1. How can the relative supersaturation be varied during precipitate formation? (10%)
2. Explain why the titration of copper ion with ammonia is not satisfactory, whereas a chelating agent such as EDTA gives good result? (10%)
3. **Define** the following terms: (30%)
   a. (2%) dynamic range
   b. (2%) matrix effect
   c. (3%) detection limit (S/N = 3)
   d. (4%) photodiode and charge coupled device
   e. (2%) internal conversion (in spectrophotometry)
   f. (3%) spectral and chemical interference (in AAS/AES)
   g. (3%) evanescent wave (ATR)
   h. (4%) inductively coupled plasma
   i. (4%) splitless injection and cold trapping (GC)
   j. (3%) electroosmotic mobility (CE)
4. When one mole of an ideal monatomic gas is allowed to expand adiabatically and reversibly from 22.7 L mol^{-1} at 1 bar and 0°C to a volume of 45.4 L mol^{-1}. How much work is done in the adiabatic expansion? ($2^{2/3}$=1.5874) (5%)
5. Helium is compressed isothermally and reversibly at 100°C from a pressure of 2 to 10 bar. Calculate (a) heat q, (b) work w, (c) $\Delta\overline{G}$, (d) $\Delta\overline{A}$, (e) $\Delta\overline{H}$, (f) $\Delta\overline{U}$, and (g) $\Delta\overline{S}$ per mole, assuming that helium is an ideal gas. (7%) (Gas constant R = 8.314 51 J K^{-1} mol^{-1}, ln5 = 1.609)
6. How many degrees of freedom of intensive variables for N_2O_4 in equilibrium with NO_2 in the gas phase. Write down one possible set of these independent intensive variables. (4%)
7. For the reaction $CO(g) + 3H_2(g) = CH_4(g) + H_2O$ at approximately 25°C (g) when 1 bar of inert gas Ar added to this reaction, the equilibrium extent of reaction ξ should increase or decrease. (2%)
8. What is the ionic strength of the solution containing both 0.01 mol kg^{-1} Na_2HPO_4 and 0.01 mol kg^{-1} NaH_2PO_4. (2%)
9. For a reversible first-order reaction $A \underset{k_2}{\overset{k_1}{\rightleftharpoons}} B$ derive the integrated rate equation for [A](t) for the initial condition of [A] (t = 0) = A_0 and [B] (t = 0) =0. Plot the concentration of [A] and [B] versus time and indicate the respective decay time constants for [A] and [B] in this plot. (10%)

填充題，每小題二分：答案勿寫在此處，要寫在答案卷上，見題末答案格式樣本。

10. (a) The point group for H_2O_2 is ____. That for planar trans $C_2H_2Cl_2$ is _____ (example: C_{2v} for H_2O)

(b) The term symbol ($^{2s+1}L_J$) for nitrogen atom in ground state is _____. That for boron atom is _____ (example: $^2S_{1/2}$ for Li)

(c) The molecular orbital configuration for the diatomic molecule C_2 is ____ and the term symbol is _____ (example: for Be_2, there are $(1\sigma_g)^2(1\sigma_u)^2$ and $^1\Sigma_g$ respectively)

(d) Sketch two more normal modes of vibration for CO_2

←•—•—•→, ←•—•→←•, _____, _____

(e) The probability to obtain the eigenvalue of $\hbar$ from the measurement of L_Z for $2p_x$ orbital is ____. The expectation value of L_Z for $2p_x$orbital is ____.

(f) Fifteen meters of water reduces red sunlight to a quarter of its intensity at surface (I_o). What is the intensity (I) reaching a depth of 30 meters? I/I_o = _____ (using Beer's law for water)

(g) For Morse potential $V(x) = D(1-e^{-\beta x})^2$, the force constant k can be expressed k = _____ (in term of D and β). Note that x=0 is the minimum of V(x))

(h) Assume that Δx=a for particle-in-a-box state function ψ_n, therefore the uncertainty product $(\Delta x)(2p_x)$= ____ (no integration needed, estimate Δp_x from $E_n = n^2h^2/8ma^2$ for box size a)

(I) Express the normalization factor N for antibonding π orbital $\pi_g 2p_x = N(2p_x(A) - 2p_x(B))$ in terms of $S = \langle 2p_x(A)|2p_x(B)\rangle$. N =_____.

(J) Give the total wavefunction for the triplet excited state of Helium atom with the configuration $1s^12s^1$ and S_Z=0. Express it in terms of (1s, 2s) orbital, and (α, β) spin. ψ(1,2) = _____.

10. (a) xxxxx, xxxxxx

(b) xxxxx, xxxxxx

.....

(f) xxxxx

(g) xxxxx