Practice Exam 2 for VandenBout and Laude Spring 2008

1. What is the concentration of hydroxide ions in a solution that contains of 0.100 M HCN(aq) and 0.200 M NaCN(aq)?

- **A.** 2.4×10^{-5} M
- **B.** 1.1×10^{-9} M
- **C.** 2.5×10^{-10} M
- **D.** 4.1×10^{-5} M

Answer: D

2. 10 ml of 0.1 M LiOH is added to each of the following solutions. Which of them will still be a buffer after addition of the base? I) 20 ml of 0.1 M HClO4 II) 20 ml of 0.1 M HClO2 III) 10 ml of 0.1 M HClO2 IV) 10 ml of 0.2 M HClO2 and 10 ml of 0.1 M HClO2 V) 10 ml of 0.1 M HClO2

- **A.** II only
- **B.** I and II
- **C.** all of them
- **D.** II and IV
- **E.** IV and V

Answer: D

3. Which of the following species is the strongest base in water?

- **A.** the conjugate base of HNO_3
- **B.** the conjugate base of a weak acid with $pK_a = 2.5$
- **C.** a compound with a $pK_b = 7.5$
- **D.** a compound with a $pK_b = 4.5$
- **E.** the conjugate base of a weak acid with $pK_a = 11.5$

Answer: E

4. A solution of 0.5 M barium hydroxide dissociates completely in 100 ml of a 0.5 M formic acid and 0.4 M lithium formate. What is the volume of barium hydroxide that can be added before the buffer capacity is exceeded?

- **A.** 20 ml
- **B.** 40 ml
- **C.** 100 ml
- **D.** 50 ml

- **E.** 90 ml

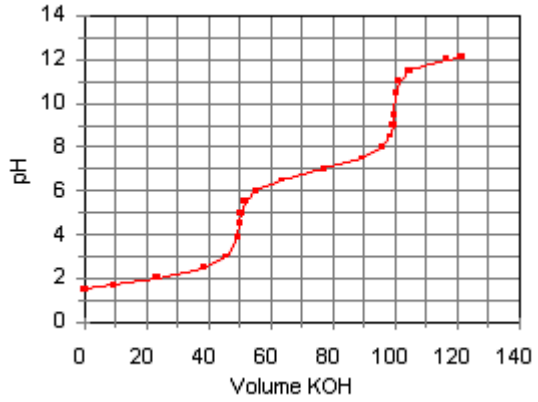
Answer: D

5. A buffer solution of volume 200.0 mL is 0.250 M Na_2HPO_4(aq) and 0.250 M KH_2PO_4(aq). The pH resulting from the addition of 50.0 mL of 0.100 M NaOH(aq) to the buffer solution will be

- **A.** 7.12
- **B.** 7.21
- **C.** 7.30
- **D.** 12.77

Answer: C

6. The titration curve for the titration of 0.100 M H_2SO_3(aq) with 0.100 M KOH(aq) is given below.



Estimate pK_{a1} and pK_{a2} of H_2SO_3.

Answer: pKa1 ~ 2.0 and pKa2 ~ 6.9

7. What is the pH at the stoichiometric point for the titration of 0.100 M CH_3COOH(aq) with 0.100 M KOH(aq)? The value of K_a for acetic acid is 1.8×10^{-5}.

- **A.** 5.28
- **B.** 8.72
- **C.** 7.00
- **D.** 9.26
- **E.** 8.89

Answer: B

8. What is the pH at the half-stoichiometric point for the titration of 0.22 M HNO_2(aq) with 0.10 M KOH(aq)? For HNO_2, $K_a = 4.3 \times 10^{-4}$.

- **A.** 2.31
- **B.** 7.00

- **C.** 2.01
- **D.** 3.37
- **E.** 2.16

Answer: D

9. Rocks with a variety of solubility product constants are thrown into water. Which of them will produce the fewest ions in solution?

