This print-out should have 51 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering.

001 10.0 points

A complete neutralization reaction is performed by combining 200 mL 0.20 M LiOH and 100 mL 0.40 M nitrous acid (HNO_2). What is the pOH of the resulting solution?

1. 5.74

2. 5.50

3. 1.90

4. 11.5

5. 8.26

6. 2.14

002 10.0 points

What is the pH of a 0.07 M $Ba(OH)_2$ aqueous solution?

1. 13.1461

2. 8.7

3. 0.853872

4. 1.31461

5. 9.8596

003 10.0 points

What is $[OH^-]$ in a 0.0050 M HCl solution?

1. 6.6×10^{-5} M

2. 1.0×10^{-7} M

3. 2.0×10^{-12} M

4. 1.0 M

5. 5.0×10^{-3} M

004 10.0 points

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

$$C_5H_5NH^+(aq) + H_2O(\ell) \rightarrow C_5H_5N(aq) + H_3O^+(aq)\,.$$

1. 1.8×10^{-16}

2. 5.6×10^{8}

3. -1.8×10^{-9}

4. 5.6×10^{-6}

5. 1.8×10^{-9}

005 10.0 points

For the neutralization reaction involving HCl and $Mg(OH)_2$, how many liters of 0.60 M HCl are needed to react with 45 g of a 2.5 M $Mg(OH)_2$ solution? (density = 1.3 g/mL)

1. 0.011 L

2. 0.12 L

3. 0.29 L

4. 120 L

5. 0.14 L

6. 0.49 L

006 10.0 points

The conjugate pair of F^- is a...

1. weak acid

2. strong acid

3. strong base

4. weak base

5. neutral salt

007 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?

1. pH = 8.93

2. pH = 9.48

3. pH = 7.12

4. pH = 10.37

5. pH = 9.26

6. pH = 3.63

7. pH = 4.74

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008 10.0 points

What is $[H_3O^+]$ when $[OH^-] = 3.3 \times 10^{-9}$ M?

1. 6.6×10^{-5} M

2. 3.3×10^{-9} M

3. 3.0×10^{-6} M

4. 3.3×10^{-5} M

5. 1.0×10^{-7} M

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009 10.0 points

Calculate the resulting pH if 365 mL of 2.88 M HNO_3 is mixed with 335 mL of 1.10 M $Ca(OH)_2$ solution.

1. 1.46

2. 0.460

3. 2.36

4. 7.20

5. 0.067

6. 0.350

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010 10.0 points

181 mL of an unknown HCl solution was neutralized in a titration with 36.2 mL of 0.250 M NaOH. What is the molarity of the unknown HCl solution?

1. 5.00×10^{-2} M

2. 8.00×10^{-1} M

3. 9.05×10^{-2} M

4. 1.64×10^{3} M

5. 2.50×10^{-1} M

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011 10.0 points

Which of the following is the WEAKEST acid?

1. $HClO_2$

2. HClO

3. HNO_3

4. $HClO_4$

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012 10.0 points

Which equation represents K_{a2} for sulfurous acid?

1. $HSO_3^-(aq) + H_2O(\ell) \rightarrow H_2SO_3(aq) + OH^-(aq)$

2. $H_2SO_3(aq) + H_2O(\ell) \rightarrow HSO_3^-(aq) + H_3O^+(aq)$

3. $HSO_3^-(aq) + H_2O(\ell) \rightarrow SO_3^{2-}(aq) + H_3O^+(aq)$

4. $H_2SO_3(aq) + 2\,H_2O(\ell) \rightarrow SO_3^{2-}(aq) + 2\,H_3O^+(aq)$

5. $SO_3^{2-}(aq) + H_2O(\ell) \rightarrow HSO_3^-(aq) + OH^-(aq)$

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013 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. 5.30

2. 1.0×10^{-3}

3. 1.8×10^{-5}

4. 5.0×10^{-6}

5. 5.0×10^{-3}

6. 2.0×10^{-5}

7. 1.0×10^{-6}

8. 2.0×10^{-9}

014 10.0 points

At 25° C, water solutions which are neutral have a pH of

1. about 7.

2. about 0.

