This print-out should have 30 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering.

$$\mathrm{K_a} = \frac{[H^+]\cdot[A^-]}{[HA]} \qquad 10^{-14} = K_w$$
$$\mathrm{pK_a} = -\log K_a \qquad [\mathrm{H^+}]\cdot[\mathrm{OH^-}] = K_w$$
$$\mathrm{pH} = -\log[\mathrm{H^+}] \qquad K_a \cdot K_b = K_w$$
$$\mathrm{pOH} = -\log[\mathrm{OH^-}] \qquad pK_a + pK_b = pK_w$$
$$[OH^-] = (K_b \cdot C_b)^{1/2} \qquad 14 = pK_w$$
$$[OH^-] = K_b \cdot \left(\frac{C_b}{C_a}\right) \qquad (K_a \cdot C_a)^{1/2} = [H^+]$$
$$K_a \cdot \left(\frac{C_a}{C_b}\right) = [H^+]$$

$$[H^+] = (K_{ax} \cdot K_{ay})^{1/2}$$
$$pH = 0.5(pK_{ax} + pK_{ay})$$
$$0 = [H^+]^2 - C_a[H^+] - K_w$$
$$K_{sp} = [C]^c \cdot [A]^a$$

$$E^o_{cell} = E^o_{cathode} - E^o_{anode}$$
$$E_{cell} = E^o_{cell} - \left(\frac{0.05916}{n}\right)\cdot \log Q$$
$$Q = \frac{[C]^c \cdot [D]^d}{[A]^a \cdot [B]^b}$$
$$\Delta G^o = -n \cdot F \cdot E^o_{cell} = -R \cdot T \cdot \ln K$$
$$E^o_{cell} = \left(\frac{R \cdot T \cdot \ln K}{n \cdot F}\right)$$
$$\left(\frac{I \cdot t}{n \cdot F}\right) = \text{moles of product}$$

Half reaction	E^o
$Au^{3+} + 3\,e^- \longrightarrow Au$	+1.50
$Cl_2 + 2\,e^- \longrightarrow 2\,Cl^-$	+1.36
$Ag^+ + e^- \longrightarrow Ag$	+0.80
$O_2 + 2\,e^- + 2\,H+ \longrightarrow H_2O_2$	+0.68
$I_2 + 2\,e^- \longrightarrow 2\,I^-$	+0.53
$Pb^{2+} + 2\,e^- \longrightarrow Pb$	−0.13
$Ni^{2+} + 2\,e^- \longrightarrow Ni$	−0.25
$Mn^{2+} + 2\,e^- \longrightarrow Mn$	−1.12
$Na^+ + e^- \longrightarrow Na$	−2.71
$Sr^{2+} + 2\,e^- \longrightarrow Sr$	−2.89

$$F = 96,485.3\,\mathrm{C\ per\ mole\ of\ e^{-1}}$$
$$\mathrm{Ampere} = 1\,\mathrm{C}\cdot s^{-1}$$
$$R = 8.314\,\mathrm{J}\cdot\mathrm{mol^{-1}}\cdot\mathrm{K^{-1}}$$
$$N = 6.022\times10^{23}$$

LDE Simple Buffer Calc 002
001 6.0 points

What would be the pH of a solution prepared from 200 mL of 5 M HOBr and 200 mL of 1 M NaOBr? The K_a of hypobromous acid is 2×10^{-9}.

1. 6

2. 10

3. 8 **correct**

4. 4

5. 7

LDE Identifying Buffers 002
002 6.0 points

Which of the following pairs of solutions would result in a buffer upon mixing?

1. 2 L of 0.1 M $C_6H_5NH_2$; 3 L of 0.05 M HI **correct**

2. 5 L of 0.1 M NH_3; 1 L of 0.5 M HCl

3. 100 mL of 0.3 M HCOOH; 50 mL of 0.3 M H_2SO_4

4. 200 mL of 1 M $HClO_2$; 100 mL of 1 M $Ba(OH)_2$

LDE Rank Base Strength by pKb 002
003 6.0 points

Rank following bases from most to least basic:

hypochlorite (ClO^-)	$pK_b = 12.1$
nitrite (NO_2^-)	$pK_b = 10.6$
hypoiodite (IO^-)	$pK_b = 3.3$
cyanide (CN^-)	$pK_b = 4.8$

1. $NO_2^- > ClO^- > IO^- > CN^-$

2. $CN^- > NO_2^- > ClO^- > IO^-$

3. $IO^- > CN^- > NO_2^- > ClO^-$ **correct**

4. $ClO^- > IO^- > CN^- > NO_2^-$

LDE Simple Buffer Capacity 001
004 6.0 points

Consider 4 L of a buffer composed of 2 M HCN and 3 M NaCN? How many moles of strong acid could this buffer withstand?

