Chemistry Lab: Acids/Bases and Aqueous Solutions

Key

Part 1- Acids and Bases (36 pts)

1. What is the conjugate base of the following acids: $HClO_4$, H_2S, PH_4^+, H_2O (_/1)

.25 for each

ClO_4^-, HS^-, PH_3, OH^-

2. What is the conjugate acid of the following bases: CN^-, SO_4^{2-}, H_2O, HCO_3^- (_/1)

.25 for each

HCN, HSO_4^-, H_3O^+, H_2CO_3

3. Label the acid, base, conjugate acid, and conjugate base in the equation (_/1)

$HCl\ (g) + H_2O\ (l) \rightarrow H_3O^+\ (aq) + Cl^-$

.25 for each

HCl: acid, H_2O: base, H_3O^+: conjugate acid, Cl^-: conjugate base

4. Predict whether equilibrium lies predominantly to the left or the right (_/1)

.5 for each

a. $HSO_4\ (aq) + CO_3^{2-}\ (aq) \rightarrow SO_4^{2-}\ (aq) + HCO_3^-\ (aq)$ right

b. $PO_4^{3-}\ (aq) + H_2O\ (l) \rightarrow HPO_4^{2-}\ (aq) + OH^-\ (aq)$ left

5. A solution made by adding solid sodium hypochlorite (NaClO) to enough water to make 2.00 L of solution has a pH of 10.50. Using the equation below calculate the number of moles of NaClO that were added to the water. (_/4)

$ClO^-\ (aq) + H_2O\ (l) \rightarrow HClO\ (aq) + OH^-\ (aq)$ $\quad K_b = 3.3 \times 10^{-7}$

3 points for work (finding $[OH^-]$, solving K_b expression, molarity→moles), 1 point for the correct answer

0.606 mol

6. In each of the following pairs choose the compound that creates a more acidic solution and briefly explain why (_/2)

1 pt if 3 are correct, 2 pts if all are correct, otherwise no points

a. HBr, HF HBr, HBr is a strong acid and Br is larger than F

b. PH_3, H_2S H_2S, S is more electronegative than P

c. HNO_2, HNO_3 HNO_3, more oxygen atoms increases the polarity

d. H_2SO_3, H_2SeO_3 H_2SO_3, S is more electronegative than Se

7. Calculate the pH of a solution containing 0.085 M nitrous acid and 0.10 M potassium nitrite. ($K_a = 4.5 \times 10^{-4}$) (_/4)

3 points for work (K_a expression, solving for $[H^+]$, calculating pH), 1 point for answer

3.42

8. Calculate the formate concentration and pH of a solution that is 0.05 M in formic acid, $HCHO_2$ ($K_a = 1.8 \times 10^{-4}$) and 0.10 M in HNO_3 (_/4)

2 points for work (solving K_a expression, calculating pH), 1 point for each right answer

8.96×10^{-5} M, 1.00

9. Calculate the pH of a buffer composed of 0.12 M benzoic acid and 0.20 M sodium benzoate ($K_a = 6.34 \times 10^{-5}$) (_/3)

4.42

2 points for work (plugging in values into Henderson-Hasselbalch equation or solving the K_a expression), 1 point for answer

10. 50.0 mL of 0.10 M acetic acid ($K_a = 1.8 \times 10^{-5}$) is titrated with 0.10 M NaOH. Calculate the pH when the following volumes of base are added:

a. 10.0 mL (_/3)

4.15

2 pts for work (using Henderson-Hasselbalch equation or K_a expression), 1 point for answer

b. 50.0 mL (_/3)

8.72

2 pts for work (calculating K_b of acetate, solving K_b expression and calculating pH), 1 point for answer

c. 75.0 mL (_/3)

12.75

2 pts for work (calculating concentration of excess OH^-, calculating pH), 1 point for answer

11. A solution is predicted to have a pH of 3.5. Give **two** indicators that can be used and explain how these indicators are used to verify the test results. (_/3)

Answers may vary. Two examples of indicators are bromophenol blue (pH range: 3.0-4.6) and methyl orange (pH range: 3.0-4.4). If the bromophenol blue yields a greenish color and the methyl orange yields an orange color, it means that the resulting pH is within the pH ranges of the indicators. If the result shows yellow, pink, or blue, the prediction may have been incorrect.

3 points total - 1 for the two indicators, 2 for explanation

12. Give **three** uses for H_2SO_4 (sulfuric acid). (_/3)

1 point for each right use, 3 points max

Corroding metals/tissues, fertilizers, pesticides, petroleum refining, iron/steel production, adhesive/sealant, air care, batteries, etc.

Part 2- Aqueous solutions (24 pts)

1. A solution is prepared by mixing 1.00 g ethanol (C_2H_5OH) with 100.0 g of water to give a final volume of 101 mL. Calculate the molarity, mass percent, mole fraction, and molality of ethanol (_/2)

0.5 points for each right answer

0.215 M, 0.99 %, 3.89×10^{-3}, 0.217 m

2. A 2.5 g sample to groundwater has 5.4 μg of Zn^{2+}. What is the concentration of Zn^{2+} in parts per million? (_/2)

1 point for work (diving Zn^{2+} mass by groundwater mass), 1 point for answer
2.2 ppm

3. Calculate the molality and mole fraction of a 36% by mass HCl solution (_/2)

1 point for each right answer
15 m, 0.22

4. Glycerin ($C_3H_8O_3$) is a nonvolatile nonelectrolyte with a density of 1.26 g/mL at 25°C. Calculate the vapor pressure (in torr) at 25°C of a solution made by adding 50.0 mL of glycerin to 500.0 mL of water. The vapor pressure of pure water at 25°C is 23.8 torr, and its density is 1.00 g/mL (_/3)

2 points for work (calculating mole fraction, multiplying by pure water vapor pressure), 1 point for answer
23.2 torr

5. Calculate the total vapor pressure of a solution containing 1.0 mol benzene (C_6H_6) and 2.0 mol toluene (C_7H_8). At 20°C the vapor pressure of benzene is 75 torr and toluene is 22 torr. (_/2)

1 point for work (multiplying mole fraction of each substance by respective pressure and adding), 1 point for right answer
40 torr

6. List the following aqueous solutions in order of decreasing freezing point: 0.050 m $CaCl_2$, 0.15 m NaCl, 0.10 m $C_{12}H_{22}O_{11}$ (_/1)

1 point for correct order

$C_{12}H_{22}O_{11}$, $CaCl_2$, NaCl

7. Calculate the concentration of CO_2 in a soft drink that is bottled with a partial pressure of CO_2 of 4 atm over the liquid at 25°C. The Henry's law constant for CO_2 in water at this temperature is 3.1×10^{-2} M/atm (_/3)

2 points for work (multiplying pressure by Henry's law constant), 1 point for answer

0.124 M

8. A sample of 2.05 g of polystyrene was dissolved in enough toluene to create 100.0 mL of solution. The osmotic pressure of this solution is 1.21 kPa at 25°C. Calculate the molar mass of polystyrene (_/2)

1 point for work (using osmotic pressure equation), 1 point answer

4.20×10^4 g/mol

9. Fill out the following table (_/5)

1 point per row

Type of colloid	Dispersing medium	Dispersed substance	Example
Emulsion	Liquid	Liquid	Milk

Sol	Liquid	Solid	Paint
Solid emulsion	Solid	Liquid	Butter
Aerosol	Gas	Liquid	Fog
Aerosol	Gas	Solid	Smoke

Part 1: __/36
Part 2: __/22
Total: __/58