0.1 M of  $\text{KNO}_2$ ,  $K_{a\text{HNO}_2} = 4.5 \times 10^{-4}$
5. 0.1 M of  $\text{KClO}$ ,  $K_{a\text{HClO}} = 3.5 \times 10^{-8}$

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**017 10.0 points**

What is the pH of a solution that contains 11.7 g of  $\text{NaCl}$  for every 200 mL of solution?

1. 1.0
2.  $10^{-1}$
3. 7.0
4.  $1.0 \times 10^{-7}$

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**018 10.0 points**

A 0.010 M solution of a weak acid HA has a pH of 4.20. What is the pOH of the solution?

1. 14.0
2. None of these
3. 4.20
4. 7.0
5. 9.80

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**019 10.0 points**

A solution has a pH of 4.35. Find the pOH.

1. 4.35

2. 9.65

3. None of these

4. 18.35

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**020 (part 1 of 2) 10.0 points**

The pH of an aqueous solution is measured as 1.21. Calculate the  $[\text{H}_3\text{O}^+]$ .

Answer in units of M

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**021 (part 2 of 2) 10.0 points**

Calculate the  $[\text{OH}^-]$ .

Answer in units of M

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**022 10.0 points**

What is the pH of a solution made by mixing 0.05 mol of NaCN with enough water to make a liter of solution?

$K_a$  for HCN is  $4.9 \times 10^{-10}$  and  $K_w = 1 \times 10^{-14}$ .

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**023 10.0 points**

Identify the list in which all salts produce a basic aqueous solution.

1.  $\text{AgNO}_3$ ,  $\text{NaCHO}_2$ ,  $\text{CrI}_3$ 2.  $\text{NH}_4\text{Cl}$ ,  $\text{C}_6\text{H}_4\text{NH}_3\text{NO}_3$ ,  $\text{FeI}_3$ 3.  $\text{AlCl}_3$ ,  $\text{Zn}(\text{NO}_3)_2$ ,  $\text{KClO}_4$ 4.  $\text{CH}_3\text{NH}_3\text{Cl}$ ,  $\text{KNO}_3$ , NaBz (sodium benzoate)5.  $\text{KCH}_3\text{COO}$ ,  $\text{NaCN}$ ,  $\text{KF}$ 

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**024 10.0 points**

What is the pH in a solution made by dissolving 0.100 mole of sodium acetate ( $\text{NaCH}_3\text{COO}$ ) in enough water to make one liter of solution?  $K_a$  for  $\text{CH}_3\text{COOH}$  is  $1.80 \times 10^{-5}$ .

1. 8.87

2. 9.25

3. 5.13

4.  $5.56 \times 10^{-11}$ 

5. 10.25

6. 5.74

7.  $5.56 \times 10^{-10}$ 8.  $1.80 \times 10^{-6}$ 9.  $7.46 \times 10^{-6}$ 10.  $1.34 \times 10^{-9}$ 

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**025 10.0 points**

A 0.200 M solution of a weak monoprotic acid HA is found to have a pH of 3.00 at room temperature. What is the ionization constant of this acid?

1.  $5.0 \times 10^{-3}$ 2.  $2.0 \times 10^{-5}$ 3.  $1.0 \times 10^{-6}$ 

4. 5.30

5.  $5.0 \times 10^{-6}$ 6.  $1.8 \times 10^{-5}$ 7.  $2.0 \times 10^{-9}$ 8.  $1.0 \times 10^{-3}$ 

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**026 10.0 points**

What is the percent ionization for a weak acid HX that is 0.40 M?  $K_a = 4.0 \times 10^{-7}$ .

1. 0.00020%

2. 0.050%

3. 0.020%

4. 0.10%

5. 2.0%

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**027 10.0 points**

A 0.28 M solution of a weak acid is 3.5% ionized. What is the pH of the solution?

1. 2.01
2. 1.46
3. 5.25
4. 0.55
5. 3.17

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**028 10.0 points**

The pH of 0.010 M aniline(aq) is 8.32.

What is the percentage aniline protonated?

1. 2.1%
2. 0.021%
3. 0.12%
4. 0.21%
5. 0.69%

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**029 10.0 points**

A 20 mL sample of 0.20 M nitric acid solution is required to neutralize 40 mL of barium hydroxide solution. What is the molarity of the barium hydroxide solution?

1. 0.050 M
2. 0.025 M
3. 0.100 M
4. 0.0025 M
5. 0.200 M

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**030 10.0 points**

When an acid and base neutralize each other, the products are generally water

1. a salt.
2. a gel.
3. a colloid.
4. an ion.

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**031 10.0 points**

How many moles of  $\text{Ca}(\text{OH})_2$  are needed to neutralize three moles of HCl?

1. three
2. 1.5
3. four
4. eight
5. 0.5
6. two
7. six
8. one

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**032 10.0 points**

A 29.1 mL sample of a solution of RbOH is neutralized by 22.51 mL of a 2.735 M solution of HBr. What is the molarity of the RbOH solution?

Answer in units of M

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**033 10.0 points**

For the neutralization reaction involving  $\text{HNO}_3$  and  $\text{LiOH}$ , how much of 2.10 M  $\text{HNO}_3$  is needed to neutralize 22.2 L of a 4.66 M  $\text{LiOH}$  solution? The molar mass of  $\text{LiOH}$  is 23.95 g/mol. The molar mass of  $\text{HNO}_3$  is 63.1 g/mol. The density of the  $\text{HNO}_3$  solution is 1.06 g/mL. The density of the  $\text{LiOH}$  solution is 1.15 g/mL.