3. about 14.

4. infinity.

015 (part 1 of 2) 10.0 points

Calculate the pH of the solute in an aqueous solution of 0.45 M C_5H_5N(aq) (pyridine) if the K_b is 1.8×10^{-9}.

1. 9.51306
2. 9.49978
3. 9.05019
4. 9.52207
5. 9.07918
6. 9.27815
7. 9.49181
8. 9.47273
9. 9.53576
10. 9.45424

Your answer must be within ± 0.005 .

016 (part 2 of 2) 10.0 points

What is the percentage protonation of the solute?

1. 0.0080904
2. 0.00518321
3. 0.00632456
4. 0.00733017
5. 0.00781133
6. 0.00524222
7. 0.0107763
8. 0.00884652
9. 0.00914991
10. 0.00569495

Answer in units of %.

017 10.0 points

Calculate the concentration of HCO_3^- present in 0.0322 M H_2CO_3.

1. 0.000236977
2. 0.000274474
3. 0.000319772
4. 0.000117669
5. 0.000225732
6. 0.000193972
7. 0.00033068
8. 0.000304127
9. 0.000152804
10. 0.000389878

Answer in units of mol/L.

018 10.0 points

What is the pH of a 0.036 M HNO_3 solution?

1. 2.72

2. 5.36

3. 12.56

4. 2.88

5. 1.64

6. 1.44

7. 1.36

8. 5.56

019 10.0 points

What is the pH of a 0.37 M solution of anilinium nitrate ($C_6H_5NH_3NO_3$)? K_b for aniline is 4.2×10^{-10}.

1. 2.53959
2. 2.62152
3. 2.75465
4. 2.70956
5. 2.73856
6. 2.55905
7. 2.60414
8. 2.67225
9. 2.52752
10. 2.58043

Your answer must be within ± 0.4%

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020 10.0 points

The ΔH° for the autoionization of water is 55.7 kJ/mol. Which of the following is/are true regarding the autoionization of pure water at 37°C?

I) The concentration of H_3O^+ will be greater at 37°C than at standard conditions

II) $[OH^-] = [H_3O^+]$

III) K_w is equal to 1 x 10^{-14}

IV) The concentration of OH^- will be lower at 37°C than standard conditions

1. I, II, and III

2. I and II

3. II and IV

4. III only

5. II only

6. I, II, and IV

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021 10.0 points

Which of the following can exhibit amphoterism?

1. CrO_4^{2-}

2. $HClO_4$

3. HPO_4^{2-}

4. Sn^{2+}

5. O^{2-}

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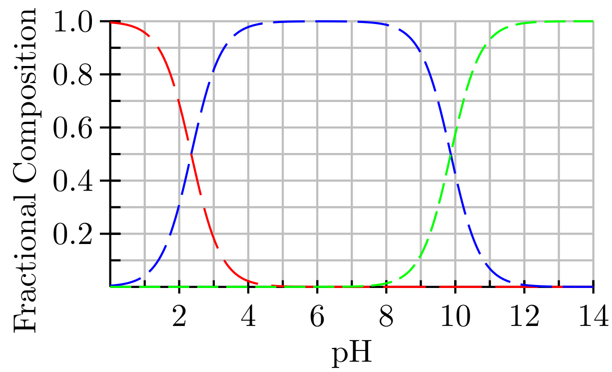
022 10.0 points

Consider the fractional composition diagram for the amino acid alanine.



What is the structure of the dominant species at pH 6?

1. $^-OOC—CH(CH_3)NH_3^+$

2. $^-OOC—CH(CH_3)NH_2$

3. $HOOC—CH(CH_3)NH_3^+$

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023 10.0 points

Trichloroacetic acid is a harsh chemical, typically used for cosmetic treatments such as tattoo removal. What is the pH of a .0800 M trichloroacetic acid solution (CCl_3COOH)?

1. 2.000

2. 1.097

3. 0.990

4. 0.824

5. 1.205

6. 2.019

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024 10.0 points

What is the hydroxide concentration $[OH^-]$ in an aqueous solution in which the hydronium ion concentration $[H_3O^+]$ is 1×10^{-5} M?

