

## Advanced Analytical Chemistry

- In a solar cell open-circuit voltage measurement experiment, 8 repetitive data were collected as following: 1.37, 1.84, 1.35, 1.47, 1.10, 1.73, 1.54, 1.08 volt.
  - Assuming the noise is random, the signal to noise ratio (S/N) is defined as the ratio of the average value to standard deviation, calculate the S/N value.
  - S/N can be enhanced by averaging over a larger number of data. How many measurements would have to be averaged to increase S/N to 10. (10%)
- Explain the temperature programming in gas chromatography. (10%)
- For a normal-phase chromatographic separation, predict the order of elution of n-hexane, n-hexanol, benzene, and explain it. (10%)
- The GC data below are for a 25 meter column with various carrier gas flow rates,  $t_R$  is retention time, W is width of the base of a peak. Determine the optimum flow rate (10%)

Gas flow rate (mL/min)	$t_R$ (min)	W (min)
50	5.81	1.04
75	4.92	0.696
100	4.03	0.523
125	3.41	0.461
150	2.88	0.423

- Calculate the voltage for the electrochemical cell  $\text{Pt}, \text{H}_2 (0.8 \text{ atm}) | \text{HCl} (0.02 \text{ M}) | \text{AgCl} (\text{sat'd}) | \text{Ag}$ , knowing that the standard half cell potential for  $\text{AgCl}/\text{Ag}$  is +0.222V. (10%)

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6. Answer the following questions about XRD: 15%

(1) Give a short explanation of the working theory and the instrumentation of XRD.

(2) Calculate the goniometer setting, in terms of theta, required to observe the  $K\alpha_1$  line for iron (1.76 angstrom) and silver (0.5 angstrom) when diffracting crystal is (a) topaz (b) LiF.

(3) What is the short-wavelength limit of the continuum produced by an X-ray tube having silver target and operated at 100kV?

7. Explain what are the differences between XPS and Auger spectroscopy from the aspects of (1) basic principle (2) instrumentation? 10%

8. Explain what are the differences between TG and DTA? 10%

9. Distinguish among the following terms: 15%

- (1) resonance fluorescence, non-resonance fluorescence.
- (2) non-radiative relaxation, radiative relaxation.
- (3) filter, monochromator.
- (4) continuum source, line source.
- (5) photodetectors, thermometers.
- (6) spontaneous emission, stimulated emission.
- (7) angular dispersion, linear dispersion.