This print-out should have 29 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering.

Strong Acid or Base

001 10.0 points

Which of

I) HCl II) HF III) LiOH
IV) $HClO_2$ V) HNO_3

are strong acids or strong bases in water?

1. All of the compounds

2. I, III, and V only **correct**

3. I, III, IV, and V only

4. I, II, IV, and V only

5. I, II, III, and V only

Explanation:

Buffer NH3

002 10.0 points

What is the pH of a solution containing 0.3 M NH_4Cl and 0.6 M NH_3? The pK_a of the ammonium ion is 9.25.

1. 5.05

2. 8.95

3. 12.25

4. 4.45

5. 9.55 **correct**

Explanation:

Buffer Prep 01

003 10.0 points

Which of the following solutions will produce a buffer?

I) 20 mL of 0.5 M $(CH_3)_3NHCl$ + 50 mL of 0.1 M $(CH_3)_3N$
II) 20 mL of 0.5 M HNO_2 + 50 mL of 0.1 M NaOH
III) 20 mL of 0.5 M HCl + 50 mL of 0.1 M NH_3
IV) 20 mL of 0.5 M $HClO_2$ + 50 mL of 0.1 M CH_3COOH
V) 20 mL of 0.5 M NH_4Cl + 50 mL of 0.1 M NaOH

1. I, II, III, and V only

2. II and IV only

3. I, II, and V only **correct**

4. I, II, IV, and V only

5. II only

Explanation:

A buffer contains a weak acid or weak base, plus the salt of that weak acid or base; or, a mixture which will have this composition after any acid-base reactions occur. You may have to calculate the number of moles of each species to determine the composition after any acid-base reaction.

Msci 18 0412

004 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 weakest base?

1. 3

2. 2

3. 1 **correct**

4. 4

5. 5

Explanation:

$$HA \rightleftharpoons H^+ + A^-$$

$$K_a = \frac{[H^+]\,[A^-]}{[H]\,[A]}$$

The 'anion of an acid' is another way of saying 'conjugate base,' and a weak conjugate base corresponds to a strong acid. So really what we're looking for is which acid is strongest (has the lowest pH).

A low pH means that the $[H^+]$ concentration is low. (Remember that values greater than 7 are basic!) The larger values of K_a means that there is more $[H^+]$ so you would expect these solutions to be more acidic; *i.e.*, have smaller pH's. The smaller K_a values mean less $[H^+]$ in solution, so higher pH's. The acid with the largest K_a (#1) will have the lowest pH; *i.e.*, highest $[H^+]$ concentration

Buffer Capacity

005 10.0 points

What is the buffer capacity of 100 mL of 0.1 M $HClO_2$ and 100 mL of 0.2 M $NaClO_2$?

1. 0.1 mol of OH^- and 0.2 mol of H^+

2. 10 mol of OH^- and 20 mol of H^+

3. 0.02 mol of OH^- and 0.01 mol of H^+

4. 0.2 mol of OH^- and 0.1 mol of H^+

5. 0.01 mol of OH^- and 0.02 mol of H^+ **correct**

Explanation:

$V_1 = 100$ mL $\qquad M_1 = 0.1$ M

$V_2 = 100$ mL $\qquad M_2 = 0.2$ M

HA	$\rightleftharpoons$	A^-	+	H^+
100 mL		100 mL		
0.1 M		0.2 M		
10 mmol		20 mmol		

Adding a strong base will introduce OH^-; the base will react with HA. There is only 0.01 mol of HA so only 0.01 mol of OH^- can be added before the buffer capacity is exceeded. Adding a strong acid introduces H^+; the acid will react with A^-. There is only 0.02 mol of A^- so only 0.02 mol of H^+ can be added before exceeding buffer capacity.

Buffer Stress

006 10.0 points

What is the final pH of a solution containing 100 mL of 0.2 M HX and 300 mL of 0.1 M NaX after 0.01 mol of NaOH is added? The pK_a is 3.00.

1. 12.40

2. 3.60 **correct**

3. 2.40

4. 2.70

5. 3.00

Explanation:

Initially

(100 mL) (0.2 M) = 20 mmol HA

(300 mL) (0.1 M) = 30 mmol A^-

Now add the impurity:

0.01 mol of NaOH = 10 mmol OH^-:

	HA	$\rightleftharpoons$	H^+	+	A^-
ini	20		≈ 0		30
Δ	-10				$+10$
fin	10				40

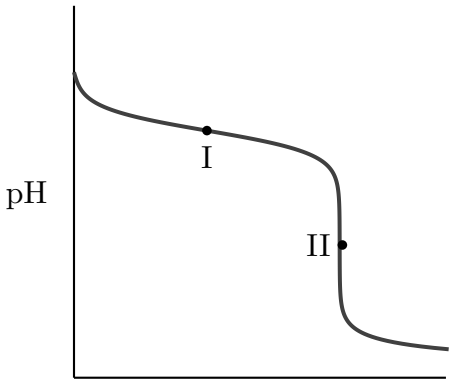
Thus $\dfrac{A^-}{HA} = \dfrac{40}{10} = 4$ and

$$pH = 3.0 + \log(4) = 3.60206\,.$$

Titration Curve 02

007 10.0 points

Consider the titration curve of a weak base with a strong acid



The pOH at point I is equal to the ___ and the pH at point II is ___ pH 7.