1. 1×10^{-9} M

2. 1×10^{-14} M

3. 1×10^{-5} M

4. 1×10^{-7} M

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025 10.0 points

In the following equation, water is acting as a(n)...

$$C_6H_5COO^-(aq) + H_2O(l) \rightleftharpoons C_6H_5COOH(aq) + OH^-(aq)$$

1. Acid

2. Base

3. Neither

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026 10.0 points

The generic weak acid HA has a percent ionization equal to 10.8% at a 0.025 M concentration. What is the K_a of this acid?

1. 1.43×10^{-3}

2. 4.54×10^{-4}

3. 2.50×10^{-4}

4. 5.97×10^{-4}

5. 3.27×10^{-4}

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027 10.0 points

A student titrated a sample containing 107 mL of 0.28 M NaOH with 0.72 M HCl. What is the pH of the solution after 23 mL of the hydrochloric acid has been added?

1. 13.02

2. 0.98

3. −0.02

4. 7

5. 14.02

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028 10.0 points

What is the concentration of H_3O^+ ions in a 0.20 M solution of $Ca(OH)_2$ at 25°C?

1. 0.40 M

2. 2.5×10^{-14} M

3. 1×10^{-13} M

4. 1.2×10^{-14} M

5. 0.20 M

6. 3.7×10^{-14} M

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029 10.0 points

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

1. 0.55

2. 5.25

3. 2.01

4. 3.17

5. 1.46

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030 10.0 points

The hydronium ion concentration in a solution at pH 10 has what relationship to the hydronium ion concentration in a solution at pH 13?

1. 3 times greater than

2. 100 times less than

3. 1,000 times less than

4. 1,000 times greater than

031 10.0 points

List the the following solution species in order of increasing acidity (weakest acid to strongest acid). Important note: measure the acidity/basicity of the solution species as written.

HCN $(CH_3)_3NH^+$ HIO NH_4^+

1. $(CH_3)_3NH^+ < HIO < NH_4^+ < HCN$

2. $HIO < (CH_3)_3NH^+ < NH_4^+ < HCN$

3. $HCN < NH_4^+ < (CH_3)_3NH^+ < HIO$

4. $HIO < NH_4^+ < HCN < (CH_3)_3NH^+$

5. $HCN < (CH_3)_3NH^+ < HIO < NH_4^+$

6. $(CH_3)_3NH^+ < NH_4^+ < HCN < HIO$

032 10.0 points

According to the Bronsted-Lowry Theory of acids and bases, a base is

1. a substance which when dissolved in water yields OH^-.

2. an electron acceptor.

3. a proton donor.

4. a proton acceptor.

5. an electron donor.

033 10.0 points

A 50.0 mL sample of 6 M HCl is added to 100.0 mL of 1.2 M NaOH. What is the pH of the resulting solution?

1. 0.09

2. 1.20

3. −0.08

4. 0.18

5. −1.20

034 10.0 points

The term "K_a for the ammonium ion" describes the equilibrium constant for which of the following reactions?

1. $NH_3 + H_3O^+ \rightleftharpoons NH_4^+ + H_2O$

2. $NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+$

3. The term is misleading, because the ammonium ion is not an acid.

4. $NH_4^+ + OH^- \rightleftharpoons NH_3 + H_2O$

5. $NH_4Cl(solid) + H_2O \rightleftharpoons NH_4^+ + Cl^-$

6. $NH_3 + H_2O \rightleftharpoons NH_4{}^+ + OH^-$

035 10.0 points

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

What is the percentage aniline protonated?

1. 0.69%

2. 2.1%

3. 0.21%

4. 0.12%

5. 0.021%

036 10.0 points

What is the conjugate acid of NO_3^-?

1. $NO_2{}^-$

2. H^+

3. $NO_3{}^{2-}$

4. NH_3

5. OH^-

6. HNO_3

037 10.0 points

Write the charge balance equation for a dilute aqueous solution of HI.

1. $[H_3O^+] = [I^-]$

2. $[H_3O^+] = [OH^-]$

3. $[H_3O^+] = [I^-] + [OH^-]$

4. $[I^-] = [OH^-] + [H_3O^+]$

5. $[HI]_{\text{initial}} = [I^-]$

038 10.0 points

Which is NOT a conjugate acid-base pair?