1. 8

2. 12 **correct**

3. 3

4. 0

5. 2

LDE Buffer Neutralization Calc 002
005 6.0 points

If one added 20 mL of 0.04 M $Ba(OH)_2$ to 100 mL of a buffer composed 0.1 M acrylic acid and 0.05 M sodium acrylate, what would be the pH of the resulting solution? Acrylic acid has K_a 5.6×10^{-5}.

1. 3.95

2. 4.15 **correct**

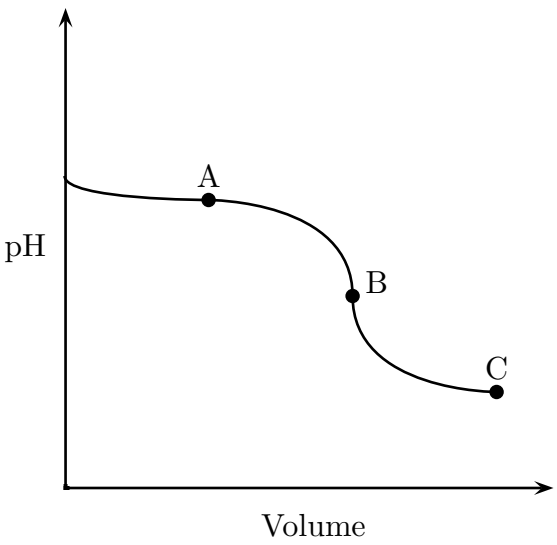
3. 4.37

4. 3.78

5. 4.55

LDE Understanding Titration Curves 001
006 6.0 points

Consider the titration curve below.



At which point is the pH = pK_b?

1. A

2. C

3. none of these **correct**

4. B

LDE Titration Excess Calc 001
007 6.0 points

WITHDRAWN

LDE Titration Equiv Pt Calc 002
008 6.0 points

What will be the pH at the equivalence point of a titration of 0.5 M acrylic acid with an equimolar solution of NaOH? Acrylic acid has a K_a of 5.6×10^{-5}.

1. 5.18

2. 8.82 **correct**

3. 8.97

4. not enough information

5. 11.57

6. 7.00

LDE Molar Solubility Estimation 001
009 6.0 points

Which of the following salts would have the lowest molar solubility?

1. $CuCl$ $K_{sp} = 1.02 \times 10^{-6}$

2. CaF_2 $K_{sp} = 3.95 \times 10^{-11}$

3. Ag_2CO_3 $K_{sp} = 6.15 \times 10^{-12}$ **correct**

4. Li_3PO_4 $K_{sp} = 2.37 \times 10^{-4}$

LDE Molar Solubility Calculation 003
010 6.0 points

The K_{sp} of $Cd_3(PO_4)_2$ at 18 ^{o}C is 1.08×10^{-33}. What is its molar solubility at this temperature?

1. 6.5×10^{-11} M

2. 2.5×10^{-9} M

3. 3.3×10^{-17} M

4. 1.0×10^{-7} M **correct**

LDE Common Ion Solubility Calc 001
011 6.0 points

What would be the molar solubility of Cu_2S ($K_{sp} = 2 \times 10^{-47}$) in a 2×10^{-3} M solution of $CuNO_3$?

1. 1.7×10^{-16}

2. 5.0×10^{-42} **correct**

3. 1.3×10^{-43}

4. 1.0×10^{-44}

LDE Selective Precipitation 001
012 6.0 points

Consider the K_{sp} data below and determine which two metal ions would be the most difficult to separate using the oxalate anion ($C_2O_4^-$).