1. pK_b of the base, greater than

2. pH of the base, less than

3. pK_b of the base, less than **correct**

4. pK_b of the base, equal to

5. pH of the base, greater than

Explanation:

Titration Excess Acid

008 10.0 points

What is the pH of a solution containing 50 mL of 0.5 M HNO_3 and 150 mL of 0.1 M NaOH?

1. 1.30 **correct**

2. 0.30

3. 7.00

4. 2.00

5. 0.70

Explanation:

Titration End Pt 01

009 10.0 points

What is the pH of a solution containing 100 mL of 0.3 M $HClO_3$ and 150 mL of 0.1 M $Ba(OH)_2$?

1. 9.60

2. 5.39

3. 7.00 **correct**

4. 13.48

5. 0.52

Explanation:

Titration Partial NH3

010 10.0 points

What is the pH of a solution containing 100 mL of 0.5 M NH_3 and 200 mL of 0.1 M HCl? The pK_b of ammonia is 4.75.

1. 9.15

2. 9.95

3. 8.72

4. 9.43 **correct**

5. 9.65

Explanation:

Titration End Pt NH3

011 10.0 points

What is the pH of a solution containing 100 mL of 0.5 M NH_3 and 250 mL of 0.2 M HCl? The pK_b of ammonia is 4.75.

1. 10.10

2. 5.05 **correct**

3. 9.75

4. 5.28

5. 4.94

Explanation:

Solubility Order

012 10.0 points

Arrange the compounds

I) CuS $K_{sp} = 1.3 \times 10^{-36}$
II) $PbCl_2$ $K_{sp} = 1.6 \times 10^{-5}$
III) FeS $K_{sp} = 6.3 \times 10^{-18}$
IV) Hg_2Cl_2 $K_{sp} = 2.6 \times 10^{-18}$
V) Cu_2S $K_{sp} = 2.0 \times 10^{-47}$

in increasing order of molar solubility.

1. II, IV, III, V, I

2. V, I, IV, III, II

3. I, V, III, IV, II **correct**

4. I, II, III, IV, V

5. II, III, IV, I, V

Explanation:

Molar Sol Ag2S

013 10.0 points

What is the molar solubility of Ag_2S? The K_{sp} is 6.3×10^{-51}.

1. 2.82×10^{-13}

2. 1.16×10^{-17} **correct**

3. 6.37×10^{-15}

4. 7.94×10^{-26}

5. 5.8×10^{-18}

Explanation:

Molar Sol CuBr in NaBr

014 10.0 points

What is the molar solubility of CuBr in 0.5 M NaBr? The K_{sp} is 4.2×10^{-8}.

1. 3.48×10^{-3}

2. 2.05×10^{-4}

3. 4.20×10^{-8}

4. 4.20×10^{-7}

5. 8.40×10^{-8} **correct**

Explanation:

Weak Acid Assumptions

015 10.0 points

The weak acid equation $[H^+] = (K_a\, C_a)^{1/2}$ can be derived from

$$[H^+]^3 + K_a\,[H^+]^2 - (K_w + K_a\, C_a)[H^+] - K_a\, K_w = 0$$

if

1. K values are far apart, K_w is negligible and C_a is significantly smaller than $[H^+]$.

2. K_a is negligible and C_a is significantly larger than $[H^+]$.

3. K_w is negligible and C_a is significantly smaller than $[H^+]$.

4. K values are far apart, K_w is negligible and C_a is significantly larger than $[H^+]$. **correct**

5. K_w is negligible and C_a is significantly larger than $[H^+]$.

Explanation:

Triprotic pH

016 10.0 points

What is the pH of a solution containing 0.2 M RbH_2PO_4? The pK_{a1} is 2.12, the pK_{a2} is 7.21, and the pK_{a3} is 12.68.

1. 9.95

2. 4.67 **correct**

3. 7.40

4. 3.95

5. 1.41

Explanation:

Sys Treat Equil 02

017 10.0 points

$NaHCO_3$, NaCl, and HBr are dissolved in water. How many equations are needed to describe this system?

1. 6

2. 4

3. 8 **correct**

4. 5

5. 7

Explanation:
The species Na^+, H_2CO_3, HCO_3^-, CO_3^{2-}, Cl^-, Br^-, H^+, and OH^- will be present in the water.

