本試題共分兩大部份，part Ⅰ 和 part Ⅱ，各佔五十分。

part Ⅰ

1. Define the following terms: (15%)

   a) population standard deviation  b) mediator

   c) junction potential  d) systematic error  e) iodometry

2. A standard Reference material is certified to contain 94.6 ppm of an organic contaminant in soil. Your analysis gives values of 98.6, 98.4, 97.2, 94.6 and 96.2 ppm. Do your results differ from the expected result at the 95% confidence level? If you made one more measurement and found 94.5, would your conclusion change? [Note: at the 95% confidence level, t = 2.776 for 4 degrees of freedom; t = 2.571 for 5 degrees of freedom] (6%)

3. State when standard additions and internal standards, instead of a calibration curve, are desirable, and why. (4%)

4. How to prepare a carbonate free NaOH standard solution ? (4%)

5. (a) Derive equations for α values of $H_3A$, $H_2A^-$, $HA^{2-}$ and $A^{3-}$ for a triprotic system. (b) Calculate the values of these fractions for phosphoric acid at pH 7.00. ($pKa_1 = 2.15$, $pKa_2 = 7.20$, $pKa_3 = 12.15$) (7%)

6. Why EDTA is the most useful reagent in the complexometric titration ? State the purpose of an auxiliary complexing agent in the EDTA titration and give an example of its use. (4%)

7. Explain why a silver electrode can be an indicator electrode for $Ag^+$ and for halides. (6%)

8. (a) What are the advantages of a dropping Hg electrode in polarography? Why is polarography used mainly to study reduction rather than oxidation? (b) What is the difference between faradaic and charging current? (4%)

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part II

1.(11%) An assay was performed using electromagnetic radiation that has a wavelength of 475 nm in methanol (refractive index = 1.329). Calculate the a) velocity, b) frequency, c) photon energy of the radiation in methanol. Also, determine the wavelength in air (refractive index = 1.0003) of the radiation.

2.(5%) Sketch and describe how a phototube works.

3.(4%) Why is atomic emission more sensitive to flame instability than atomic absorption or fluorescence?

4.(6%) What are the advantages and disadvantages of Raman Spectroscopy over Infrared Spectroscopy?

5.(4%) A mixture of nonane, octane, and methane was injected into a gas chromatograph. Methane gave a sharp spike in 55 sec, whereas nonane was eluted in 375 sec and octane required 285 sec. Find the relative retention of the two solutes, nonane and octane.

6.(6%) Lithium-drifted silicon detectors, Si(Li), have assumed importance as detectors of x-radiation. Sketch and discuss how Si(Li) works.

7.(8%) a) Discuss the working principles behind x-ray photoelectron spectroscopy and Auger electron spectroscopy. b) Which of the two spectroscopies may find more applications in nanotechnology? Why?

8.(6%) Design a circuit to perform the following calculation: $y = -8x_1 - 2x_2$