CuC_2O_4 $K_{sp} = 2.87 \times 10^{-8}$
FeC_2O_4 $K_{sp} = 2.10 \times 10^{-7}$
PbC_2O_4 $K_{sp} = 2.74 \times 10^{-11}$
MgC_2O_4 $K_{sp} = 8.57 \times 10^{-5}$

1. Cu^{2+} and Pb^{2+}

2. Cu^{2+} and Fe^{2+} **correct**

3. Fe^{2+} and Mg^{2+}

4. Pb^{2+} and Mg^{2+}

5. Fe^{2+} and Pb^{2+}

6. Cu^{2+} and Mg^{2+}

LDE Acid/Base Assumptions 002
013 6.0 points

When using the equation $[H^+] = (K_a C_a)^{1/2}$, why should the value of K_a be less than 10^{-4}?

1. To enure that $[H^+]$ and $[A^-]$ are nearly equal.

2. To ensure that the initial and equilibrium concentrations of HA are nearly equal. **correct**

3. K_a doesn't need to be less than 10^{-4}

4. To ensure that water's contribution to $[H^+]$ is negligible.

LDE Polyprotic Acid Equil 002
014 6.0 points

Consider a tetraprotic acid of the form H_4A. If a buffer is formed by placing Li_2H_2A and Li_3HA in solution, which K_a is used to solve the buffer equation?

1. not enough information

2. K_{a4}

3. K_{a3} **correct**

4. K_{a1}

5. K_{a0}

6. K_{a2}

LDE Polyprotic Amphiprotic Calc 003
015 6.0 points

Determine the pH of a 0.03 M solution of NaH_2PO_4? Assume H_3PO_4 has a pK_{a1} of 2.1 and a pK_{a2} of 7.2 and a pK_{a3} of 12.7.

1. 7.40

2. 7.11

3. 1.81

4. 4.36

5. 4.65 **correct**

6. 9.95

LDE Charge Balance 001
016 6.0 points

Write the charge balance for a solution that initially contains CsF and $CaCO_3$.

1. $[Cs^+] + 2[Ca^{2+}] = [F^-] + 2[CO3^{2-}] + [HCO3^-]$

2. $[Cs^+] + [Ca^{2+}] = [F^-] + [CO3^{2-}] + [HCO3^-]$

3. $[Cs^+] + 2[Ca^{2+}] = [F^-] + 2[CO3^{2-}]$

4. $[Cs^+] + 2[Ca^{2+}] + [H^+] = [OH^-] + [F^-] + 2[CO3^{2-}] + [HCO3^-]$ **correct**

5. $[Cs^+] + 2[Ca^{2+}] + [H^+] = [OH^-] + [F^-] + 2[CO3^{2-}]$

6. $[Cs^+] + [Ca^{2+}] + [H^+] = [OH^-] + [F^-] + [CO3^{2-}] + [HCO3^-]$

LDE Complex Equilibria 002
017 6.0 points

How many equations are needed to fully determine an aqueous system initially containing the strong electrolyte NH_4NO_2?

1. 4

2. 6 **correct**

3. 7

4. 2

LDE Polyprotic K Expression 001
018 6.0 points

Which of the following would be equal to K_{a3} for orthocarbonic acid, H_4CO_4?

1. $\dfrac{[H_4CO_4]}{[H^+]^3 \cdot [HCO_4^{3-}]}$

2. $\dfrac{[H^+]^3 \cdot [HCO_4^{3-}]}{[H_2CO_4^{2-}]}$

3. $\dfrac{[H_2CO_4^{2-}]}{[H^+] \cdot [HCO_4^{3-}]}$

4. $\dfrac{[H^+] \cdot [HCO_4^{3-}]}{[H_2CO_4^{2-}]}$ **correct**

5. $\dfrac{[H^+]^3 \cdot [HCO_4^{3-}]}{[H_4CO_4]}$

LDE Dilute Strong Quadratic Calc 001
019 6.0 points

What would be the pH of a 10^{-9} M solution of HCl?

1. 6.954

2. 6.921

3. 6.998 **correct**

4. 6.876

LDE Sulfuric Acid Calc 001

020 6.0 points

WITHDRAWN

LDE Polyprotic Conj Base Calc 001
021 6.0 points

What would be the pH of a 0.4 M Na_2CO_3 solution? Carbonic acid has $K_{a1} = 2.5\times10^{-4}$, $K_{a2} = 5.6 \times 10^{-11}$.