1. 0.567 g
2. 109.7 g

3. 56,600 g

4. 56.6 g

5. 52,200 g

6. 103.5 g

7. 49.3 g

8. 1,620,000 g

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**034 10.0 points**

An aqueous solution is prepared with 2 moles of HCl and 1 mole of  $\text{Ca}(\text{OH})_2$ . The resulting solution contains mainly of

1. water and  $\text{Cl}^-$ ,  $\text{H}^+$ , and  $\text{Ca}^{2+}$  ions.
2. water and  $\text{Cl}^-$  and  $\text{Ca}^{2+}$  ions.
3. water and  $\text{Cl}^-$ ,  $\text{H}^+$ ,  $\text{OH}^-$ , and  $\text{Ca}^{2+}$  ions.
4. water and  $\text{Cl}^-$ ,  $\text{OH}^-$ , and  $\text{Ca}^{2+}$  ions.

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**035 10.0 points**

Assume you have a 0.4 M solution of acetic acid that is 1.3 percent ionized or dissociated. What is the pH?

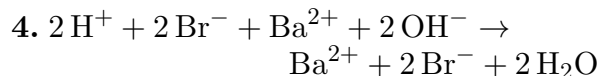
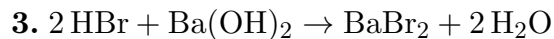
1. 2.3
2. 0.3
3. 0.4
4. 1.5
5. 4.3

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**036 10.0 points**

Determine the total ionic equation for the reaction between  $\text{HBr}(\text{aq})$  and  $\text{Ba}(\text{OH})_2(\text{aq})$ .

1.  $2 \text{H}^+ + 2 \text{OH}^- \rightarrow 2 \text{H}_2\text{O}$
2.  $2 \text{Br}^- + \text{Ba}^{2+} \rightarrow \text{BaBr}_2$



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**037 10.0 points**

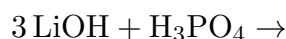
If aqueous acetic acid is reacted with sodium hydroxide, which of the following substances are in the net ionic equation?

1. acetate ion, hydroxide ion, hydronium ion, and water
2. acetate ion, hydronium ion, and water
3. acetic acid, hydroxide ion, acetate ion, and water
4. acetic acid, hydroxide ion, hydronium ion, acetate ion, and water
5. acetic acid, sodium ion, hydroxide ion, and acetate ion

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**038 10.0 points**

Identify the products of the chemical equation

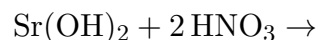


1.  $3 \text{LiH} + (\text{OH})_3\text{PO}_4$
2.  $\text{Li}_3\text{PO}_4 + 3 \text{H}_2\text{O}$
3.  $3 \text{H} + 3 \text{O}_2 + \text{H}_3\text{Li}_3$
4.  $\text{Li}_3\text{P} + 2 \text{H}_2\text{O} + \text{H}_3\text{O}_5$

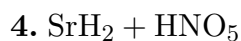
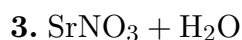
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**039 10.0 points**

What are the products of the following reaction?



1.  $\text{Sr}(\text{NO}_2)_2 + 2 \text{H}_2\text{O}_2$
2.  $\text{Sr}(\text{NO}_3)_2 + 2 \text{H}_2\text{O}$



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**040 10.0 points**

Aqueous ammonia can be used to neutralize sulfuric acid ( $\text{H}_2\text{SO}_4$ ) and nitric acid ( $\text{HNO}_3$ ) to produce two salts extensively used as fertilizers. They are

1.  $(\text{NH}_4)_2\text{SO}_4$  and  $\text{NH}_4\text{NO}_3$ , respectively.
2.  $\text{NH}_4\text{SO}_4$  and  $\text{NH}_4\text{NO}_3$ , respectively.
3.  $\text{NH}_4\text{SO}_3$  and  $\text{NH}_4\text{OH}$ , respectively.
4. cyanamide and cellulose nitrate, respectively.

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**041 10.0 points**

Identify the salt that is produced from the acid-base neutralization reaction between potassium hydroxide and acetic acid ( $\text{CH}_3\text{COOH}$ ).

1. potassium cyanide
2. potassium acetate
3. potassium formate
4. potassium amide

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**042 10.0 points**

What volume of 0.585 M  $\text{Ca}(\text{OH})_2$  would be needed to neutralize 15.8 L of 1.51 M HCl?

1. 40.8 L
2. 12.2 L
3. 6.12 L
4. 3.06 L
5. 20.4 L

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**043 10.0 points**

It was found that 25 mL of 0.012 M HCl neutralized 40 mL of NaOH solution. What was the molarity of the base solution?

1. 0.006 M
2. 0.012 M
3. 0.050 M
4. 0.0075 M

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**044 10.0 points**

The pH of a solution of hydrochloric acid is 1.57. What is the molarity of the acid?

Answer in units of mol/L

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**045 10.0 points**

How many moles of NaOH are needed to neutralize three moles of HCl?

1. 0.5
2. one
3. six
4. 1.5
5. three
6. two
7. eight
8. four