- **A.** A rock of the form AB2 with a $pK_{sp} = 10$
- **B.** A rock of the form AB3 with a $pK_{sp} = 10$
- **C.** A rock of the form A2B3 with a $pK_{sp} = 30$
- **D.** A rock of the form AB2 with a $pK_{sp} = 20$
- **E.** A rock of the form AB with a $pK_{sp} = 20$

Answer: E

10. What is the solubility in moles/liter for lead (II) iodide at 25 ^{o}C given a K_{sp} value of 1.4×10^{-8}. Write using scientific notation and use 1 or 2 decimal places (even though this is strictly incorrect!)

Answer: 1.52e-3

11. The K_{sp} of AgCl is 1.6×10^{-10}. What is the solubility of AgCl in 0.0010 M $CaCl_2$? Give your answer using scientific notation and to 2 significant figures (i.e., one decimal place).

Answer: 8.0e-8

12. The solubility of all except which the following compounds increases as the pH of the solution decreases?

- **A.** CaF_2
- **B.** Na_2CO_3
- **C.** $PbSO_3$
- **D.** $KClO_4$
- **E.** CuS

Answer: D

13. A 0.0010 M solution of a weak acid, HA, with $K_a = 2 \times 10^{-10}$ produces $[H_3O^+] < 10^{-6}$ M. Which of the following equations can be used to determine $[H_3O^+]$?

- **A.** The acid is so weak that the pH is about 7.
- **B.** $[H_3O^+]^2 + K_a [H_3O^+] - [HA]_{initial}K_a = 0$
- **C.** $[H_3O^+] = (K_w + K_a[HA]_{initial})^{1/2}$

- **D.** $[H_3O^+] = [HA]_{initial}$
- **E.** $[H_3O^+] = (K_a[HA]_{initial})^{1/2}$

Answer: C

14. In a solution that is labeled "0.10 M $H_3PO_4(aq)$," $[H_3O^+] = 0.024$ M. Match the species below with their concentrations.

H_3PO_4	6.2×10^{-8}
$H_2PO_4^-$	8.0×10^{-2}
HPO_4^{2-}	5.4×10^{-19}
PO_4^{3-}	2.4×10^{-2}

Answer: $[H_3PO_4] = 8.0 \times 10^{-2}$, $[H_2PO_4^-] = 2.4 \times 10^{-2}$, $[HPO_4^{2-}] = 6.2 \times 10^{-8}$, $[PO_4^{3-}] = 5.4 \times 10^{-19}$

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

- **A.** $[KOH]_{initial} = [K^+]$
- **B.** $[OH^-] = [H_3O^+] + [K^+]$
- **C.** $[H_3O^+] = [OH^-]$
- **D.** $[K^+] = [OH^-] + [H_3O^+]$
- **E.** $[OH^-] = [K^+]$

Answer: B

16. How many simultaneous equations need to be solved to determine the equilibrium concentrations of all species when $NaHPO_4$ and H_3PO_4 are added to solution? (Don't include the concentration of water in your considerations.)

- **A.** 4
- **B.** 5
- **C.** 6
- **D.** 7
- **E.** 8

Answer: D

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

- **A.** $[H_2PO_4^-]$ is greater than 0.10 M.
- **B.** $[H^+] = 0.30$ M.
- **C.** $[PO_4^{3-}] = 0.10$ M.

- **D.** $[H^+] = 0.10$ M.
- **E.** $[H^+]$ is less than 0.10 M.

Answer: E

18. Estimate the pH of 0.10 M Na_2HPO_4(aq) given $pK_{a1} = 2.12$, $pK_{a2} = 7.21$, and $pK_{a3} = 12.68$ for phosphoric acid.

- **A.** 12.68
- **B.** 9.94
- **C.** 7.40
- **D.** 4.67
- **E.** 2.12

Answer: B

19. Estimate the pH of 10^{-7} M KOH(aq).

- **A.** 6.9
- **B.** 9
- **C.** 13
- **D.** 7.2
- **E.** 7.0

Answer: D

20. For a solution labeled "0.10 M H_2SO_4(aq),"

- **A.** $[HSO_4^-]$ is greater than 0.10 M.
- **B.** the pH is less than 1.0.
- **C.** $[SO_4^{2-}] = 0.10$ M.
- **D.** the pH equals 1.0.
- **E.** the pH is greater than 1.0.