1. 2.07

2. 8.60

3. 5.40

4. 11.93 **correct**

5. 7.00

LDE Balance Half Rxn Acid 001
022 6.0 points

Fully balance the half-reaction below in acid.

$$PbO_2 + HSO_4{}^- \longrightarrow PbSO_4$$

What is the change in oxidation number for lead (Pb)?

1. +4 to +8

2. +4 to +3

3. +4 to +6

4. +4 to +2 **correct**

5. no change

6. +4 to +1

LDE Balance Full Rxn Base 001
023 6.0 points

Fully balance the half-reaction below in base.

$$I_2 + Mn^{2+} \longleftrightarrow I^- + MnO_2$$

What is the sum of the coefficients?

1. 11 **correct**

2. 12

3. 14

4. 5

5. 9

LDE Rank Oxidzing Agent 001
024 6.0 points

Consider the provided table of standard reduction potentials. Rank the following species from weakest to strongest oxidizing agent: Ni^{2+}, Sr^{2+}, I_2, Au^{3+}, Ag^+.

1. $Ag^+ < Au^{3+} < I_2 < Ni^{2+} < Sr^{2+}$

2. $Sr^{2+} < I_2 < Au^{3+} < Ag^+ < Ni^{2+}$

3. $Ag^+ < I_2 < Ni^{2+} < Au^{3+} < Sr^{2+}$

4. $Au^{3+} < Sr^{2+} < Ag^+ < I_2 < Ni^{2+}$

5. $Sr^{2+} < Ni^{2+} < I_2 < Ag^+ < Au^{3+}$ **correct**

LDE EC Cell Nomenclature 001
025 6.0 points

If the two half reactions below were used to make an electrolytic cell, what species would be consumed at the anode?

Half reaction	E°
$Au^{3+}(aq) + 3\,e^- \longrightarrow Au(s)$	+1.50
$I_2(s) + 2\,e^- \longrightarrow 2\,I^-(aq)$	+0.53

1. Au^{3+} (aq)

2. I^- (aq)

3. I_2 (s)

4. Au (s) **correct**

LDE EC Cell Nomenclature 002
026 6.0 points

Far a battery, the cathode is the (positive/negative) terminal and the electrons flow through the external circuit from (anode to cathode/cathode to anode).

1. positive, cathode to anode

2. negative, anode to cathode

3. negative, cathode to anode

4. positive, anode to cathode **correct**

LDE Simple Ecell Calc 002
027 6.0 points

What would be the E° cell of an electrolytic cell made from the following two half reactions?

Half reaction	E°
$AgCl(s) + e^- \longrightarrow Ag(s) + Cl^-(aq)$	$+0.22$
$Al^{3+}(aq) + 3\,e^- \longrightarrow Al(s)$	-1.66

1. 1.88

2. 1.44

3. -1.44

4. -1.88 **correct**

LDE G from E Calc 001
028 6.0 points

What is ΔG° for the reaction below?

Reaction	E°
$ClO^{3-} + 6\,H^+(aq) \longrightarrow \frac{1}{2}\,Cl_2(g) + 3\,H_2O(\ell)$	$+1.47$

1. $194\ \text{kJ} \cdot \text{mol}^{-1}$

2. $194,000\ \text{kJ} \cdot \text{mol}^{-1}$

3. $-1,418\ \text{kJ} \cdot \text{mol}^{-1}$

4. $-709\ \text{kJ} \cdot \text{mol}^{-1}$ **correct**

LDE Current Stoicihometry Calc 001
029 6.0 points

How long would a current of 10 mA take to produce 0.096 g of $Mo(s)$ from $Mo^{5+}(aq)$?

1. 48, 242, 500 s

2. 964, 850 s

3. 9, 648, 500 s

4. 48, 242.5 s **correct**

5. 4, 824, 250 s

6. 9, 648.5 s

LDE Nernst Equation Calc 001
030 6.0 points

A battery formed from the two half reactions below dies (reaches equilibrium). If $[Fe^{2+}]$ was 0.24 M in the dead battery, what would $[Cd^{2+}]$ be in the dead battery?

Half reaction	E°
$Fe^{2+} \longrightarrow Fe$	-0.44
$Cd^{2+} \longrightarrow Cd$	-0.40

1. 120.3 M

2. 0.01 M **correct**

3. 5.4 M

4. 0.0.0005 M