Mass Balance Equation

018 10.0 points

0.5 M of HCOOH is dissolved in water. Which equation describes a possible mass balance equation for this system?

1. $C_{HCOOH} = [HCOO^-] + [H^+]$

2. $C_{HCOOH} = [HCOOH]$

3. $C_{HCOOH} = [HCOOH] + [HCOO^-] + [H^+]$

4. $C_{HCOOH} = [HCOOH] + [HCOO^-]$ **correct**

5. $C_{HCOOH} = [HCOO^-]$

Explanation:

Equil Expression

019 10.0 points

Which of the equilibrium expressions for a triprotic acid H_3A would be involved in the calculation to find the pH of a solution found from LiCaA and Na_2HA? Assume the K values are far apart and K_w is not involved in the calculation.

1. K_{a2}

2. K_{a2} and K_{a3}

3. K_{a1}

4. K_{a3} **correct**

5. K_{a1}, K_{a2}, and K_{a3}

6. K_{a1} and K_{a2}

Explanation:
The salts use HA^{2-} and A^{3-}, so K_{a3} is needed.

Dilute Sol 01

020 10.0 points

What is the pH of a solution containing 10^{-9} M $HClO_4$?

1. 6.996 **correct**

2. 9.000

3. 5.232

4. 8.768

5. 5.000

Explanation:

Equation Setup

021 10.0 points

Which of the following is a correct expression to use to solve for $x = [SO_4^{2-}]$ in a 0.2 M H_2SO_4 solution?

1. $x \dfrac{2}{x} = 1.1 \times 10^{-2}$

2. $x = 1.1 \times 10^{-2}$

3. $x \dfrac{0.2}{0.2 - x} = 1.1 \times 10^{-2}$

4. $x \dfrac{0.2 + x}{0.2 - x} = 1.1 \times 10^{-2}$ **correct**

5. $\dfrac{x^2}{0.2 - x} = 1.1 \times 10^{-2}$

Explanation:
0.2 M $H_2SO_4 \rightarrow$ 0.2 M H^+ and 0.2 M HSO_4^-, so the equilibrium occurs for

HSO_4^-	$\rightleftharpoons$	H^+	+	SO_4^{2-}
0.2		0.2		0
$-x$		$+x$		$+x$
$0.2 - x$		$0.2 + x$		x

$$K_{a2} = \frac{x\,(0.2 + x)}{0.2 - x}$$

Triprotic pH 01

022 10.0 points

What is the pH of 1 M Na_3A if $pK_{a1} = 2$, $pK_{a2} = 6$, and $pK_{a3} = 10$ for the triprotic acid H_3A?

1. 2

2. 10

3. 12 **correct**

4. 11

5. 8

Explanation:

Redox Bal 01a

023 10.0 points

When the equation

$$FeCl_3 + Au(s) \rightleftharpoons Fe(s) + AuCl$$

is correctly balanced, what is the coefficient of $FeCl_3$?

1. @@@

2. 2

3. 4

4. 1 **correct**

5. 5

Explanation:

The balanced equation is

$$FeCl_3 + 3\,Au(s) \rightleftharpoons Fe(s) + 3\,AuCl$$

Bal Redox in Acid

024 10.0 points

For a reaction in acid involving the following two half reactions,

$$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$$

$$Cr_2O_7^{2-} + 6\,e^- \rightleftharpoons 2\,Cr^{3+}$$

what is the coefficient for H^+ in the balanced reaction?

1. 6

2. 14 **correct**

3. 1

4. 7

5. 36

Explanation:

The balanced equation is

$$14\,H^+ + 6\,Fe^{3+} + Cr_2O_7 \rightleftharpoons 6\,Fe^{2+} + 2\,Cr^{3+} + 7\,H_2O$$

Ox Agent Order

025 10.0 points

Arrange the agents

I) $Fe^{3+} + e^- \rightarrow Fe^{2+}$ $\quad E^\circ_{red} = +0.77$

II) $Cu^{2+} + e^- \rightarrow Fe^{+}$ $\quad E^\circ_{red} = +0.15$

III) $S + 2\,e^- \rightarrow S^{2-}$ $\quad E^\circ_{red} = -0.48$

IV) $Mn^{3+} + e^- \rightarrow Mn^{2+}$ $\quad E^\circ_{red} = +1.51$

V) $Ca^{2+} + 2\,e^- \rightarrow Fe$ $\quad E^\circ_{red} = -2.87$

in increasing order of oxidizing agent strength.

1. V, IV, III, II, I

2. I, II, III, IV, V

3. III, V, IV, I, II

4. IV, I, II, III, V

5. V, III, II, I, IV **correct**

Explanation:

Lyon 49740 e5 q20

026 10.0 points

Consider the standard reduction potentials

$Cu^{2+} + 2\,e^- \rightarrow Cu$ $E^0 = 0.337$ V

$Ag^+ + 1\,e^- \rightarrow Ag$ $E^0 = 0.7994$ V

$Au^+ + 1\,e^- \rightarrow Au$ $E^0 = 1.68$ V

Which of the following statements about oxidizing strengths of Group IB metal ions is true?