Answer: B

21. What is the sum of the coefficients when the following redox couple is balanced in acidic solution? $MnO_4^- + 2I^- \rightarrow Mn^{+2} + I_2$

- **A.** 12
- **B.** 14
- **C.** 38

- **D.** 43
- **E.** 36

Answer: D

22. What is the sum of the coefficients when the following redox couple is balanced in basic solution? MnO_4^- + Ag → MnO_2 + Ag^+

- **A.** 4
- **B.** 12
- **C.** 14
- **D.** 4
- **E.** 3

Answer: C

23. If the standard potentials for the couples Cu^{2+}/Cu, Ag^+/Ag, and Fe^{2+}/Fe are +0.34, +0.80, and –0.44 V, respectively, which is the strongest reducing agent?

- **A.** Fe
- **B.** Ag
- **C.** Ag^+
- **D.** Cu
- **E.** Fe^{2+}

Answer: A

24. What is the proper cell diagram for the reaction

$$2AgCl(s) + H_2(g) \rightarrow 2Ag(s) + 2H^+(aq) + 2Cl^-(aq)$$

- **A.** $Pt|Cl^-(aq)|H^+(aq) \,\|\, H_2(g)|AgCl(s)|Ag(s)$
- **B.** $Pt|H_2(g)|H^+(aq) \,\|\, Cl^-(aq)|AgCl(s)|Ag(s)$
- **C.** $Ag(s)|AgCl(s)|Cl^-(aq) \,\|\, H^+(aq)|H_2(g)|Pt$
- **D.** $Pt|H_2(g)|H^+(aq) \,\|\, Cl^-(aq)|Ag(s)|Pt$
- **E.** $Ag(s)|AgCl(s)|H^+(aq) \,\|\, Cl^-(aq)|H_2(g)|Pt$

Answer: B

25. In a working electrochemical cell (+ cell voltage), the electrons flow from the anode through the external circuit to the cathode. True or false?

Answer: True

26. The standard potential of the Cu^{2+}/Cu electrode is +0.34 V and the standard potential of the cell

$$Pb(s)|Pb^{2+}(aq) \| Cu^{2+}(aq)|Cu(s)$$

is +0.47 V. What is the standard potential of the Pb^{2+}/Pb electrode?

- **A.** –0.26 V
- **B.** +0.81 V
- **C.** –0.81V
- **D.** –0.13 V
- **E.** +0.13 V

Answer: D

27. The standard potential of the cell

$$Pb(s)|PbSO_4(s)\square SO_4^{2-}(aq) \| Pb^{2+}(aq)|Pb(s)$$

is +0.23 V at 25°C. Calculate the equilibrium constant for the reaction of 1 M $Pb^{2+}(aq)$ with 1M $SO_4^{2-}(aq)$.

- **A.** 3.7×10^{16}
- **B.** 8.0×10^{17}
- **C.** 6.0×10^{7}
- **D.** 1.7×10^{-8}
- **E.** 7.7×10^{3}

Answer: C

28. In an electrolytic cell, a current is passed through a solution of a chloride of iron, producing Fe(s) and $Cl_2(g)$ according to the reaction:
$FeCl_2(l) \rightarrow Fe(s) + Cl_2(g)$
The current that would produce chlorine gas at a rate of 3.00 grams per hour is:

- **A.** 1.126 A
- **B.** 2.25 A
- **C.** 1.51 A
- **D.** 4.53 A

Answer: B

29. Consider the following cell:

$$Pt|H_2(g, 1\ atm)|H^+(aq, ?\ M) \| Ag^+(aq, 1.0\ M)|Ag(s)$$

If the voltage of this cell is 1.04 V at 25°C and the standard potential of the Ag^+/Ag couple is +0.80 V, calculate the hydrogen ion concentration in the anode compartment.

- **A.** 4.6×10^{-10} M
- **B.** 8.8×10^{-5} M
- **C.** 9.4×10^{-3} M
- **D.** 1.0 M
- **E.** 3.7×10^{-8} M

Answer: B

30. When a cell of a lead storage battery is being charged, it is:

- **A.** A galvanic cell
- **B.** A Daniell cell
- **C.** An electrolytic cell
- **D.** A dry cell

Answer: C