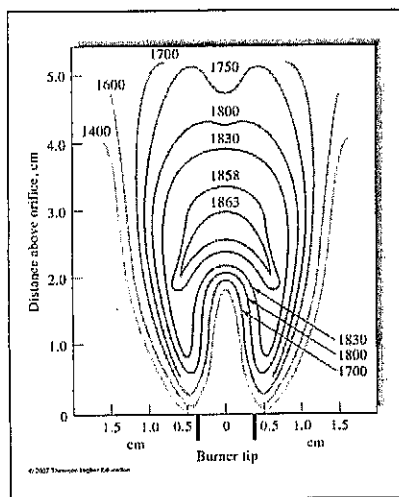


『分析化學』，問答題 13 題，總分 100 分

- (1) Briefly explain the working principle of phase sensitive detector (synchronous demodulator) in a lock-in amplifier? [8 points]
- (2) How to avoid the noise interference picked from a power source line? [5 points]
- (3) (a) Please calculate the ionic strength of  $\text{MgSO}_4$  solution and  $\text{NaNO}_3$  solution when the molar concentrations are both 0.01M; (b) Explain why  $\text{AgCl}$  solid has higher solubility in the above  $\text{MgSO}_4$  solution than in  $\text{NaNO}_3$  solution. [Hint:  $\log(\gamma) \sim -0.51z^2 I^{1/2}$  in dilute solution where  $\gamma$ ,  $z$ , and  $I$  are activity coefficient, valence, and ionic strength of solute respectively.] [12 points]
- (4) Find the pH and fraction of dissociation ( $\alpha$ ) of a 0.100 M solution of weak acid HA with  $K_a = 1.00 \times 10^{-5}$ . [12 points]
- (5) Write the Henderson-Hasselbalch equation of a solution of weak acid HA of which the dissociation constant is  $K_a$ . [5 points]
- (6) Given that the  $\text{p}K_b$  for nitrite ion ( $\text{NO}_2^-$ ) is 10.85, find the quotient  $[\text{HNO}_2]/[\text{NO}_2^-]$  in a solution of sodium nitrite at (a) pH 2.00; (b) pH 10.00. [8 points]
- (7) According to Van Deemter equation, the theoretical plate height of a chromatographic peak  $H$  is a function of flow rate  $u$ ,  $H(u) = A + B/u + Cu$  where  $A$ ,  $B$ , and  $C$  are constants, please derive the optimum flow rate to result in the minimum  $H$ . [Hint: When  $dH/du = 0$  at  $u_0$ ,  $H$  has minimum value.] [4 points]
- (8) When the retention times of two chromatographic peaks are 7.0 and 8.0 min respectively, if these two peaks are of the same width, (a) how long is the peak width to achieve resolution  $R = 2$ ? (b) How many theoretical plates ( $N$ ) does the second peak have? [Hint:  $N = 16 (t_R/W)^2$ , where  $t_R$  and  $W$  are retention time and peak width, respectively] [8 points]
- (9) (a) What is the wavelength response range of photomultiplier tube (PMT)? (b) What is the typical operation voltage of PMT? [8 points]
- (10) What are the major advantages of using photodiode detector? [5 points]

- (11) For the flame shown in the below figure, calculate (a) the energy difference between the excited state and the ground state; (b) the relative intensity of the 766.5-nm emission line for K at the 2.0 and 4.0 cm above the flame, respectively. (Assume no ionization) [Hint: Planck constant  $h = 6.63 \times 10^{-34}$  J·s; Boltzman constant  $k_B = 1.38 \times 10^{-23}$  J·K<sup>-1</sup>] [12 points]



- (12) To prepare a solution of NaCl, you weigh out 2.634 ( $\pm 0.002$ ) g and dissolve it in a volumetric flask whose volume is 100.00 ( $\pm 0.08$ ) mL. Express the molarity of the solution, along with its uncertainty, with an appropriate number of digits. [Hint: the molecular weight of NaCl is 58.443 ( $\pm 0.002$ ) g/mol.] [5 points]
- (13) The percentage of an additive in gasoline was measured six times with the following results 0.13, 0.12, 0.16, 0.17, 0.20, 0.11%. Calculate (a) the mean; (b) standard deviation; (c) 95% confidence interval for the percentage of the additive. [Hint: At 95% confidence level, Student's t-values at the degrees of freedom 5, 6, and 7, are 2.571, 2.447, and 2.365, respectively.][8 points]