INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR
DEPARTMENT OF CHEMISTRY

Date..................FN / AN

Time : 2 hrs.

Full Marks :30

No of Students : 30

Subject No. : CY 61006

Mid-Spring Semester, 2012

5th year M. Sc. and Ph.D. students

Sub. Name : Application of Fluorescence Spectroscopy in Chemistry and Biology
Answer all questions.

1. a) Draw a schematic diagram of a double beam fluorescence spectrophotometer. Explain the design of a spectrofluorometers for high throughput. Write down the name of two source lamps used in a fluorescence spectrophotometer? What are the other sources used instead of lamps?

   $[2 +2+1+1=6]$

   b) How will you take fluorescence excitation spectrum in a spectrofluorimeter? Is it possible to detect impurity in a flurophore using fluorescence excitation spectra?

   $[2]$

   c) Draw the Jablonski diagram of a fluorescence probe and show the different photophysical processes occurring in the excited state of the molecule. $[2]$

   d) Write down the 'Kasha's rule' for electronic relaxation. Do you think that this rule is still valid?

   $[2]$

   e) The singlet to triplet transition is spin forbidden. But in what condition the triplet state can be populated? Justify your answer.

   $[2]$

   f) How do you take the phosphorescence spectrum of a flurophore in a spectrofluorimeter?

   $[1]$

   g) The radiative lifetime and fluorescence quantum yield of 1-iodonaphthalene are 7 ns and 0.70 respectively. Calculate the actual fluorescence lifetime of the molecule. Ignoring the rate constant of intersystem crossing from triplet (T_1) to Singlet (S_0) state compared to the rate constant of phosphorescence, calculate the rate constant of intersystem crossing from singlet (S_1) to triplet (T_1) state. $[2]$

   h) In an isomerisation process from cis-stilbene to trans stilbene what will be the structural feature of the absorption and emission spectra? $[1]$

2. a) Establish the relation between Einstein coefficient of spontaneous emission and stimulated emission for a non-degenerate system. Show that for non-degenerate system coefficient of absorption and stimulated emission are same. $[3]$

   b) Explain the laser action in a three level laser system with a suitable application in

case of a solid state laser. Give an example of a femtosecond solid state laser which can be tunable from visible to near IR region. [2 +1]

c) How will you determine the oscillator strength of $\pi \rightarrow \pi^*$ transition of different bands in anthracene experimentally? [2]

d) Distinguish between intrinsic and Weber's extrinsic fluorescence probes citing two examples of each category. [3]

e) Draw the structure of the flurophore, which is normally used as DNA binding agent. [1]

****** THE END******

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