1. When 2.00 mol of SO₂Cl₂ is placed in a 2.00 L flask at 303 K, 56% of the SO₂Cl₂ decomposes to SO₂ and Cl₂:

$$SO₂Cl₂(g) \rightleftharpoons SO₂(g) + Cl₂(g)$$

What is the equilibrium constant in terms of molar concentrations, $K_c$, for this reaction at 303K?

2. The following $K_c$ values were attained at 823 K:

- $CoO(s) + H_2(g) \rightleftharpoons Co(s) + H_2O(g)$  $K_c = 67$
- $CoO(s) + CO(g) \rightleftharpoons Co(s) + CO₂(g)$  $K_c = 490$

Calculate the equilibrium constant for:

$$H_2(g) + CO(g) \rightleftharpoons CO(g) + H_2O(g)$$ at 823K.

3. Calculate the Gibbs free energy of reaction, $\Delta G_{r,x,n}$, that occurs in a closed vessel with constant volume, temperature and total pressure for the reaction:

$$2H_2S(g) \rightleftharpoons 2H_2(g) + S_2(g)$$

when the partial pressures of the substances are as follows: $P_{H₂S} = 0.445$ bar; $P_{H₂} = 0.112$ bar; $P_{S₂} = 0.055$ bar. The value of $K = 2.4 \times 10^{-4}$ at 1073K.

4. A 0.084 M solution of phenylacetic acid, $C₆H₅CH₂COOH$, has a pH of 2.68. What is the acid dissociation constant for this acid?

5. Which of the following will act as the strongest base in water?

- $Cl^-$
- $NO₃^-$
- $HSO₄^-$
- $ClO^-$

6. Hypoiodous acid, $HIO$, has a $pKₐ = 10.64$ at $25°C$. A solution is 0.250 M of hypoiodous acid. What is the $[OH^-]$ in the solution?

7. What is the pH of 0.045 M solution of Sr(OH)₂?

8. $K_{sp} = 1.4 \times 10^{-7}$ for copper(II) iodate, $Cu(IO₃)₂$ in water at $25°C$. Estimate the molar solubility of the compound at $25°C$.

9. A buffer contains equal amounts of a weak base and its conjugate acid. It has a $pH = 10.84$. Out of the following, what is a reasonable value for the $pH$ after the addition of a small amount of base?

- $3.16$
- $7.00$
- $10.74$
- $10.94$
- $13.84$

10. What is the pH of a 0.265 M solution of ammonium nitrate, $NH₄NO₃$? The $K_b$ value of $NH₃ = 1.76 \times 10^{-5}$.

11. Consider the titration of 30.0 mL of 0.115 M KOH with 0.250 M HClO₄. What is the pH after 10.0 mL of HClO₄ has been added?

12. Approximately how many moles of NaOH must be added to 1.00 liter of 0.150 M acetic acid to make the $pH$ of the solution 5.240? Assume no change in volume. The $K_a$ of acetic acid = $1.8 \times 10^{-5}$.

13. Calculate $\Delta G_{r,x,n}$ in kJ for the following reaction occurring in a galvanic cell at $25°C$.

$$Pb^{2+}(aq) + Mg(s) \rightarrow Pb(s) + Mg^{2+}(aq) \quad E_{cell}^o = +0.63V$$
14. Balance the following reaction in acidic solution.

\[ \text{Mn}^{2+}(aq) + \text{NaBiO}_3(s) \rightarrow \text{Bi}^{3+}(aq) + \text{Na}^+(aq) + \text{MnO}_4^-(aq) \]

What is the coefficient in front of \( \text{H}^+(aq) \) and which side of the equation is it on in the overall, balanced reaction?

15. Gold can be plated out of a solution containing \( \text{Au}^{3+} \). What mass of gold (in grams) can be plated by a 10.0-min. flow of a 5.5 Amp current?

16. A galvanic electrochemical cell was made at 25°C using the redox couples \( \text{Mn}^{2+}/\text{Mn} \) and \( \text{Sn}^{2+}/\text{Sn} \). What is the cell potential of the electrochemical cell?

17. If the cell potential of a galvanic cell made using the redox couples \( \text{H}^+/	ext{H}_2 \) and \( \text{Zn}^{2+}/\text{Zn} \) is 0.55 \( \text{V} \) at 25°C when the concentration of zinc ions is 1.2 M and the partial pressure of \( \text{H}_2 = 1.0 \text{ atm} \), what is the \( \text{pH} \) of the cathode solution?

18. If you start with 0.0250 \( \text{mol} \) of \( \text{N}_2\text{O}_5(g) \) in a volume of 2.0 \( \text{L} \), how many minutes will it take for the quantity of \( \text{N}_2\text{O}_5(g) \) to drop to 0.010 \( \text{mol} \)?

19. Which of the following extrinsic semiconductors would form a \( p \)-type semiconductor?

\( \text{Ge : S} \quad \text{Ge : P} \quad \text{Si : Al} \quad \text{Si : N} \)

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1. 0.71
2. \( K_c = 0.14 \)
3. 24 \( \text{kJ/mol} \)
4. \( 5.4 \times 10^{-5} \)
5. \( \text{ClO}^- \)
6. \( 4.2 \times 10^{-9} \)
7. \( \text{pH} = 12.95 \)
8. 0.0033 \( \text{mol/L} \)
9. 10.94
10. \( \text{pH} = 4.911 \)
11. \( \text{pH} = 12.376 \)
12. 0.114 \( \text{mol NaOH} \)
13. \(-120 \text{ kJ} \)
14. 14, left side of the equation.
15. 2.2 \( \text{g} \)
16. +1.04 \( \text{V} \)
17. \( \text{pH} = 3.51 \)
18. 2.2 \( \text{min} \)
19. \( \text{Si : Al} \)