

## 2007 Fall Analytical Chemistry Qualification Exam

1. Design a circuit containing a **resistor** (R), an **inductor** (L) and a **switch** (S) which the character of time constant  $\tau$  is corresponding to a half-life time in kinetics ( $A=A_0\exp(-kt)$  when  $A=0.5A_0$ ) 10%
2. Anodic stripping voltammetry is used for analysis of trace metals. 12%
  - (a) Briefly explain how the mercury working electrode is produced for anodic stripping voltammetry.
  - (b) In anodic stripping voltammetry, what electrical quantity is varied during the measurement?
  - (c) In anodic stripping voltammetry, what electrical quantity is measured?
  - (d) What electrochemical processes occur with an analyte at the mercury working electrode during preconcentration?
  - (e) What electrochemical processes occur with an analyte at the mercury working electrode during stripping?
3. Briefly explain the differences between DSC and TGA methods. 10%
4. Give the **full name** of the following X-ray spectroscopes and explain what **properties** of material they measure. 18%
  - (1) XRD (2) XRF (3) EXAFS (4) XANES
5. Describe the major components of the typical spectroscopic instruments and plot the cartoon of the arrangement of these optical components for fluorescence. 10%
6. (a) Describe the Standard Addition Method.  
(b) A 25.0 mL sample containing  $\text{Cu}^{2+}$  gave an instrument signal 23.6 units (corrected for a blank). When exactly 0.5 mL of 0.0287 M  $\text{Cu}(\text{NO}_3)_2$  was added to the solution, the signal increased to 37.9 units. Calculate the molar concentration of  $\text{Cu}^{2+}$  assuming that the signal was directly proportional to the analyte concentration. 9%
7. Substances A and B have retention times of 16.40 and 17.63 min, respectively, on a 30.0-cm column. An unretained species passes through the column in 1.30 min. The peak widths (at base) for A and B are 1.11 and 1.21 min, respectively. Calculate (a) the column resolution, (b) the average number of plates in the column, (c) the plate height, (d) the length of column required to achieve a resolution of 1.5, (e) the time required to elute substance B on the column that gives an  $R_s$  value of 1.5. 10%
8. Define (a) Rayleigh scattering, (b) deviation of polychromatic radiation, (c) deviation of stray radiation, (d) Four-level laser system, (e) stoke shift, (f) releasing agent, and (g) protective agent. 21%