1. $HCl : Cl^-$

2. $H_3SO_4^+ : H_2SO_4$

3. $H_2SO_4 : SO_4^{2-}$

4. $H_2 : H^-$

5. $H_2O : OH^-$

039 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	1.0×10^{-3}
2	3.0×10^{-5}
3	2.6×10^{-7}
4	4.0×10^{-9}
5	7.3×10^{-11}

The anion of which acid is the strongest base?

1. 1

2. 5

3. 3

4. 4

5. 2

040 10.0 points

What is the pH of a 0.24 M solution of potassium generate (KR-COO)? K_a for the generic acid (R-COOH) is 2.7×10^{-8}.

1. 3.526

2. 10.604

3. 7.000

4. 6.431

5. 10.234

6. 10.474

7. 10.844

8. 3.396

9. 7.569

10. 10.324

041 10.0 points

For a solution labeled "0.10 M H_3PO_4(aq),"

1. $[H_2PO_4^-]$ is greater than 0.10 M.

2. $[PO_4^{3-}] = 0.10$ M.

3. $[H^+] = 0.10$ M.

4. $[H^+]$ is less than 0.10 M.

5. $[H^+] = 0.30$ M.

042 10.0 points

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

1. $[H_3O^+][OH^-] = 1.0 \times 10^{-14}$

2. $[H_3O^+] = [OH^-]$

3. pH = 7.0 or greater than 7.0

4. K_w decreases with increasing temperature.

5. pH = 7.0

043 10.0 points

Determine the pH of a 0.000496 M solution of NaOH.

1. 10.7459
2. 10.4928
3. 10.2833
4. 10.6955
5. 10.8506
6. 10.9138
7. 10.8156
8. 10.9523
9. 10.2279
10. 10.7924

044 10.0 points

The pH of 0.010 M H_3PO_4(aq) is 2.24. Estimate the concentration of PO_4^{3-} in the solution. For H_3PO_4, the values of K_{a1}, K_{a2}, and K_{a3} are 7.6×10^{-3}, 6.2×10^{-8}, and 2.1×10^{-13}, respectively.

1. 2.1×10^{-13} M

2. 5.8×10^{-3} M

3. 6.2×10^{-8} M

4. 2.3×10^{-18} M

5. 7.6×10^{-3} M

045 10.0 points

What is the conjugate base of HPO_4^{2-}?

1. OH^-

2. HPO_4^{2-}

3. H_3PO_4

4. $H_2PO_4^-$

5. PO_4^{3-}

046 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. 2.0%

2. 0.10%

3. 0.050%

4. 0.020%

5. 0.00020%

047 10.0 points

In the complete neutralization of butanoic acid (a weak acid) with an equal amount of sodium hydroxide (NaOH), the dominant species in the resulting solution is a...

1. weak base

2. weak acid

3. strong base

4. neutral salt

5. strong acid

048 10.0 points

What is the pH of a 0.480 M trimethylamine ($(CH_3)_3N$) solution?

1. 8.81

2. 11.48

3. 11.87

4. 8.86

5. 2.13

6. 8.96

7. 2.25

8. 11.74

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049 10.0 points

Which of the following aqueous solutions gives a pH greater than 7?

1. 10^{-8} M CH_3COOH

2. 10^{-8} M HCl

3. None of the solutions gives a pH greater than 7.

4. 10^{-8} M NH_4Cl

5. 10^{-8} M HCOOH

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050 10.0 points

What is $[OH^-]$ when $[H_3O^+] = 8.2 \times 10^{-5}$ M?

1. 1.2×10^{-10} M

2. 6.3×10^{-9} M

3. 1.2×10^{-4} M

4. 1.0×10^{-7} M

5. 8.2×10^{-5} M

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051 10.0 points

Which pH represents a solution with 1000 times higher $[OH^-]$ than a solution with pH of 5?

1. pH = 3

2. pH = 6

3. pH = 2

4. pH = 8

5. pH = 7

6. pH = 0.005

7. pH = 4

8. pH = 5000

9. pH = 1