1. Nothing can be predicted about oxidizing strengths from the data given.

2. Cu^{2+} is a stronger oxidizing agent than Ag^+.

3. Ag^+ is a stronger oxidizing agent than Cu^{2+}. **correct**

4. Cu^{2+} is a stronger oxidizing agent than Au^+.

5. Ag^+ is a stronger oxidizing agent than Au^+.

Explanation:

Cell Type 01

027 10.0 points

What is the cathode in

$$Ag(s) \mid Ag^+(aq) \,||\, Fe^{2+}(aq) \mid Fe(s)$$

$Ag^+ + e^- \rightarrow Ag$ $\mathcal{E}^\circ_{red} = +0.80$

$Fe^{2+} + 2\,e^- \rightarrow Fe$ $\mathcal{E}^\circ_{red} = -0.44$

and what type cell is it?

1. $Ag(s) \mid Ag^+(aq)$; an electrolysis cell

2. $Fe^{2+}(aq) \mid Fe(s)$; a battery

3. $Ag(s) \mid Ag^+(aq)$; a battery

4. $Fe^{2+}(aq) \mid Fe(s)$; an electrolysis cell **correct**

5. Not enough information is provided.

Explanation:

The diagram A | B || C | D is read as follows:

$A \rightarrow B + n\,e^-$ (oxidation)

$C + m\,e^- \rightarrow D$ (reduction)

Since reduction occurs at the cathode, the cathode is $Fe^{2+}(aq) \mid Fe(s)$

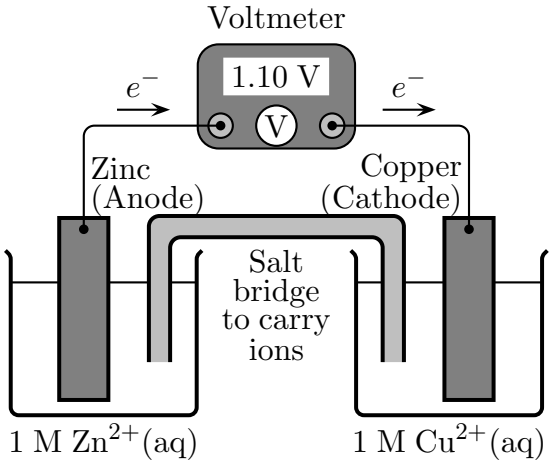
To determine cell type, calculate $\mathcal{E}^\circ$ cell:

$$2\,Ag(s) \rightarrow 2\,Ag^+(aq) + 2\,e^-$$
$$\mathcal{E}^\circ_{anode} = -0.80\text{ V}$$
$$Fe^{2+} + 2\,e^- \rightarrow Fe$$
$$\mathcal{E}^\circ_{cathode} = -0.44\text{ V}$$
$$2\,Ag(s) + Fe^{2+} \rightarrow 2\,Ag^+(aq) + Fe$$
$$\mathcal{E}^\circ_{cell} = -1.24\text{ V}$$

Since $\mathcal{E}^\circ$ cell is negative, the reaction is not spontaneous; potential has to be applied to the cell to enable this reaction to occur; *i.e.*, an electrolytic cell.

CIC T08 09

028 10.0 points



In this electrochemical cell, what is the reduction half reaction?

1. $Zn^{2+}(aq) + 2\,e^- \rightarrow Zn(s)$

2. $Cu(s) \rightarrow Cu^{2+}(aq) + 2\,e^-$

3. $Zn(s) \rightarrow Zn^{2+}(aq) + 2\,e^-$

4. $Cu^{2+}(aq) + 2\,e^- \rightarrow Cu(s)$ **correct**

Explanation:

$$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$$

Reduction occurs at the cathode. In this cell the reduction half reaction is

$$Cu^{2+}(aq) + 2\,e \rightarrow Cu(s)$$

Cu^{2+} cations are attracted to the solid Cu electrode where they are reduced to Cu(s).

Std Cell Potential

029 10.0 points

What is the E°_{cell} of

$$Zn(s) \mid Zn^{2+}(aq) \parallel Ce^{4+}(aq) \mid Ce^{3+}(aq)$$

$Zn^{2+} + 2\,e^- \rightarrow Zn$ $\quad E^\circ_{red} = -0.76$
$Ce^{4+} + e^- \rightarrow Ce^{3+}$ $\quad E^\circ_{red} = +1.61$

1. $+2.37$ **correct**

2. $+1.61$

3. -0.85

4. $+0.85$

5. -2.37

Explanation: